VIETNAM STUDIES

U.S. Army Engineers 1965-1970

DEPARTMENT OF THE ARMY

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U.S. ARMY ENGINEERS
1965 - 1970

by

Major General Robert R. Ploger

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Foreword

The United States Army has met an unusually complex challenge in Southeast Asia. In conjunction with the other services, the Army has fought in support of a national policy of assisting an emerging nation to develop governmental processes of its own choosing, free of outside coercion. In addition to the usual problems of waging armed conflict, the assignment in Southeast Asia has required superimposing the immensely sophisticated tasks of a modern army upon an underdeveloped environment and adapting them to demands covering a wide spectrum. These involved helping to fulfill the basic needs of an agrarian population, dealing with the frustrations of antiguerrilla operations, and conducting conventional campaigns against well-trained and determined regular units.

As this assignment nears an end, the U.S. Army must prepare for other challenges that may lie ahead. While cognizant that history never repeats itself exactly and that no army ever profited from trying to meet a new challenge in terms of the old one, the Army nevertheless stands to benefit immensely from a study of its experience, its shortcomings no less than its achievements.

Aware that some years must elapse before the official histories will provide a detailed and objective analysis of the experience in Southeast Asia, we have sought a forum whereby some of the more salient aspects of that experience can be made available now. At the request of the Chief of Staff, a representative group of senior officers who served in important posts in Vietnam and who still carry a heavy burden of day-to-day responsibilities has prepared a series of monographs. These studies should be of great value in helping the Army develop future operational concepts while at the same time contributing to the historical record and providing the American public with an interim report on the performance of men and officers who have responded, as others have through our history, to exacting and trying demands.

The reader should be reminded that most of the writing was accomplished while the war in Vietnam was at its peak, and the monographs frequently refer to events of the past as if they were taking place in the present.

All monographs in the series are based primarily on official records, with additional material from published and unpublished secondary works, from debriefing reports and interviews with key participants, and from the personal experience of the author. To facilitate security clearance, annotation and detailed bibliography have been omitted from the published version; a fully documented account with bibliography is filed with the U.S. Army Center of Military History.

The author of this monograph brings to his subject a wide background of experience in combat engineering operations, construction, and staff planning. Major General Robert R. Ploger first held a position of major engineering significance in 1943–1945 as the staff engineer and commander of the engineer troop contingent, a combat battalion, for the 29th Infantry Division which was one of two U.S. assault divisions on OMAHA Beach in Normandy. Some twenty years later, upon being selected in 1966 as the command engineer in South Vietnam, he had successfu ly held command of every level of engineer troop formation fron. platoon through brigade. Aside from the construction aspects of combat engineering, he first developed competence in performance of formal large-scale construction as a key manager, 1950–1953, within the Okinawa Engineer District, which managed a $400 million base development program in the Ryukyu Islands. Later, immediately before proceeding to South Vietnam, he directed the New England Division of the Corps of Engineers where he had responsibility for flood and hurricane protection, water resource development, and military construction throughout the six New England states for the Chief of Engineers. General Ploger gained competence in staff planning through assignments to the War Department General Staff toward the end of World War II; to Japan Logistical Command for U.S. participation in the Korean War; and to Supreme Headquarters, Allied Powers Europe (SHAPE), 1958–1961, where he engaged in planning for physical facilities for the North Atlantic Treaty Organization (NATO). In August of 1967, Major General Ploger left his position as the head of one of the largest engineer commands in U.S. history to become the principal assistant to the Chief of Engineers in matters of topography and military engineering. In July 1970 he assumed the position of commander of the U.S. Army Engineer Center and Fort Belvoir. There he has directed the educational program for engineer officers and enlisted men of the Army and co-ordinated the development of engineer doctrine and its supporting training literature while commanding a major military installation of the United States Army. Significant to his appreciation of the inherent difficulties of operating in a country less advanced economically than the United States is that from 1961 to 1963 General Ploger studied international economics, contributing a thesis entitled Planning for Long Range Economic Development of Underdeveloped Nations.

Washington, D.C.
10 April 1973

VERNE L. BOWERS
Major General, USA
The Adjutant General

Preface

The story of the Army engineers in Vietnam is a chronicle of ingenuity and selflessly applied energy. To the combat infantryman, facing a treacherous and elusive enemy on successive operations in mud, paddy, swamp, or jungle, the engineer remained evanescent; but even though the infantryman seldom observed him, the engineer's efforts were evident in nearly every phase of military activity. In the path of the advance the engineer had ferreted out and destroyed enemy mines and tunnels. There were the clearings he had made in the jungle for passage and defense; the airfields, roads, and bridges for assembly and movement; and the base camps to return to, never as comfortable as desired yet somehow each one better than the last. There were supplies, the wherewithal to endure, to sustain strength, and to tangle with any enemy with confidence in machines, weapons, and support. All were made possible through the successful struggles of the engineer soldier and his officers against hostile forces of man and nature.

To write a monograph which does justice to the thousands of officers and enlisted men who forged the history of the U.S. Army engineers in Vietnam would be a life's work. I have sought here to provide a broad summary of the engineer's activities and contributions to the cause of independence and self-determination in the Republic of Vietnam. Of necessity, this study is concerned only with the years before 1970. Those achievements following the U.S. phase-down will constitute another story. There is also a need to chronicle the many thousand individual "war stories" that have emerged from the conflict. I urge each officer and soldier who feels himself or his organization in any sense slighted to move promptly to record those events which will clarify, correct, or extend this summary monograph. Every engineer commander and staff officer who felt pride in his organization or his work should give others an opportunity to share in that pride by writing articles of historical significance for the library of the Engineer School at Fort Belvoir, for the *Engineer* magazine, or for one of the several professional engineer publications.

I must confess that a great deal of the material contained herein reflects, albeit unintentionally, my personal attitudes, ideas, and concepts. Also, because of my personal involvement as engineer commander from September 1965 to August 1967, the events of those days perhaps receive undue emphasis and importance. The contributions of my successors speak for themselves, and whereas I am inclined to feel that no subject addressed after my departure had not been addressed previously, I recognize equally that the deeds of my successors merit far more notice than this text affords.

My duties as commanding officer of the U.S. Army Engineer Center and Fort Belvoir, Virginia, during the time this study was prepared naturally precluded the devotion of my undivided attention to the development of this history. I should, therefore, like to acknowledge the efforts of three enlisted members of my command whose research and editorial assistance were invaluable during the preparation of the manuscript: Specialists Five Terence S. Cooke and Richard K. May and Specialist Four Lawrence D. Cress. To the scores of individuals who offered their advice and suggestions during the research, and to Mrs. Doreen E. Marciniec, who found her way through all the confusion associated with typing the final draft, I extend my special appreciation.

One final comment is necessary. I personally have supported the United States' involvement in South Vietnam, as a soldier and also as an American. I believe unreservedly that the U.S. participation was right, timely, and well conducted by my military superiors and by most of my peers and subordinates. I have come to admire those South Vietnamese with whom I had contact, both as individuals and as a nationality. To those unthinking Americans who affect to view the South Vietnamese deprecatingly or who somehow consider a human being 12,000 miles away as less a human than his fellow American, I say try wearing his shoes for a while; the world is too small for any form of superciliousness.

Washington, D.C.
10 April 1973

ROBERT R. PLOGER
Major General, U.S. Army

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Coastal Lowlands
Highlands
Delta
Plateau

MAP 1

CHAPTER I

U.S. Army Engineers in 1965

The growing American commitment to the preservation of the Republic of Vietnam found its most dramatic manifestation in 1965 in the rapid manpower buildup carried out by the U.S. Army. The expanding involvement of the Army Engineer forces was more a reaction to the growing U.S. strength in Vietnam than the execution of a precisely drawn plan. From the time the first large contingent of Army engineer troops waded ashore at Cam Ranh Bay in June 1965, the demands upon the engineers were so immediate and overwhelming that their initial mission appeared impossible. At Cam Ranh the sand, the heat, tropical rains, and the incessant calls for engineer assistance all contributed to a discouraging situation, but the engineer troops there, as elsewhere in South Vietnam, were to establish themselves rapidly as formidable challengers of the impossible. In an amazingly short time they would change the face of a country, win the admiration and respect of those who depended upon them so heavily for support and facilities, and contribute substantially to the defense of the republic.

Beginning of the Troop Buildup

In January 1965 it was obvious that North Vietnam's immediate objective was a full-scale offensive aimed at cutting South Vietnam in two and capturing the local and district centers of government. If successful such a move would place the Saigon government in jeopardy and might give Hanoi its long-sought total victory. The United States responded to the urgency of the situation by deploying forces to the extent necessary to thwart any hopes Hanoi might entertain for an easy and immediate victory in the south.

The United States military commitment in South Vietnam in January 1965 consisted of about 23,000 men of whom fewer than a hundred were Army engineer troops. This force, the United States Military Assistance Command, Vietnam (MACV), consisted of a substantial number of U.S. advisers with South Vietnamese units, Army and Marine Corps helicopter units with their necessary logistic support, the 5th U.S. Special Forces Group, seven Air Force squadrons, a Navy headquarters command in Saigon, and an office of the Navy's Bureau of Yards and Docks whose function it was to supervise civilian contractor construction support to the various U.S. military elements in Vietnam. The civilian contractors alone, however, could not be expected to cope with a dangerously deteriorating military situation and the rapid influx of U.S. Army forces.

Initial deployment of U.S. ground combat forces took place in early March of 1965 when marines of the 9th Marine Expeditionary Brigade, later redesignated the III Marine Amphibious Force, landed at Da Nang and took up defensive positions in the very vulnerable northern provinces of South Vietnam. The 173d Airborne Brigade was airlifted from Okinawa to Bien Hoa on 5 May to relieve South Vietnamese Army forces of some of their security responsibilities and to free them for missions designed to search out and destroy threatening forces. With the growth in tactical responsibilities of U.S. forces in 1965, more combat and logistical support units became necessary.

Late in 1964 General William C. Westmoreland as the senior U.S. commander in South Vietnam had recommended to the U.S. Joint Chiefs of Staff the deployment of an Army Engineer group and a logistical command to South Vietnam. Although the need for a sound logistical base and more extensive U.S. support facilities was foreseen as early as 1962, resources for them had not been provided at the time. The Joint Chiefs approved General Westmoreland's request, noting that a "military capability was needed to supplement that of the construction contractor and to respond to a critical need for military engineers to accomplish work unsuitable for the contractor." On 15 January 1965 the request was forwarded to Secretary of Defense Robert S. McNamara, who turned it down after a task force visited South Vietnam in February. Instead, he approved deployment to Vietnam of 38 logistical planners and 37 operating personnel. General Westmoreland had requested 3,800 logistical troops and 2,400 engineers.

The director of the Pacific division of the Bureau of Yards and Docks, a naval officer, had stated that the contractor's "mobilization and rate of construction accomplishment can and will be promptly expanded as required by further program expansion." At that time, however, the potential extent of "further program expansion" was unknown. It was soon to become all too apparent that a critical gap with regard to engineer resources existed in contingency planning for the buildup of U.S. forces.

Early planning for the buildup and operations in Vietnam had little more to go on than tentative indications of the number of maneuver battalions that might be deployed. There was no generally accepted tactical concept, campaign plan, or scheme of logistic support upon which effective engineer planning could be based. In fact, subsequent difficulties tended to confirm that there had been a remarkable lack of appreciation of the amount of engineer effort required to support deployments of the scale being considered in early 1965. The myriad factors to be considered in planning for any one of the hundreds of engineer tasks to be performed made the planning process much more complex than most commanders who were not engineers realized. The essence of engineer planning involves a series of evaluations, improvisations, and compromises which, when given proper attention, produce comprehensive and effective engineer support.

The most immediate consideration in any construction planning is the selection of the site, its preparation, and its development. Next, material and manpower requirements have to be studied with respect to the type of facilities to be constructed. Methods and particular techniques to be employed in construction are determined. Various options in design are considered and the choice is made on the basis of utility and materials available. Most important of all, requests have to be fed into supply channels to insure timely and sequential delivery of construction materials to the site in order that the project can be completed within the time allotted. The size and scope of the initial engineer work load in South Vietnam caused inevitable shortcuts in the planning process at various levels resulting in equally inevitable delays and complications in execution.

Convincing the Department of the Army staff, the Joint Chiefs of Staff, and Department of Defense officials that engineering requirements had expanded was made more difficult by the normal tendency of these organizations to wait for the statements of requirements sent in by the overseas commanders. These commanders, however, were ill prepared to make such crash estimates because they lacked enough qualified staff engineers. Indicative of the problem was the fact that the U.S. Army Support Command, Vietnam, the predecessor of both the 1st Logistical Command and Headquarters, U.S. Army, Vietnam, had only a very small number of engineers in the country. The assigned engineers had been committed primarily for maintenance of facilities in support of the advisory groups and for minor construction projects for the Army aviation units that were already engaged in supporting South Vietnamese forces.

The engineers in Vietnam worked hard to assemble a reasonably valid Army base development plan and construction program before the arrival of the first major engineer contingents. But force levels, tactical concepts, and stationing plans were so tenuous that precise long-range planning was impossible. Only through ingenuity and a good bit of scrounging were some materials made available to the first engineer units to arrive in Vietnam.

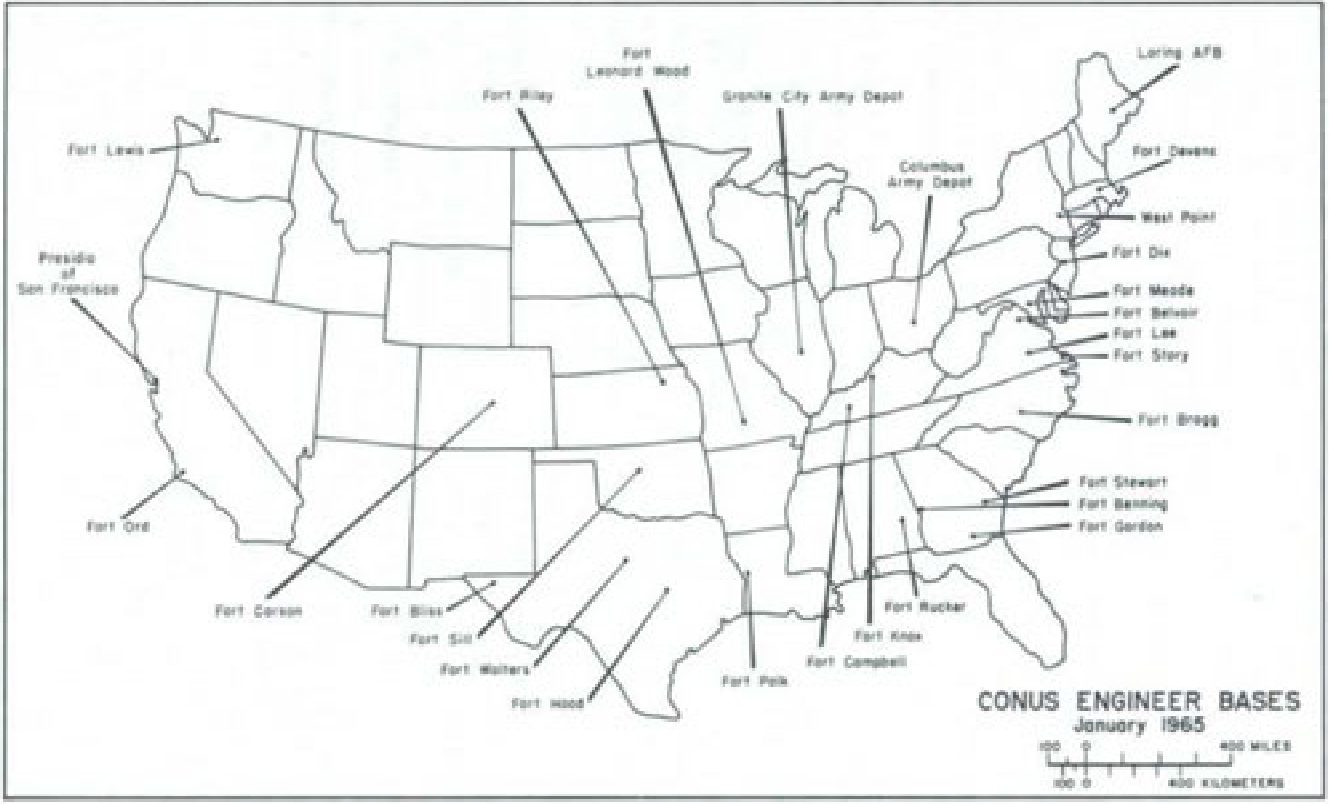
Expansion of the Training Base

Throughout the spring and early summer of 1965 it was generally assumed both within the Department of the Army staff and at Headquarters, United States Continental Army Command, that any augmentation of the Army force structure would include at least a partial call-up of Reserve component units and men. As late as 22 July 1965 in a briefing to a conference of selected Army commanders, Major General Michael S. Davison, Acting Assistant Chief of Staff for Force Development, reported that on 16 July the Department of the Army had received tentative guidance which authorized an increase of 350,000 in the strength of the Army by the end of fiscal year 1966 (30 June 1967). Of this number, 100,000 spaces were to be filled by members of Reserve components.

Contingency plans for a manpower buildup in the Department of the Army contained the proposed call-up of Reserve components and men for a period not to exceed twelve months. Based upon experience gained during a partial mobilization in 1961, Continental Army Command plans had called for an even larger two-year activation of Reserve component units. Experience had shown that Reserve units could be readied for deployment overseas much more quickly than could reorganized or newly activated units in the active Army. It was the contention of Continental Army Command that approximately seven months lead time was required to prepare Reserve units for relief from active duty, and that so much lead time tended to defeat the effectiveness of an activation of only twelve months. Policies set at higher levels, however, prohibited Reserve call-ups of a duration greater than one year, and consequently Continental Army Command's plan could not be supported.

In any event all such plans were rendered useless on 28 July 1965. On that date in a nationally televised press conference, President Lyndon B. Johnson announced plans for the buildup of U.S. forces in South Vietnam. U.S. combat forces in Vietnam would be increased immediately to 125,000 men, with additional forces to be deployed as necessary. This increase was to be accomplished, the President went on to say, through expansion of the active Army by increased draft calls, but no Reserve units or individuals were to be called up.

Since major planning policies for expanded U.S. activity in Southeast Asia had been based on the now fallacious assumption that a significant proportion of the necessary manpower would come


CONUS ENGINEER BASES
January 1965
100 0 400 MILES
100 0 400 KILOMETERS
Fort Lewis
Presidio of San Francisco
Fort Ord
Fort Carson
Fort Bliss
Fort Sill
Fort Wolters
Fort Hood
Fort Riley
Fort Leonard Wood
Granite City Army Depot
Columbus Army Depot
Fort Polk
Fort Campbell
Fort Knox
Fort Rucker
Loring AFB
Fort Devens
West Point
Fort Dix
Fort Meade
Fort Belvoir
Fort Lee
Fort Story
Fort Bragg
Fort Stewart
Fort Benning
Fort Gordon

MAP 2

from Reserve components, the stage was set for shortages not only of units but also of men with technical training and managerial ability. In the understandable desire to maximize its readiness to fight, the Army tries to retain a high proportion of combat formations in its active forces in peacetime. The cost is always a shortage of ready-to-go support units, including engineers. Major General Thomas J. Hayes III described the situation when he observed that "supporting units seem to bear more than their share of losses as a Nation progressively reduces its Armed Forces in the years between wars." After the Korean War many military activities were turned over to civilians in the United States and the military establishment became more and more dependent on the Reserves for the majority of Army combat support units as well as technicians required for wartime operations.

Suddenly deprived of their anticipated reservoir of trained and skilled manpower, the services in varying degrees experienced difficulty in meeting initial and subsequent requirements for logistic and combat support troops and units. The Army was hit hardest of all. Its strength requirements increased rapidly, and with already critical deficiencies in the support units the decision not to mobilize the Reserves or to allow selective call-up of experienced men led the Army to draw necessary men from other theaters. New units were later activated in the United States and soon after sent to South Vietnam; the peak of the engineer buildup was reached in January of 1968. *(Map 2, Charts 1 and 2)*

Since nearly half the Army's engineers and engineer equipment rested with Reserve components, equipment in the early stages of expansion had to be gathered from Reserve units all over the country to outfit fully those Regular Army units alerted for Vietnam. Crash training programs, intensive recruitment of civil service employees, reduction of stateside and European tours of duty, and volunteer programs were initiated to help fill immediate manpower needs. When these programs failed to meet the demands, the Army began to place officers of its other branches on detail in the Corps of Engineers.

The Army had to expand its training base to provide the troops necessary to meet Vietnam deployment schedules as well as to satisfy the worldwide requirements for individual replacements in accordance with the Army's rotational overseas service policy. The U.S. Continental Army Command had the responsibility for shipping entire units as well as individual replacements to Vietnam and at the same time maintaining an adequate strategic Army force and training base in the United States.

The Continental Army Command's principal centers for engi-

CHART 1—LOCATION OF ENGINEER UNITS IN THE UNITED STATES, JANUARY 1965

Fort Belvoir, Virginia
- 21st Engineer Company (Map)
- 30th Engineer Battalion (Topography)
- 38th Engineer Detachment (Well Drilling)
- 60th Engineer Detachment (Special Equipment Maintenance)
- 67th Engineer Detachment (General)
- 73d Engineer Company (Construction Support)
- 80th Engineer Detachment (Forestry)
- 81st Engineer Detachment (Forestry)
- 87th Engineer Battalion (Construction)
- 91st Engineer Battalion (Combat)
- 99th Engineer Company (Topography)
- 100th Engineer Company (Float Bridge)
- 156th Engineer Detachment (Well Drilling)
- 171st Engineer Detachment (Well Drilling)
- 497th Engineer Company (Port Construction)
- 514th Engineer Detachment (Chemical)
- 518th Engineer Detachment (General)
- 521st Engineer Detachment (Water Tank)
- 523d Engineer Detachment (Topography)
- 536th Engineer Platoon (Port Construction)
- 537th Engineer Company (Topography)
- 540th Engineer Detachment (Special Equipment Maintenance)
- 547th Engineer Detachment (Map)
- 565th Engineer Detachment (Water Tank)
- 569th Engineer Detachment (Water Tank)
- 573d Engineer Detachment (Water Tank)
- 581st Engineer Company (Maintenance, Direct Support)
- 585th Engineer Company (Dump Truck)
- 588th Engineer Detachment (Well Drilling)
- 610th Engineer Detachment (Construction)

Fort Benning, Georgia
- 2d Engineer Battalion (Divisional)
- 36th Engineer Detachment (Water Purification)
- 544th Engineer Detachment (Utility)
- 586th Engineer Company (Float Bridge)

Fort Bliss, Texas
- 42d Engineer Detachment (Field Maintenance)
- 82d Engineer Detachment (Field Maintenance)
- 31st Engineer Battalion (Combat)
- 630th Engineer Company (Light Equipment)

CHART 1—LOCATION OF ENGINEER UNITS IN THE UNITED STATES, JANUARY 1965—Continued

Fort Bragg, North Carolina
- 14th Engineer Battalion (Combat)
- 14th Engineer Detachment (Water Purification)
- 64th Engineer Company (Maintenance, Direct Support)
- 66th Engineer Company (Topography)
- 82d Engineer Company (Supply)
- 86th Engineer Detachment (Utility)
- 102d Engineer Company (Construction Support)
- 159th Engineer Group (Construction)
- 500th Engineer Company (Panel Bridge)
- 501st Engineer Company (Supply)
- 508th Engineer Detachment (Utility)
- 517th Engineer Detachment (Terrain)
- 533d Engineer Detachment (Intelligence)
- 534th Engineer Detachment (Intelligence)
- 535th Engineer Detachment (Intelligence)
- 568th Engineer Detachment (Water Tank)
- 573d Engineer Company (Float Bridge)

Fort Campbell, Kentucky
- 27th Engineer Battalion (Combat)
- 39th Engineer Battalion (Combat)
- 46th Engineer Detachment (Utility)
- 70th Engineer Battalion (Combat)
- 326th Engineer Battalion (Airborne)
- 511th Engineer Company (Panel Bridge)
- 553d Engineer Company (Float Bridge)
- 572d Engineer Company (Light Equipment)
- 597th Engineer Company (Maintenance, Direct Support)
- 937th Engineer Group (Combat)

Fort Carson, Colorado
- 7th Engineer Battalion (Divisional)

Columbus Army Depot, Ohio
- 141st Engineer Detachment (Parts)
- 142d Engineer Detachment (Parts)

Fort Devens, Massachusetts
- 20th Engineer Battalion (Combat)
- 507th Engineer Detachment (Utility)
- 553d Engineer Detachment (Utility)

Fort Dix, New Jersey
- 86th Engineer Battalion (Combat)

Fort Gordon, Georgia
- 299th Engineer Battalion (Combat)

CHART 1—LOCATION OF ENGINEER UNITS IN THE UNITED STATES, JANUARY 1965—Continued

Granite City Army Depot, Illinois
- 185th Engineer Company (Highway Maintenance)
- 273d Engineer Detachment (General Support)
- 512th Engineer Detachment (General Support)
- 513th Engineer Detachment (General Support)
- 574th Engineer Company (Depot)
- 593d Engineer Group (Maintenance)

Fort Hood, Texas
- 16th Engineer Battalion (Combat)
- 17th Engineer Battalion (Combat)
- 542d Engineer Detachment (Special Equipment Maintenance)
- 567th Engineer Detachment (Water Transport)
- 569th Engineer Company (Topography)

Fort Knox, Kentucky
- 522d Engineer Company (Armor)

Fort Lee, Virginia
- 76th Engineer Company (Maintenance, Direct Support)
- 329th Engineer Detachment (Utility)
- 362d Engineer Company (Light Equipment)
- 526th Engineer Detachment (Utility)
- 588th Engineer Battalion (Combat)

Fort Lewis, Washington
- 4th Engineer Battalion (Divisional)
- 178th Engineer Company (Maintenance, Direct Support)
- 504th Engineer Detachment (Field Maintenance)
- 543d Engineer Detachment (Field Maintenance)
- 549th Engineer Detachment (Special Equipment Maintenance)
- 554th Engineer Company (Float Bridge)
- 557th Engineer Company (Light Equipment)
- 617th Engineer Company (Panel Bridge)
- 905th Engineer Detachment (Water Purification)

Loring Air Force Base, Maine
- 628th Engineer Detachment (Field Maintenance)

Fort Meade, Maryland
- 19th Engineer Battalion (Combat)

Fort Ord, California
- 59th Engineer Company (Armor)

Fort Polk, Louisiana
- 168th Engineer Battalion (Combat)
- 578th Engineer Company (Maintenance, Direct Support)

Presidio of San Francisco, California
- 510th Engineer Detachment (Utility)

CHART 1—LOCATION OF ENGINEER UNITS IN THE UNITED STATES, JANUARY 1965—Continued

Fort Riley, Kansas
- 1st Engineer Battalion (Divisional)
- 509th Engineer Company (Panel Bridge)
- 593d Engineer Detachment (Fire Fighting)

Fort Rucker, Alabama
- 92d Engineer Battalion (Construction)

Fort Sill, Oklahoma
- 593d Engineer Company (Construction)

Fort Stewart, Georgia
- 169th Engineer Battalion (Construction)

Fort Story, Virginia
- 2d Engineer Amphibious Support Company
- 560th Engineer Amphibious Equipment Company
- 793d Engineer Amphibious Equipment Company

West Point, New York
- 6th Engineer Battalion (Combat)
- 50th Engineer Company (Construction)

Fort Wolters, Texas
- 697th Engineer Company (Pipeline)

Fort Leonard Wood, Missouri
- 31st Engineer Detachment (Field Maintenance)
- 46th Engineer Battalion (Construction)
- 62d Engineer Battalion (Construction)
- 63d Engineer Detachment (Field Maintenance)
- 103d Engineer Company (Construction Support)
- 520th Engineer Company (Maintenance, Direct Support)
- 582d Engineer Detachment (Field Maintenance)
- 643d Engineer Company (Pipeline)
- 921st Engineer Group (Headquarters and Headquarters Company)

CHART 2—ENGINEER UNITS ON ACTIVE DUTY, CONTINENTAL UNITED STATES, JULY 1965

Engineer Group Headquarters
- 159th Engineer Group [1]
- 921st Engineer Group
- 937th Engineer Group [1]

Combat Engineer
- 1st Engineer Battalion [1]
- 2d Engineer Battalion
- 4th Engineer Battalion [1]

Chart 2—Engineer Units on Active Duty, Continental United States, July 1965—Continued

- 7th Engineer Battalion (–) [1]
- 14th Engineer Battalion [1]
- 16th Engineer Battalion
- 17th Engineer Battalion
- 19th Engineer Battalion [1]
- 20th Engineer Battalion [1]
- 27th Engineer Battalion [1]
- 31st Engineer Battalion [1]
- 39th Engineer Battalion [1]
- 70th Engineer Battalion [1]
- 86th Engineer Battalion [1]
- 91st Engineer Battalion
- 169th Engineer Battalion [1]
- 186th Engineer Battalion [1]
- 299th Engineer Battalion [1]
- 326th Engineer Battalion [1]
- 588th Engineer Battalion [1]
- 59th Engineer Company (Armored)
- 522d Engineer Company (Armored)

Construction Engineer
- 46th Engineer Battalion [1]
- 62d Engineer Battalion [1]
- 87th Engineer Battalion [1]
- 92d Engineer Battalion [1]
- 50th Engineer Company
- 593d Engineer Company
- 610th Engineer Detachment

Float Bridge
- 100th Engineer Company [1]
- 553d Engineer Company [1]
- 554th Engineer Company [1]
- 573d Engineer Company [1]
- 586th Engineer Company

Panel Bridge
- 500th Engineer Company [1]
- 509th Engineer Company [1]
- 511th Engineer Company [1]
- 617th Engineer Company [1]

Light Equipment
- 362d Engineer Company [1]
- 557th Engineer Company [1]

CHART 2—ENGINEER UNITS ON ACTIVE DUTY, CONTINENTAL UNITED STATES, JULY 1965—Continued

572d Engineer Company [1]
630th Engineer Company [1]

Construction Support
73d Engineer Company [1]
82d Engineer Company
102d Engineer Company [1]
103d Engineer Company [1]
501st Engineer Company
643d Engineer Company [1]

Map Depot
547th Engineer Platoon [1]

Base Photo Map
21st Engineer Company

Engineer Utility
46th Engineer Detachment [1]
86th Engineer Detachment [1]
329th Engineer Detachment [1]
507th Engineer Detachment [1]
508th Engineer Detachment [1]
510th Engineer Detachment [1]
526th Engineer Detachment [1]
544th Engineer Detachment [1]
553d Engineer Detachment [1]

Engineer Dump Truck
585th Engineer Company [1]

Engineer Pipeline
697th Engineer Company

Water Transport
567th Engineer Detachment [1]
568th Engineer Detachment [1]

Well Drilling
38th Engineer Detachment [1]
156th Engineer Detachment [1]
171st Engineer Detachment [1]
588th Engineer Detachment [1]

Engineer Heavy Maintenance [2]
185th Engineer Company

Engineer Maintenance and Support Group Headquarters
593d Engineer Group

Direct Support Maintenance
64th Engineer Company
76th Engineer Company

CHART 2—ENGINEER UNITS ON ACTIVE DUTY, CONTINENTAL UNITED STATES, JULY 1965—Continued

- 178th Engineer Company [1]
- 520th Engineer Company
- 578th Engineer Company
- 581st Engineer Company
- 597th Engineer Company

Field Maintenance
- 31st Engineer Detachment
- 42d Engineer Detachment
- 63d Engineer Detachment
- 82d Engineer Detachment
- 504th Engineer Detachment
- 520th Engineer Detachment
- 543d Engineer Detachment
- 628th Engineer Detachment

Special Equipment Maintenance
- 60th Engineer Detachment [1]
- 540th Engineer Detachment
- 542d Engineer Detachment
- 549th Engineer Detachment

Depot
- 574th Engineer Detachment

Amphibious
- 2d Engineer Amphibious Support Company
- 560th Engineer Equipment Company
- 793d Engineer Equipment Company

General Support
- 273d Engineer Detachment [1]
- 512th Engineer Detachment
- 513th Engineer Detachment [1]

Parts
- 141st Engineer Detachment [1]
- 142d Engineer Detachment [1]

Firefighting
- 582d Engineer Detachment
- 593d Engineer Detachment

Forestry
- 80th Engineer Detachment [1]
- 81st Engineer Detachment [1]

Water Purification
- 14th Engineer Detachment [1]
- 36th Engineer Detachment [1]
- 905th Engineer Detachment [1]

Port Construction
- 497th Engineer Company [1]
- 536th Engineer Detachment [1]

Water Tank
- 521st Engineer Detachment [1]
- 565th Engineer Detachment [1]
- 569th Engineer Detachment [1]
- 573d Engineer Detachment [1]

Gas Generator
- 67th Engineer Detachment [1]
- 518th Engineer Detachment [1]

Carbon Dioxide Generator
- 514th Engineer Detachment [1]

Topographic
- 30th Engineer Battalion
- 66th Engineer Company [1]
- 569th Engineer Company [1]

Base Survey
- 537th Engineer Company

Reproduction Base
- 99th Engineer Company

Geodetic Survey
- 523d Engineer Detachment

Terrain
- 517th Engineer Detachment [1]

Technical Intelligence Research
- 533d Engineer Detachment
- 534th Engineer Detachment
- 535th Engineer Detachment

[1] Deployed to South Vietnam before January 1968.

[2] The functions of engineer equipment maintenance were reassigned by the Army to Ordnance Corps carrier units in 1965. Consequently few engineer maintenance units were sent to South Vietnam. Most provided personnel fillers and were soon inactivated.

neer training were Fort Leonard Wood, Missouri, and Fort Belvoir, Virginia. Like other Army training centers, their operations and training programs had been greatly curtailed during the years after Korea. Now their facilities would again undergo a tremendous expansion within a very short time. It is a tribute to the command's flexibility and responsiveness that the manpower crisis was met; the 235,000-man increase in Army strength had been absorbed by Continental Army Command by 20 June 1966.

Within the Army engineer troop structure, the major problems in the expansion of U.S. efforts in South Vietnam arose from shortages of men, equipment, and materials. The proportion of Engineer units in the active Army before the buildup promised to be woefully inadequate. In a situation in which most equipment had to be bought through a time-consuming procedure of competitive procurement, availability of equipment was the deciding factor not only in the activation of new units within the continental United States but also in establishing dates for unit readiness. Since there were critical shortages of technically trained officers and certain enlisted specialists such as equipment operators and maintenance men, new recruits in steadily rising numbers were funneled into the advanced individual training facilities at Forts Leonard Wood and Belvoir to be schooled in basic engineering skills.

When increased draft calls and a related jump in enlistments raised the number of men to be trained beyond the capacity of the existing training base, new programs had to be instituted. To bring units to full strength as soon as possible as well as to relieve some of the stress on normal training facilities, Strategic Army Forces units were assigned some of the responsibility for training recruits under what was known as the "train and retain as permanent party" system. Under this program a specialized unit could train men to fill particular positions in the unit with the prospect of keeping them to alleviate its own shortages. Because of the diversity of engineer training, however, this program was of limited usefulness in bringing engineer units to full capability, particularly in the face of equipment shortages within units as they underwent training. The relatively slow rate at which new men could be trained and made available through established training bases presented a particularly acute problem to new diverse engineer units demanding a high degree of technical expertise. *(Table 1)*

A most serious problem was the shortage among enlisted men of qualified noncommissioned officers. Throughout the process of recruit training, stress was placed on the development of leadership qualities as well as technical proficiency. Those individuals who demonstrated talent for leadership were singled out early in their training cycles and given opportunities to qualify for advancement to positions of greater responsibility through assignment to a noncommissioned officer academy or an officer candidate school. Since there was a critical need to develop noncommissioned officers rapidly and continuously, academies were organized to produce competent noncoms in much the same way as the officer candidate schools produced second lieutenants. Forts Leonard Wood and Belvoir conducted courses designed to instruct new noncommissioned officers in leadership principles and to improve their technical proficiency before they were sent to Vietnam. Some of these men became of further value to the Army by returning from service

TABLE 1—ENGINEER OFFICER AND ENLISTED SPECIAL SKILLS REQUIRED AND AVAILABLE IN NONDIVISIONAL UNITS IN SOUTH VIETNAM, JANUARY 1968

Engineer Officer Requirements, U.S. Army, Vietnam

Grade	Required	Operational
Colonel	29	26
Lieutenant Colonel	119	110
Major	253	186
Captain	755	278
Lieutenant	1,056	1,247
Warrant Officer	141	107
Total	2,353	1,954

Engineer Enlisted Military Occupational Specialties (MOS)
U.S. Army, Vietnam

MOS	Title	Authorized	Operational
12A10 *	Pioneer	2,281	4,078
12B20	Combat Engineer	3,465	2,754
12B2N	Combat Engineer	0	13
12B30	Combat Engineer	939	534
12B40	Combat Engineer	1,739	1,085
12B4N	Combat Engineer	0	34
12B50	Combat Engineer	27	19
12C20	Bridge Specialist	835	656
12C30	Bridge Specialist	0	24
12C40	Bridge Specialist	220	207
12C50	Bridge Specialist	1	1
12D40	Combat Engineer Operations and Intelligence NCO	24	12
12D50	Combat Engineer Operations and Intelligence NCO	4	3

12Z50	Combat Engineer Senior Sergeant	157	139
51A10 *	Construction and Utilities Specialist	837	416
51B20 *	Carpenter	1,588	1,999
51C20	Structures Specialist	158	63
51C30	Structures Specialist	111	55
51D20	Mason	187	147
51E20	Camouflage Specialist	0	4
51E40	Camouflage Specialist	2	1
51F20	Pipeline Specialist	56	30
51F40	Pipeline Specialist	66	26
51F50	Pipeline Specialist	7	1
51G20	Soils Analyst	63	56
51H40	Construction Foreman	557	380
51H50	Construction Foreman	125	109
51H20	Heating and Ventilation Specialist	21	12
51F30	Heating and Ventilation Specialist	16	10
51K20	Plumber	653	462
51L20 *	Refrigeration Specialist	199	199
51M20	Firefighter	378	338
51M40	Firefighter	114	61
51N20 *	Water Supply Specialist	464	497
51N40	Water Supply Specialist	103	73
51N50	Water Supply Specialist	1	0
51O20	Utilities Foreman	74	82
51P40	Terrain Analyst	34	17
52A10	Powerman	404	79
52B20 *	Power Operator and Mechanic	938	1,004
52B30	Power Operator and Mechanic	404	222
52C20	Power Pack Specialist	77	15
52D20	Power Generator Repairman	242	134
52D40	Power Generator Repairman	22	22

TABLE 1—ENGINEER OFFICER AND ENLISTED SPECIAL SKILLS REQUIRED AND AVAILABLE IN NONDIVISIONAL UNITS IN SOUTH VIETNAM, JANUARY 1968—Continued

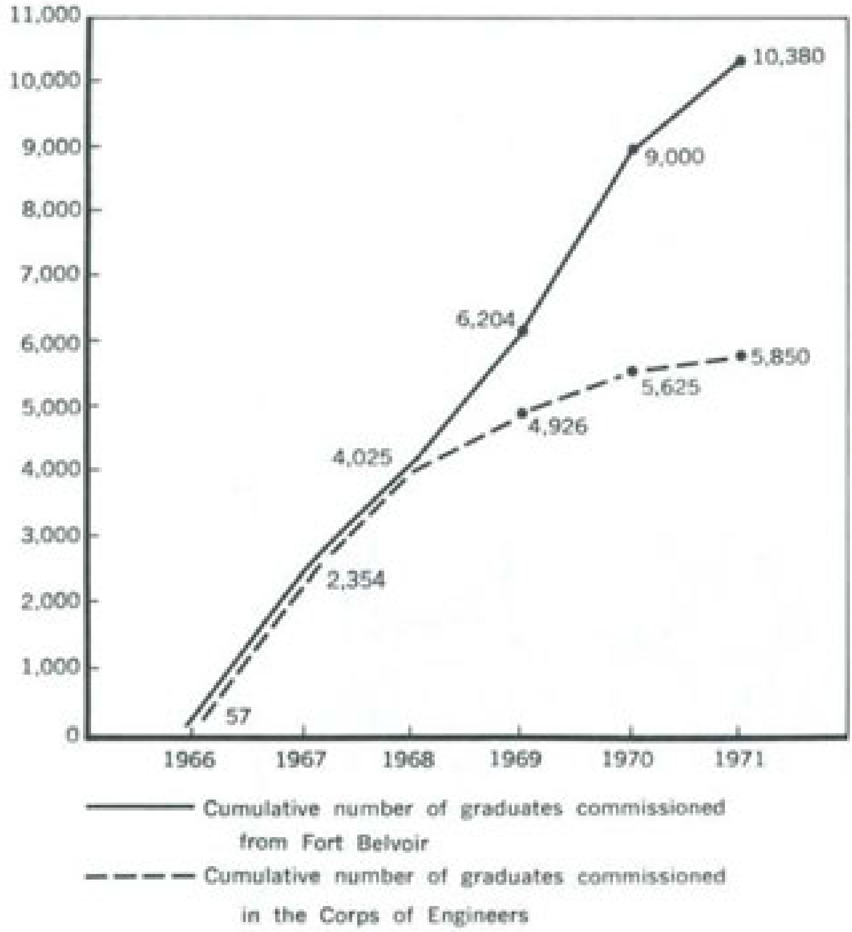
Engineer Enlisted Military Occupational Specialties (MOS)
U.S. Army, Vietnam

MOS	Title	Authorized	Operational
52E20	Power Station Operator	20	8
52E40	Power Station Operator	6	7
52F20	Electrician	698	479
52G20	High Voltage Electrician	0	2
53B20	Oxygen and Acetylene Production Specialist	75	45
53B40	Oxygen and Acetylene Production Specialist	3	0
53C20	Carbon Dioxide Production Specialist	14	5
53C40	Carbon Dioxide Production Specialist	6	0
62A10	Engineer Equipment Assistant	1,543	838
62B10 [a]	Engineer Equipment Repairman	1,313	1,773
62B30	Engineer Equipment Repairman	686	838
62B40	Engineer Equipment Repairman	42	41
62C20	Engineer Missile Equipment Specialist	8	50
62C30	Engineer Missile Equipment Specialist	10	13
62C40	Engineer Missile Equipment Specialist	7	13
62D20 [a]	Surfacing Equipment Specialist	347	395
62D40	Surfacing Equipment Specialist	40	30
62E20 [a]	Construction Machine Operator	3,915	4,715
62E30	Construction Machine Operator	596	284
62E40	Construction Machine Operator	460	452
62E50	Construction Machine Operator	30	12
62F20 [a]	Crane Shovel Operator	131	604
62F30	Crane Shovel Operator	813	394
62G20 [a]	Quarryman	396	421

62G30	Quarryman	566	21
62G40	Quarryman	27	29
81A10	General Draftsman	158	113
81B20 [a]	Construction Draftsman	186	231
81B40	Construction Draftsman	6	6
81C20 [a]	Cartographic Draftsman	80	66
81C40	Cartographic Draftsman	7	3
81C50	Cartographic Draftsman	4	2
81D20 [a]	Map Compiler	6	7
81D30	Map Compiler	12	4
81D40	Map Compiler	6	5
81F20	Illustrator	23	41
81F40	Model Maker	0	2
82A10	Rodman and Tapeman	117	10
82A20	Construction Surveyor	142	178
82B40	Construction Surveyor	22	9
82D20 [a]	Topographic Surveyor	24	38
82D40	Topographic Surveyor	8	7
82E20	Topographic Computer	14	16
82E40	Topographic Computer	2	3
Total		30,162	28,284

[a] Military occupational specialties for which advanced individual training was provided during 1965–1970.

CHART 3—GRADUATES OF OFFICER CANDIDATE SCHOOL AT FORT BELVOIR, CUMULATIVE OUTPUT, 1966–1971



in Vietnam and teaching new recruits, but many at the conclusion of two years of draft service took with them to civilian life their Army-developed skills and experience.

The expansion of the officer candidate school system provides one of the more easily chronicled examples of the race between requirements and resources in the period of troop buildup. In the spring of 1965 the dearth of junior engineer officers was even more critical than that of noncommissioned officers. In response to this urgent need for new leadership talent, the Engineer Officer Candidate School at Fort Belvoir was reactivated in the fall of 1965. The first class began on 15 November, and by 30 June 1966, 1,132 junior engineer officer graduates had been commissioned. The number climbed steadily and when the school at Fort Belvoir closed on 1 January 1971 it had graduated a total of 10,380 second lieutenants, not all of whom entered the Corps of Engineers. *(Chart 3)*

Because the engineers lacked the manpower base in the active Army at the beginning of the troop buildup and because the facilities for engineer recruit training were largely limited to two posts, units going to South Vietnam during the first year of the buildup proved short of engineer experience and skills. But the engineers' reputation for resourcefulness and determination which became their trademark in Vietnam had its beginning in their preparations for deployment. The professional Engineer Corps commanders at all levels continuously strove to bring newly activated or reorganized units to an acceptable degree of readiness in spite of compressed training times and frequently in the face of understrength cadres and equipment shortages.

The first contingent of U.S. Army engineers in Vietnam faced the challenge of developing a base of support activities in a combat zone with a logistical backup consisting of a single source of supplies at a distance of nine to twelve thousand miles across the Pacific Ocean. When the decision was made in 1965 to expand the role of the United States in the defense of the Republic of Vietnam, it was apparent at once that a large complex of airfields, roads, ports, pipelines, storage facilities, and cantonments to support tactical operations would be needed. And soon after he arrived in South Vietnam the engineer soldier—enlisted man or officer—realized that he was essential to the total effort. His sense of purpose and his ability to improvise with whatever materials could be scraped together quickly made him indispensable.

CHAPTER II

Preparations for Engineer Operations in Vietnam

As the number of American advisers and the amount of technical aid to Vietnam increased, commands at Pentagon and Pacific theater level as well as small advisory detachments already in Vietnam prepared contingency plans against a substantial troop buildup in Southeast Asia. The purpose of the planning, a routine military practice, was to establish an adequate base from which realistic detailed planning could proceed. Operational concepts stating numerous alternatives were prepared, as were programs for expanding logistical support throughout the area. Obstacles that might become decisive factors in operational planning were described and assessed.

A construction program developed by the staff of the Commander in Chief, Pacific, during 1964 called for the use of tents from D-day to D plus six months, except for hospitals, and a minimum of temporary or emergency facilities to be constructed for extending the established mission beyond D plus six months. Provisions were made for the forecast troop effort to be managed first by the Army command in the Ryukyu Islands, then by a logistical command, which was to be cadred from the resources of the U.S. Army Support Command already in South Vietnam. Construction before D-day was to be financed under the normal peacetime procedures of the Military Construction, Army, program. Anticipating a change after combat operations began, the plan left post-D-day construction programming and funding to the discretion of the Department of the Army. The existence of civilian contractors in Vietnam was noted, but they were not expected to furnish a significant amount of military construction.

In spite of this initial stab at preparatory planning, few authorities were willing to address the subject of engineer support prior to a national commitment. No commander wished to prescribe the investment of hundreds of millions of dollars in supplies alone without a clear mandate. Unfortunately, this unwillingness resulted in almost unavoidable planning inadequacies, especially in long-range building programs.

Planners estimated correctly that the Vietnamese economy was incapable of providing the construction material necessary to support U.S. troops, but failed to give adequate consideration to the severely limited port capacities in South Vietnam. Plans for port facilities to receive the massive shipments of supplies and equipment necessary to sustain a large military buildup were not fully developed before the initial deployment of American troops.

One reason for the lack of planning for port facilities can be credited to the numbers of American troops finally sent to Vietnam and the timing of their arrival. Early contingency plans called for rapid movement of the majority of American fighting forces (a number much smaller than that finally sent to Vietnam) within a period of sixty to ninety days. The decision to deploy troops gradually and in numbers far exceeding original estimates invalidated much of the work done by planners.

Financing procedures mentioned in the contingency plans echoed preliminary experience from military deployments of the recent past. It was expected that military construction funds, which had been in use in Vietnam since American advisers first arrived there, would be used until the deployment of American troops began in earnest. Thereafter, complete flexibility in the use of all military funds was anticipated. The planners had no way of knowing that there would be no national mobilization for the war effort. Resistance in Congress to large budgetary requests for construction funds without specific statements of purpose and destination pushed the rigid peacetime accounting system of the Military Construction, Army, program into the war zone. The needs of the construction program in Vietnam and the requirements of the accounting system plagued Army engineers during some of the early and most critical periods of the war.

At the beginning of 1965 the Army command in Vietnam drew up a set of plans suggesting priorities for a large-scale construction program in the event of a large troop buildup. Airfields were considered of vital importance. General Westmoreland realized that aviation would play a key role in jungle warfare, and the mobility of troops and supplies could very well depend upon the availability of airfields at strategic points throughout the country. Next in importance were the construction and maintenance of supply routes —roads and railroads that would provide the Army with safe routes for convoy travel and give the citizens of South Vietnam the means to bring produce to market. Port facilities were ranked third. Finally, logistic bases and support facilities were to be built. The theme of the entire program was to be austerity and utility; no money was to be wasted and every ounce of material was to be used.

Though the plans drawn up at all levels of the Army command system were basically sound, they failed to provide the latitude that was necessary for operations in the unconventional war in Vietnam. When troop deployment surpassed levels described in contingency plans, many plans were nullified. Base development plans, geared closely to expected troop levels, became obsolete when the scale of operations differed substantially from the specified force level upon which construction plans were based.

Engineer Advisers

While contingency planning was the principle concern of the staffs of major commanders both overseas and within the United States, individual Army advisers worked diligently to assist the Vietnamese in strengthening their national military forces and in developing a stable, politically viable society.

Under guidance from staff members of the Military Assistance Command, Vietnam, engineer advisers persuaded the Vietnamese to organize a workable engineer structure in their own armed forces. In the Military Assistance Command staff organization, the engineer branch was responsible for every aspect of advice in engineer planning and direction. Alongside their counterparts in the Vietnamese Army, American engineer advisers assisted in operational matters pertaining to the receipt, storage, and issue of engineer and transportation equipment, material, and repair parts. Equipment maintenance, repair, and the management and utilization of materials and equipment received particular emphasis. As Military Assistance Program funds became available, engineers aided the South Vietnamese Army in the determination of construction needs and in the preparation of priority statements necessary for allocation of funds.

The American engineer advisers worked with their Vietnamese military counterparts across the full range of engineer functions and at every level of the command structure. Assisting in the planning and advising on engineer operations in the field were only two aspects of the engineer role. To overcome cultural and educational differences that often generated distrust, engineer advisers were constantly briefing their American chiefs on problems that confronted them in the field. In addition to their other duties, they were responsible for collecting military geographic intelligence that could contribute later to full-scale engineer operations in their local areas.

Civic action projects constituted another important part of the engineer advisers' responsibilities. With funds made available from a provincial office of the U.S. Operations Mission—a branch of the

State Department responsible for military and technical aid to Vietnam—cement, reinforcing steel, and galvanized roofing could be purchased for use in repairs and small construction projects. Advisers were encouraged to provide local citizens with engineer hand tools and construction equipment for small projects in hamlets. The resulting co-operative building projects improved relations between the American military and local citizenry.

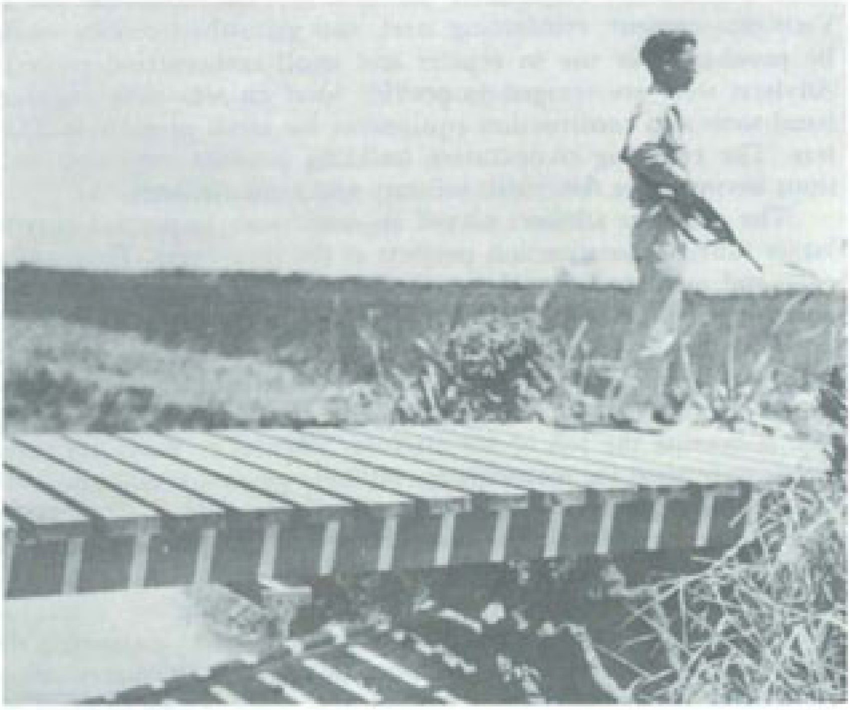
The engineer advisers played an even more important part in larger military construction projects at the local level. Their influence and assistance in defining building needs and characteristics aided Vietnamese engineers in securing funds for such projects.

Three times a year funds were released by the Agency for International Development to meet routine Vietnamese maintenance needs. An after-the-fact check was made on the use of these funds, and it became the job of the engineer advisers to make sure that funds were used for materials for self-help programs and approved construction projects. They often found themselves spending as much time supervising the accounting for construction funds as supervising actual construction.

The advisory detachment of the Vietnamese Engineer School at Phu Cuong, fifteen miles north of Saigon, aimed at improving the effectiveness of the school, whose purpose was to train officers, officer candidates, noncommissioned officers, and enlisted men of the Vietnamese Corps of Engineers and associated agencies in the techniques, procedures, and methods of military engineering. Officer instruction included courses in preventive maintenance, demolition, and soils engineering. Enlisted courses covered the operation of air compressors, wagon drills, cranes, dozers, and scrapers; carpentry; engineer supply; and a host of related subjects.

Civilian Contractors

Before 1962 construction and facility maintenance support for American advisers in Vietnam was provided by a management structure organic to the U.S. Naval Support Activity and patterned after the public works and utilities organizations found on military installations in the United States. Directed from a central headquarters in Saigon, working detachments were stationed and operated at locations where there were concentrations of American advisers. In 1962 Lieutenant General Paul D. Harkins, then head of the Military Assistance Command, Vietnam, desiring to free more troops for advisory duties, requested that the U.S. Army and Japan negotiate a contract for facilities engineering services for the advisory installations in Vietnam. In May 1963 a cost-plus-a-fixed-fee contract was awarded to Pacific Architects and Engineers.



VIETNAMESE SOLDIER GUARDING FOOTBRIDGE *erected as a local civic project.*

This first contract provided for the support of military installations at Tan Son Nhut, Da Nang, Pleiku, Qui Nhon, Nha Trang, and the central office of the Military Assistance Command in Saigon. In the initial phase requirements were minimal, consisting of normal maintenance and repair to leased facilities housing some five thousand advisers and their dependents. Water and electricity were provided from commercial sources and necessary equipment was furnished by the Military Assistance Command. The contractor was expected to make repairs, operate equipment, and fill needed management positions.

While organizing his management and work forces along the same lines as the repair and utilities sections in the Army, the contractor hired a staff of 5 Americans, 284 local citizens, and 9 experienced, free-lance engineers of other nationalities. The initial contract, valued at $384,000, was administered by the U.S. Army Support Group purchasing and contracting officer in Saigon.

The number of troops receiving contract engineer maintenance support increased from 5,000 at six sites in 1964 to 48,000 at eleven installations by the end of 1965. The funded cost increased from $384 thousand to over $4 million, while total employment rose from less than 300 to over 2,000. By the end of 1965 some 700 U.S. Army troops had been assigned throughout Vietnam to administer the contract and supplement the activities of the contractor.

The decision to use civilian contractors to assist in the construction program caught most of those contractors already in Vietnam in the process of closing down their operations. In October 1963, it had been anticipated by some that the major role of U.S. forces in Vietnam would be over by 1965. The construction combine of Raymond International and Morrison-Knudsen, mobilized in Vietnam in 1962, was preparing to disband its organization during the spring of 1964. By July of that year the value of work performed by the contractors had been reduced to a monthly rate of about $0.9 million from a previous peak of about $2 million. Material stockpiles had been depleted and no construction equipment was on order. Logistical base building had been cut back and construction was slowly coming to a halt. There were no construction troops in Vietnam and plans to send them were being held up by the Office of the Secretary of Defense.

While the Army and the Department of Defense were attempting to settle the questions of whether to introduce engineer units into Vietnam and how many, civilian construction began to pick up speed. Military Assistance Program funds became available in September 1964 and additional construction equipment was ordered. A Saigon stockpile was authorized and a contractors' supply system from San Bruno, California, to Saigon was put in operation. The contractors' capabilities were expanded in an attempt to push the rate of performing construction above $5 million value per month. Even at this work rate only the most critical projects assigned to civilian contractors in the last half of 1964 could be completed by January 1966. Less critical projects funded by the Military Assistance Program and the Agency for International Development and assigned to these contractors were of necessity deferred, hopefully to be completed by Vietnamese contractors, Army engineers, or Navy construction battalions (Seabees). At that time nearly all Army engineers and most Seabees were still in the United States, with a scattering of Seabee elements on bases throughout the Pacific Command.

Until May 1965 the planning for engineer support of a general troop buildup was characterized by the same lack of definition suffered by operations planning. The absence of precise operational plans could be expected to force solutions that were less than satisfactory on the engineer as well as the logistician. The latter was in

VIETNAMESE VILLAGERS BUILDING A BRIDGE. *U.S. Army provided materials, equipment, and technical aid.*

a poor position to estimate his own requirements for construction; this in turn lessened the ability of the Army engineers to prepare a well-reasoned response. The presence of some engineers, including competent contractors, in Vietnam perhaps fostered a false confidence that needs would be met. All available engineer resources were actually already committed. When there is competitive pressure to complete current tasks while devoting attention to potential tasks, the long-range problem too often is set aside. The cost can be tragic. In South Vietnam, the Army engineers were introduced at the latest possible moment that could permit success.

Readying of First Engineer Units

The primary source of units for rapid deployment to the Republic of Vietnam was the Strategic Army Forces whose units were presumably ready to respond quickly and professionally to short notice commitments anywhere in the world. Such units were intended to provide an immediate source of highly trained and capable soldiers and outstanding leaders. Through the Unit Readiness Report system, the Department of the Army received information on the degrees of readiness of all combat, combat support, and combat service support units of the active Army. Through this information, the Department of the Army sought to insure that each unit had its full complement of men with the required skills, that it had all authorized equipment on hand in operating condition, and that it maintained a state of training that would permit it to accomplish its normal mission. The index rating assigned a unit to reflect the actual level of readiness was called REDCON (readiness condition). Each Strategic Army Forces unit was assigned a REDCON rating from 1 to 4, with REDCON 1 designating the highest state of readiness.

The following elements went into the calculation of a unit's readiness condition: the strength of the unit as compared to its full table of organization and equipment; the proportion of individual fillers capable of performing in designated military occupational specialties; the percentage of refresher training, squad or crew proficiency training, and unit proficiency training that had been accomplished; the readiness rating the unit had received in field exercises and in technical proficiency inspections; the equipment in hand as compared to the authorized equipment on the unit's table of organization and equipment; and the equipment's suitability for deployment. Before the troop buildup was complete, almost every element of engineers in the Strategic Army Forces would be sent to the Republic of Vietnam. (*See Chart 2.*)

On 10 April 1965 the headquarters of the 35th Engineer Group (Construction) at Fort Polk, Louisiana, with a readiness condition of 1, was alerted for deployment to Vietnam. Colonel William F. Hart, Jr., commanded the group, to which was assigned the 46th Engineer Battalion (Construction), the 168th Engineer Battalion (Combat), and a maintenance company. However, neither of the assigned battalions was selected to accompany the group headquarters to Vietnam. Instead, the 864th Engineer Battalion (Construction) from Fort Wolters, Texas, and the 84th Engineer Battalion (Construction) from Fort Ord, California, were chosen to go to Vietnam with Headquarters, 35th Engineer Group. The original two battalions of the group soon followed.

Deployment criteria contained in Department of the Army movement directives brought about considerable changes in the 35th Group headquarters. The criteria dictated that before deployment an individual must have at least six months time remaining in service and be outside prior commitments of troops to other assignments. A significant number of men in the 35th Group headquarters and headquarters company failed to qualify for deployment; as a result there was an initial turnover of 30 percent in officers, 66 percent in warrant officers, and 23 percent in enlisted men. Ultimately only four officers, two of them field grade, of the original staff of twenty were sent to Vietnam: Colonel Hart himself, the executive officer, the adjutant, and the commander of the aviation section. The vacancies created by reassignment of the ineligibles from the unit were filled before embarkation, but Colonel Hart and most of his staff did not get really acquainted nor did they work together until they were aboard the USNS *Eltinge*, bound for Vietnam. Further, since the two battalions that were to be assigned to the 35th Engineer Group were not from Fort Polk, Colonel Hart first met their commanders and staffs after boarding the transport *Eltinge*. In fact, although the commanding officer of the 84th, Lieutenant Colonel Joseph J. Rochefort, was on board the *Eltinge*, the commander of the 864th, Lieutenant Colonel James E. Bunch, was not. He had left with an advance party from his battalion for Cam Ranh Bay where he was to prepare for the arrival of the transport.

While the 35th Group was busy preparing to embark for Southeast Asia, a flurry of activity was taking place at Fort Campbell, Kentucky, where the 70th Engineer Battalion (Combat), commanded by Lieutenant Colonel Leonard Edelstein, was located. Originally alerted for possible deployment in August 1964, the battalion spent the next year as a "One-Buck" unit—a code designation applied by the Continental Army Command which required the battalion to be in readiness for deployment on 48-hour notice. The 70th Battalion finally departed its home station on 2 August 1965, arriving at Qui Nhon seventeen days later.

Despite the imposed rules for readiness, the battalion's posture in mid-June 1965, when the actual movement order was received, had dropped considerably below the required status. This was due, in part, to the protracted waiting period, which created inefficiencies in manpower utilization. Other factors forced local exceptions to rules and use of administrative shuffling to meet requirements. Nevertheless, almost all the key men were on hand and the battalion staff had worked together for nearly a year when the unit left for Vietnam. The equipment, also kept prepared during a year for a 48-hour deployment notice, was ruled inadequate for deployment until the arrival of new standard road graders and the multifuel series of vehicles.

Movement of battalion equipment of the 70th to the port of Mobile, Alabama, began on 15 July. Approximately two days were required for the move, for which only a few railroad flatcars were called into service. The use of commercial trucks lessened many of the burdens inherent in the overland movement of a battalion's equipment. Loading, chocking, and bracing were much more easily accomplished on truck transports than on railroad flatcars.

Because the 70th Battalion's alert status was prolonged, it was able to avoid many personnel problems that plagued other units. Soldiers who became ineligible for overseas deployment for administrative reasons were replaced in the unit by men capable of meeting the criteria fully. As a result, an abnormal number of personnel actions was processed during the year prior to deployment, but only a minimal amount after the receipt of final alert orders. By 2 August, when the troops were airlifted to Oakland for deployment to Vietnam by ship, the battalion was as ready as it could be.

All equipment was shipped out of Mobile aboard one of the new Lykes automated freighters and arrived in Vietnam before the main body of the battalion. The advance party, with the assistance of Colonel Rochefort's 84th Engineer Battalion, already at Qui Nhon, collected the battalion's equipment in an assembly area on the beach as it was off-loaded so that the men of the 70th upon landing were able to utilize their own equipment to move to their bivouac area. Two days later, on 23 August, the 70th was hard at work constructing access roads into, and assisting in the construction of, the base camp for the 1st Cavalry Division at An Khe.

At Fort Belvoir the 87th Engineer Battalion (Construction) also spent the early summer of 1965 preparing for deployment to Vietnam. When Lieutenant Colonel John J. McCulloch assumed command of the 87th in June, he was told by Lieutenant General William F. Cassidy, the commanding general of Fort Belvoir, that the unit would move to Vietnam in about ten days. The battalion had been alerted to such a move for more than a month.

In June of 1965 the personnel situation in the 87th was critical. Morale was low: the battalion was understrength both in officers and enlisted men, and the untimely retirement of the battalion sergeant major and one line company first sergeant had aggravated the situation. Immediate requests for relief from assignment due to physical and personal problems had to be evaluated. Fillers were coming in, and with them came administrative and assimilation problems. The most serious was the difficulty of obtaining men trained in construction engineer skills. This critical shortage of construction men was alleviated to some degree through assignment of men trained as combat engineers. These apparent mal-assignments later proved an advantage to the battalion when it was called upon to support various combat missions in Vietnam. The battalion was plagued with the usual inconveniences associated with the mass movement of a large number of troops to an overseas area. Housing for dependents, physicals, dental examinations, and insuring that all had their predeparture leaves were all part of preparing the unit for departure. Most of the problems in themselves were not unusual. The difficulty stemmed from the number of problems, all occurring at the same time.

The preparation of the 87th Battalion's equipment for movement was handled routinely for the most part, but trouble arose in finding substitutes for items in the battalion's normal stocks which would be out of place in Southeast Asia. Colonel McCulloch had talked to a few individuals who had recently returned from Vietnam and he had also studied intelligence reports of the area. Basing his selection on what he could ascertain through his own investigations, Colonel McCulloch sought to obtain additional tents, refrigeration equipment, and water distributors in place of much less practical items such as space heaters. The command at Fort Belvoir was most responsive to such attempts. Before the 87th left Fort Belvoir, it had secured through donation and salvage nine household refrigerators which were worth their weight in gold once the battalion landed in Vietnam.

Headed by Colonel McCulloch, the advance party of the 87th departed for Saigon in the latter part of July. The flight was rough and filled with delays. The advance party of fifty men arrived in Saigon quite unexpectedly to find that a decision on the initial location for the 87th had been delayed. While awaiting instructions from the commander of the 1st Logistical Command, Colonel Mc-

Culloch was able to obtain some of the items excluded from the shipment from the United States. He was successful in acquiring tentage for his entire battalion as well as a number of small electrical generators.

Word finally arrived indicating that the 87th was to be located at Cam Ranh Bay under the command of the 35th Group. The majority of the advance party and the equipment flew first to Nha Trang and then on to Cam Ranh Bay. The bulk of the equipment brought by the advance party was moved by barge to Cam Ranh Bay a short time later.

By September of 1965 the American buildup and, in particular, the buildup of U.S. Army engineers had been launched. Many more companies, battalions, groups, and even two engineer brigades would follow these first engineer units to the Republic of Vietnam in the months and years to come. Their efforts would provide a lasting tribute to the professional resourcefulness of Army engineers in the support of the allied military effort.

CHAPTER III

Initial Engagement of Engineers

Just seventeen days after they were alerted, on 27 April 1965, the 35th Group headquarters and the 864th Battalion dispatched an advance party to the Republic of Vietnam. Under the command of Lieutenant Colonel Thomas C. Haskins, executive officer of the 35th Group, members of the party arrived in Saigon on 3 May and co-ordinated with the newly activated 1st Logistical Command of the Army in planning for the arrival of the 35th Group. They learned that the group was to operate under the command of Colonel Robert W. Duke (not to be confused with the Engineer officer of the same last name), head of the 1st Logistical Command, whose headquarters was located in the outskirts of Saigon close to the international airport at Tan Son Nhut.

Tactical plans being formulated at the time contemplated putting the American marines in the northernmost political-military section of the country, known as I Corps Tactical Zone. Since it already possessed an operating port at Da Nang, the U.S. Navy, normally charged with logistical support of its marines, was given the responsibility for support activities throughout that zone. In the other three zones the Army was to arrange for reception of troops, equipment, and supplies—a task assigned to the 1st Logistical Command. After reviewing anchorages, ports, roadnets, and security considerations, the command decided to expand port and airfield capacities at Saigon, Qui Nhon, and Vung Tau. In addition a massive construction project was to transform the Cam Ranh peninsula with its well-protected natural harbor into a major port and logistical complex. The matter of how best to apply the slim resources of the incoming 35th Group was studied by its advance party and Army command elements in Saigon. Jointly they arrived at the priorities of troop construction and developed a plan for the initial distribution of the 2,300 engineer troops that were to arrive at the end of May. They selected landing points for the group and made the necessary arrangements for the landings.

Preparations To Receive First Units

A provisional post detachment in the person of a single lieutenant had arrived at Cam Ranh Bay on 22 April and was working with the government of the Republic of Vietnam and the Vietnamese Navy to plan for the arrival of the first U.S. troop contingent. The lieutenant and the advance parties concluded arrangements for security for the landing, acquisition of land, and organization of an indigenous labor force to support engineer operations.

Before the U.S. troop buildup, land used by U.S. advisory troops was either leased from private owners or provided by the government of Vietnam. When there were squatters the United States paid the cost of indemnification and relocation but the title itself was obtained and held by the government of Vietnam, which lacked the financial resources to pay the real estate costs for the influx of U.S. troops. Such a system for land acquisition was obviously unrealistic. For example, in the spring of 1965 when the marines arrived at Da Nang two Army officers from the Military Assistance Command had to negotiate on the spot with 1,800 different land owners and spend $620,000 to get the land at Da Nang.

Although the government of Vietnam established a real estate board during the spring of 1966 to deal with U.S. real estate officers, acquiring land continued to be an annoying problem for the U.S. engineers. The seriousness of the difficulties as early as 1965 is reflected in an unofficial change in troop structure in the late summer of that year. When a terrain analysis detachment of five officers and five enlisted men arrived in Saigon ready to perform its customary mission of evaluating land forms, topography, and surface characteristics, it was placed within the Engineer Section of the U.S. Military Assistance Command where it became the real estate office within that section. The terrain analysts promptly became embroiled in real estate matters, never performing the mission for which they had been dispatched.

Because of the absence of a local labor pool in the Cam Ranh Bay area, General Westmoreland in April 1965 recommended to the government of Vietnam that it resettle refugees and displaced persons there. The recommendation was well received and the government began planning for the relocation of approximately 5,000 Vietnamese in a model village to be built at Ba Ngoi across Cam Ranh Bay from the peninsula. Settlers began to arrive at the village as early as July 1965 and soon provided much needed support for various engineer activities in the area. By mid-1968, the population of the village had climbed to over 15,000.

The priorities for troop construction and the plan for the initial distribution of construction troops were dictated by the importance attached to ports and harbors that could accommodate oceangoing vessels. The fact that the U.S. logistical system in Vietnam was in its infancy and that there was no delineation of front lines or rear areas led to the establishment of three major combat support areas for the Army. These were Saigon with its neighboring Vung Tau, Cam Ranh Bay, and Qui Nhon. At first construction would be concentrated in these areas. Contractor construction was at this time heavily committed in the Saigon area but was to be extended to develop a fighter base for the Air Force on the Cam Ranh peninsula as soon as possible. The first Army engineers were to work at Cam Ranh and Qui Nhon. With the arrival in June of the 35th Engineer Group the urgent projects of developing Qui Nhon and Cam Ranh Bay into port-depot staging area complexes got under way.

The 35th Engineer Group

The main body of the 35th Engineer Group headquarters and headquarters company left Fort Polk, Louisiana, on 12 May 1965, and along with the 84th Battalion, the 864th Battalion, the 513th Engineer Company (Dump Truck), the 584th Engineer Company (Light Equipment), the 178th Engineer Company (Maintenance), and the 53d Engineer Company (Supply Point), boarded the USNS *Eltinge* and left San Francisco, California, for the Republic of Vietnam on 13 May. The time of arrival was set as 30 May; however, the ship, a World War II Liberty ship just out of mothballs, had mechanical breakdowns almost daily. Finally, multiple pump failures occurred in mid-Pacific and the ship had to be towed 500 miles to Midway Island where all the troops and the cargo were transferred to the USNS *Barrett*. After some additional delay occasioned by the loading operation, the *Barrett* sailed for Vietnam via the Philippines.

Although the journey was not an auspicious beginning for the engineer story in Vietnam, it had its bright side for the troops. The delay at Midway provided the men an opportunity for recreation and exercise after the cramped living conditions aboard the *Eltinge*. The *Barrett* continued to its original destination, the Philippines, where it discharged dependents and other travelers before setting out for Vietnam. This unprogrammed stop for the engineers permitted the leader of the advance party, Colonel Haskins, to fly in from Saigon and brief commanders and staff officers. When plans were finished, Colonel Haskins flew back to Saigon to complete preparations for landing and deploying troops when they reached Vietnam.

PORT AT CAM RANH BAY, AUGUST 1965

The First Engineers at Cam Ranh Bay

On 9 June 1965, just twenty-seven days after the main body had left for Southeast Asia, the USNS *Barrett* dropped anchor in Cam Ranh Bay and the first major contingent of U.S. Army engineers landed. These engineers found a peninsula seventeen miles long and five miles wide at its widest point, connecting with the mainland at the northern extremity and forming a protected harbor of approximately forty square kilometers with depths to twenty-four meters, and covered with low shrubs in the north. Near the tip of the peninsula was a group of granitic mountains averaging one hundred meters above sea level and a small freshwater lake. One worn, unpaved road existed on the peninsula, and one narrow pier, recently built by contract for the U.S. Operations Mission in Vietnam, thrust out into the bay. This finger pier could accommodate no more than two ships at any one time. A small 800-foot airstrip which the French Army had built and which had been used by the pier contractor paralleled the shoreline. The peninsula was bleak and barren, but from this scattering of sand and shrubs

MAP 3

soldiers were to build one of the major logistical bases and supply depots in the Republic of Vietnam.

The party that disembarked on the peninsula consisted of the 35th Group headquarters, the 864th Engineer Battalion, Company

D of the 84th Engineer Battalion, the 584th Engineer Company, the 513th Engineer Company, the 178th Engineer Company, the 53d Engineer Company, and the 22d Finance Detachment. The remainder of the 84th Battalion proceeded north aboard ship to Qui Nhon, arriving there two days later. Several of the units that disembarked at Cam Ranh Bay left shortly thereafter for other locations in South Vietnam. Company D of the 84th left Cam Ranh on an LST (landing ship, tank) for Vung Tau on orders from the 1st Logistical Command. The 22d Detachment was transferred to Nha Trang, the maintenance company to Saigon. The supply point company remained at Cam Ranh but later passed from the control of the 35th Group to that of the Cam Ranh Bay Logistics Area. Remaining on the peninsula at Cam Ranh Bay and under the command of the 35th Group headquarters were the group headquarters company and the 864th Battalion, as well as the dump truck and light equipment companies.

Most of the engineers at Cam Ranh Bay in 1965 were professional soldiers. *(Map 3)* At this early stage in the war the Army was not yet an army of conscripts, and many of the senior officers and noncommissioned officers had been in service long enough to see action in Korea and even in World War II. There were few at Cam Ranh who had not welcomed their new assignment, and these first engineers were particularly competent, aggressive soldiers.

From the time of his landing at Cam Ranh Bay, the commanding officer of the 35th Engineer Group, charged with troop construction operations, also had the mission assigned by the Commanding Officer, 1st Logistical Command, of establishing the Cam Ranh Bay Logistics Area and commanding all 1st Logistical Command troops in the area. Thus Colonel Hart and his staff found themselves in a dual role in which they had to plan, establish, and operate area mail, chaplain, and medical services; operate a military police detachment; procure rations and establish and operate depots for all supplies; and concern themselves with all manner of nonengineer functions. This arrangement lasted for the better part of three months until the command of the Cam Ranh Bay Logistics Area passed to an incoming quartermaster unit.

The Engineers Tackle the Environment

The first night the engineers stayed on Cam Ranh peninsula, Colonel Hart had machine gun positions established and listening posts set up. The rain poured down, indifferent to the calendar's dictate for the dry season. The Viet Cong made their presence felt with some long-range, ineffective sniping. The uninitiated spent a

EARTHMOVERS LEVEL SAND *at Cam Ranh engineer complex, 1965.*

very apprehensive first night, but the presence of seasoned officers and noncommissioned officers strengthened morale.

For the next few days Vietnamese troops provided security while the engineers set up bivouac. A campsite immediately adjacent to the landing point quickly appeared as the engineers set up their cots and arranged their belongings in an inescapable sea of unstable sand. Tents for headquarters as well as for kitchens and for vehicle maintenance added more dark green canvas in neatly aligned rows above the orange-yellow sand that glittered in the tropic sun.

After the base camp had been established, the engineers assumed their full responsibility for security. A mutual security plan was worked out and co-ordinated locally with the commander of the Vietnamese naval training establishment, Lieutenant Commander Ha, but security measures were a heavy burden until 12 July when a battalion of the 2d Brigade, 1st Infantry Division, arrived at Cam Ranh. In October the responsibility for providing security for the Cam Ranh peninsula and the surrounding area was given to the 2d Marine (Dragon) Brigade from the Republic of Korea. The major threat remained long-range sniping, but the danger of direct assault was always present.

Along with security, the chief problems of the engineers were the sand and the lack of natural construction materials on the peninsula. The first requirement was to get the equipment to the various work sites, a task that proved to be extremely difficult because the sand was wind-deposited, of uniform gradation, consisting of spherical rather than irregular particles and extremely hard to stabilize. In some places it was fifteen to twenty feet deep over rock formations. The first trails cut through this sand by bulldozers were frustratingly unstable. Heavy vehicles were immobilized in the sand and dozers had to stay along the trails to tow them from the shore to the work areas. As a first step it was necessary to stop everyone from driving until the drivers could be taught how to operate properly in sand. Tire pressure was reduced below the minimum prescribed in technical manuals and sand dunes were climbed by contour driving rather than by direct approach. As General Frank S. Besson, Jr., remarked on a visit to Cam Ranh early in 1966, "we probably ruined a lot of tires but saved a lot of transmissions."

Sand was everywhere and persisted in invading even those places constructed specifically to keep it out. The onshore winds carried sand into kitchens, foodstuffs, and clothing. The gleaming granules multiplied the already intense heat, making even the shade offered by the dark green tentage hot and uncomfortable. When tent sides were raised to vent the hot, confined air, the sand moved uninhibited through the modest engineer homes. Escape from the elements was hard to find on Cam Ranh, and the engineers often welcomed the blowing sand as a relief from the searing sunlight reflected off the blue waters of the ocean and the seemingly limitless dunes.

The sand caused serious maintenance problems. The pusher fan on some tractors drew flying sand into the engine, pushing it through the radiator at tremendous speeds. The engineers resorted to field expedients to keep the equipment in use. Covers of canvas or sheet metal kept some of the sand out of the engines; damaged, worn, and abraded parts were replaced by parts fabricated locally. The sand posed a tough problem to repairmen, operators, and builders.

A major priority was assigned early to the construction of a firm road network on the peninsula, but success here depended on stabilizing the sand and discovering enough suitable natural resources. The engineers conducted an extensive reconnaissance to uncover construction materials of any sort, but the most sought-for material in the early operations was rock. As one commander explained, "Rock was the word over there. I woke up in my sleep saying, 'Rock, rock, rock.' " Just outside their perimeter the engineers found an abandoned rock quarry that Raymond, Morrison-Knudsen had opened when they were building the U.S. Operations Mission pier. Company A of the 864th reopened the quarry and soon began producing crushed granite for road construction.

Laterite, a soil unique to tropical regions, occurred extensively in Vietnam both as a hard massive crust and in the alluvial or river-deposited silt. Both types, red to brown in color, were rich in the secondary oxides of iron and aluminum. Engineer units came to use laterite extensively as a subgrade material for constructing roads and airfields. Unfortunately, Cam Ranh peninsula had no laterite. Later the laterite was hauled from the mainland for subgrades, but throughout the early months other means of stabilization had to be found.

Lumber was another critical material. Although intelligence had reported that there was enough lumber available in Vietnam to support construction, the Cam Ranh peninsula had little flora and that was mostly shrubs. Across the bay were forests that could have supplied some lumber, but this territory had become a sanctuary of the Viet Cong, who used it as a rest area. It would have been expedient to set up a sawmill there, but such an operation, it was feared, would aggravate the enemy and invite serious attack, thus increasing the already demanding security requirements of the engineers. There were too few South Vietnamese military forces nearby to encourage any incursions into enemy areas. As the shortage of lumber continued, all wood the engineers had or could collect went into the most essential projects. It was not unusual for Philippine mahogany plywood, normally reserved for more sophisticated construction, to serve as form lumber in pouring concrete.

The sand also took its toll of the soldiers' energy. Traveling short distances by foot through deep sand could bring on exhaustion. Laboring in daytime heat of 120 degrees, intensified by the reflection from the white sands, soldiers were issued sun helmets and allowed to wear T-shirts at their work. They were platooned into two shifts to take full advantage of the cooler night air. One shift worked from 1 a.m. until 11 a.m. and the second from 3 p.m. to 1 a.m., a schedule that allowed everyone to rest during the hottest hours of the day. Commanders encouraged their men to take salt tablets and drink plenty of water both on and off the job. Still the heat was intense and the dark green tents that were home to the

PARTIALLY DEVELOPED CANTONMENT AT CAM RANH, JUNE 1966

soldiers on the Cam Ranh peninsula provided little escape from the direct rays of the sun. Only in the tepid waters of the bay immediately adjacent to the established tent city could the troops find relief, and here they relaxed in off-duty time.

Special procedures were developed to combat the intense heat and the damage it could do to construction projects on the beach. Forms were set during the daylight hours, leaving the heavier work of placing concrete floor slabs for the evening hours. This practice served both to protect the men and to insure that the concrete slabs were properly set before the intense heat of the day removed the hydration water.

Upon arrival of the 35th Group at Cam Ranh Bay the demand for fresh water was an immediate problem. Potable water was first obtained by boiling surface water or using simple water purification methods. As soon as conditions permitted, the 35th set up its organic water purification units at a series of springs originally developed by the French. During the first year at Cam Ranh water was also drawn from a trapped lake filled by seasonal runoff from the monsoon rains. This supply was not deemed adequate for

SANDBAG-REVETTED MACHINE GUN POSITION AT DAU TIENG

long-range use because it lacked a continuous flow of water, making it extremely susceptible to contamination. Ultimately, deep wells were sunk on the peninsula and became the primary source of fresh water for the giant port complex.

All construction at Cam Ranh was organized and directed to meet imposed priorities. The projects of immediate concern on the peninsula were the building of an airfield, assigned to Raymond, Morrison-Knudsen; a rudimentary road network; storage facilities; and the expansion of port facilities. Since the airfield enjoyed the highest priority, the contractor had first call on the unloading of equipment and supplies through the limited port facilities.

To speed the massive earthmoving operations connected with airfield construction, the 35th Group provided training sessions for the Vietnamese operators hired by Raymond, Morrison-Knudsen to drive much of its heavy equipment. From time to time the group also allocated some of its own equipment to assist in the airfield project. A month or two later when Raymond, Morrison-Knudsen fell seriously behind its ambitious schedule and appeared unable to meet the prescribed operational date for the initial airstrip of aluminum matting, identified in military parlance as AM2, the 35th Group was assigned the mission of supporting the contractor through the permanent allocation of two groupings or "spreads" of its earthmoving equipment. In addition, the Army engineers helped to install foundations for permanent structures and to build roads. Such co-operative efforts on the part of U.S. Army engineers are sometimes overlooked. It was not unusual for an Army engineer unit to lend assistance to a civilian contractor who needed help to meet an imposed deadline. By the same token the contractor lent assistance to troops from time to time.

The sand at Cam Ranh did serve a useful purpose despite all the problems it caused. The engineers used sandbags in the construction of bunkers, revetments, machine gun positions, and even stairs.

Thus even before construction materials began flowing into the Cam Ranh Bay project, a tent and sandbag city had sprung up on the peninsula. By early July serious work on certain essential projects had begun. The construction of a landing ship unloading site on the beach to relieve port congestion had begun. Temporary motor pools, storage platforms, and a dump for 55-gallon drums of petroleum products were also under way. June of 1965 was for the engineers a month of digging in and tackling the environment at Cam Ranh Bay—the beginning of the long and intricate development of a major logistical complex.

CHAPTER IV

Early Operations

Beginnings at Qui Nhon and Vung Tau

On 11 June 1965 the 84th Engineer Battalion, less Company D, landed at the port of Qui Nhon, capital of the province of Binh Dinh, about halfway between Saigon and the boundary with North Vietnam. The engineers established their base camp in the southern sector of the town and began transporting equipment from ship to shore by amphibious vehicles. Immediate priority was given to the construction of permanent LST beaching ramps and ammunition storage pads. Landfill operations aimed at the development of a depot soon began. At Qui Nhon sand was also a major problem, but it was not so loose as that found at Cam Ranh because here the particles were angular and more evenly distributed as to size. Equipment nevertheless broke down frequently as a result of sand abrasion; what was originally regarded as a healthy stock of repair parts quickly disappeared from the shelves of the maintenance tents.

Rock needed for the construction projects was abundant in a nearby quarry, but before a rockcrusher could be moved to the quarry three miles of access roads and numerous heavy culverts had to be built. To make roads passable the engineers applied layers of the laterite overburden from atop the rock at the quarry as quickly as it could be extracted. A makeshift rock-crushing plant was established to speed production. A lumber retaining wall was constructed with dunnage from the cargo vessels in the harbor, and backfilled with quarry run rock, that is, random-size rocks taken directly from the quarry after blasting. The loading shute to the crusher, erected on a rock-filled crib, consisted of a salvaged 2½-ton dump truck body, the sides of which were extended with channel beams and pierced steel planks to provide an efficient funnel onto the feeder of the crusher. This improvised crusher plant, a tribute to engineer resourcefulness, was the highest volume producer of crushed granite in the Republic of Vietnam until commercial plants reached heavy production levels in late 1966.

On 23 August 1965 the 937th Engineer Group (Combat) headquarters arrived at Qui Nhon and established a base camp adjacent to the camp of the 84th Battalion. On 28 August it took command

SOLDIERS OF 84TH ENGINEER BATTALION LAND AT QUI NHON

of the 84th Battalion, less company D, relieving the 35th Group of the command responsibility at Qui Nhon.

Company D of the 84th Battalion transshipped from Cam Ranh, arriving at Vung Tau in the south during early June. Unlike the sandy, mountainous peninsula at Cam Ranh, the Vung Tau peninsula was quite marshy. Here, as in Cam Ranh and Qui Nhon, the engineers found few usable facilities. Company D immediately set to work establishing a base camp. The company commander, First Lieutenant Reed M. Farrington, was a Naval Academy graduate who had accepted his commission in the Army. He now found his company charged with developing Vung Tau into a combat support complex designed to relieve Saigon of some of its off-loading and storage responsibility. The urgent priority at Vung Tau was the improvement of existing port facilities, which were in a state scarcely deserving of the title. The young commander and his company faced a monumental task in planning, design, and construction.

The design for the depot facilities at Vung Tau had been the responsibility of a contractor working for the U.S. Navy construction agent. When the drawings were 60 percent completed, Lieutenant Farrington discovered that the original terrain analysis had been faulty. A subsurface investigation of the area had not been made, and the design did not take into account the marshy soil found at Vung Tau. A redesign was ordered and the 18th Engineer Brigade took responsibility for the task upon its arrival. Although the development of Vung Tau as a staging depot complex was consequently behind schedule, Company D troops continued to work on the port and storage facilities at Vung Tau, getting whatever supplies they could from local resources. These engineers lived in tents on the marshy peninsula and worked with little supervision or support from higher headquarters until the arrival in September at Long Binh of the 159th Engineer Group (Construction). Not until September 1967, when the 36th Engineer Battalion (Construction) arrived at Vung Tau, did the effort there receive significant augmentation.

The most common problems encountered by the first engineer units in Vietnam centered around the shortage of construction materials and the delay in receiving repair parts. Throughout Vietnam, rock was in short supply; lumber and nails were critical items, as were prefabricated buildings and electrical supplies. Some of the most severe equipment shortages were in concrete mixers, rock-drilling equipment, and hauling equipment. Deadline rates on dozers, scoop loaders, and 5-ton dump trucks climbed to alarming heights because of intensive operation, and the slow process of getting repair parts aggravated the maintenance problem. Shortages in repair parts stemmed from the loss of many replacement requisitions in the supply system and a discrepancy between theater assets as they actually were and as they were reflected by Department of the Army agencies. These problems were among the first that faced the 18th Engineer Brigade headquarters upon its arrival in Vietnam in September 1965.

More Engineers Arrive at Cam Ranh Bay

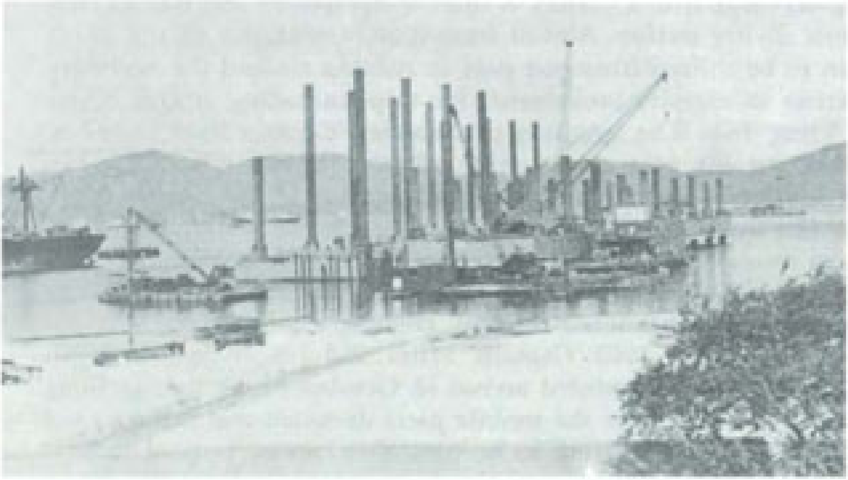
August and September saw the arrival of two more construction battalions as well as three separate companies at Cam Ranh Bay. These were the 62d Engineer Battalion (Construction), commanded by Lieutenant Colonel Paul D. Triem, and the 87th Engineer Battalion (Construction), commanded by Lieutenant Colonel John J. McCulloch. By Christmas of 1965 the 35th Group had installed a DeLong pier; built roads, warehouses, troop housing, and administrative facilities, hardstands, a jetty for unloading tankers, and a 7.4-mile pipeline from the port to the airfield; and had begun work in Nha Trang, Dong Ba Thin, and Phan Rang.

On 24 August the 497th Engineer Company (Port Construction) arrived with 13 officers and 208 enlisted men. Designed to carry out port and waterfront construction and rehabilitation, the company came with a variety of marine equipment and had its own organic diving section. Almost immediately, elements of the 497th began to be shifted from one port to another to lend the necessary expertise to early improvements for ship unloading at Qui Nhon and Vung Tau. The company commander, Captain Paul L. Miles, Jr., became the port construction adviser and consultant for the 18th Engineer Brigade and the headquarters of U.S. Army, Vietnam. His work and that of the 497th became so widely acclaimed and so instrumental in later successes that Captain Miles received the coveted Wheeler Medal of the Society of American Military Engineers for outstanding military engineering in 1965.

In September 1965 Captain Miles and his engineers began preparing for the scheduled arrival in October of the first DeLong pier. For the first time the mobile piers designed and built by the DeLong Corporation were to be committed in support of tactical operations. These quickly assembled piers were to save many valuable man-hours in readying Vietnamese ports to accept the large influx of American war material. At Cam Ranh Bay the first new finger pier accepted deep-draft cargo just forty-five days after the towed pier reached its selected location. Besides preparing for the arrival of the DeLong pier, the 497th was responsible for removing all obstacles from the harbor approaches to the bulkheads or piers under construction, a considerable task since there were many sunken vessels in Cam Ranh Bay.

The diving section of the 497th was frequently called upon for special jobs. For instance it was used in the installation of submarine pipelines at several locations and was detailed to perform propeller maintenance for Transportation Corps vessels docked in the Cam Ranh Bay area. Later the diving section was used in the maintenance of the submarine pipelines and the salvage of sunken Army aircraft. The time spent by the 497th on all these projects jeopardized the successful completion of its primary mission of underwater construction. It was not until the summer of 1966 that the 1st Logistical Command requested a diving section of its own to perform these functions. Until then the 497th continued to provide the requested support.

The first DeLong pier to be sent to Southeast Asia left Charleston, South Carolina, in August 1965. Towed by a tug through the Suez Canal and across the Indian Ocean, the 90x3,000-foot steel pier arrived in Cam Ranh Bay on 30 October after eighty-one days at sea. While the actual emplacement and elevation of the pier barges was performed as requested by Mr. DeLong by his own employees, the Army engineers, particularly those of the 497th Port Construction Company, laid the groundwork for the pier's opera-



FIRST DELONG PIER UNDER CONSTRUCTION AT CAM RANH

tion. To protect the pier from the effects of beach erosion, the 497th erected a 550-foot sheet pile bulkhead while the 87th Battalion completed a causeway to connect the pier with the beach. The 497th also built a 400-foot timber pier which allowed petroleum products to be transferred directly from ship to shore at Cam Ranh Bay.

Inadequate mechanical lifting equipment, tools, and supplies constantly taxed the resourcefulness of the engineers. The available sheet piling, hurriedly ordered out of Japanese-fabricated stocks, was too short. Many of the fittings and much of the hardware of barges and caissons arrived in poor condition. By repairing or rebuilding vital components of the pier, the men of the 497th were instrumental in its quick installation. The sheet pile bulkhead lasted almost five years before the improvised reinforcing finally failed and parts of the wall collapsed.

It must be recognized that the DeLong equipment by itself could not provide the instant piers sometimes associated with the employment of prefabricated piers. In most instances, complementary construction such as dredging, hydraulic fills, and earth fill causeways was necessary before the piers could be installed and used. All of this was accomplished by Army engineers under difficult circumstances. Technical problems that developed in preparing for the installation of DeLong piers were often solved through the close co-operation between Mr. DeLong and the Engineer Corps command. Information was exchanged readily and it was not uncommon for Mr. DeLong, a former engineer officer, to help the Army engineers with equipment from his own reserves.

In December of 1965 Secretary McNamara approved the contract negotiation by the Army Materiel Command with the DeLong Corporation calling for the delivery and installation of eight more piers. Since the equal of his corporation's experience in the installation, operation, and servicing of the equipment could not be approached within the military, Mr. DeLong preferred to have his own engineers and technicians install and service his piers.

On 24 August 1965 the 87th Engineer Battalion (Construction), which had been the support battalion for the U.S. Army Engineer School at Fort Belvoir, arrived at Cam Ranh peninsula. After establishing its camp, the 87th was directed to begin construction of a 6,400-man cantonment and a tank farm. It also undertook construction of the 7.4-mile pipeline and a 40x800-foot rock fill causeway with two 80-foot spans of double-single Bailey bridge to connect the DeLong pier with the shore.[1] The 35th Group also assigned to the 87th the mission of conducting tests on the relative merits of the various methods used and proposed to stabilize the sand on the peninsula.

Stabilization tests were conducted on the routes to the depot area and to the ammunition supply point. Eight different sections were tested, each 500 meters long and 10 meters wide. In the first trial section sand was mixed in place with cement and measured quantities of water, and the section was compacted and moistened for seven days. The surface thus produced wore rapidly under moderate traffic, but it proved to be satisfactory when used as a base. In the second section 40 percent sand and 60 percent coral fines were combined and mixed in place. The coral was obtained from a single small deposit off the south beach of Cam Ranh peninsula discovered in the exhaustive searches of the 87th Engineer Battalion. After RC3 asphalt treatment of the sand and coral fines only minor deflection and cracking resulted even under heavy traffic. A third section consisted of 40 percent local sand and 60 percent coarse beach sand from the mainland, also treated with RC3 asphalt and then compacted. This section stood up relatively well under light traffic. The fourth section, 40 percent local sand and 60 percent granitic quarry screenings treated with RC3 asphalt, proved as effective as sections two and three, and the material was more readily available. The fifth section, 100 percent dune sand treated with

[1] Bailey bridges are made up of one, two, or three tiers of connected, prefabricated panels with one, two, or three parallel panels per tier to obtain desired variations in load capacity at varying spans. A double-single configuration defines a bridge with one tier of double panels on each side of the roadway.

CRUSHED CORAL ROAD AT CAM RANH, *built to test road building over unstable natural sands.*

asphalt, was the only section to fail completely. Section six, 100 percent coral fines treated with cement to ten inches in depth and then watered to optimum moisture content, proved to be an extremely strong base course. When protected by a wearing surface, it provided an all-weather heavy-duty road. Section seven consisted of twelve inches of coral fines overlaid with six inches of crushed coral, watered extensively and compacted. This section compared favorably with section six and was less expensive. (The earliest attempt to use crushed coral promised some success.) The road to the ammunition point was later built entirely of this combination. The eighth and last section, made up of decomposed granite and cement to a thickness of eight inches and "moist cured" for seven days, afforded a very substantial base course. Eventually, all depot roads were provided with this base.

The 864th Battalion engineers were working on the depot and by 3 December had erected nine 50x40-foot prefabricated warehouses and had almost completed four 120x200-foot structures. They had begun work on a reinforced concrete automatic data processing center. Company C of the 864th, detached some twenty miles away at Nha Trang, was building a tank farm for gasoline and oil, clearing storage areas, and constructing warehouses and cantonments.

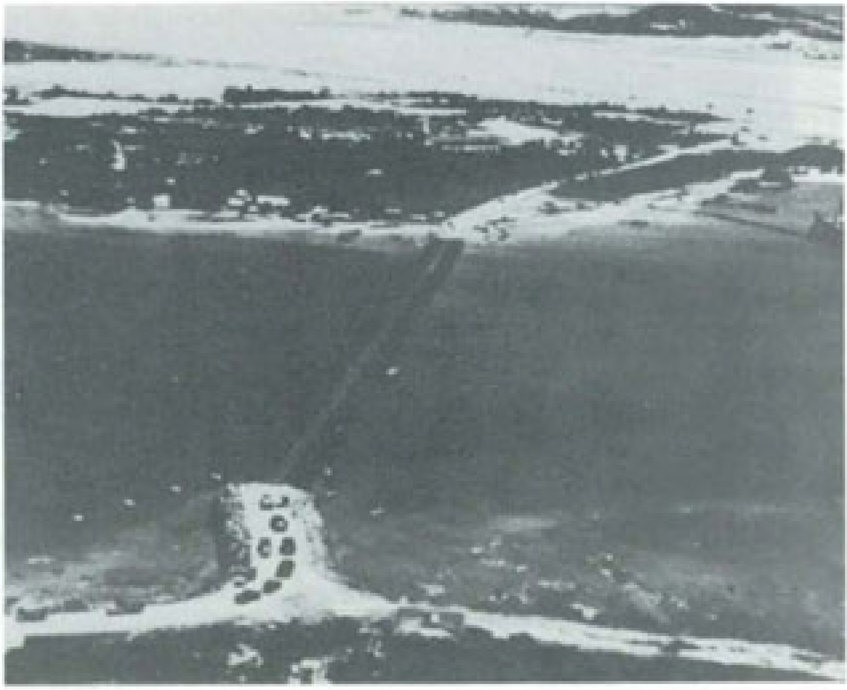
On 28 August the 62d Engineer Battalion (Construction) arrived at Cam Ranh from Fort Leonard Wood, Missouri, and was soon sent to Phan Rang. The process by which the battalion finally reached Phan Rang illustrates the effect of shifts in priorities at the last minute. The 62d had originally been slated to go to the Qui Nhon peninsula; in fact its advance party was already at Qui Nhon when the transport carrying the rest of the battalion reached the coast of Vietnam opposite Qui Nhon. In the meantime, however, a prior decision made in Headquarters, Military Assistance Command, Vietnam, for an airfield to be built on the peninsula to the northeast of Qui Nhon harbor had been reversed and the site abandoned as impractical from the point of view of engineering feasibility and security. A proposed airfield at Phan Rang then immediately assumed the highest priority after the one at Cam Ranh Bay. Since no troops had been scheduled to start construction in Phan Rang at that time, the 62d was diverted to Cam Ranh Bay where its equipment was to have been unloaded for transshipment by small water craft to Qui Nhon. However, from Cam Ranh the battalion was routed into Phan Rang, with heavy equipment going over the beach in landing craft and light vehicles going by the road in a series of convoys organized as Operation ESSAYONS. An advance element of the 25th Infantry Division, still in Hawaii, Company C of the 65th Engineer Battalion, which had not yet received its organic equipment and which had landed at Cam Ranh to locate at Dong Ba Thin, organized itself in an infantry configuration and provided convoy security. Air cover and surveillance were supplied by aircraft from the 35th Group headquarters. The chief projects of the 62d Battalion were the construction of an aluminum airstrip (AM2), 10,000 feet long and 102 feet wide, as well as a cantonment for incoming Air Force units. Later the 62d was charged with building a base camp for the 1st Brigade, 101st Airborne Division, while the division engaged in field operations.

The small Vietnamese village of Dong Ba Thin on the western shore of Cam Ranh Bay became the site of a major engineer effort begun by Company C of the 65th Engineer Battalion, which had arrived in early September. The 65th, organic to the 25th Infantry Division, began leaving Hawaii for Vietnam in August 1965. Company C, the first element of the battalion to arrive in Vietnam, worked under the 35th Group until December.

Assisted by elements of the 513th Engineer Company (Dump Truck) and the 584th Engineer Company (Light Equipment), Company C was to design and construct an Army aviation base astride the main coastal route, National Highway 1, complete with cantonment areas, heliports, and a runway on what was in essence a swamp. When Company C left the area in late December, it had completed 99 percent of the runway and had made significant progress on many of the other facilities. On 22 January 1966 work was renewed at Dong Ba Thin by the newly arrived 20th Engineer Battalion (Combat) under the command of Lieutenant Colonel Richard L. Harris. The 513th Engineer Company and the 584th Engineer Company were attached to and under operational control of the 20th Battalion for the remainder of its time at Dong Ba Thin. By May of 1966 the 20th Battalion with its attached units had graded the aviation cantonment area, built seventy-five aircraft parking pads, finished a cargo plane parking area, and begun construction of a taxiway to the completed runway.

As previously indicated, there was no laterite on the Cam Ranh peninsula, but a laterite pit was operated on the mainland across the bay from My Ca. Before the arrival at Cam Ranh of the 553d Engineer Company (Float Bridge) a ferry had made trips rather irregularly across the upper bay at My Ca, a service provided by Transportation Corps units using strike force boats. On 6 October the 553d under the command of Captain Richard L. Copeland inaugurated regular service at My Ca, using a standard 2-boat, 6-float M4T6 pontoon raft augmented by a Navy cube barge powered by sea mules. The new service soon proved unable to cope with the ever-increasing traffic between the peninsula and the mainland. Near the end of November, the 6-float raft was replaced by a "fast ferry" consisting of a much longer M4T6 raft powered by a bridge boat on either side. The bridge boat sideslipped the raft in the direction of its long axis instead of propelling it in the direction of the long axis of the floats. The boats were fastened to the raft by means of a swivel arrangement to facilitate changing direction at each shore. This field expedient permitted the engineers to cope with the steadily increasing traffic for the time being. The fast ferry carried trucks full of the quarried and crushed laterite from the mainland to the peninsula; the quarry became indispensable as a source of laterite for Cam Ranh peninsula.

The 102d Engineer Company (Construction Support), commanded by Captain Jesse M. Tyson, Jr., was assigned the responsibility of producing asphalt and rock. A unit with this job should have consisted of 6 officers and 158 enlisted men with quarrying, asphalt paving, and other specialized engineer equipment. Captain Tyson and his lieutenants had had no experience in asphalt production, but by making use of the knowledge of some of its non-



AERIAL VIEW OF MY CA FLOAT BRIDGE, *with 10,000-foot Cam Ranh airfield runway in background. Radio-connected control points at each terminus directed traffic.*

commissioned officers the 102d set up a plant and successfully accomplished its mission. The 102d Engineer Company began crushing rock on 3 November to meet the demands of the company's asphalt plant. Soon thereafter the roads on Cam Ranh peninsula took on a new look.

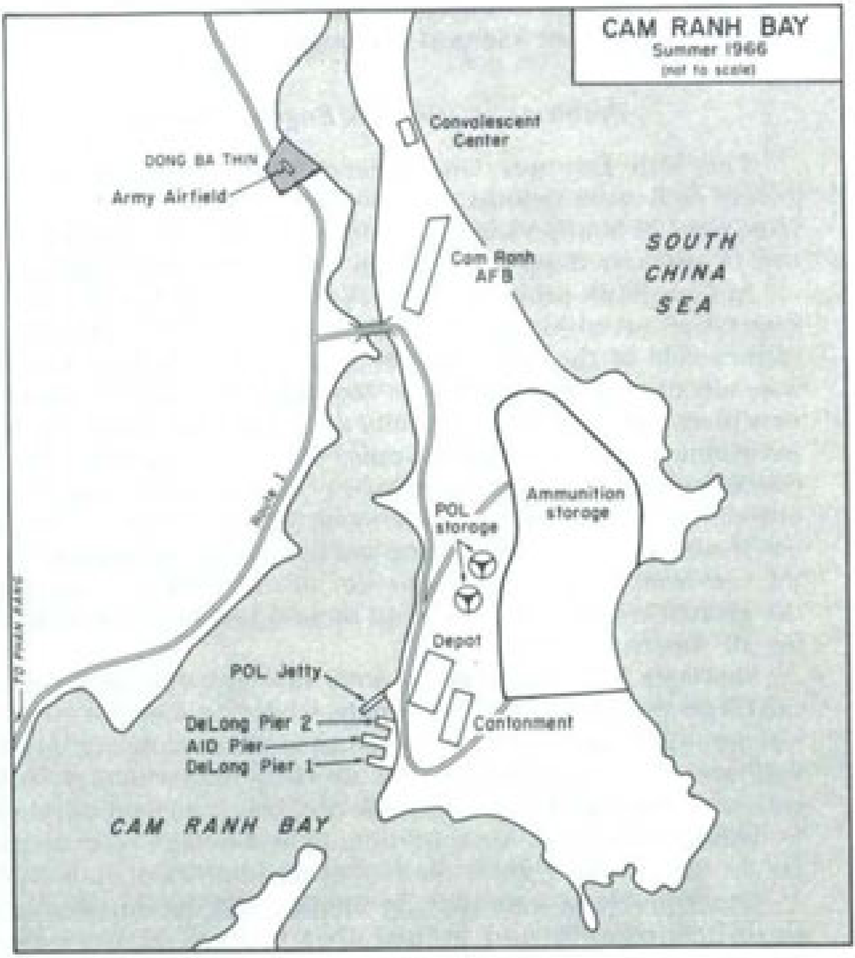
Traffic between the peninsula and the mainland had meanwhile reached the point where the 553d's rafting operation was again inadequate. About half the unit's equipment had been sent to Qui Nhon in support of the 937th Engineer Group. Finally, early in January 1966 the 35th Group received long-sought permission to install a floating bridge. The 39th Engineer Battalion (Combat), commanded by Lieutenant Colonel Ernest E. Lane, Jr.,[2] together with the 553d Engineer Company and the 217th Vietnamese Army Engineer Float Bridge Company, commanded by Captain Ngo Duy

[2] Colonel Lane was later killed by enemy ground fire while on a reconnaissance mission near Vung Ro Bay. The port at Vung Ro was subsequently dedicated to him and bears his name.

CONVALESCENT HOSPITAL UNDER CONSTRUCTION AT CAM RANH. *Buildings are made of frame sections, precut and prefabricated on site, and have concrete floors and sheet metal roofs.*

Lam, then proceeded to build the one-lane bridge across the 1,115-foot expanse of the Bay at My Ca. The bridge was assembled into rafts on 6 and 7 January 1966 and installed in sixteen hours on 8 January. The I Field Force commander, who flew over the bridge on 8 January, had flown over the site the day before when there had been no bridge. Upon noticing the newly installed bridge he could only exclaim "Where did that damn thing come from?" Construction of the bridge posed no particular difficulty other than that of devising an anchoring system to cope with reversals in current caused by tide and wind. The participation of Captain Lam's Vietnamese bridge company was essential to the project since the 553d did not have enough bridging to complete the lengthy span, nor could it be accumulated from other points in South Vietnam because of potential tactical demands. Through the kind of ingenuity and resourcefulness reflected above, the complex at Cam Ranh Bay took shape between June and January of the engineers' first year in Vietnam.

The strength of the 35th Group increased greatly on the first day of 1966, when the 20th Engineer Battalion from Fort Devens, Massachusetts, and the 39th Engineer Battalion from Fort Campbell, Kentucky, had arrived at Cam Ranh aboard the USNS *Wigle.*



MAP 4

Their arrival enabled the group to accelerate the construction of warehouses, hardstands, and a convalescent hospital north of the airfield complex, and at the same time to provide at least one company in combat support of either the 2d Republic of Korea Marine Brigade at Cam Ranh or the 1st Brigade, 101st Airborne Division, at Tuy Hoa. The 102d Engineer Company began improving the internal movement of traffic by producing pavement for the existing roads on the peninsula. The 87th Battalion continued work on cantonments and the connections for the petroleum facilities south of the air base. The 864th continued work on the depot and the automatic data processing facility. By the middle of 1966 Cam Ranh

Bay was a thriving complex containing even clubs, canteens, chapels, dispensaries, and post exchanges. (*Map 4*)

Problems of the 35th Engineer Group

The 35th Engineer Group encountered numerous problems during its first six months of operation in the new and hostile environment of South Vietnam. Unforeseen difficulties escalated the cost of engineer troop construction beyond the initial projections.

At Cam Ranh peninsula the lack of man-made facilities made it imperative to build necessary troop facilities, thus delaying the construction of the more sophisticated logistic complex. Construction was not the expedient type acceptable for tactical situations; structures had to be built carefully and solidly to endure the harsh environment for an extended time. The lack of ground lines of communication between commanders and their units caused extraordinarily heavy reliance on air and sea lines of communication, the use of which was time consuming and costly. The attempts to isolate the war from the "normal existence" of the Vietnamese people to the greatest extent possible caused tactical and logistical headaches for all American forces.

Shortages in electrical power were an early problem for American forces throughout South Vietnam, where the demand for power was unusually great. The hot, humid climate made refrigeration vital and air conditioning more a necessity than a luxury. Refrigeration was required for a multitude of things from medical supplies to flashlight batteries. Air conditioning became almost as necessary for the men working inside the sweltering administrative buildings.

Other problems were those of funding and the initial policy of single-item requisitioning insisted upon by the U.S. Army, Pacific, Inventory Control Point. Use of the peacetime procedures of programming, justifying, and accounting for funds reduced engineer capacity at the foxhole and bulldozer level. The U.S. Army, Pacific, policy of single-line requisitioning did not insure the most timely supply of construction materials. For example, if base development plans called for the construction of a particular type of cantonment, each item necessary to construct the facility had to be requisitioned as a distinct piece of material. Such a system was in marked contrast to a bulk requisitioning system keyed to bills of materials for pre-engineered facilities that could have provided at one time all materials necessary to construct a cantonment of the size and standard specified in the requisition.

Commanders at all levels were forced to turn their attention to base development planning. At the group level the task at first

EROSION CONTROL AT DONG TAM *in the delta where sandbags and burlap treated with peneprime (asphalt derivative) were used.*

seemed too large for the organization. Staff officers were obliged to concentrate on construction already in progress and had little time to devote to long-range planning. Nevertheless, planning sections were established and well-conceived base development plans were devised to guide construction throughout the group's area of responsibility.

To help alleviate the manpower shortages during the early phases of the mammoth construction program in Vietnam, engineer commanders sought to hire skilled laborers from the indigenous work force. But the predominantly agricultural economy of South Vietnam had not produced many men with the technical skills required in so many branches of construction. The few skilled workers that were available had been snapped up by civilian contractors before the Army engineers were committed to the struggle. Although the 35th Group did manage to find and employ a few experienced draftsmen, most of the Vietnamese hired were common laborers. To overcome this shortage in technical skills, training programs were instituted at various unit levels to teach new skills to the local Vietnamese and to develop those skills through experience gained on the job. Two ends were thus served. Overburdened engineer commanders benefited from a competent work force, and previously untrained Vietnamese acquired skills that would serve them and their country after the Americans were gone.

A shortage of handling equipment at the 53d Engineer Supply Point Yard caused long delays in the off-loading and distribution of needed materials. In addition, advance reports of incoming shipments were inconsistent and misleading, and the officer in charge of construction found it impossible to plan or schedule the necessary construction operations. Construction projects were often delayed because appropriate construction materials were not available.

In the process of building on Cam Ranh peninsula, insufficient attention was given the existing ground cover. In clearing and leveling work sites the first U.S. engineers removed the scanty scrub cover. Later, in November, the monsoon season brought serious erosion. The heavy rains frequently washed out completed work and roads, and the fierce winds drifted the sand like snow. These problems were later minimized by selective planting of grass and the erection of snow fences.

The year 1965 saw the number of engineer troops in Vietnam increase from less than a hundred to more than seven thousand. The 35th Group landed on a bleak sandy peninsula in June, and by December had effectively "tamed the sands at Cam Ranh Bay." It was also a year of learning. The problems encountered were many and varied, but the Army engineers proved that they could adapt to their new environment.

CHAPTER V

The Initial Engineer Command

The 18th Engineer Brigade

In mid-June 1965 Secretary of Defense Robert S. McNamara announced that a substantial troop buildup was about to begin in Southeast Asia. Within a month orders were received at Fort Bragg, North Carolina, returning the Headquarters, 18th Engineer Brigade, to active duty. Movement orders arrived at brigade headquarters on 30 July and the unit left for Vietnam one month later.

The 18th Brigade, under acting commander Colonel C. Craig Cannon, spent its first six weeks at Fort Bragg frantically gathering a staff of 34 officers and 110 enlisted men qualified to fill its table of organization. The brigade command staff, most of whom came from the already alerted 159th Engineer Group, would have to provide the manpower necessary to co-ordinate the construction activities of three to four engineer groups and their battalions. The mission of the brigade also required that it provide a technical staff capable of handling the engineer planning and design problems encountered by its subordinates. These technicians were an important addition to the limited planning and design staff already supporting engineer troops in Vietnam.

During the course of Colonel Cannon's preparations for the 18th Brigade's move to Southeast Asia, steps were taken to assign an engineer general officer as the brigade commander. The lot fell to Brigadier General Robert R. Ploger, then in command of the New England division of the Corps of Engineers. Almost totally unaware of plans for the detailed development of the engineer buildup in South Vietnam, in August he was just four months into an engrossing assignment with responsibility for Corps of Engineers participation in water resource development and shore protection in the six New England states.

At 11 p.m. on 12 August (which happened to be his birthday) General Ploger received a phone call from the Chief of Engineers, Lieutenant General William F. Cassidy, who informed him that he had been selected to command the 18th Brigade and that he should plan to be in Saigon on 1 September to meet the brigade's advance party. Little more than a week later, General Ploger met in Wash-

TABLE 2—TROOP LIST, 18TH ENGINEER BRIGADE, 21 SEPTEMBER 1965

Unit	Officers	Warrant Officers	Enlisted Men	Total
18th Engineer Brigade	31	2	119	152
35th Engineer Group (Construction)	26	4	169	199
62d Engineer Battalion (Construction)	42	7	807	856
87th Engineer Battalion (Construction)	33	11	758	802
864th Engineer Battalion (Construction)	39	13	828	880
102d Engineer Company (Construction Support)	4	2	128	134
497th Engineer Company (Port Construction)	12	1	199	212
513th Engineer Company (Dump Truck)	3	0	101	104
553d Engineer Company (Float Bridge)	6	1	134	141
569th Engineer Company (Topography)	3	3	109	115
584th Engineer Company (Light Equipment)	4	1	175	180
Subtotal	172	43	3,408	3,623
937th Engineer Group (Combat)	21	8	97	126
19th Engineer Battalion (Combat)	30	3	533	566
70th Engineer Battalion (Combat)	30	3	547	580
84th Engineer Battalion (Construction)	39	10	796	845
362d Engineer Company (Light Equipment)	5	1	144	150
509th Engineer Company (Panel Bridge)	2	0	125	127
511th Engineer Company (Panel Bridge)	4	0	103	107
Subtotal	131	25	2,345	2,501
Grand Total	334	70	5,872	6,276

counter any enemy threat to the accomplishment of their mission."

Finally, General Ploger reminded his engineers that they were visitors in a foreign land. Though their work would be directed primarily toward the success of military operations, their attention must extend to a consideration for the "development of a sound economy and an improved environment" for the citizens of Vietnam. *(See Appendix E.)*

On 4 November General Ploger gave as his first engineer briefing to General Westmoreland an overview of the engineer situation in Vietnam. At this meeting General Ploger discussed the magnitude of the construction program and gave General Westmoreland an idea of the limitations that were already hampering the building effort. He also described in some detail the peculiar problems faced by the 18th Brigade and the unique circumstances surrounding engineer operations in Vietnam. *(See Appendix A.)*

The mission of all Army engineer operations in Vietnam was characterized simply as an effort to "enhance and promote" the ability of the U.S. Army and its tactical allies to win. Of primary significance was engineer support of tactical operations; the importance of responding to the needs of tactical commanders was to be kept foremost in every engineer's mind. The construction effort that would augment the tactical support of combat units was designed first to meet the minimum needs of all units in Vietnam, then gradually to refine existing facilities. To insure standardized development, six precisely defined levels of physical improvement were outlined. They ranged from Standard 1, with no site preparation, to Standard 5, Modified, which was substantial enough to permit occupation for longer than twelve months. *(See Appendixes A and B.)*

Limited funding for building materials and the severe shortage of engineer soldiers in Vietnam placed many unavoidable limitations on this construction program. Considering the available manpower resources, the initial goal of the Army engineers was to provide all supported units with troop cantonments and administrative centers equal to the Standard 4 level before further upgrading. Wooden frame buildings would be built to house all administrative functions and piped water from central storage tanks would be available at each cantonment site for infirmaries, bath houses, and kitchens. Troops would be quartered initially in tent-covered frames with floors. Electricity would be provided to both administrative buildings and troop quarters.

The difficulty of moving heavy construction machinery and the lack of adequate stocks of spare parts were to hamper the efforts of the engineers. Weight limitations placed on airmobile operations made the movement of heavy pieces of equipment such as scrapers, graders, and tractors from one part of the country to another virtually impossible except by relatively slow water transport. Most roads in Vietnam were either in poor repair or ran through areas heavily infested by the Viet Cong, making convoy traffic both difficult and susceptible to interception.

Operations were further complicated by the lack of construction material. Enemy activity in the countryside and the absence of a significantly productive lumber industry in Vietnam necessitated ordering and shipping all wood products from points outside Vietnam. Few rock quarries were in operation; potential quarries would have to be developed and provided with men and machines if they were to supply the needs of the proposed construction program. Even sand of the proper consistency was scarce or inaccessible from work sites.

Goods could not be allowed to arrive in Vietnam haphazardly. Since 15 percent of all expected materials was related to construction needs, these materials would have to be carefully distributed to points of intended use. The arrival of supplies in Saigon that were need in Cam Ranh Bay, for example, would only create yet another logistic exercise for an already severely taxed support system. Tactical operations dependent on the timely arrival of supplies for bridge building, road improvement, and other combat engineer services demanded advance attention to unloading priorities.

Engineers in Vietnam were forced to cope with a number of distinct environmental features. The high water table that resulted from heavy rainfall and the low terrain in much of Vietnam created problems in drainage and earthmoving.

Weather and the Viet Cong were constant foes in the battle to open and maintain lines of communication throughout the country. Roads were washed away as heavy rains drenched the countryside in the monsoon season. The previously extensive nationwide rail network had been chopped up by enemy action, rendering it totally ineffective for either military or civilian purposes. Enemy saboteurs disrupted even the local residual rail traffic around Saigon by attacks on bridges and sections of track. Fortunately the railroad directorate of the government of the Republic of Vietnam proved to be one of the most aggressive and competent government agencies and continued to thrust spur lines outward from many of the former rail-served population centers. The rail system expanded without help from U.S. and allied engineers but was limited by need for major rail bridges which had been destroyed by enemy forces and which could not be replaced until structural materials arrived.

The planning of logistic centers and troop cantonments was hampered by the inaccessability and poor quality of land made available to many military construction projects. Only the least valuable land could be obtained, and it always came encumbered with an imposing variety of engineering handicaps.

The local economy could offer only insignificant assistance in overcoming engineering and construction difficulties. The population was small and relatively unskilled. The civilian contracting firms which had been in Vietnam since 1962 had absorbed most of the skilled labor force. The Army had to train and then manage any people who were available for hire. The local market afforded no source for construction supplies for anyone but local inhabitants. The already inflated economy could ill afford the injection of more American dollars, nor could the Vietnamese farmer or consumer hope to compete with the Americans, whose demands were so great, in the open market for the scant stock of building tools and materials. It was early evident that the U.S. military would have to import to meet its needs.

The entire military procedure being followed in Vietnam put pressures on the Army engineers that they had never before experienced. Providing base camp security at night by floodlighting the surrounding area demanded generators capable of producing sustained electric power. Construction plans called for sophisticated products, while the draftee-soldier and even many of the Regulars provided for the job had limited training and virtually no experience at the level of sophistication demanded. In short, expectations directed toward engineer troops were at a new high, while the preparedness of engineer soldiers appeared to be approaching a new low. The credit for engineer success rightfully belongs to those engineer leaders, officers and noncommissioned officers of the Regular Army, who applied education and experience with dedication to overcome shortcomings in their subordinates.

General Westmoreland on 4 November 1965 approved the suggested list of priorities that guided engineer officers in the field in the accomplishment of their mission through the next two years. In late 1966, as a separate action, he gave high priority to the development of port facilities and the expansion of rock production.

To ease the strain generated by supply shortages in both construction materials and repair parts available to units in the field, the 18th Engineer Brigade took advantage of the establishment of a red ball shipping system designed to expedite the movement of specific urgently needed items of supply by air delivery from the United States to Vietnam. The pressure for spare parts led to air delivery of complete bulldozer tracks and other heavy items seemingly inappropriate for airlifting across the Pacific. As early as

October 1965 goods were being tied up offshore because port facilities were incapable of meeting the heavy demands being placed on them. The materials for building improved port facilities would be many months in arriving.

Nevertheless, the engineers were making progress. By the end of the year the 18th Engineer Brigade had grown to three group headquarters, ten battalions, and twelve separate companies, all working, in spite of frustrations, at the steadily growing construction demands before them.

Funding

When the 18th Engineer Brigade took command of the engineer operations formerly directed by the 1st Logistical Command, it also assumed responsibility for a growing funding problem which had little precedent in the history of military construction. Traditionally, combat construction had been financed with military operating funds which demanded only limited field accounting. Seldom had construction operators been required to do any kind of cost accounting in the field.

Two aspects of construction in Vietnam altered the traditional flow of operational funds for the support of construction in the war zone. For the first time American contractors were used to a significant extent in a foreign combat zone. Though their work was done primarily in well-secured areas, the absence of a front line made their activities susceptible to interruption by the enemy. In 1964 the Office of the Secretary of Defense decided to centralize the approval of construction requests through the use of standard military construction programming and funding procedures. This decision meant that construction requirements in Vietnam would have to be estimated and programmed in dollars, then converted into material and equipment needs as well as work force and management requirements. The need to recognize construction requirements in terms of dollars introduced many new funding problems into the buildup.

The principal source of financing for construction work for the Army in Vietnam was the Military Construction, Army, account. Funds for this account were appropriated by the Congress to build facilities that were expected to become permanent structures in those projects estimated to cost more than $25,000. Features designed in master plans for base development usually fell into this category; the surfacing and drainage of access roads and internal roads, the deliberately installed sewerage systems, and the security lighting or fencing connected only incidentally with the defensive fire plan of an installation were examples of items considered appropriate for charges to Military Construction, Army, funds.

Permanence of a completed facility was the critical determinant for the use of Military Construction, Army, funds. Water towers with metal tanks, power plants designed in accordance with base development plans, and structures intended to provide long-term service to installations dictated financing through these funds. Even self-help projects designed to conform to or be ultimately incorporated into base development plans or utilities designed for the semipermanent support of the facilities fell into this category.

The normal procedure for financing through Military Construction, Army, was extremely slow, tied as it was to the normal military budget cycle. Though the engineers pleaded that flexibility in applying funds would better serve tactical field commanders, Congress would not grant what was in effect a blank check for military construction in Vietnam. Military Construction, Army, funding required that requests be submitted in advance with a "reasonably defined project" in mind. In view of the tremendous scope of the proposed construction program, the Office of the Secretary of Defense had said, careful advance planning would have to become an important part of all military construction in Vietnam.

The requirement for detailed prior planning suggested a system of increment funding which in itself went well with the administration's policy of a "graduated response" to tactical needs as they arose. Problems began to develop when the time necessary to pass Military Construction, Army, fund requests through channels and the lack of manpower needed to compile the supporting information began to hinder tactical operations taking place in the field.

General Ploger had been in command of the 18th Engineer Brigade for only a few weeks when a message arrived from the Army command in Hawaii advising him that requests detailing the construction planned for Vietnam in the next year had to be sent forward immediately. Pentagon planners needed the information to prepare budget requests to be submitted to the Congress. Each project planned would be budgeted individually for review by Congressional committees in much the same manner that construction projects were funded for the Army posts in the United States.

The recent arrival of brigade headquarters personnel and their immediate concern for responding to the evident needs of U.S. troops already in South Vietnam or scheduled to arrive made the preparation of a precise budget request for the coming year's undetermined construction program nearly impossible. Funding regulations required that a detailed statement be drawn up for each prospective project, giving the precise location and user of each site, the facility size, its cost, and the amount of construction needed to complete the project. Yet the planners in Vietnam had no clear idea of even the types of troop units that could be expected over the next year. Itemizing the construction requirements for an uncertain future buildup was a job the brigade was ill equipped and inadequately manned to handle, particularly when it was at the same time occupied with the pressing matter of keeping pace with the present military manpower and material buildup.

General Ploger immediately dispatched a message to Hawaii saying that he had neither the men to spare nor the expertise available in his command to prepare detailed projected planning résumés. He asked the engineer staff in Hawaii to send him men who had had experience in compiling the facts and figures needed to prepare Congressional budgetary requests. Within a week Colonel Joseph H. Collart arrived in Saigon with a staff of civilians trained in the preparation of Military Construction, Army, budget requests. Their work led to the allocation of funds with which the 18th was able to maintain its early construction momentum in Vietnam.

After preparing the initial funding requests, Colonel Collart and his staff returned to Hawaii, but the accounting requirements remained. Once a project was approved by Congress, the administrative effort needed to sustain it had only begun. Monthly reports had to be forwarded to Washington indicating the dollar value of materials installed during the month and the percentage of work completed in terms of the value of materials in place compared to the final estimated total cost. The degree of accuracy and the detail called for by Military Construction, Army, accounting regulations placed demands on local field commanders that, if allowed to stand, would soon have detracted from construction progress.

After his initial exposure in South Vietnam to application of the complicated Military Construction, Army, procedures, General Ploger set about developing a system that would simplify the accounting load in the combat zone and still meet legal minimums. He acted first to remove cost accounting as a responsibility of engineer company and battalion commanders. Field engineer commanders were instructed to use their judgment, applying the set of approved priorities as a guide, in initiating construction projects. Commanders were required to keep the brigade, which managed all accounting procedures, informed of the start of each new project so that funds could be reprogrammed to accommodate materials withdrawn from stock for the necessary but yet unbudgeted projects.

A system for periodic progress reporting that incorporated the maximum use of bills of material and strength accounting was instituted. Routinely produced for other purposes, these still could provide a general picture of the construction progress in Vietnam. Some relief came when a ruling from the Office of the Secretary of Defense required material accountability to be only as accurate as general engineering estimates. Indicators of work completed were to be measured by man-hours expended in comparison with the estimated total man-hour requirement. This was far easier to determine than the value of materials in place. Every change made was aimed at making reporting as simple as possible yet responsive to the variable of tactical operation as well as to the needs of military budget managers.

The problem of stockpiles of construction material was handled by permitting only one stock in the country. There was no attempt, as regulations would have dictated, to separate supplies originating from separate funds. All materials were placed in the same stockpile and the supply accountants were expected to see that no project suffered for lack of materials because it happened to be funded by a source not having a stockpile at the moment. Materials were costed to a particular funding source only when they were used on a project.

These simple adjustments in the control of Military Construction, Army, funding and costing saved many hours and much paper work for the war effort in Vietnam. Had the original system been allowed to stand, construction could not have met the tactical needs of the field commanders. Many men would have been drawn from the construction units in order to accomplish the detailed computations and reporting normally prescribed.

Costs of the day-to-day operation of the Army were paid from resources of the operation and maintenance, Army, fund. The principal engineer targets for these annual appropriations were projects directly associated with support of tactical operations. Tactical bunkers other than those sited on base development plans, security lighting for short-term defensive deployments, and expedient power installations, including temporary distribution systems, were authorized to be charged to these funds. Materials used to control dust, short of semipermanent surfacing; matting used to surface airfields; and materials expended in the installation of tactical bridging, regardless of location, also fell into this category.

Certain other minor construction projects could also be built with operation and maintenance, Army, funds. The critical determinant here was the degree of permanence the completed facility was to have. If the installation was to be replaced by a more lasting facility, it could be paid for with these funds. Structures designed to protect tactical tentage or to facilitate maintenance or storage, except when the design was intended to accommodate semipermanent or prefabricated buildings, were also chargeable to these funds.

Supplementing the operation and maintenance, Army, allocation were monies from funds for procurement of equipment and missiles, Army. Not an annual appropriation, these funds were part of the capital account of the Army. Theoretically, materials purchased with money from this account would someday be returned to the United States. In practice this was frequently not feasible because disassembling was usually more expensive than the original expenditure. Oil storage tanks, pumping equipment for oil pipelines, and tactical bridging were usually funded under this account.

Aid-in-kind funds also contributed to construction through the purchasing of labor services and materials that might become available locally, such as sand and rock. Contracts funded by this account were awarded occasionally to local contractors to carry out work in support of Military Assistance Command, Vietnam, adviser detachments. The contracts seldom ranged above the $100,000 mark.

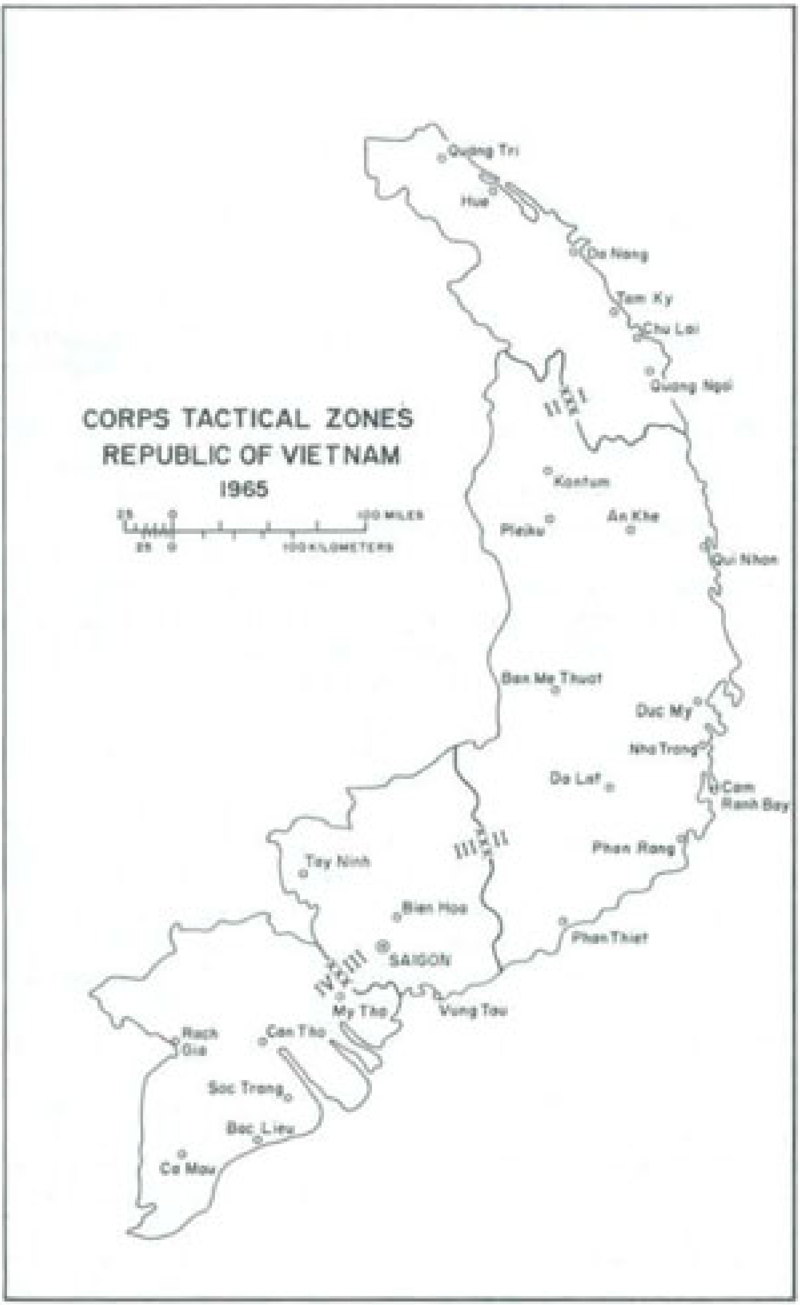
CHAPTER VI

Engineer Group Deployment

In evaluating the logistical and tactical requirements for engineer support for the U.S. Army in Vietnam, certain geographical and tactical factors had to be considered. The physical geography of the country, a long narrow land mass bordered on one side by Cambodia and Laos and on the other by the sea, and the insecure land lines of communication dictated a logistical concept oriented from the sea toward the Cambodian and Laotian borders. Because the Viet Cong were able to interrupt continuously traffic along the highway network, north-south lines of communication were restricted mainly to sea and air. The country was divided into four areas, or tactical zones, which required semiautonomous support: I Corps, the northernmost sector of South Vietnam, in which the U.S. Navy retained initial responsibility for engineer support; II Corps, which contained the two major ports of Cam Ranh and Qui Nhon; and III and IV Corps, which for initial engineer support purposes were grouped as one. *(Map 5)*

In 1965 most combat consisted of guerrilla activity or small unit engagements. Fighting could and did erupt anywhere and at any time. Knowing that isolated inland locations were vulnerable, commanders placed newly arriving engineer units at strategic points along the coast of South Vietnam to provide maximum support during the first months of the buildup. From the time the first engineer units reached Vietnam, every effort was made to prepare for the tremendous influx of U.S. military forces which would follow.

The most immediate need for combat and support engineers existed in northern II Corps where enemy forces were making a concerted effort to cut the country in two along the Pleiku–An Khe–Qui Nhon axis. In response to the urgency of the situation in II Corps Tactical Zone, the advance parties of the 70th Engineer Battalion (Combat) and the 937th Engineer Group headquarters arrived at the coastal city of Qui Nhon on 16 August 1965 to prepare for the main body of their troops that would arrive a week later. The 70th, which arrived at Qui Nhon on 23 August, was the first engineer combat battalion in the Republic of Vietnam.


CORPS TACTICAL ZONES
REPUBLIC OF VIETNAM
1965
25 0 100 MILES
25 0 100 KILOMETERS
Quang Tri
Hue
Da Nang
Tam Ky
Chu Lai
Quang Ngai
Kontum
Pleiku
An Khe
Qui Nhon
Ban Me Thuot
Duc My
Nha Trang
Da Lat
Cam Ranh Bay
Phan Rang
Tay Ninh
Bien Hoa
Phan Thiet
SAIGON
My Tho
Vung Tau
Rach Gia
Can Tho
Soc Trang
Bac Lieu
Ca Mau

MAP 5

The arrival of the 70th Battalion and the 937th headquarters significantly changed the engineer situation in II Corps Tactical Zone. Both organizations were experienced, having been in fully trained status for some time at Fort Campbell, Kentucky, before their deployment to Southeast Asia. Their immediate mission was to begin preparations for adequate logistical and tactical support of the 1st Cavalry Division (Airmobile), whose arrival was imminent.

The 84th Engineer Battalion (Construction) minus Company D had been in Qui Nhon since 11 June as part of the initial deployment of engineer forces with the 35th Engineer Group and had been working since then on the preliminary aspects of depot construction and improvement of Qui Nhon's port. A provincial capital and coastal city, Qui Nhon is located at the eastern terminus of National Route 19, which runs west to Pleiku and the Darlac Plateau. Although Qui Nhon had only a limited port capacity, it possessed a reasonable network of streets and roads for moving supplies as well as available land that was suitable for military facilities. The city's location made it a gateway to the northern section of II Corps Tactical Zone. The 937th assumed the responsibility for building into the quiet city an operating logistics base. Accumulating equipment for the many construction projects, however, had to be paced to the off-loading of engineer items by ship-to-shore shuttle. The advance party of the 70th Battalion had been fortunate enough to meet the ships carrying the battalion's equipment, and by the time the troops of the main body crossed the beach their equipment was ready and waiting. Drivers went immediately to their vehicles and the battalion moved directly to its base camp on the outskirts of the city. After the 937th Group had moved ashore and become operational, it assumed command, under the 1st Logistical Command, of the 84th (–) and 70th Battalions.

The 937th's most immediate task was the preparation of a cantonment site for the 1st Cavalry Division. The 70th Battalion, under cover of the 1st Brigade, 101st Airborne Division, moved forty kilometers over Route 19 to An Khe where, under the planning guidance of the 8th Engineer Battalion of the 1st Cavalry Division, it began construction of the base camp. A two-lane access road, 1.3 miles long, had to be constructed from Route 19 through the jungle of the An Khe valley in order to get men and equipment into the area to be developed. As was the case in most road building operations in South Vietnam, the engineers first had to find a large enough rock deposit and develop a quarry to produce the crushed rock necessary for a road foundation. Six thousand five-ton truckloads of fill were eventually hauled in for the access road. At the site preliminary activities included clearing, stripping, and grading nearly a million square yards of land. The advance party of the division under the direction of the assistant division commander, Brigadier General John M. Wright, Jr., hired hundreds of local Vietnamese to clear the land to topsoil level with the objective of retaining sod as permanent protection against the downwash of helicopter blades. The 70th worked meanwhile on a circumferential road for access to each assigned bivouac location.

The 70th Battalion had quickly established itself as the workhorse of the 937th Group. While it was providing direct engineer support for the 1st Cavalry, it was given the task of constructing bridges, roads, helipads, hospitals, guard towers, ammunition storage areas, administration buildings, and a 20,000-man cantonment. Lighting, water, and base security were also provided by engineer troops at An Khe. Throughout its logistical support mission the 70th maintained its tactical posture. On several occasions the engineer troops served as either the combat reaction force for the divisional support brigade defending the An Khe base camp or as part of the perimeter defense force.

In Qui Nhon the other major component of the 937th, the 84th Engineer Battalion (minus Company D) was encountering a problem that became all too common among engineer units in Vietnam. In the course of expanding the logistical facilities at the port of Qui Nhon, the 84th discovered that many of the prefabricated buildings, which were to be used widely in Vietnam, had arrived without some of the necessary construction components. The battalion was able to improvise and fabricate locally many of the missing items, but not without added costs and delays. Work schedules ran around the clock in an effort to keep pace with the ever-increasing demands; however, the theater-wide lack of construction materials and shortages of repair parts for engineer equipment plagued the engineers and caused construction to lag behind over-ambitious schedules. Incoming units bolstered the manpower of the 937th, but delays in the delivery of necessary equipment and materials limited the effectiveness of the new troops.

The lack of port capacity in Vietnam in 1965 was perhaps the most acute problem during the influx of American forces. Vessels carrying engineer equipment, supplies, and construction material often waited offshore for weeks to unload their cargoes while construction projects languished for lack of materials.

The 19th Engineer Battalion (Combat) arrived at Qui Nhon from Fort Meade, Maryland, on 2 September at almost the same time as elements of the 1st Calvary Division (Airmobile) landed. In the face of priorities for tactical units, the engineer equipment met delays in off-loading. The battalion could not contribute fully to the construction effort until 5 November when it undertook the assigned construction of a major aviation facility twelve miles west of the city. Within one hundred days the combat battalion constructed a macadam heliport in the shape of a Christmas tree and capable of supporting fifty UH-1 (Huey) helicopters. A maintenance area and the basic living facilities for two aviation companies were included in the heliport.

On 26 October, after deployment from Fort Gordon, Georgia, the 299th Engineer Battalion (Combat) landed at Qui Nhon. As in the case of the 19th, delays in the arrival and unloading of equipment prevented the battalion from becoming operational until it had been in Vietnam for nearly a month. In November the 299th began construction of a permanent ammunition storage area near Qui Nhon, at the same time expanding and upgrading the road network in and around Qui Nhon. By Christmas of 1965 Qui Nhon was providing a base of logistic support for the tactical forces operating in northern II Corps.

In the southern part of South Vietnam in the III Corps Tactical Zone around Saigon, there was a sharp need for engineer troops by the fall of 1965. On 15 September 1965 Headquarters, U.S. Army, Vietnam, approved a diversion of the 46th Engineer Battalion (Construction), en route to Vietnam from Fort Leonard Wood, Missouri, from Qui Nhon to Vung Tau. When the 46th arrived at Vung Tau, a shallow-draft port approximately thirty-five miles southeast of Saigon, it picked up Company D of the 84th Engineer Battalion. Later, when the main body of the 46th Battalion moved on to establish its base camp at Long Binh, D Company of the 46th was transferred to the 84th Battalion at Qui Nhon to replace the 84th's D Company, which had earlier been diverted to Vung Tau.

On 16 October D Company of the 84th Battalion was redesignated D Company of the 46th and continued its work on the logistical complex and port at Vung Tau. As soon as the 46th became operational it was made a subordinate unit of Headquarters, 18th Engineer Brigade, which had only recently arrived in Vietnam and established itself in the Saigon area. This initial command relationship lasted for only three weeks, however. The headquarters of the 159th Engineer Group arrived in Vietnam from Fort Bragg on 30 September and was assigned control of all nondivisional engineer operations in the III and IV Corps areas.

During the late summer of 1965 at Fort Bragg, the 159th had been rebuilt after providing most of the men for the 18th Brigade headquarters. Upon its arrival in Vietnam, headquarters for the 159th was established at Long Binh just fifteen miles northeast

THE 93D EVACUATION HOSPITAL AT LONG BINH. *In an advanced state of construction in the spring of 1966 and of unique local design, this hospital had revetments around critical wards and on two sides of helicopter parking stands. Blackened area was treated with dust palliative.*

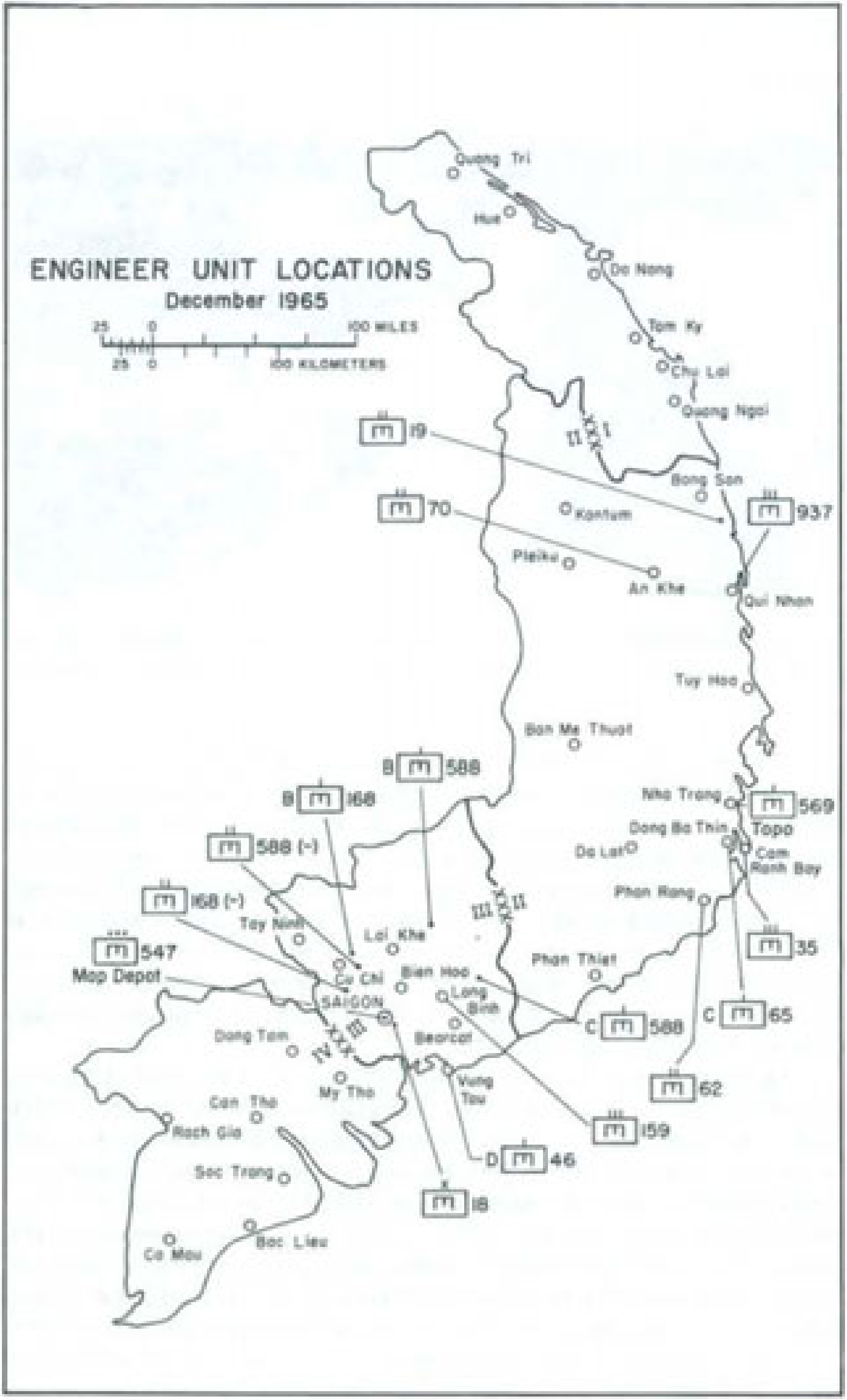
of Saigon in a once cleared area now overgrown with scrub jungle. Starting with a work force consisting only of the 46th Engineer Battalion, the 159th soon grew to include three battalions and two separate companies. The expansion of its command brought a corresponding expansion of tasks as the 159th began construction work at Di An, Lai Khe, and Phu Loi, base camps of elements of the newly arrived 1st Infantry Division. Members of the 159th also stretched to provide direct support to the 173d Airborne Brigade at Bien Hoa and the 1st Logistical Command at Long Binh. As directed by the engineer brigade commander, initial construction concentrated on providing a minimum of living quarters in the base camps of the various combat units and on hospital and logistics construction necessary to support tactical operations.

The first major project of the 46th Engineer Battalion was the construction of the 93d Evacuation Hospital at Long Binh. This 400-bed hospital was to consist of sixty vertical-wall quonset huts

PERIMETER DEFENSE OF 168TH ENGINEER BATTALION CAMP NEAR DI AN *withstood a number of attacks by Viet Cong from the nearby woods.*

(a circular arch roof, metal sides closed on both ends) on concrete floor slabs. The structures were arranged in X-shaped clusters of four with a roofed center square portion used as a nursing station to serve the four wards. Some forty-five days after ground was broken, the hospital was ready for patients. During the same period elements of the 46th also constructed a tactical operations center at Di An for the 1st Infantry Division and tropical buildings for the command flight detachment at Tan Son Nhut and began construction on what eventually became the largest ammunition storage area in Vietnam at Long Binh.

At Vung Tau, what had been Company D of the 46th Engineer Battalion was redesignated by Headquarters, 18th Engineer Brigade, as Company D of the 84th Engineer Battalion. Before the actual Company D of the 46th arrived in October, the decision had been made to have that unit proceed to Qui Nhon to join the 84th, thereby averting any loss in the continuity of operations in the Vung Tau area. Personnel rosters and property books were exchanged between the two battalions and the newly designated Company D, 46th Engineer Battalion, continued its previous operations. Significant progress was being made by the 46th in preparing the port at Vung Tau to handle the debarkation of men and equipment throughout the first year of the U.S. troop buildup in Vietnam.


ENGINEER UNIT LOCATIONS
December 1965
25 0 100 MILES
25 0 100 KILOMETERS
Quang Tri
Hue
Da Nang
Tam Ky
Chu Lai
Quang Ngai
Bong Son
Kontum
Pleiku
An Khe
Qui Nhon
Tuy Hoa
Ban Me Thuot
Nha Trang
Dong Ba Thin
Topo
Da Lat
Cam Ranh Bay
Phan Rang
Phan Thiet
Tay Ninh
Lai Khe
Cu Chi
Bien Hoa
Long Binh
SAIGON
Map Depot
Bearcat
Vung Tau
Dong Tam
My Tho
Can Tho
Rach Gia
Soc Trang
Bac Lieu
Ca Mau
19
70
937
B 588
B 168
588 (-)
168 (-)
547
569
35
C 588
C 65
62
159
D 46
18

MAP 6

On 2 November 1965 the 588th Engineer Battalion (Combat) from Fort Lee, Virginia, arrived at Vung Tau on board the USNS *Upshur* and immediately moved inland to its staging area near Bien Hoa. Various elements of this battalion were promptly dispatched to assist the 46th with construction projects already in progress.

The last battalion to join the 159th Group in 1965 was the 168th Engineer Battalion (Combat) from Fort Polk, Louisiana. The 168th debarked on 27 November at Vung Tau, which was becoming a major port of entry for American forces. In mid-December, after the battalion had moved inland and become operational at Long Binh, its headquarters and Company A went to Di An to assume responsibility for construction at the base camp of the headquarters and support brigade of the 1st Infantry Division. The remaining elements of the battalion relieved parts of the 46th Battalion in support of the 1st Division's 3d Brigade at Lai Khe and supplemented the construction work of the 46th Engineers at Long Binh.

The problems encountered by the 159th Engineer Group during the initial phases of its operation in the south matched substantially those experienced by the groups farther north. Shortages of materials slowed construction while the continuous influx of U.S. forces increased the demand for facilities. The inadequacy of the system for supplying repair parts caused essential pieces of engineer equipment to be deadlined for long intervals. The oppressive heat and seemingly omnipresent enemy created their own measure of discomfort and anxiety for the engineers who had to labor long hours. Despite adversity, the engineers made steady progress and by year's end construction was taking place at the maximum pace material and equipment resources would allow.

By Christmas of 1965 U.S. Army engineer forces in Vietnam had grown in eight months from less than one hundred to over seven thousand, and many thousands more were to follow. *(Map 6)*

CHAPTER VII

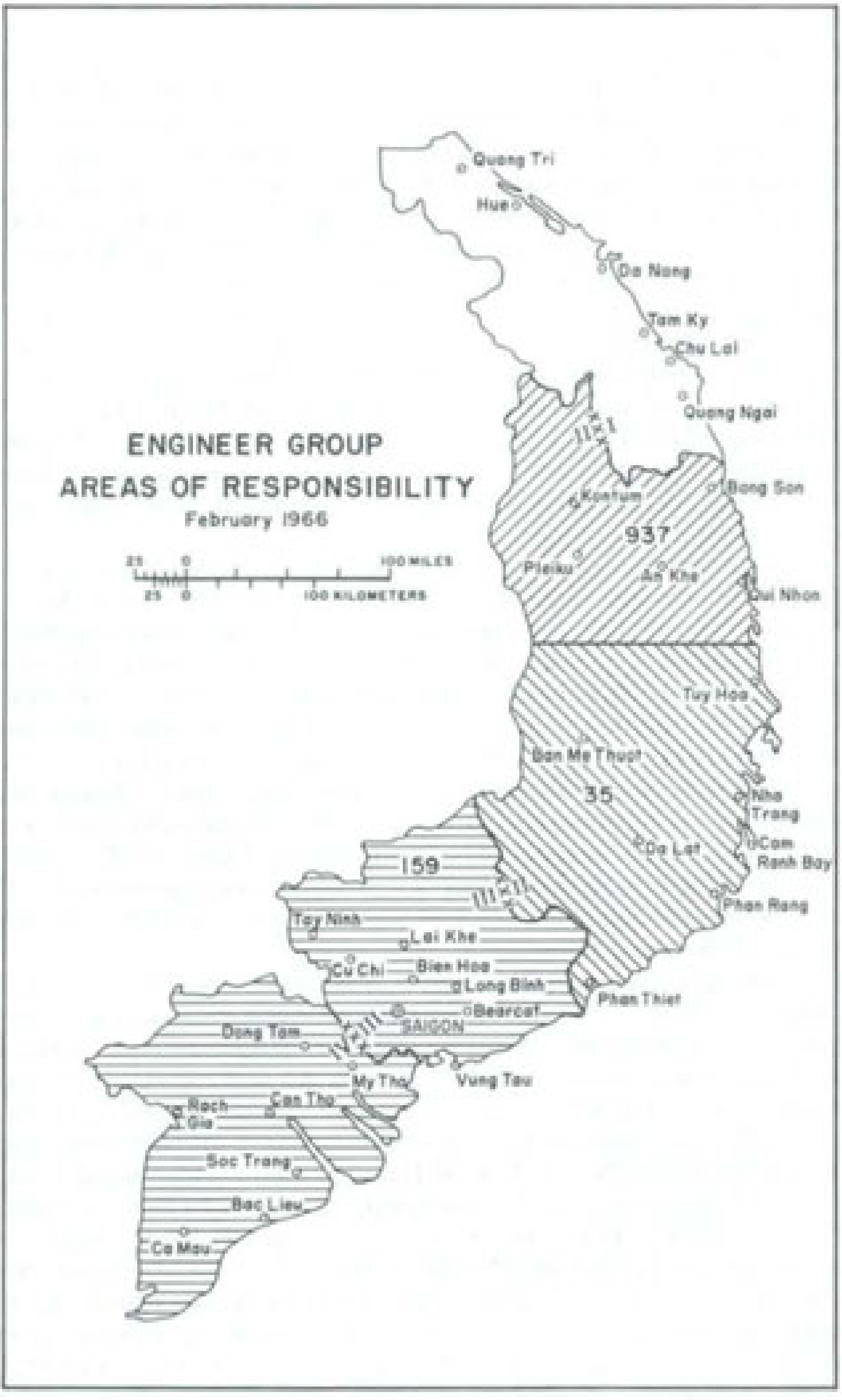
Engineer Mobilization and Performance

On Christmas Eve of 1965 President Johnson declared a halt in the bombing of North Vietnam as part of his "peace offensive" that was to last through the first month of the new year. His efforts to negotiate with the North Vietnamese through representatives of neutral countries met a flat refusal from Hanoi that dashed all hope of an early end to hostilities. Bombing was then resumed and American forces attempted a military solution by mounting a campaign designed to seize the initiative and carry the fight to Viet Cong strongholds. It was at the beginning of the peace move that the last engineers for some time to come arrived in Vietnam.

On New Year's Day 1966 the 20th and 39th Engineer Battalions, along with the 572d Engineer Company (Light Equipment), landed at Cam Ranh Bay and joined the 35th Engineer Group. With the exception of two separate companies that came in May and the 169th Engineer Battalion (Construction) that joined the 159th Engineer Group at Long Binh from Okinawa in April, no more engineer units would arrive in Vietnam until summer. During these months the 18th Brigade concentrated on providing the operational, logistical, and support facilities required for the rapidly expanding U.S. military forces. The plan for base development was to construct several deep-draft ports with satellite shallow-draft ports; to build major airfields, depots, and logistical facilities at the port complexes; to extend the land lines of communication inland from the ports; to build the necessary troop bases throughout the country; and finally to expand the roadnet to connect the major bases. As American participation in tactical operations increased, additional engineer effort had to be devoted to combat support. Concentration on base construction became impossible, though every effort was made to give each project some attention.

Engineer Command and Control

Although engineer forces in Vietnam at the beginning of 1966 still consisted of a single brigade with three subordinate groups, demands for engineer support mounted rapidly as American combat forces continued to stream into the country. (*Map 7*) Their arrival


ENGINEER GROUP
AREAS OF RESPONSIBILITY
February 1966
25 0 100 MILES
25 0 100 KILOMETERS
Quang Tri
Hue
Da Nang
Tam Ky
Chu Lai
Quang Ngai
Bong Son
Kontum
937
Pleiku
An Khe
Qui Nhon
Tuy Hoa
Ban Me Thuot
35
Nha Trang
Cam Ranh Bay
Da Lat
Phan Rang
Phan Thiet
159
Tay Ninh
Lai Khe
Cu Chi
Bien Hoa
Long Binh
Bearcat
SAIGON
Vung Tau
Dong Tam
My Tho
Rach Gia
Can Tho
Soc Trang
Bac Lieu
Ca Mau

MAP 7

necessitated a more extensive deployment of engineer troops throughout the 67,108 square miles of South Vietnam and created problems of command and control. Since all nondivisional engineers were either attached or assigned to the 18th Engineer Brigade and the brigade, in turn, to U.S. Army, Vietnam, no direct relationship existed between the brigade, its groups and battalions, and the combat forces. Direct co-ordination between the field force and divisional engineers and the engineer groups was authorized and encouraged, and was usually accomplished through an exchange of visits between field force, division, and group staff members. To facilitate co-ordination and utilize fully individual expertise, junior officers were often delegated responsibilities far beyond those usually assigned to them. The commander of the 18th, General Ploger, found that his junior officers responded to the demands made upon them with an ingenuity and resourcefulness that made them one of his great assets.

As commanding general of all nondivisional engineer troops in South Vietnam and as the Army Engineer on the staff of U.S. Army, Vietnam, General Ploger had dual responsibilities, an arrangement that conserved scarce manpower resources by eliminating the need for duplicate staffs at brigade and U.S. Army, Vietnam, levels and reduced the number of problems between planning and operating elements. Aware that charges of self-serving could easily arise from the potential power inherent in his position, General Ploger insisted that all construction priorities reflect the engineers' primary mission of combat support. The combination of his two offices gave General Ploger both procurement and management powers as well as an ideal position from which to supervise the allocation of equipment and material resources.

Vesting in one man both staff and command responsibility had long been doctrine in the U.S. Army at both division and corps levels of organization. When the 18th Engineer Brigade arrived in South Vietnam the logistics office of the U.S. Army, Vietnam, headquarters included a small engineer section staffed by Lieutenant Colonel Andrew Gaydos and one or two enlisted men. The larger engineer office in U.S. Military Assistance Command, Vietnam, was concerned with formulating policies to apply to Army, Navy, and Air Force activities, and could not cope with the co-ordination needed in the staff of the U.S. Army, Vietnam. Accordingly, the normal Army engineer tasks of co-ordination, of computing material requirements, of recommending priorities, and of advising the deputy commanding general of U.S. Army, Vietnam, General Norton, on engineer matters were initially absorbed by the staff of the 18th Brigade.

When Colonel William W. Watkin, a senior engineer officer who was seeking to withdraw from his position as a permanent professor at the United States Military Academy, arrived in September, he was appointed Deputy Army Engineer as a part of the USARV staff. Subordinates were drawn from several elements of the 18th Brigade to obtain a full operating engineer section that could respond to demands for information on engineer matters from higher headquarters outside South Vietnam. At first the section gave its attention to supply computations, Army real estate policies, repairs and utility policies (implemented by the engineer contractor element of the 1st Logistical Command), and the rapidly changing plans for receiving incoming tactical and logistical units.

From the very early days of the buildup General Ploger functioned through two deputies, Colonel C. Craig Cannon in the brigade and Colonel Watkin in Headquarters, U.S. Army, Vietnam. When Colonel Cannon was reassigned as a brigadier general selectee in December of 1965, he was promptly replaced by Colonel Paul W. Ramee, who had just arrived and who remained a deputy commander until the Engineer Command was formed in December of 1966. At that time Colonel Ramee became the acting commander of the brigade and moved its headquarters to Dong Ba Thin, adjacent to Cam Ranh Bay. Colonel Watkin left his deputy position in February of 1966 to assume command of the 937th Group at Qui Nhon. His successor, Colonel Roland A. Brandt, stayed only three months before he was replaced by Colonel Frank E. Walker, Jr. Thus, throughout the hectic buildup period, the upheavals that the engineer structure in South Vietnam underwent matched those of many other functional organizations within U.S. Army, Vietnam.

The dual-role concept for the engineer headquarters of U.S. Army, Vietnam, received added support when similar concepts were adopted for medical services, whose commander was the USARV surgeon; the military police, whose commander was the USARV provost marshal; and the aviation brigade, whose commander was the USARV aviation officer.

As the U.S. Army corps headquarters were formed—Headquarters, I Field Force, Vietnam, at Nha Trang and Headquarters, II Field Force, Vietnam, at Long Binh—they were not provided with normal complements of organic engineer units.

The "corps" engineers' lack of engineer units to command first became evident as a potential source of difficulty in operations in II Corps Tactical Zone, but the engineers' avowed principle of priority support to tactical operations gave Colonel Edward L. Waddell, the corps engineer of I Field Force, operational control of engineer troops needed in any operation. The directed responsiveness of engineer commanders combined with Colonel Waddell's flexibility fostered the development of standards of procedure which led to repeated successes on the battlefield and at the same time allowed great progress in construction.

Construction Standards and Priorities

In the face of mounting demands for construction but with limited construction resources, U.S. Army, Vietnam, took steps to insure the most effective utilization of engineer manpower and material. After General Ploger had briefed General Westmoreland on construction standards in November, he traveled to each command headed by a general officer to acquaint the commanders promptly with the standards and priorities approved by the Army commander.

Self-sacrifice meanwhile became the hallmark of the engineers as they worked almost around the clock for the units they supported. Their own facilities went unimproved for the most part because the so-called free time which would have allowed the engineers to work on their own camps and cantonments was an almost unknown commodity. At no time did engineer units enjoy a higher standard of living than the combat units they supported, but they enjoyed a high morale derived from their sense of purpose and their pride of accomplishment in the face of obvious need, and they garnered the utmost respect from field commanders.

Just as construction standards were necessary to assure the orderly accomplishment of the formal construction program, construction priorities were intended to make certain that the full range of support facilities was provided for tactical operations. Any list of priorities had to be realistic enough to reflect current engineer capacity, which was dependent upon equipment and materials on hand. It also had to be flexible enough to allow changes, for it was occasionally necessary to shift men and material from project to project almost on a daily basis. Nonetheless, maintaining at least theoretical priorities in the field provided a basic framework for construction in a situation ripe with potential chaos. The priorities, as will be seen, did change. One of the first and very significant changes concerned tents. Early in 1966, it became evident that tentage could be expected to survive little more than one year in the severe climate. Then, by decision of General Westmoreland, the erection of wooden tropical shelters for troop quarters was accepted, to be accomplished at each site as soon as practicable.

The delineation of construction priorities provided not only a sequence for concentrating engineer effort but also a check rein on

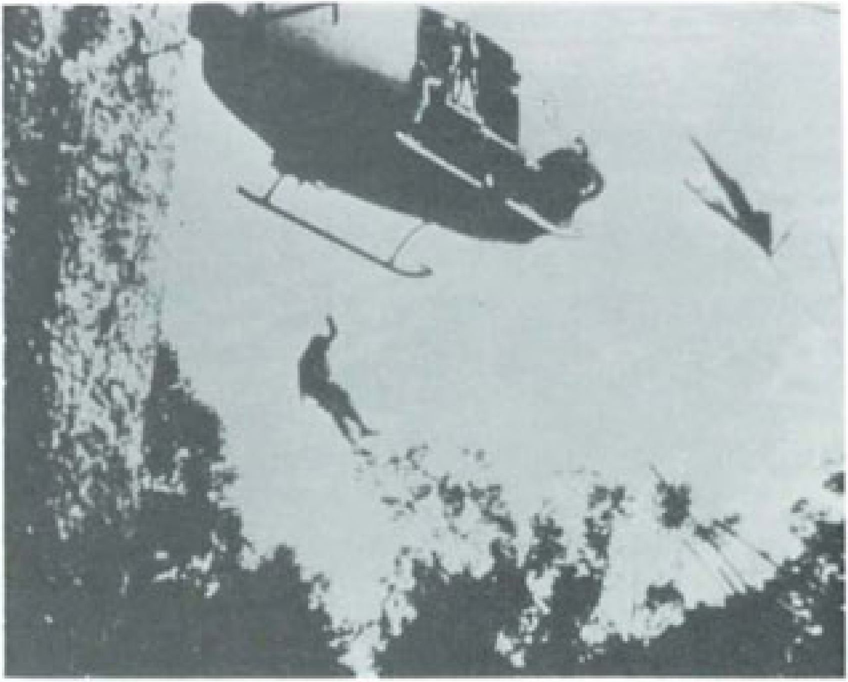
BASE DEVELOPMENT AT QUI NHON, *showing transition from tents to more permanent facilities.*

requests for construction that was not essential. Requests from some field commanders for the more sophisticated comforts reflected a poor understanding of the extent of the engineer work load. A listing of the work to be done and the order in which various tasks were to be undertaken gave such commanders a better picture of the engineer situation.

The engineers devoted themselves during the first half of 1966 primarily to base development, which, although it encompassed almost every phase of engineer activity, was still concentrated near large logistical and tactical complexes. The necessity for developing fixed, relatively permanent bases from which to operate was accepted and appreciated by commanders at all levels. But with the increase in the number of tactical operations, engineer effort would soon be drawn more deeply to combat support.

Operational Support

All engineer activity was by its very nature geared to support tactical operations. However, the engineers involved in the most



SOLDIERS OF 8TH ENGINEER BATTALION RAPPELING FROM HELICOPTER

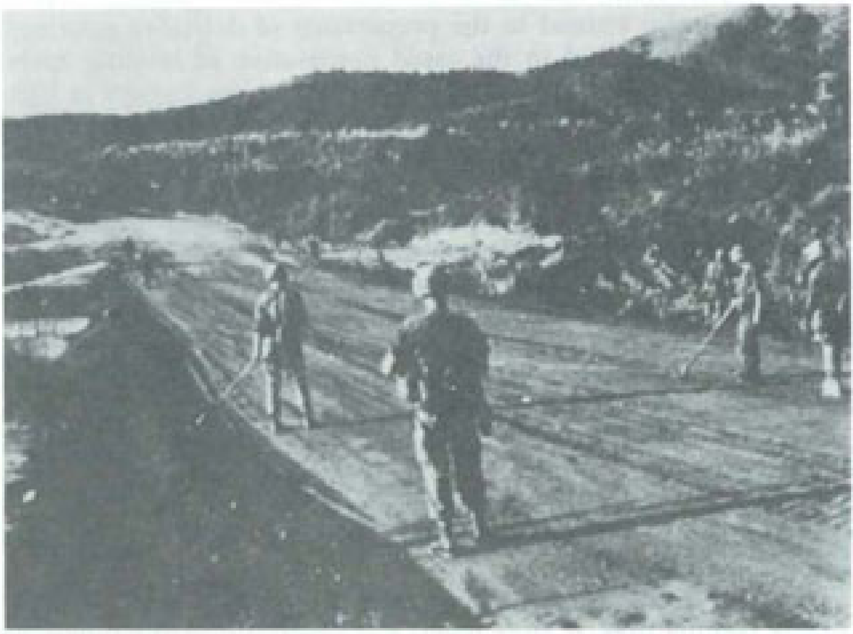
direct support of combat forces were those organic to the combat formations, the divisional engineers. The doctrinal mission of an engineer battalion organic to a division is to increase the combat effectiveness of the division by performing various engineer tasks and, when necessary, fighting as infantry. To use other terms, the mission of the divisional engineers in Vietnam was to improve the mobility of friendly forces and to impede the mobility of the enemy. Their specialized skills and equipment were often of vital importance in sustaining the impetus of an offensive operation carried out by U.S. and allied troops.

Engineer demolition teams were frequently called upon in combat operations to destroy enemy base camps, material, and tunnels. Divisional engineer battalions often designated one of their subordinate engineer teams to support an infantry company on operations involving larger formations to assure immediate engineer assistance on every unit level. When the teams did not actually accompany the infantry units on their operations, they stayed in rear areas on alert so that they could be immediately airlifted to the point where they were needed. Besides destroying enemy fortifications and bunkers, those engineers assigned directly to divisions also assisted in the preparation of defensive positions, in minesweeping, and in the rapid preparation of landing zones. The airmobile concept of warfare was coming into its own in Vietnam and the use of the helicopter in tactical operations led to the development of new expedients for preparing landing sites. Beginning in January 1966 U.S. and Vietnamese forces conducted a series of operations intended to seek out and destroy the enemy in what had been his sanctuaries. It was during these operations that the procedure for constructing forward landing zones by the use of flying engineer teams was developed.

The 8th Engineer Battalion, as part of the 1st Cavalry Division (Airmobile), refined the technique of using helicopters to transport an engineer platoon or squad to the landing zone site. The engineers were flown to a site and would then descend by means of a "troop ladder," or rappel, from the hovering helicopter to begin clearing operations with demolitions and chain saws. A landing zone for helicopters usually could be cleared in a matter of minutes using this technique.

Later a more expeditious method was devised for preparing bigger landing sites. A large bomb was dropped over the jungle by an aircraft and detonated above ground to gain maximum effect from the force of the blast and to prevent cratering within the site. Carrying the necessary land-clearing equipment, Army engineers then descended to the site from helicopters and enlarged the opening enough to allow a special air transportable bulldozer to be lowered into the area for more extensive land clearing. Approach zones were created by blasting away the dense foliage at each end of the landing site. In supporting roles such as this, engineers made it possible for American and South Vietnamese combat forces to reach hitherto inaccessible areas where they could challenge the enemy. The Viet Cong and North Vietnamese forces soon learned that there was no place in South Vietnam impervious to assault by large forces of U.S. and Vietnamese troops.

Another engineer contribution to operational support was mine clearing. Minesweeping was conducted daily in less secure areas of operation adjacent to base camps. The 8th Battalion, for example, had to check a twelve-mile stretch of road along Route 19 in the vicinity of An Khe every morning before troops or vehicles could be allowed to traverse it. Throughout 1966 sweeping operations were conducted almost exclusively by teams of men traveling the miles of roadway on foot. Although many attempts were made to speed up minesweeping by using such devices as jeep-mounted mine detectors or multiple-wheeled rollers extended from the front of



ENGINEER MINE-SWEEPING TEAM

tanks, each new device caused supply and equipment difficulties and none was wholly successful.

Although extensive land-clearing operations were conducted by divisional engineers in several large-scale offensives, nondivisional engineers were best equipped to handle major clearing. Tank dozers of the division battalions were used for smaller more localized tasks such as plowing through booby-trapped perimeters of enemy base camps and cutting short paths for the advance of the infantry.

The search and destroy tactics developed by U.S. commanders in 1966 paid immediate dividends by uncovering enemy supplies and munitions. The reconnaissance conducted during such operations often disclosed enemy sanctuaries in the form of vast networks of tunnels. One such complex used by the Viet Cong in the III Corps Tactical Zone was probably as much as twenty years in the building. Constructed in impervious layers of hard clay at varying depths, with small, well-camouflaged entrances, these tunnels defied any simple method of destruction. Most of them had no electric power and lighting nor forced ventilation; they were large enough for the Vietnamese to crawl through comfortably but Americans could get through them only with difficulty.

ENGINEER TUNNEL DEMOLITION TEAM. *"Tunnel rat" is preparing to place charges and make connections for detonation. Note smallness of access hole which is easily camouflaged.*

A thorough search of the tunnels often produced significant intelligence concerning the strength and intended operations of the enemy within the area. Once the complexes had been thoroughly searched, the problem remained as to the best method of destroying them so completely that they could not easily be repaired by the enemy and used again.

Generally, enemy tunnels were of two kinds: simple, shallow structures, hastily built and used primarily by local Viet Cong and guerrillas, or well-constructed systems used by large forces and usually found in uninhabited areas. Tunnels varied in length from twenty to over ten thousand feet. The larger networks were sometimes quite elaborate, having as many as four distinct levels and consisting of large compartments usable as living quarters, hospitals, and mess facilities. Some even contained facilities for manufacturing and storing war materials.

Finding the cleverly concealed tunnel entrance often was the most difficult part of tunnel destruction. Once an opening was located, smoke grenades were thrown in to drive out enemy troops and any civilians who were being held as hostages. The tunnels could then be searched.

Exploration was usually conducted by two-man teams. While one man stayed at the entrance the other descended into the tunnel equipped with a phone, communications wire, compass, bayonet, flashlight, and pistol. As he explored the network, the man in the tunnel maintained communication with his partner at the entrance, to whom he reported his progress, findings, and changes of direction. The man on the surface recorded all such information as it was received.

Several methods of destruction were used once the tunnel had been completely searched. For tunnels within ten feet of ground surface, acetylene gas was used. Necessary equipment included chemicals for making acetylene gas, air blowers, and small explosive charges. Acetylene generated on the spot was forced into the tunnel by blowers and, with all openings sealed, the small charges were detonated, thereby exploding the mixture of acetylene and tunnel air. The roof of the tunnel usually collapsed. The results were frequently less effective than desired because the explosive gases were not completely mixed. Introducing oxygen at the time the acetylene was generated produced better results but aggravated the logistical aspects of the operation. Understandably the tactical commanders were disinclined to keep combat troops in alert security status after a tactical operation in order to allow time for deliberate destruction of Viet Cong tunnels. Consequently, engineers were constantly seeking faster and more effective means of destruction.

For tunnels deeper than ten feet, charges were placed in a series at 100-foot intervals on the floor of the passageways and sacks of powdered riot-control agent C2 were placed on top of the charges. When the explosives were detonated the C2 was blown into the walls between the collapsed sections. The chemical remained effective from two to six months and made remaining sections of the tunnel uninhabitable.

Efforts at determining tunnel traces from the surface met only partial success. Obviously destruction by surface means should have been the most effective way of eliminating tunnels. Another means that was investigated was destruction by flooding. This solution, for an engineer, was not unlike trying to fill all the water pipes in a new house by feeding water into an open pipe at the second story level. Without knowing all the potential air locks and without sealing all but the appropriate single outlet, there was scant hope of success. Moreover, the sheer volume of water which might be required was enough to give anyone pause.

Land Clearing

Land clearing was another important job of the engineers in their operational support role; in fact, engineer methods of land clearing gained wide acceptance as among the most effective tactical innovations of the war. As techniques evolved for the employment of land-clearing units, these units more and more became the key elements in successful operations aimed at penetrating enemy strongholds, exposing main infiltration routes, denying areas of sanctuary, and opening major transportation routes to both military and civilian traffic. Engineer land-clearing troops on many occasions formed the vanguard of assault forces attacking heavily fortified enemy positions, while even under ordinary circumstances their use in clearing the jungle ahead of tactical security elements placed them routinely in a position of direct vulnerability to enemy action. These engineer troops rapidly developed a zestful pride in the importance, difficulty, and hazards of their occupation, and while their deportment and appearance sometimes fell short of normal standards, their spirit, courage, and persistence under the most adverse conditions entitled them to a substantial claim to elite status.

In the vocabulary of U.S. forces in Vietnam, Rome Plow came to be synonymous with land clearing. Of all the various types of land-clearing equipment tested in Vietnam, the military standard D7E tractor, equipped with a heavy-duty protective cab and a special tree-cutting blade manufactured by the Rome Company of

ROME PLOW AT WORK

Rome, Georgia, proved to be by far the most versatile and effective. The tractor took its name from its most imposing feature—the huge blade on the front.

The giant Rome Plow blade was designed to move over the ground six inches above the surface, shearing off most of the vegetation but leaving the root structure to prevent erosion. The blade has a leading knife-edge that was sharpened by a portable grinder at least once daily. It is slightly angled so that cut material is discarded to the right. The leading corner of the blade is extended by a rigid "stinger" with which the operator attacks the larger trees by a succession of stabbings and dozer turnings.

The potency of the Rome Plow was early recognized by the troops in the field. Lieutenant General Julian J. Ewell, commander of II Field Force, was so impressed that he was led to remark that the Rome Plow was "the most effective device" for winning the war. It played a substantial role not only in achieving military success but also in building the South Vietnamese economy through land clearing for redevelopment purposes.

An integral part of the land-clearing operation was aimed at improving security along roadways. No road, no matter how well

LAND CLEARING ON BOTH SIDES OF A PUBLIC ROAD *to reduce chances of enemy ambush.*

constructed, was of much value if enemy interdiction made the use of it too hazardous. Wherever a highway passed through jungle or heavy brush in areas subject to enemy activity, the land had to be cleared on either side for distances up to a hundred meters. The Rome Plow was the principal tool in these clearing operations. When the cover provided by the brush was removed, it was difficult for the enemy to stage an ambush. In addition, the land cleared by the plows was often fertile enough for farmers to move in and cultivate.

The story of how the Rome Plow reached the U.S. Army in Vietnam and came to be one of its most effective weapons merits recounting. U.S. military leaders had recognized early the tremendous advantage the jungle offered the Viet Cong and North Vietnamese Army in terms of limiting the movement of firepower of the modern military equipment employed against them and in protecting their bases, their lines of communication, and their arsenals. As early as November of 1965 General Westmoreland put his staff to work looking for means of jungle clearing. An officer was dispatched to Australia where success had been reported with a ten-ton or heavier hollow ball approximately twelve feet in diameter towed

THE LETOURNEAU TREE-CRUSHER *could fell large trees and cut moderate size timber into sticks which were pressed into the ground.*

by ship anchor chains linked to a pair of very heavy tractors. This towed ball worked well in the Australian jungle, but when attempts were made in Vietnam to fabricate some sets of balls and chains, the large size of the ball, the difficulty of transporting it, and inadequate equipment stood in the way of an early success. Suggestions from the United States meanwhile included a 100-ton tracked tank-like vehicle, the three-wheeled LeTourneau tree-crusher, and a Rome Plow attachment for military tractors. A small number of tractors with Rome Plow attachments and accessories were ordered at once. Within hours after they had arrived, been assembled, and been hurried through field tests, large orders for Rome Plow kits were under preparation. While awaiting delivery, the test models in South Vietnam were put to immediate use and organizational training and operating plans were developed. The 100-ton tank was rejected as too hard to move; getting it from ship to shore in South Vietnam and subsequently to the jungle would have created impossible problems.

The LeTourneau tree-crusher was also originally rejected, even though it was capable of being broken down into four or five pieces for shipment. Flotation characteristics were appealing, but it was only marginally effective in the water. Although it weighed sixty tons, it was less trouble to move than some other proposed devices, but it was vulnerable—a target too big to miss in a tactical situation; a complex, though well-protected hydraulic system; and little prospect of extracting the machine if it became deadlined in the middle of the jungle. Nevertheless, the commanding general of the 1st Logistical Command arranged for rental and shipment of a test model to the Long Binh area. In the early spring of 1967 the tree-crusher proved its ability to perform in a swampy jungle; however, it was not reliable enough in South Vietnam and was returned to the United States when the lease expired.

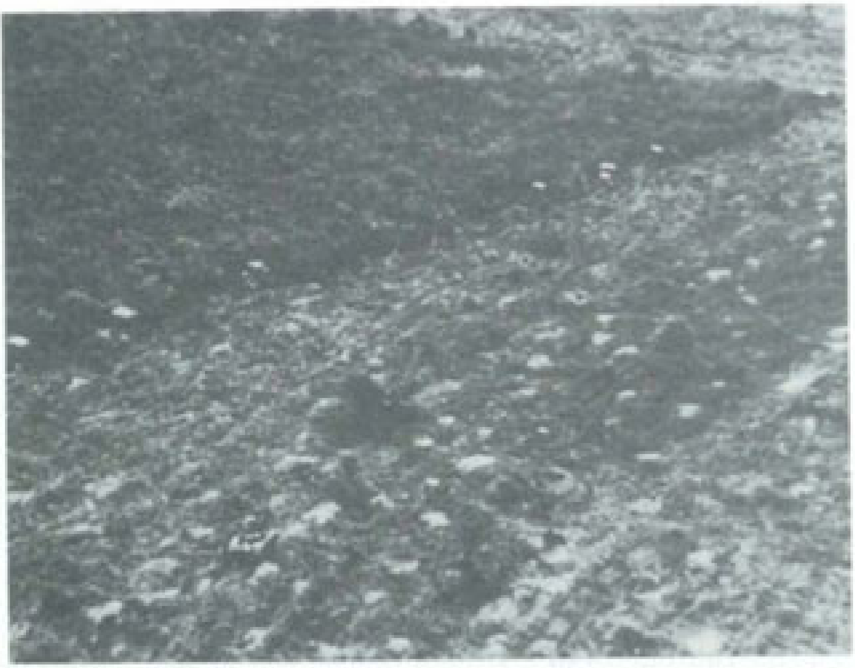
The Rome Plow meanwhile had already fully demonstrated its suitability in major tactical operations. By the summer of 1967 three land-clearing platoons (or teams as they were called at that time) were operating in Vietnam, each equipped with thirty Rome Plows. Two platoons were assigned to the 20th Engineer Brigade, which was supporting II Field Force, and the third was assigned to the 18th Engineer Brigade, which was deployed in I Field Force. In addition, land clearing on a lesser scale was carried out by other engineer units throughout Vietnam, particularly by the divisional engineer combat battalions.

As the intensity of U.S. involvement in the conflict increased, the requirement for additional land-clearing units became apparent. The need for organizational changes was also recognized since many tactical units to which land-clearing teams were attached experienced an almost traumatic drain on their command, administrative, and, particularly, their maintenance capabilities. With only sixty-four men, a land-clearing team could contribute little more than a complement of operators for its thirty Rome Plows under the operational conditions that existed. Consequently, in December 1968 the three land-clearing teams were reorganized as companies with thirty Rome Plows each and were also provided with a significantly better capacity for self-support, particularly in maintenance. One month later, in January 1969, three additional land-clearing companies were activated, bringing the total to six, a number that was maintained until April 1970 when one of the companies was inactivated under the terms of the phase-down.

Three of the land-clearing companies were assigned to the 20th Engineer Brigade and three to the 18th Engineer Brigade. The 20th Engineer Brigade area of operation included large, reasonably level tracts in III Corps Tactical Zone that were occupied by major enemy units. These areas were particularly in need of land-clearing operations; furthermore, the roadnets were adequate for the large convoys of heavy tractor-trailers which transported land-clearing companies from a central base to the cutting area. These factors were prominent in the decision to organize a land-clearing battalion that would incorporate the three land-clearing companies of the 20th Engineer Brigade. The 62d Engineer Battalion based at Long Binh was selected for this purpose. Its lettered construction companies were inactivated, and in January 1969 the 62d was assigned the 60th, the 501st, and the 984th Engineer Companies (Land Clearing) to perform the mission of land-clearing operations in support of II Field Force.

The 18th Engineer Brigade supporting I Field Force in Military Regions I and II was faced with a different situation. Although objectives were plentiful enough in the form of enemy strongholds, the terrain was severely restrictive and so were the roadnets. Therefore the 59th, 538th, and 687th Engineer Companies (Land Clearing) were employed and supported on the basis of a geographic area of responsibility, with one company assigned to each of three engineer groups. Regardless of the method of deployment, land-clearing operations were closely controlled by the field force commander concerned. Since requests for Rome Plows far exceeded their availability, high-level control was essential to assure that land-clearing units were used only for tasks of the highest priority.

Much was learned from the employment of the original land-clearing platoons on large-scale clearing operations in 1967. Techniques were developed and perfected in planning and execution in order to solve such exceptionally difficult problems as controlling an operation in dense jungle and co-ordinating the actions of the combat security force and the engineers operating the Rome Plows—particularly when troops were engaged with the enemy. The extreme heat, the dust (or mud during the monsoon season), large falling trees, bomb craters, hidden ravines, and enemy mines took a serious toll of equipment and accessories. Probably no item of equipment was ever operated so far beyond the limits of its designed capabilities as was the Rome Plow tractor in Vietnam. Yet this problem, too, was overcome, at least to the extent that the cost of land-clearing operations was brought to an acceptable level. The organizational changes mentioned earlier formed part of the solution; so did the establishment of direct dealings between land-clearing units and major logistical support facilities. But most of the solution was provided by the land-clearing engineers themselves. Once these men learned what it took in terms of skill, hard work, inventiveness, and just plain desire to keep their equipment operating, they did it. It became routine for a plow operator to spend twelve hours clearing jungle under conditions of extreme physical discomfort and hazard, and then return to the night defensive position and work for six or eight more hours in the darkness repairing his tractor for the honor of being able to repeat the cycle on the



LAND-CLEARING OPERATION

following day. Since operations generally lasted forty-five days before a unit was allowed a fifteen-day maintenance stand-down at its home base, the plow operators were called upon for almost unbelievable self-sacrifice. Without their heroic efforts the cost of land-clearing operations on any significant scale would have been prohibitive.

For the uninitiated observer, a visit to a land-clearing unit was unforgettable. The operation was conducted from a hastily constructed nighttime defensive position which, depending on the season, was rapidly churned by the tractors into either a bowl of choking dust or a sea of impassable mud. This was home for a task force that consisted of a land-clearing company and a security force, the latter normally of at least company strength and preferably mechanized. As the clearing progressed the night base was moved, usually every five to seven days, to a new location. Each day's clearing was carefully planned the previous evening by the security force commander, who was usually in over-all charge of the operation, and by his supporting land-clearing commander. Planning included the exact delineation of the area to be cleared, the deployment of security forces, the routes to be followed to and from the cut, special procedures to be followed in case of enemy contact, and the use of preparatory and supporting artillery and small arms fire.

Because of difficulties in navigating in heavy jungle, the operation was controlled as a rule from a helicopter by an officer from the land-clearing unit. The lead tractor was guided by radio in cutting a trace or outline of the area to be cleared while the remaining plows followed in an echelon formation, leaving in their wake an ever-widening swath of cleared jungle. Once the trace was completed, the most difficult navigational problem was over, and the formation of plows continued around the decreasing perimeter until the area of jungle was eliminated. The vehicles of the security force followed the plows as closely as they were able. Quite often it was necessary to assign tractors to push fallen trees aside to permit passage of the combat vehicles.

In the course of a day it was common for one-half to two-thirds of the Rome Plows to sustain disabling damage of some sort. Much of this damage was repaired on the spot by a team of mechanics. In other cases the plow had to be towed back to the night defensive position. Since the operational area was often inaccessible by road, removal of the damaged equipment was complicated. For this reason land-clearing troops developed enough skill to make repairs in the field that were ordinarily made in depots. It was not unusual to have a tractor hauled into its defensive base, disassembled to its very framework, fitted with new major components, and returned to service in just two or three days. To meet the massive demands of a land-clearing company for spare parts, daily deliveries by Chinook helicopter became routine.

It was expected that land-clearing companies would suffer high casualty rates both from enemy action and from natural hazards. Most enemy-inflicted casualties came from mines encountered in the cut or from mortar attacks on night defensive positions. Aside from the obvious danger from falling trees, some of which ranged up to six feet in diameter, there were other natural hazards. Perhaps the most notable of these was the bee. Swarms of these insects often brought clearing activity to a standstill, and many operators had to be hospitalized, some in serious condition. Green smoke flares proved the best means for repulsing bees. No other color than green seemed effective.

On the average, a land-clearing company could be expected to clear between 150 and 200 acres of medium jungle each day. Of course, in any specific operation, production depended on many variables including terrain, weather, maintenance, and enemy action. Because of the intense command interest in land-clearing operations, daily production reports received careful scrutiny at all echelons. Unit commanders and even the troops themselves quickly learned this fact and competition between land-clearing companies became intense. The most forthright production report ever received was submitted by a company commander whose Rome Plows had all become hopelessly mired in the monsoon mud before reaching the cut area. His report for the day in the line reserved for "acres cleared" was the most famous one-liner in land-clearing history. It said, "one tree." Needless to say, this report created great concern as it filtered up through channels. An investigation clearly disclosed the impossible situation of the unit; in fact, to cut down a single tree under the circumstances was a major achievement. Queried on this point, the company commander admitted that when one of his plow operators attached his winch cable to a dead tree in an attempt to extract his tractor from the mud, the tree fell over and was counted.

From a strategic standpoint, the cumulative effects of land-clearing operations in Vietnam had a decided impact as the enemy was forced increasingly to adjust to the disappearance of his operational bases or to interdiction of connecting trails. The vastly improved capability of allied forces to observe, shoot, and move throughout hundreds of thousands of acres of what was formerly "enemy country" represented dramatic progress, not only in a strict military sense but also in terms of pacification and economic development. In the wake of land-clearing operations came a distinct revitalization of the countryside as villages began to spring up in once-threatened areas, agriculture bloomed where only the impenetrable jungle had stood, and traffic appeared on hundreds of miles of roads made safer by pushing back the jungle growth that once concealed the enemy. This was accomplished at a cost, and that cost was borne primarily by the Engineer Corps soldier who served in the land-clearing units throughout Vietnam. While statistics are usually bland and often misleading, in the case of these young engineers they are extremely interesting. In most land-clearing companies, two out of three men became casualties from enemy action during a one-year tour. Those who were specifically assigned to operate Rome Plows were statistically a cinch to earn a Purple Heart. That all of them did not is attributed to the fact that some received more than one. Add to this the other physical hazards inherent in land clearing, and the occupation appears to be one to be avoided. Yet the rates at which land-clearing specialists re-enlisted or voluntarily extended their tours in Vietnam were consistently at or near the top of U.S. Army, Vietnam, statistics. Of even greater significance is the fact that these engineer soldiers were not specially trained or screened for land-clearing assignments. In fact, many initially resisted being assigned because of what they had heard about land clearing and its hazards. Yet once assigned, almost universally these men acquitted themselves most admirably.

CHAPTER VIII

The Lines of Communication Program

In the Vietnam War, as in all wars, transportation was a big factor in military operations. The desire of the United States to improve political and economic life in South Vietnam was an added incentive to make every part of the country easily accessible to commerce and government. Strategic, tactical, and logistic mobility were essential ingredients of military success; the ability to move enough units, men, equipment, and material where they were needed and when they were needed was the index of such success. Since most existing land lines of communication in the Republic of Vietnam were either incapable of supporting American military vehicles or were subject to continuous enemy interdiction, it was necessary at first to depend heavily on water and limited air transport to provide logistic support.

The plan to move extensively by water encompassed not only the major ports of Saigon and Cam Ranh Bay and the shallow-draft ports of Qui Nhon and Da Nang, but also entailed the establishment of a series of shallow-draft ports along the coast. Through port improvement it would be possible to capitalize on Vietnam's long coastline for lateral distribution of supplies. As the larger ports developed, supplies could be shipped by water to the smaller ports and then inland by highway or airlift either to the forward support areas being established throughout the country or directly to the combat elements.

Port Construction

When U.S. Army engineers landed in Vietnam in 1965, only two deep-draft ports existed in the entire country—Saigon and Cam Ranh Bay. Shallow-draft port facilities existed at Nha Trang and Qui Nhon, and there were several beaches along the coast over which cargo could be transported from ships lying offshore. Although the Army lacked ships to take advantage of the shallow ports, this lack was offset to some degree by unloading cargo across the beaches. The two deep-draft ports with their severely limited berthing facilities were totally inadequate for handling the volume of American materials being shipped to Vietnam during the troop buildup.

The 497th Engineer Company (Port Construction), the Army's only such company in 1965, estimated the requirements and made plans for both long-range and short-range port facilities throughout South Vietnam, except in I Corps, which received its support from the Navy. Over-all plans called for making Saigon and Cam Ranh Bay into major logistical bases, and Qui Nhon, Nha Trang, Phan Rang, and Vung Tau into minor support bases. As the ports were developed a variety of attendant projects were undertaken in addition to the basic pier construction. Barge off-loading facilities, airfields, ramps for landing craft, and logistical storage facilities were incorporated in the plan.

The greatest single aid in the rapid development of port sites in Vietnam was the DeLong pier. Essentially one version of this pier consists of a 90x300-foot barge supported by eighteen tubular steel caissons 6 feet in diameter and 50 feet long. These caissons are placed in collars attached to the piers and are pressed into the harbor bottom by pneumatic jacks that are a part of the collar apparatus. Therefore the pier is further jacked up on its caisson legs to the desired elevation above the water surface.

Each DeLong pier provided berthing for at least two ships simultaneously, and use of these finger or T-shaped piers made possible the rapid development of deep-draft ports at Qui Nhon and Vung Tau and expansion at Cam Ranh Bay. The first DeLong pier assembled in South Vietnam was at Cam Ranh Bay. Its installation required the efforts of sixteen men for forty-five days; a timber pile pier of comparable dimensions would have required at least six months' work by a platoon of forty men with special equipment. DeLong piers were emplaced as quickly as they became available.

A wide spectrum of engineer activity accompanied the development of port facilities at Cam Ranh Bay. An 800-foot rock causeway and 80-foot bridge span previously discussed were constructed to provide access to the first DeLong pier, a large cargo-handling area was prepared, and a roadnet capable of supporting the inland shipment of cargo was build. The first tactical airfield with a runway of expedient surfacing to support jet fighter aircraft was constructed, and along with it a 400-foot timber jetty to assist in pumping fuel from the piers to the air base.

Eventually Cam Ranh Bay was served by four DeLong piers as well as facilities for off-loading shallow-draft vessels. In addition to being the largest logistical storage area in the republic, Cam Ranh Bay became one of the largest and most effective ports in Southeast Asia.

MAIN PORT FACILITIES AT CAM RANH, SEPTEMBER 1967

Farther up the coast, elements of the 497th Engineer Company and the 937th Engineer Group were occupied with increasing the capacity of the port at Qui Nhon. Since is was a shallow-draft port, ramps for landing craft were needed, but there was no suitable land available for them. As a first step, therefore, a new jetty was extended from the shore at Qui Nhon with approximately 45,000 cubic yards of fill to create a usable area 620x360 feet. This extension provided excellent landing facilities for the shallow-draft landing craft and more than doubled the storage area of the port. When Qui Nhon was upgraded in February 1966 from a support area to a logistical base, storage capacity was expanded even more. In addition, deep-draft berths were provided through the installation of DeLong piers and permanent LST ramps.

Port facilities in Saigon were quickly swamped by the heavy volume of war materials that poured in during the buildup. Numerous improvements were made along the original pier lines and approaches. To relieve the congestion on the Saigon docks and in the city itself, the Engineer Section of U.S. Army, Vietnam, planned a completely new port on the Saigon River upstream from the city. Designed and constructed primarily by civilian architects and contractors and christened Newport, it became a U.S. Army port and

EXPANDED PORT AT QUI NHON, SUMMER 1967. *Island is man-made.*

assumed responsibility for handling the greatest proportion of the war-related shipping into the Saigon area. Engineer troops of U.S. Army, Vietnam, contributed to construction by performing a number of minor tasks. When the port was nearly completed, engineer port construction specialists installed chain link fencing completely around the pier face from deck to river bottom to protect it against underwater swimmers and explosives, and mounted floodlights under the pier deck to improve night surveillance.

Airmobility

Air terminals were built in each major port complex and many of the minor ports. The lack of airfields throughout the nation created a demand for a large amount of engineer construction during the latter half of 1966. General Westmoreland early in the buildup expressed his desire that every point in South Vietnam be within twenty-five kilometers of an airfield. Such a strategy required not only the building of new airfields in what was often inhospitable terrain but also the reconstruction of old ones. Many of the existing airstrips had been built by the French and were paved with little more than a surface treatment from one-half to one inch thick—hardly adequate for American C–123's and C–130's. Forward airstrips were often the only means of resupply for

NEWPORT, THE ARMY ADDITION TO THE PORT OF SAIGON

large-scale combat operations. Contractors were used to develop major permanent airfields for jets in the more secure areas while troops constructed forward strips at an astonishing rate to support combat operations and to permit forward supply. Army logistics and engineering were adapting to the airmobile concept.

The Army had been training airborne engineer units since the inception of airborne combat units, but it was not until the beginning of counterinsurgency operations in Vietnam that the airmobile concept of engineer operations came into its own. The term "airborne" was normally applied to units or operations involving parachute delivery of assault troops and subsequent delivery by large Air Force cargo planes to supporting airfields. "Airmobile" on the other hand was applied to units and operations using helicopters either independently or in conjunction with Air Force cargo planes. Throughout U.S. operations in South Vietnam scores of Special Forces camps and remote fire support bases required engineer support for building gun pads, airstrips, and defensive positions. The inaccessibility of many of these installations to surface transport and the likelihood that the enemy was near made airmobility a necessity.

Because of the nature of their mission, airmobile engineers had to be capable of segmenting their equipment for air transport by the giant Sky Cranes or Chinooks. The limited capacity of tactical

ARTILLERY FIRE SUPPORT BASE *known as Landing Zone Uplift under construction by 35th Engineer Battalion.*

support air transports made it necessary for airmobile engineer units to have specially designed miniaturized equipment. Such units had small ¾-ton dump trucks instead of the standard 5-ton; D5 and D2 dozers instead of the larger, heavier D7; and their scrapers were designed to be split into sections for air transport. With their unique equipment and capabilities, the airmobile engineers could function wherever their assistance was required, often in areas cut off from the outside world except for radio communications and resupply helicopters. The airmobility of U.S. Army engineer units contributed greatly to their "go anywhere, do anything" reputation.

Airfield Construction

In II Corps the airmobile 8th Engineer Battalion spent the early months of 1966 mastering the problems inherent in the rapid construction of forward airfields. Within a six-month period the battalion constructed nine airfields capable of handling cargo aircraft ranging from the smaller C–123's and CV–2's to the larger and

AIRFIELD AT AN KHE

heavier C–130 transports. Over a two-year period from mid-1965 to mid-1967, U.S. Army engineer units installed or rehabilitated more than eighty airfields.

The construction of an airfield at An Khe, built initially with an expedient surfacing by the 8th Engineer Battalion for its parent unit, the 1st Cavalry Division (Airmobile), was a testimony to the proficiency developed by Army engineer units in tactical airfield construction. Working seven days a week and nearly twelve hours a day, the engineers of the 8th Battalion combined speed and technical expertise to meet imposed completion dates. Even at that rapid pace, maintenance and repairs on construction equipment were not neglected; spaced during the twelve-hour day were three forty-minute maintenance periods. This valuable time committed to maintenance increased the useful life of the machines and decidedly lowered deadline rates, factors particularly important in view of the lighter construction equipment available to the airmobile battalion.

The construction of the runway at An Khe required extensive earthmoving and the development of special techniques to control erosion. After the runway surface was graded, it was compacted and sealed by a rubber-tired roller. The hard-packed surface that resulted could withstand heavy tropical rainfall with little or no erosion. The final phase of construction involved the application of the newly developed T17 membrane, a tough rubberized fabric, to the surfaces of the runway, taxiways, and parking area. Emplacement time for the membrane averaged half an hour for each hundred feet. While a force of about a hundred men installed the membrane, others dug anchor ditches to hold the edges in place. As a final touch, a skid-proofing compound was applied to the surface of the membrane.

Other divisional battalions as well as many of the nondivisional battalions soon adapted the experience of the 8th Engineer Battalion to their own operations with notable success, even though they lacked some of the flexibility afforded by the light, sectionalized equipment peculiar to the airmobile units. As early as the late months of 1965, the Army Engineer sought more airmobile engineer equipment. Requests for an airmobile light equipment company from the United States were consistently refused because of the need for strategic reserves at home. Thereafter requests were repeatedly entered for shipment of individual items of airmobile engineer equipment. However, the continuing expansion of usable road networks reduced the urgency for wide distribution of that equipment throughout engineer units. By mid-1967 a number of light dozer tractors had been received and allocated by U.S. Army, Vietnam, to selected engineer units. Later, provision was made for stockage of limited amounts of specialized equipment within Army depots. These engineer items could then be issued under control of the Army Engineer.

The T17 membrane proved highly successful as an expedient airfield surfacing material. It was easily and quickly installed and provided a durable, waterproof, dustproof surface. When placed on a well-compacted, crowned subgrade, properly joined and anchored and afforded adequate shoulder drainage, it was one of the most effective new materials for fast airfield construction to come out of the war in Vietnam. For sustained heavy use by cargo planes, the T17 membrane required replacement by the more sturdy steel or aluminum matting and ultimately by concrete. These replacement tasks were normal functions of support engineers.

Forward airfield construction in South Vietnam was a science in itself. The finished product was crude when compared with more permanent airfields, but in Vietnam, where the success of a combat operation often depended on the quick construction of one forward airstrip, speed and basic utility were far more important than a

INSTALLING T17 MEMBRANE AT BAO LOC

sophisticated product. Through their proficiency in operations such as the construction of the An Khe airfield, the U.S. Army engineers made a significant contribution to the success of the combined arms team.

The customary tactical or logistical support airfield in South Vietnam called for a 3,500-foot-long surfaced runway, 60 feet wide, with a surfaced parking area for three C–130 aircraft. There were technical limitations on slopes, grades, and approach clearings, and a drainage plan had to be developed and incorporated during, if not before, construction. Air Force representatives certified the technical adequacy of runways and hardstands (parking areas) before the C–123 and C–130 aircraft were allowed to operate on the field. Protective earthen mounds six to ten feet high, called berms, were necessary for both ammunition and fuel storage to restrict and control potential damage from enemy attack. In World War II and the Korean War the standard expedient surfacing had been pierced steel plank. The residual Army stocks of this material were in South Vietnam even before the troop buildup and were widely used for surfacing in truck parks and elsewhere. The large holes in the expanded metal added to mud problems in South Vietnam and the engineers greeted with relief the arrival of solid steel plank, designated M8A1. Another metal surface consisted of interlocking rectangular panels of aluminum—two flat sheets bonded to internal

CONSTRUCTION DATA ON AN KHE AIRFIELD

Equipment	No. of Items	Equip Hours	Man-Hours
Total		3,811	24,858
Tractor	3	747	21,628 (Construction of airfield facilities)
Tractor	4	545	
Grader	4	981	3,230 (installation of T17 membrane)
Loader, 2½-cubic-yard	1	231	
Tractor, dozer, small	2	359	
Roller, pneumatic	2	244	
Truck, dump	6	731	

structural dividers. This material, purchased by the Air Force, was acceptable for fighter planes and was used on the 10,000-foot runways at Cam Ranh and Phan Rang. Later it was also used on selected Army airfields, for example An Khe and Cu Chi. Still another surface, the square MX19 aluminum panel with a honeycomb interior, arrived in South Vietnam in 1966 and proved preferable for heavily used forward airfields.

One great trouble the engineers had with all prefabricated metal surfacing in South Vietnam was that they could not seal water out of the joints between panels. The volume and frequency of rainfall contributed to recurrent failure of sections of trafficked runways, thus burdening engineer units with extraordinary maintenance and replacement tasks. Many attempts were made to overcome the airfield maintenance problem, which grew with each additional field that was built. Engineers tried laying the T17 membrane below the metal or on top, and introduced asphalt products, but they found all their attempts less than satisfactory. Since each takeoff and landing produced powerful thrusts against the surface, some means of anchoring was necessary to prevent "creep" of a runway, and yet any adequate anchorage provided surface water with a simple access to the runway subgrade. Upon the urging of engineers, the matting designers have since developed rubber inserts that fit into the panel edges of the MX19 matting to produce an effective seal against water seepage. All the required runways had been built, however, before the improvement could be adopted. The maintenance and replacement problem remained. It is to be hoped that in future operations fewer men will be needed to deal with the problem of water on airfields.

Helicopters brought with them a new set of problems for engineer soldiers. The sandy or dusty soil which was commonplace throughout most of Vietnam during the dry season was a serious consideration in heliport construction. During takeoffs and landings the downblast of air from the main rotor blades of the helicopters pushed thick swirling clouds of dust into the air, causing damage to engines and rotor blades as well as restricting pilot visibility. Without adequate dust control, the damage done by dust to turbine blades could be just as effective as combat action in reducing the number of aircraft available.

Aluminum or steel planking was an effective means of dust control but it proved to be economically unfeasible for use on hastily constructed tactical facilities built solely for helicopters. Diesel fuel, distributed from spraying systems mounted on trucks or trailers, was used extensively to keep down dust for short periods of time.

The 45th Engineer Group (Construction), commanded by Lieutenant Colonel George M. Bush, made an important contribution toward dust control with the development of a new style of heliport called the minipad. The important innovation in this new design was the use of peneprime, a dust palliative material with an asphalt base. When an area had been selected as a helipad site, it was leveled, graded and compacted, then sprayed with peneprime. The asphaltic substance when sprayed onto sand bound small particles together, making the surface dust-free. Peneprime required little time to set, and the construction of a minipad could be begun immediately after its application to the surface.

At Tuy Hoa Company B of the 39th Engineer Battalion used this new method to reduce sharply a severe dust problem which had greatly limited aviation support available to combat operations in the area. The entire project consisted of sixty-four minipads and two refueling pads and was completed in just six days.

Road Construction

Development of the land lines of communication appeared to lag far behind the improvements in air and water lines because it was a much larger problem. Movement by highway increased throughout 1966 and continued to increase at an accelerated rate thereafter. By mid-1966 General Westmoreland had let it be known that in his estimation U.S. commanders were too timid about making use of the roadways and relied too heavily on limited helicopter resources as a means of transportation.

As early as April 1966 the Army Engineer had recommended to Lieutenant General Jean E. Engler, deputy commanding general of USARV, the construction of an entirely new road connecting Long Binh with Cu Chi, the base camp of the 25th Infantry Division. The proposed two-lane paved highway would require the building of a large bridge near Phu Cuong but could be completed by November. When the commander of II Field Force, Lieutenant General Jonathan O. Seaman, was briefed on the proposal, he was loath to commit tactical troops to a campaign intended to improve security for the engineer road and bridge builders. However, after his views were presented at U.S. Army, Vietnam, headquarters, General Engler approved the highway and detailed planning began.

Until June 1966 the Vietnamese Bureau of Public Works and the South Vietnamese Army engineers had done very little work on roads and bridges. U.S. Army engineers, while concentrating on base development and vertical (above ground level) construction to house and supply the growing number of allied forces, had already tackled the problem of road improvements, primarily in connection with tactical support operations and with their own needs for surface movement around the country. After General Westmoreland's reference to commanders who were too timid to use existing road systems, U.S. engineer group commanders were directed to provide support for the road and bridge building operations of the South Vietnamese and to issue appropriate materials to them on condition that bridges and roads be built to U.S. specifications. Characterized by insufficient subgrade and poor drainage, existing roadways were in serious disrepair and required continuous maintenance. By adhering to U.S. specifications, the South Vietnamese developed the ability to build roads that could sustain the volume of heavy traffic generated by the war.

After numerous and extensive planning conferences, Headquarters, U.S. Military Assistance Command, Vietnam, issued directives outlining the construction program for the land lines of communication for engineer troops. South Vietnamese Army engineers, as stipulated in a directive, continued to be responsible for road and bridge construction in the more pacified areas. Those roads used primarily by allied forces for tactical or logistical operations were the primary responsibility of American engineer troops. The priorities for construction, maintenance, and upgrading of roads and bridges were to be determined by the various corps commanders, subject to authorization from the Office of the Directorate of Construction.

The lines of communication program in Vietnam was one of the largest single engineer projects ever undertaken by the United States

UNIMPROVED STRETCH OF HIGHWAY 1 NEAR CAM RANH

military in a foreign country. When completed, this massive construction project would tie together the major population centers of the country with 4,106 kilometers (3,038 miles) of modern high-speed highways.

While the formal road construction program was not fully defined until 1968, a considerable amount had been accomplished before that time. The 35th Group had begun paving operations at Cam Ranh and had proceeded with National Route 1 both north and south, using standards set by U.S. Army, Vietnam. It had established by early summer of 1967 a factory for fabricating reinforced concrete 20-foot spans to use in place of culverts on the highway. The 159th Group was paving Route 15 and had built a causeway across a water gap near Vung Tau. A significant start had been made by the 45th Group on paving Route 19 between Qui Nhon and Pleiku. Tactical priorities had precluded an all-out effort by engineer troops on a national road construction project until the military situation demanded less combat support. By 1968 base development had reached a stage where engineer manpower and equipment could be gradually shifted to the lines of communication program. In the spring of 1970 more than 11,000 men of the 26,000 in the U.S. Army Engineer Command, Vietnam, were engaged in some aspect of the highway construction program.

ROAD FAILURE IN THE DELTA

The repair and improvement of secondary roads was initially the responsibility of Vietnamese engineer units. From time to time as early as 1966, U.S. Army engineers had worked on small stretches of secondary roads where immediate gains could be made in promoting commerce, travel, and communication. In late 1969 the secondary road network received more formal attention. Concerted effort was devoted to establishing priorities with the result that by mid-1970 some 75 percent of the scheduled repair and upgrading had been accomplished. The impact on certain localities was more noticeable than that on the country as a whole; with the opening of each new road from a small community there was a dramatic revival of local commerce.

The wide variations in terrain and climate in Vietnam posed many unusual problems for the engineers and called for new methods of highway construction.

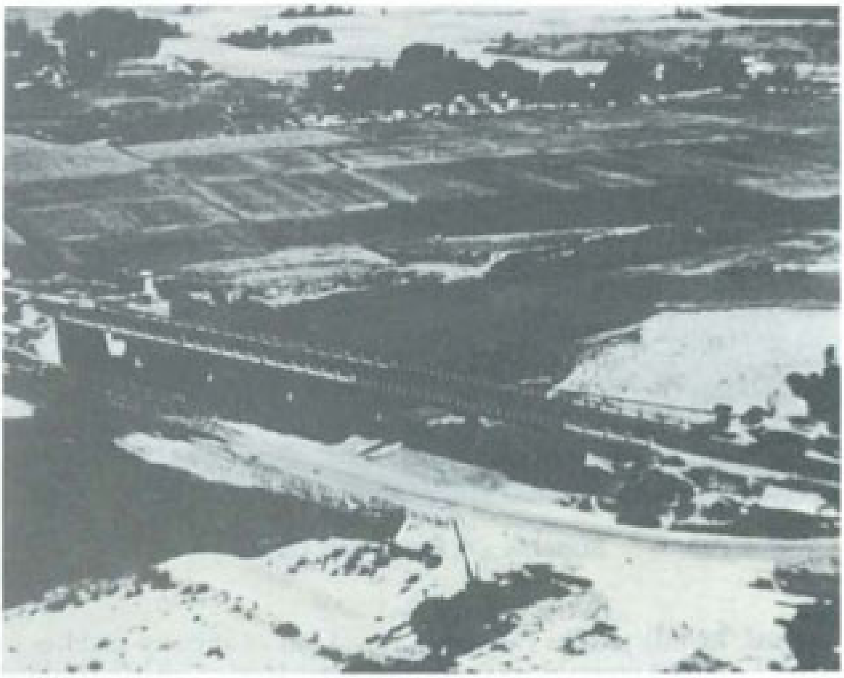
At times mud and a critical shortage of rock threatened to impede seriously any construction of roads capable of supporting heavy traffic in the Mekong Delta region. To cope with these natural obstacles a process known as clay-lime stabilization was de-

BUILDING A ROAD IN THE DELTA

veloped. In this process clay was scraped out of the rice paddies to form a roadbed several feet above the water level. A predetermined amount of lime was spread over the surface of the clay with large scrapers, then mixed into the clay with a rotary tiller or disc harrow. Finally, the mixture was mechanically compacted and allowed to cure. The process was repeated with several eight-inch layers of subbase after which an eight-inch layer of crushed rock was added on top. The surface was then ready to be paved with a double course of asphaltic concrete.

The reaction of the lime and clay was basic to the process. The lime caused the clay to coagulate into particles the size of grains of sand. These larger particles then adhered to one another, forming a considerably more stable base than clay alone. The lime-clay stabilization process had been used successfully in airfield construction in parts of South Vietnam, and its use in road construction was an example of applying lessons learned to good advantage. Nearly all of the fifty-nine kilometers of Route 4 in the IV Corps area were constructed by using this method.

A process similar to clay-lime stabilization was used on portions of Route 13 in III Corps. In this case the natural soil was a silty sand to which Portland cement was added instead of lime to build a conventional soil-cement subgrade that was topped with a single layer of asphaltic concrete. Wherever problems arose in the lines of communication program, engineers repeatedly applied their pro-



PERMANENT BRIDGE ON HIGHWAY 19 BETWEEN QUI NHON AND AN KHE *replaces tactical one-lane Bailey bridge.*

fessional knowledge in devising solutions occasionally as unusual as the problems themselves.

Bridge Construction

The restoration and construction of bridges was an essential part of lines of communication development. To link all the stretches of paved highway, construction plans called for building approximately 250 new bridges. Totaling 11,300 meters, these new bridges, in addition to older but still serviceable spans, would give the republic a network of uninterrupted highways stretching from the Mekong Delta to the demilitarized zone and from the seacoast to the western borders.

The bridges were the most vulnerable links of the highway system, and engineer commanders were deeply concerned for their security. Under cover of darkness, a few determined Viet Cong could sneak to a newly built bridge and with a well-placed satchel charge of explosives destroy the result of months of engineer work.

Various methods were devised to provide adequate bridge security beyond the scope of ordinary patrolling.

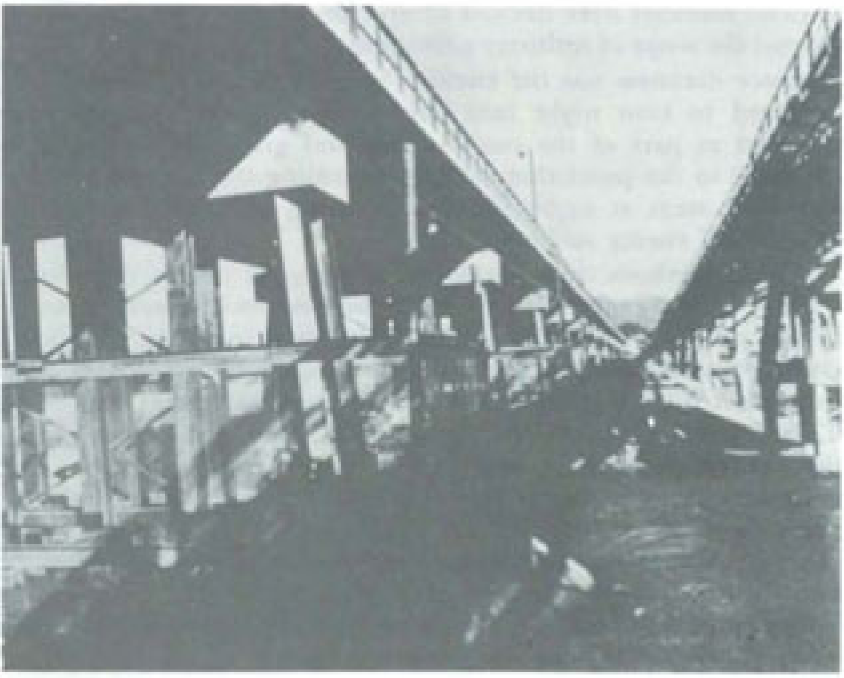
Since darkness was the enemy's greatest ally, the engineers endeavored to turn night into day. Bridge lighting systems were designed as part of the construction and gradually advanced in efficiency to the point that soldiers patrolling the bridges and surrounding areas at night had fair warning of suspicious floating objects and enemy soldiers.

Other methods were developed to frustrate enemy demolition teams. Antiswimmer devices, mine booms, and several types of bridge and pier protective systems were used to enhance security. One common antiswimmer device consisted of concertina wire suspended from floating buoys and secured on the river bottom. Tidal fluctuation, prevalent in most of Vietnam's waterways, caused the concertina to shift and agitate unpredictably, discouraging swimmers from trying to pass through it. Mine booms were employed to arrest or detonate mines intended to float with the current into the pilings of the bridge. Such booms were constructed of heavy timber attached to steel cables and extended across the river a short distance from the bridge. Several feet of chain link fence was usually hung from the timbers to catch slightly submerged mines.

Two distinct pier protection systems were used in Vietnam. The first type that was tried was referred to as a chain link fence standoff, and consisted of steel beams driven into the river's bed with fencing and concertina hung from the beams. This system is still used in waters reaching depths of forty feet or more. Variable tides and currents tended to dislodge and bend the beams, however, and in a waterway with a rocky, muddy bottom it was difficult to achieve equal penetration of the beams.

A low-cost, highly flexible flotation system known as a floating catwalk was designed to function in regions with extreme tidal variations. Using as buoyants either styrofoam or floating steel balls called ping pong balls, the system could be prefabricated easily and then floated to the bridge site for installation. Once emplaced and capped with wide wooden platforms, it was connected with chain link fence and the interior was filled with concertina wire. This floating catwalk provided an advantageous observation post for guards, who could walk completely around the bridge pilings at water level.

Although the efforts of many agencies went into the lines of communication program, the construction directorate of the Military Assistance Command maintained over-all supervision and co-



BRIDGE PROTECTED WITH CAGES AGAINST SABOTAGE *on Highway 1 near Bong Son.*

ordination of the program between the various U.S. agencies, the Army of the Republic of Vietnam, and allied forces in Vietnam.

One purpose of the highway program was to facilitate the movement of military supplies and increase the flexibility of tactical maneuver. In previous wars when adequate roads were lacking temporary military roads were constructed solely to meet military needs. In Vietnam, however, the nature of the war and the tactics employed were very different from those of previous American conflicts. The desire of the United States to improve the economic and social conditions of the people as well as to improve the military situation fostered the development of dependable roads of good quality.

Even more important was the contribution the program made to the pacification effort. By making travel easier and safer, communication between the villages and the cities—socially, economically, and politically—was increased. New and better roads enabled the farmer to transport his products farther and faster. Goods from cities could reach more rural markets and thereby contribute to

GRAVEL PIT AND QUARRY NEAR AN KHE

raising the standard of living in these areas. Engineer bridge builders were gratified to witness the surge of civilian traffic across their roads and bridges.

On 1 February 1970 the goal for the paved highway portion of the road program was set at 4,106 kilometers. As of that date, 40 percent of the proposed roadways had already been completed. The U.S. Army engineer troops along with South Vietnamese engineers and engineers of other allied forces in Vietnam were responsible for two-thirds of that construction. Nevertheless, these figures do not present the whole picture of the road construction program carried out by the U.S. Army engineers. A great portion of the effort involved in the finished product was expended months and years ahead of the actual construction. Before any permanent highway systems could be constructed, suitable natural resources such as rock and sand had to be found. Much effort in the highway program was consumed by the widening and reconstruction of the foundation of existing roads in preparation for paving.

Development of Vietnam Resources

When U.S. Army engineers first arrived in Vietnam in 1965, there were only a few rock quarries, developed by the French, in operation. Rock was a scarce and critical resource in South Vietnam where much of the terrain was sandy and marshy. Since construction of base camps and tactical roads was dependent upon adequate supplies of rock for foundations, a great deal of emphasis was placed upon the development of rock quarries and crusher sites.

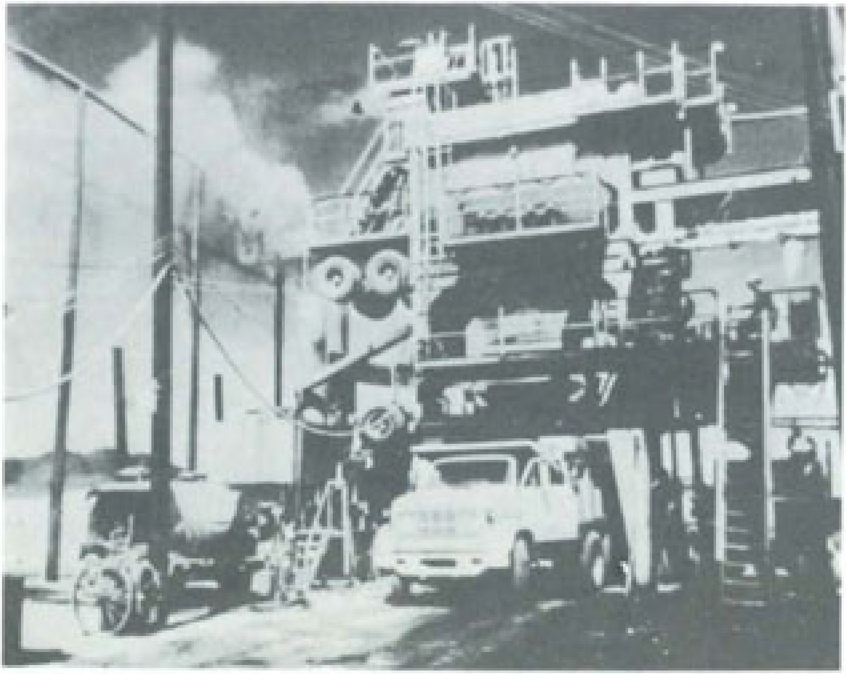
By mid-1970 there were eighteen U.S. Army rock-crushing operations throughout Vietnam. During 1969 U.S. Army statistics show that more than 70,000 tons of rock were used by Army engineers every week, a rate that more than doubled in 1970. Most of this rock was used in landfill, base course construction, and asphalt production in support of the lines of communication program.

To build roads in the Mekong Delta region, where simply finding dry ground could sometimes be a problem and where accessible rock deposits were virtually nonexistent, it was necessary to transport large quantities of rock into the area. A program for this purpose was developed in early 1967 and by 1968 was keeping more than 150,000 tons of rock per month moving by barge to off-loading sites throughout the delta from quarries at Vung Tau, Thu Duc, Nui Sam, and Nui Sap.

Asphalt plants for the preparation of hot surfacing material were usually built beside the quarries. Of the eleven asphalt plants that were scattered throughout Vietnam in 1970, all but two operated in conjunction with quarries. The other two plants were located at sites near paving operations; rock was trucked to the plants from quarries and stockpiled to be used as needed.

Special Equipment

A major innovation in the lines of communication program was the introduction of specialized road building equipment into U.S. Army engineer units to supplement the units' own organic equipment. In December 1968 a special purchase of equipment was undertaken with Military Construction, Army, funds. The 669 items of equipment purchased supplemented every phase of road construction. Among the most important items were eight 250-ton-per-hour rock crushers and 226 12-cubic-yard dump trucks. The crushers played a vital part in the production of large quantities of rock. The trucks in most cases were simply added to the great number of standard 5-ton Army dump trucks which had been hard pressed to meet hauling needs. Quarry operations were also supplemented with tracked pneumatic drills, 6,000-cubic-foot-per-minute air compressors, ground-level rock feeders, and six-cubic-yard scoop loaders. Other road construction items included several types of



ASPHALT PLANT NEAR KONTUM

compaction equipment, soil stabilization plants, asphalt distributors, and pavers. Special purpose items such as the heavy-duty D9 bulldozers, excavators, backhoes, and water distributors rounded out the equipment needs.

Lines of Communication Maintenance

The enemy persistently tried to interdict principal lines of communication in order to impede reinforcements moving to units under attack, prevent resupply of ammunition and other supplies, and minimize the use of U.S. and Free World forces mobile resources. Bridges and culverts were blown; roadblocks of various descriptions were thrown up; and mines, both pressure and command-detonated, were used extensively by the enemy in attempts to disrupt the use of main traffic arteries.

The Army engineers needed all their Yankee ingenuity and resourcefulness to repair continuous damage to roads, remove roadblocks, and clear away mines.

The engineer units were charged with keeping all main arteries

EQUIPMENT DAMAGED BY MINE DETONATION

open to traffic with a minimum of delay and inconvenience to the users. In many areas trucks and other organic equipment were loaded each night with laterite, crushed rock, and culvert material. At first light, reconnaissance was conducted over the roadnet in a particular area, and if any damage was detected engineer crews were immediately dispatched and repairs were promptly made.

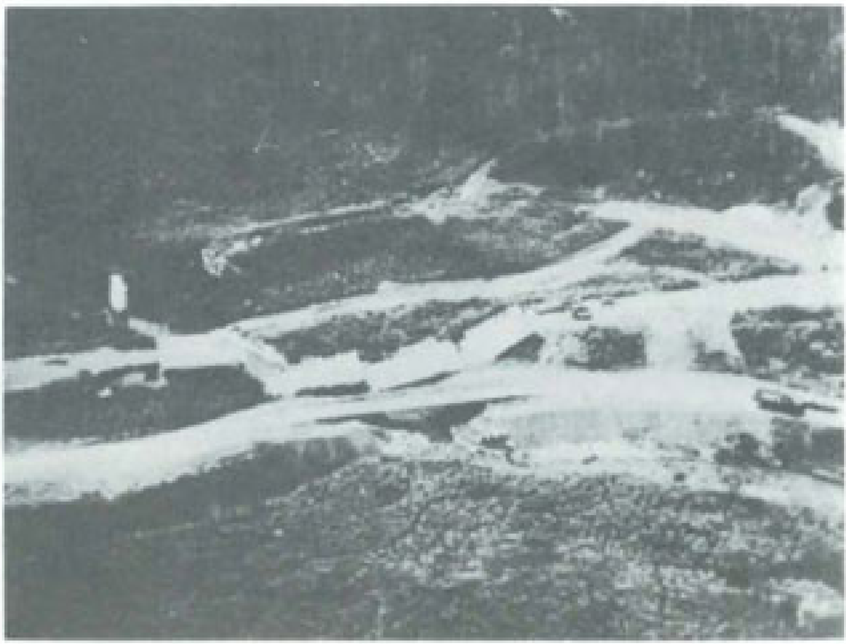
The type of equipment available to engineer units was an essential factor in both construction and maintenance of lines of communication. As military operations continued, new and more effective equipment became available and units achieved greater capability. Engineer unit equipment eventually included armored vehicle launch bridges capable of spanning 60-foot gaps in bridges and culverts, and dry span bridges which had skeleton sections pinned together and which could be airlifted and emplaced by Chinook or Sky Crane helicopters. A 38-foot bridge could be installed in twenty minutes.

An incident on Route 4 provides an example of the expertise and proficiency gained by the engineers in lines of communication maintenance. Because Route 4 was the main supply road from the rice fields in the Mekong Delta to the markets in Saigon, its bridges were natural enemy targets. On 19 February 1968 Viet Cong forces blew a bridge over one of the tributaries of the Song Lu River near the small village of An Ngai in III Corps. The damage was dis-

SKY CRANE LIFTING BRIDGE SPAN

covered at 0730 by a reconnaissance team from the 15th Engineer Battalion organic to the 9th Infantry Division and stationed at Dong Tam. By 0830 the team had reported the damage to the operations section at division headquarters. Headquarters then informed the II Field Force engineer section, which defined the replacement mission and sent it on to the 20th Engineer Brigade. Because of the strategic and economic importance of the bridge, its repair was classified as an immediate reaction mission. Since the bridge was within the area of responsibility of the 34th Engineer Group (Construction), that group headquarters assigned the mission to the 617th Engineer Company (Panel Bridge), the only such unit in the group.

After linking up with a prearranged security force in Dong Tam, the 617th proceeded to An Ngai. To impede repairs the Viet Cong had exploded cratering charges in the road from Dong Tam to An Ngai. The bridge convoy was preceded by fifteen dump trucks from the 15th Battalion, loaded with sand which was put down to make the road passable for the equipment of the 617th. By 1800 on 23 February a new 140-foot Bailey bridge had replaced the old destroyed span. Only 106 hours had elapsed between the time damage was reported and the time the bridge was replaced and ready for use. Such action typified the efficiency of the Army engineer organization in South Vietnam; whenever and wherever a bridge was



BAILEY BRIDGE REPLACES DESTROYED BRIDGE NEAR AN KHE

destroyed, the engineers made sure that it was repaired or replaced in the shortest possible time.

During 1968 and 1970 when large segments of the lines of communication program were completed, the nature of highway maintenance changed. Once a section of road had been paved the enemy stopped mining it, although he continued to mine the shoulders occasionally. An example of the effectiveness of pavement in reducing mining was the completion of Routes 1 and 22 from Cu Chi to Tay Ninh in the III Corps area. Before upgrading, an average of one vehicle per day was lost along this route, but once paving was completed, mine damage was almost eliminated.

One technique developed to reduce damage from the demolition of culverts consisted of welding prefabricated reinforcing steel grills over both ends of the culverts. In July 1970 the enemy attempted to cut Route 13 about thirty-five kilometers north of Lai Khe. Grills which had been previously installed kept the enemy from placing charges inside the culvert, and although both ends of the culvert were destroyed and the shoulders cratered, the pavement was undamaged. Two-way traffic continued unimpeded.

Continuous heavy convoy traffic, particularly tracked vehicles, resulted in an increasing need for maintenance of the asphalt pavements. Small patch crews were continuously used to repair potholes and prevent further pavement damage, especially during the monsoon season. In some instances an asphaltic concrete overlay of short sections was required.

CHAPTER IX

Engineer Tactical Operations

The most direct factors governing engineer construction capability in the Republic of Vietnam were men, materials, and equipment. The last two items were in short supply throughout the early phases of the construction program but became more plentiful in 1966 as the logistical situation improved steadily and as more base and port development projects neared completion. With control of materials and equipment vested elsewhere, the improvement in quality or quantity of manpower remained the most likely means for early increases in the construction capability of the 18th Brigade. But there were prospects of loss of know-how among its units.

During April and May 1966 a significant proportion of the engineer troops in South Vietnam were nearing the end of their twelve-month tours of duty. The loss of so many seasoned men at approximately the same time threatened the operational expertise of many units. To lessen the effect of this "rotational hump," the several group headquarters initiated programs of which the measures taken by the 45th Group were representative. The primary goal of the group was to prevent one month's rotation from exceeding 25 percent of any one battalion's strength. Four steps were taken to accomplish this goal: an overstrength of 10 percent was authorized for the battalion; some individual tours of duty were shortened by as much as one month, allowing the administrative load to be spread over at least two months; the tours of 10 percent of the men eligible for rotation were voluntarily or involuntarily extended for one month or longer if necessary; and soldiers were interchanged with men in other battalions who had less Vietnam service in order to lessen the impact of the loss on any specific battalion.

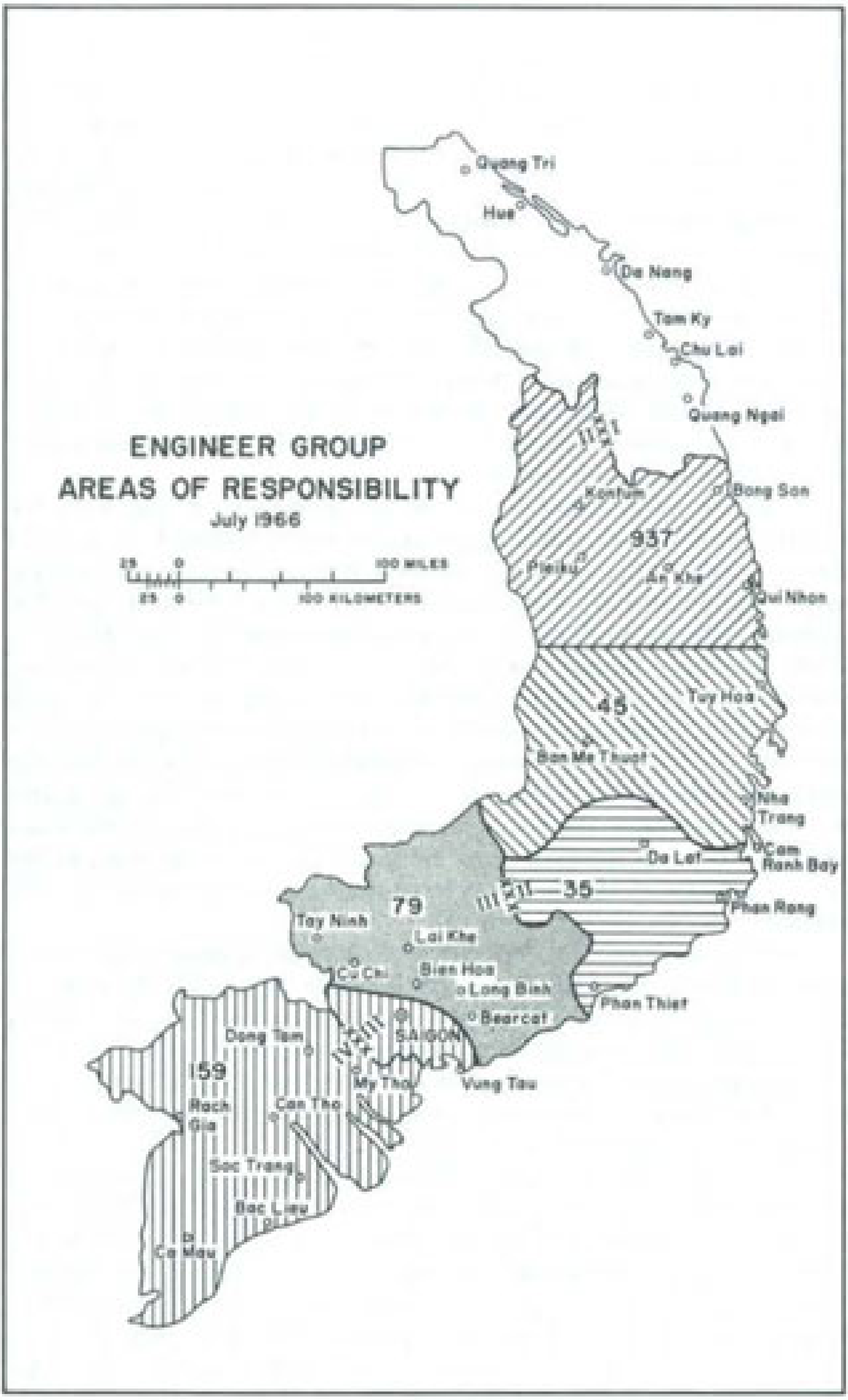
To maintain the manpower resources capable of sustaining operational support, General Ploger agreed to soldiers with non-engineer military occupational specialties as fillers. He also requested and obtained temporary authorization for an overstrength of between 10 and 15 percent, since a 15-percent overstrength could be economically employed without augmenting equipment. The temporary increase in personnel enabled engineer commanders to take full advantage of the dry season to complete as much construction as possible before the monsoon weather curtailed activity.

Local Vietnamese laborers and some from other countries, primarily Filipinos, were employed whenever and wherever possible, but their use had several drawbacks. South Vietnam was traditionally an agricultural country and its people lacked most of the skills common to a more technological society. There was very little skilled labor available to the South Vietnamese Army. The civilian contractors, who had preceded the Army engineers to Vietnam by several years, had exploited the skilled labor market to such a degree that most indigenous workers employed by the Army could be used only on jobs requiring few or no technical skills. Nonetheless, the Vietnamese proved to be industrious, easily adaptable people, eager to learn and contribute.

Engineer units came to realize the potential of the local nationals, and several training programs were initiated to instruct them in such skills as carpentry, masonry, mechanics, and vehicle operation. Eventually Vietnamese workers were providing valuable assistance throughout the construction program. By late 1966 the 159th Engineer Group was graduating a class of heavy equipment operators every two weeks, and thus alleviating a serious shortage which existed among military men in that particular specialty. Not only did the training of formerly unskilled Vietnamese increase the Army's construction capability, it also provided a base of skilled workers who, once the war was over, could put their experience to good use in developing their nation. Their contributions to the future growth of the South Vietnamese economy would be substantial.

On 8 June 1966, the 45th Engineer Group headquarters arrived at Cam Ranh Bay, breaking the drought in the deployment of engineer organizations from the United States that had lasted nearly five months. After establishing its command post at Dong Ba Thin, the group assumed command of the 20th and 39th Combat Engineer Battalions as well as two light equipment companies and a dump truck company from the 35th Group.

Not long after the arrival of the 45th Group, headquarters of the 79th Engineer Group (Construction) was deployed from Fort Lewis, Washington, arriving in Vietnam in July. The 168th and 588th Engineer Battalions (Combat) were attached to the 79th Group with added support acquired from the 362d and 577th Engineer Companies (Light Equipment). In September the 79th assumed command of the newly arrived 27th Engineer Battalion (Combat), and in October the 86th Engineer Battalion (Combat). The addition of two more group headquarters, while increasing


ENGINEER GROUP
AREAS OF RESPONSIBILITY
July 1966
100 MILES
100 KILOMETERS
Quang Tri
Hue
Da Nang
Tam Ky
Chu Lai
Quang Ngai
Kontum
Bong Son
937
Pleiku
An Khe
Qui Nhon
45
Tuy Hoa
Ban Me Thuot
Nha Trang
Cam Ranh Bay
Da Lat
35
Phan Rang
79
Tay Ninh
Lai Khe
Cu Chi
Bien Hoa
Long Binh
Bearcat
Phan Thiet
SAIGON
Vung Tau
Dong Tam
159
My Tho
Rach Gia
Can Tho
Soc Trang
Bac Lieu
Ca Mau

MAP 8

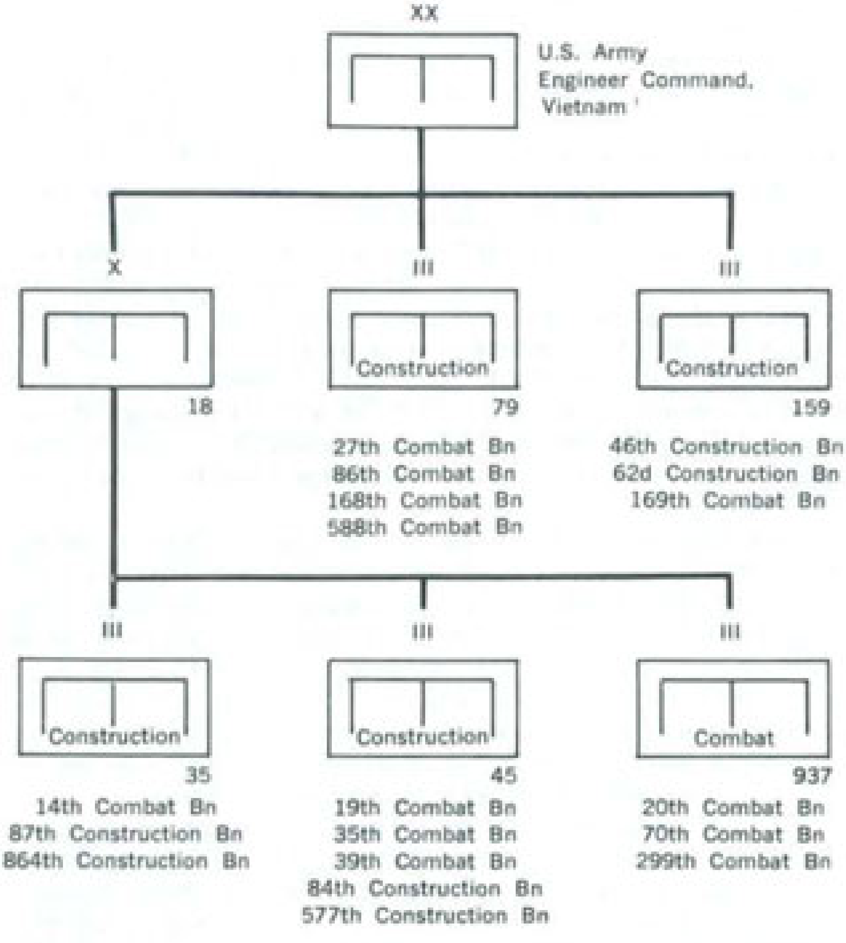
engineer capability, put an added burden on the headquarters staff of the 18th Brigade. The brigade had expanded to include five groups with a total of seventeen battalions. A redistribution of areas of responsibility was effected in order to apportion the work load as equally as possible.

By early 1966 three principal bases of logistical support had been established in Vietnam. Qui Nhon, supported by the 937th Engineer Group, was the primary base of nondivisional strength in the northern II Corps area. The 35th Group at Cam Ranh Bay was geared to the support of the southern region of II Corps. The Saigon-Long Binh complex manned by engineers from the 159th Group was responsible for both the III and IV Corps. While their support was never completely limited to their respective field force elements, most of each group's activities took place within the bounds of the particular tactical zone it supported. When the 45th Group arrived, its immediate area of responsibility included Tuy Hoa, Dong Ba Thin, Ninh Hoa, and the northern Cam Ranh peninsula, thus relieving both the 937th and 35th Groups of some responsibility. The 79th was given responsibility for nondivisional engineer activities in northern III Corps, thereby assisting the 159th Group.

Co-ordination of the various group activities became increasingly difficult for brigade headquarters at Tan Son Nhut. To establish a better position from which to manage the efforts of the entire brigade, the 18th moved a task group to Dong Ba Thin, establishing northern headquarters for the brigade on November 18th. With five group headquarters, eighteen battalions, twenty-one companies, seven detachments, and two separate platoons to supervise, it was time for a modification of the command structure to relieve the strain on the overburdened 18th Brigade headquarters.

On 1 December 1966, using personnel from the headquarters of the 921st Engineer Group (Combat) which had remained uncommitted since its arrival in midsummer, the U.S. Army Engineer Command, Vietnam (Provisional) (USAECV), was established, subordinate to U.S. Army, Vietnam, but operating with considerable independence. *(Chart 4)* The 18th Brigade colors were shifted to Dong Ba Thin and the north headquarters was dissolved. On 20 December the Engineer Command moved from Tan Son Nhut to establish its headquarters at Bien Hoa in response to General Westmoreland's promptings to all the headquarters within Saigon to move elsewhere. Soon there was a scheduled exodus, known as MOOSE, an acronym for "move out of Saigon expeditiously." The entire Army headquarters began to move, principally into the Long Binh area, creating a sudden crush of new construction require-

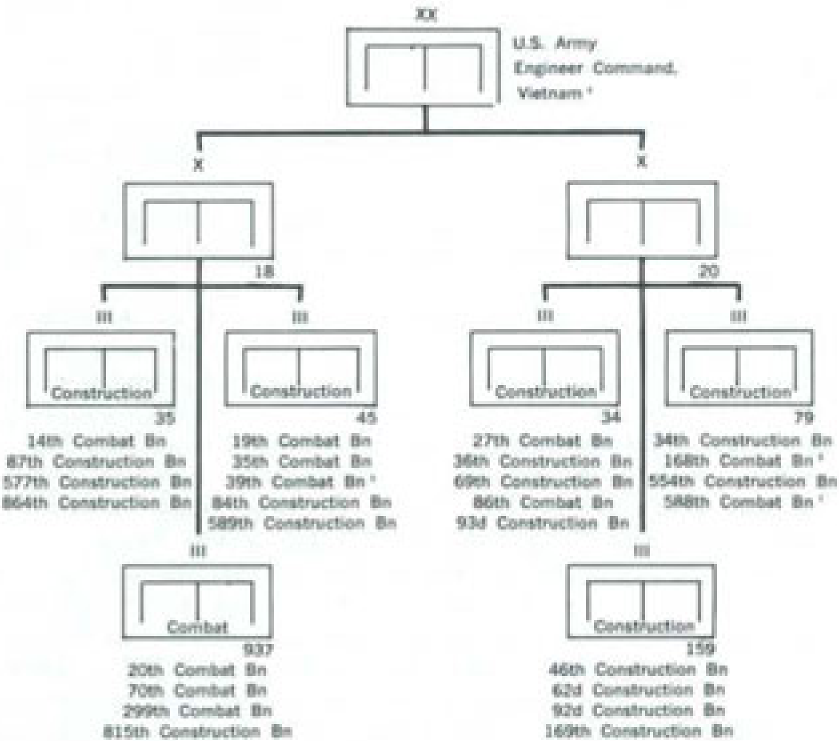
CHART 4—ORGANIZATION, U.S. ARMY ENGINEER COMMAND, DECEMBER 1966



[1] The provisional headquarters of the United States Army Engineer Command, Vietnam, reduced the span of control from five to three major subordinates.

ments for the engineer units in the Saigon area. The Engineer Command was the first major headquarters to move and settled quickly into a partially completed tent and prefab cantonment which had been scheduled for construction in early 1965 by contract to provide housing for the 173d Airborne Brigade. The 62d Engineer Battalion (Construction) was moved from Phan Rang to Long Binh at the cost of one month's production to help in the MOOSE program.

CHART 5—ORGANIZATION, U.S. ARMY ENGINEER COMMAND, NOVEMBER 1967



[1] operational control, Americal Division

[2] operational control, II Field Force, Vietnam

[3] The Army Engineer Command remained a provisional organization, lacking the approval of the Office of the Secretary of Defense.

The Engineer Command drew further personnel from the 18th Brigade, including its commanding officer. In ceremonies conducted at Tan Son Nhut, Major General Robert R. Ploger, recently promoted, assumed command of U.S. Army Engineer Command, Vietnam (Provisional), while his former deputy commander, Colonel Paul W. Ramee, succeeded him as commander of the 18th Brigade. Still additional engineer headquarters positions were filled from the U.S. Army, Vietnam, Engineer Section, which was dissolved with the formation of the new command. The 921st Engineer Group headquarters remained on the books, uncommitted, as a basis for personnel requisitions until its inactivation much later.

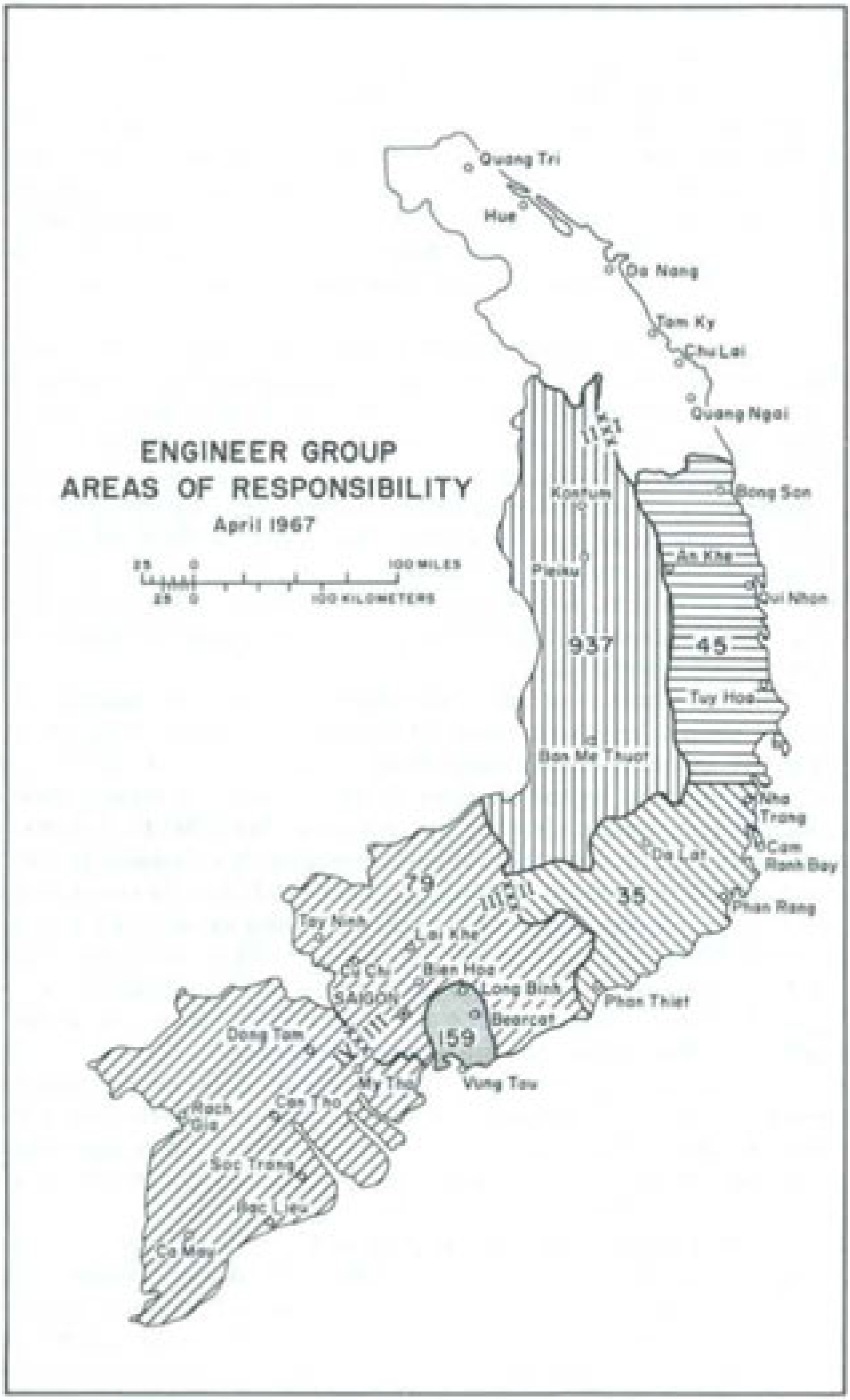
Under the new arrangement, the Engineer Command directed the operations of the 18th Brigade headquarters as well as those of the 79th and 159th Groups. The 18th Brigade, in turn, exercised command over the 35th, 45th, and 937th Groups. *(Chart 5)* Necessary engineer support of I Field Force was handled by the 18th Brigade while the Engineer Command worked primarily with II Field Force. In both cases the groups continued to deal with the tactical commanders, providing assistance as requested. Areas of responsibility for the brigade and groups were established, with the 18th Brigade responsible for all of II Corps, the 159th Group responsible for the Saigon-Long Binh-Vung Tau-Dong Tam area, and the 79th Group responsible for the remainder of III and IV Corps.

The shift of the 18th Brigade from Saigon to Dong Ba Thin was soon followed by a shift of boundaries within the new brigade area. *(Map 9)* Headquarters, 937th Group, moved inland from Qui Nhon to Pleiku and assumed responsibility for all the Central Highlands; Headquarters, 45th Group, then moved from Tuy Hoa to Qui Nhon to fill the gap in the northern half of coastal II Corps created by the move of the 937th. The 35th Group extended its responsibility from Cam Ranh Bay to north of Nha Trang.

In its new area, the activity of the 18th Brigade was split between combat support and construction in a 35 to 65 percent ratio. (The proportion of combat support showed a notable rise from the 10 to 15 percent being contributed at the end of 1965.) Combat support operations centered on building new air and ground lines of communication and maintaining those already in existence. Major construction effort was directed to the expansion at Qui Nhon and Cam Ranh Bay.

The 159th Construction Group concentrated on improving the continuously expanding logistical complex at Long Binh and developing the port at Vung Tau. In late 1966, as a result of the arrival of the 9th Infantry Division, the group shifted some of its efforts to new construction in the Long Thanh and Dong Tam areas. With the acquisition of another construction battalion and construction company, the 159th became almost completely organized for and oriented to construction. In recognition of this, the group's responsibility was reduced in January 1967 so that it consisted of only the area around Long Binh and Saigon.

The 79th Construction Group continued to support construction at the base camps of the 1st and 25th Divisions. The group's area of responsibility expanded by January 1967 to include all of the II Corps Tactical Zone except those base complexes under construction by the 159th Group. Shifting frequently from construc-


ENGINEER GROUP
AREAS OF RESPONSIBILITY
April 1967
25
0
100 MILES
25
0
100 KILOMETERS
Quang Tri
Hue
Da Nang
Tam Ky
Chu Lai
Quang Ngai
Bong Son
Kontum
Pleiku
An Khe
Qui Nhon
937
45
Tuy Hoa
Ban Me Thuot
Nha Trang
Da Lat
Cam Ranh Bay
79
35
Phan Rang
Tay Ninh
Lai Khe
Cu Chi
Bien Hoa
Long Binh
SAIGON
Phan Thiet
Bearcat
Dong Tam
159
My Tho
Vung Tau
Rach Gia
Can Tho
Soc Trang
Bac Lieu
Ca Mau

MAP 9

tion to combat support, the group made sizable contributions to Operations CEDAR FALLS and JUNCTION CITY.

The engineer command and control structure in the Republic of Vietnam was significantly strengthened again during 1967 with the arrival of Headquarters, 34th Engineer Group (Construction), from Fort Lewis, Washington, on 23 March, and Headquarters, 20th Engineer Brigade, on 3 August. Two additional battalions and several separate companies had joined these units by early fall.

The arrival of a second brigade headquarters allowed U.S. Army Engineer Command, Vietnam, to place the groups operating in III and IV Corps under the control of one headquarters, thereby reducing to two the number of headquarters reporting directly to the command. The new structure also allowed the engineer organization to parallel that of the tactical field forces. With the 20th Brigade headquarters at Bien Hoa and the 18th Brigade at Dong Ba Thin, the brigade areas of responsibility now coincided with the tactical areas assigned the two field force commands. This new arrangement facilitated the engineer support needed by the two tactical commands.

The distribution of effort within the Engineer Command continued to shift emphasis from construction to combat support and lines of communication upgrading. The arrival of three land clearing platoons by the summer of 1967 permitted a commitment to large-scale jungle clearing operations in both field force areas. The arrival of six construction battalions and three asphalt platoons boosted the progress in upgrading of the land lines of communication to new levels. Under the approved program all critical highways in South Vietnam were to be upgraded to two-lane paved surface roads with permanent steel beam bridges installed as required. Of first consideration was the vital National Route 1 which paralleled the entire coastline north of Saigon.

In the construction field, Army engineers inherited a much-needed windfall of equipment from civilian contractors when a cutback in funds forced the contractors to phase down operations. With the equipment, however, the engineers also inherited the projects already begun by the contractors.

As the Engineer Command continued to expand in the summer of 1967, the organization and functions of its staff underwent a series of changes. On 10 June General Westmoreland, as U.S. Army, Vietnam, commander, directed that the USARV Engineer Section be re-established. The Commanding General, U.S. Army Engineer Command, Vietnam, was then formally designated U.S. Army, Vietnam, Engineer, a position he had held in fact if not in title. Under

DOZER-INFANTRY TEAM AT WORK

this new organization, the Engineer Section was essentially the planning staff and the Engineer Command staff functioned as the operating staff. After reorganization, the Engineer Section moved from Bien Hoa to Long Binh to occupy a portion of the newly completed headquarters building complex of U.S. Army, Vietnam.

Cedar Falls and Junction City

The first two months of 1967 saw the beginning of the war's two largest operations to date, CEDAR FALLS in the Iron Triangle and JUNCTION CITY in War Zone C. CEDAR FALLS, conducted in January 1967, began as a battalion operation and ended with two divisions and three separate brigades involved in destroying the enemy in what had been one of his strongest sanctuaries. As part of this operation, for the first time in the war the engineers virtually eliminated large areas of jungle, clearing nine square kilometers. To do this the 1st Engineer Battalion, 1st Division, developed and, with the support of the 79th Group, tested the "dozer-infantry team" concept in which bulldozers, equipped with the newly introduced Rome Plow and previously used only in relatively secure areas, actually became part of the assault force.

During one phase of Operation CEDAR FALLS an engineer task force consisting of 300 men from the 1st Division, including some of the divisional engineers, and 300 men from the 79th and 159th Groups was organized into clearing teams to operate under four field control centers in separate areas within the Iron Triangle, a Viet Cong stronghold thirty-five kilometers north of Saigon. During the eighteen days in which the task force operated, teams of two tank dozers followed by six conventional dozers, some equipped with Rome Plow blades, moved with the infantry to cut and clear 2,233 acres and checkerboard the area with landing zones to support future operations.

Engineer activity in Operation JUNCTION CITY closely followed that in CEDAR FALLS, with the locale shifting from the Iron Triangle to War Zone C in Tay Ninh Province. The 65th Engineer Battalion of the 25th Infantry Division conducted the major clearing operations, constructing landing zones and bridges as the area was cleared. The battalion also maintained sixty-six kilometers of roadway in addition to providing the normal minesweeping and demolition teams. During the operation Army engineers built three airfields capable of handling C–130's and established two new Special Forces camps to guard the airfields and provide continuing surveillance of the area.

Operational Control

As more and more engineers arrived in Vietnam and the pressures of mounting tactical responsibilities grew in each of the two field force commands, operational control of nondivisional engineer units became increasingly a matter of debate and concern. Although combat divisions had organic engineer units under their direct control, many felt that the work load and demands being placed upon the field force called for additional units to insure rapid response to critical tactical situations.

From the time of their introduction in Vietnam and specifically since the arrival of the 18th Engineer Brigade in September of 1965, nondivisional engineers had divided their efforts between combat support and base development. The massive effort required in base development made engineer officers resist the transfer of any of the scant number of their units to the tactical headquarters of the field forces. General Ploger and his immediate superior, General Engler, deputy commander of U.S. Army, Vietnam, were convinced that engineer units transferred to field force control would lose their maximum construction potential when they were not directly engaged in combat support. Both men felt that the demands of the construction program were such that the Engineer Command could not afford to lose any of its production potential.

In the spring and summer of 1967 the entire matter came to a head. Lieutenant General Bruce Palmer, Jr., having just taken command of II Field Force, requested operational control of non-divisional engineer battalions to carry out directly the engineering functions of missions being assigned to tactical headquarters. After investigating the situation, General Engler refused the request on the grounds that the field force had never been able to use more than one and a half support battalions at any one time in tactical operations. He insisted that operational control of engineer battalions remain with the Engineer Command until complete support units could be committed to combat support 100 percent of the time.

During late spring of 1967 General Engler returned to the United States and General Palmer moved from the position of II Field Force commander to that of deputy commander of U.S. Army, Vietnam. Lieutenant General Frederick C. Weyand then became the commander of II Field Force. In an effort to assure his successor direct control of some engineer troop resources, General Palmer moved to formalize a more precise means of identifying engineer support for the field forces. He asked that agreements be drawn up between the field force commanders and the Army Engineer in which particular engineer units were designated "on call" for possible duty in tactical operations.

Lieutenant General Stanley R. Larsen, commander of I Field Force, saw little advantage in the new arrangement. He had been pleased with the response of local engineer units to the needs of the tactical operations in his sector. He felt that an agreement whereby only certain engineer units could be used by his commanders would reduce the flexibility he had enjoyed in previous situations. According to the new proposal, units located in the area of an operation would have to be bypassed while units on call might have to be moved a considerable distance to provide the needed support. The result in I Field Force was the formalizing of an agreement that maintained the same kind of relationship with the area's non-divisional engineer, heading the 18th Engineer Brigade, that had existed before General Palmer's request.

In the south an agreement was drawn up with General Weyand to put two battalions of the 79th Engineer Group, the 168th and the 588th, under the operational control of II Field Force to meet tactical requirements. The 100th Engineer Company (Float Bridge), the 500th Engineer Company (Panel Bridge), and the 362d Light Equipment Company were also earmarked for II Field

Force. The 79th Engineer Group, which was assigned to the Engineer Command, was still responsible for all formal construction projects assigned these units. The II Field Force maintained operational control for all combat support operations, revolutionary development projects, and lines of communication maintenance and upgrading within the group's area of responsibility. This arrangement was made in June and as of mid-August the identified units reported no significant change in their day-to-day operations.

The method which had evolved for providing engineer support to what corresponded to a corps did not conform with established U.S. Army doctrine. That doctrine prescribed within an interior corps, that is, with other corps on either flank, an engineer structure of at least one group, and perhaps one group per division, commanded by the corps engineer. In South Vietnam, while there was a field force (corps) engineer with his own planning section, he had no assigned troops. Engineer support was furnished after the fashion of that for Army artillery units placed in general support. The two concepts differ in that a corps engineer normally orders subordinate units to carry out prescribed missions, whereas when the corresponding units are placed in general support, the corps engineer requests them to carry out missions but each supporting unit commander may disapprove the request in whole or in part. It is easy to appreciate the uncertainty which might attach to a situation where support units are not commanded by the tactical commander. Even so, in spite of repeated urging to identify deficiencies in the general support system extant in South Vietnam, no field force commander would admit to any lack of engineer support in any operation. In fact, all commanders expressed only praise for the timeliness and efficiency of that support.

The II Field Force continued to exercise operational control of the two combat battalions and three separate companies of the 79th Engineer Group into the fall. On 12 August General Ploger concluded his tour of nearly two years in South Vietnam and was succeeded by Major General Charles M. Duke, who had previously headed the 18th Engineer Brigade. Most operational support requirements of II Field Force during this time had been transmitted through the headquarters of the 20th Engineer Brigade, which had arrived in Vietnam in early August. In a letter to General Weyand, commander of II Field Force, on 16 September 1967, General Duke reiterated that units of the Engineer Command would respond immediately to operational support requirements. When the need for support was urgent, General Duke encouraged the field force commander to transmit his requirements directly to the engineer group or battalion headquarters immediately concerned. All routine or planned requirements, however, were to be processed through channels leading to Brigadier General Curtis W. Chapman, Jr., commanding general of the 20th Engineer Brigade.

On 26 September General Duke met with Major General George S. Eckhardt, the deputy commanding general of II Field Force, to discuss again the matter of operational control of engineer units in the two southern corps tactical zones. At this meeting General Eckhardt asked for operational control of combat group headquarters plus all the combat battalions, light equipment companies, and bridge companies in the 20th Brigade. He stated that the operational support requirements in the area had increased to such an extent that a group-size element could be kept fully occupied. General Eckhardt also pointed out that the responsibilities of the field force included the revolutionary development program and the training of Vietnamese Army troops. He suggested that engineers were especially vital in these fields and that since the field force had operational control of all other elements necessary to carry them out, it was only natural that the engineers be placed in the same status.

General Duke was surprised at the new and enlarged request in light of the success that had been evident in past operations. He reaffirmed that he could accept this arrangement only if the field force commander would be willing to account for the formal construction projects assigned these units. This condition was not acceptable to General Eckhardt. His command was a tactical one and could not be concerned with construction programs outside the tactical realm.

Since no new agreement could be reached, the procedure discussed in General Duke's letter to General Weyand remained in effect. Engineer units continued to respond to their primary mission of operational support with the ease and timeliness that made any change in the control arrangements seem unnecessary. Neither the support of tactical operations nor the prosecution of the base development program suffered appreciably. Had more engineer troops been available in South Vietnam, it is possible that their effort could have been completely allocated to assisting field force programs aimed at Vietnamese refugee resettlement, Army training, and civic action.

United States Army Engineer Construction Agency, Vietnam

As a result of field visits by General Harold K. Johnson, former Chief of Staff, U.S. Army, the USARV Engineer Section initiated studies to develop an organization which would centralize control over the soaring Military Construction, Army, and facilities engineering costs in Vietnam. By reducing a number of engineer detachments and shifting spaces within U.S. Army, Vietnam, the U.S. Army Engineer Construction Agency, Vietnam, was organized in April of 1968. With the exception of its real estate missions, the construction agency was essentially a management organization, charged with co-ordinating both military and contractor effort in the areas of real property maintenance and construction. Although the organization was not empowered to award nor to modify contracts for performance by engineering contractors, it provided at each installation serviced by the contractor some representatives of the procurement officer for U.S. Army, Vietnam, who retained authority to award or amend contracts. The Engineer Construction Agency could analyze contractor operations and management in detail and recommend improvements in contracts to minimize costs. This arrangement, with its withholding of contract authority, forced the referral of engineer problems outside the engineer structure.

In the area of construction, the new agency co-ordinated the military and contractor positions in the USARV Military Construction, Army, program and the USARV portion of the MACV lines of communication program. It provided design, quality control, construction management, and equipment utilization assistance to the construction agencies. The construction agency also assumed the management of the USARV base development program.

The ability of engineers to respond to commanders' requirements for the support of facilities was due largely to the unusual organization of the Army Engineer Construction Agency. With a designated installation engineer in full control of construction organization at each military base, not subject to directive authority of local commanders, more control and emphasis could be placed where limited resources were most effective. The engineers have generally been reluctant to have engineer units attached to combat units for support because of their occasional misuse by tactical commanders who sometimes do not understand the capabilities and missions of engineers. Rather, they are better utilized in the general support role where the engineer command controls over-all priorities and engineer efforts throughout a whole area. The vertical organization of the construction agency placed engineer support of facilities in a similar role and thus retained centralized control of engineer resources. By relieving the installation engineer of the burden of direction and evaluation from tactical commanders, the agency produced better response theater-wide and more stringent control over not only facilities engineering services but also minor new construction efforts.

Dong Tam

By the end of 1966 the tactical situation in IV Corps made it necessary for the Engineer Command to develop plans for a large base development program in the Mekong Delta region. A location was sought for use as a staging area for operations by U.S. Army tactical units south of Saigon. The site had to be deep enough in hostile territory that the presence of American troops would alone deter enemy activity. It also had to be located in a rather sparsely populated area to reduce the expensive resettlement of local civilians. The problems of tactical resupply and of transporting materials dictated that the base be accessible to a system of navigable waterways. Finally, since during the monsoon season there was virtually no dry land south of Saigon, the site might well be determined by the proximity to a suitable source of fill material. Enough fill would have to be available to raise an area of approximately six hundred acres to a level higher than the watery countryside. It was apparent from geological formations that sand would have to come from a riverbed to provide the needed fill.

A site was finally chosen on the My Tho River about three miles west of the city of My Tho. The land for this camp that became known as Dong Tam was obtained by dredging sand from the Bassac River and pumping it into what had been rice paddies; approximately eight million cubic meters of fill were required.

Company C of the 577th Engineer Battalion arrived at the partially filled Dong Tam site on 21 January 1967 to begin work on the 7,500-man camp and operational base to be manned by troops from the 9th Infantry Division. Mess halls, showers, and latrines were immediately put under construction. To assist in the movement of supplies, two Bailey bridges were placed across an intervening river to connect the camp with the city of My Tho to the east. During the spring of 1967 Company C was joined by engineers of the 169th Engineer Battalion from their previous location at Long Binh and men from the 9th Infantry Division working in the self-help program. By May, 20 percent of the planned construction for Dong Tam had been completed; it included a brigade headquarters, several mess halls, and numerous prefabricated buildings. A 1,670-foot runway enabling fixed wing light Army aircraft and helicopters to bring supplies to the site had also been completed.

A sixty-bed MUST (medical unit, self-contained, transportable)

DONG TAM IN EARLY STAGES OF DEVELOPMENT, JANUARY 1967

hospital was begun during the spring. Two inflatable wards had been completed along with a surgical building and supply center when the 169th arrived. A medical helipad was also under construction. The inflatable buildings were susceptible to collapse if punctured and when during an attack an enemy mortar round impacted nearby, two of the key structures were hit by fragments. From the engineer point of view, the added work and materials needed to protect the inflatables raised a serious question as to the utility of the MUST in Vietnam.

Another question raised in the development of Dong Tam (as well as a few other sites) related to the advisability of erecting the standard two-story wooden barracks in view of the vulnerability of the second story to long-range, flat trajectory weapons. The vulnerability was more apparent than real and the trade of ground space for elevation, extra roofs, and roof trusses kept the seemingly safer single story structure from becoming standard. There is no known incident of a soldier being wounded while in the second story.

The summer saw the completion of more permanent buildings, including wood frame billets for hospital personnel and covered storage areas. Work was also begun on a water and electrical distribution system and on a waterborne sewage system.

The construction project at Dong Tam was hampered as much by nature as by enemy activity. Changing weather plagued the engineers in the delta at every turn. During the summer and fall the monsoons brought rain and the problems of erosion and mud. During the winter and spring, in the dry season, wind erosion damaged machinery as well as terrain. To stabilize the soil during the monsoon season the engineers of the 169th developed a mixture of sand and concrete to gain the desired surface strength in road and hardstand construction. Concrete curbs were designed with corrugated metal pipe spillways in an effort to reduce extensive damage from excessive runoff. Overland grades were kept at a maximum of 2 percent to minimize erosion. Terraces were sodded or seeded with rice to keep them from washing away in the fall or blowing away in the spring.

As areas were filled sufficiently to raise them above the water table, they were immediately occupied by troops. Living in tents with wooden floors, the infantry soldiers played an important role in the construction program through their own self-help effort.

The building program at Doñg Tam necessitated the development of engineering techniques found nowhere else in Vietnam. The instability of the ground in the Mekong Delta required that most large buildings be supported by piles. The extensive use of sand cement was another important innovation. Because concrete aggregate had to be shipped by barge from Vung Tau to Dong Tam, a five- to ten-day trip, it could be used only in the most important concrete structures. The high water table in the area created many other special problems for Army engineers. Holes dug for signal and power poles had to be shored with 55-gallon drums. If the poles were not placed and set immediately, the holes filled with water and new ones had to be drilled.

A peculiar problem also developed in connection with the unusual underground storage tanks installed for protection at the Dong Tam site. Concrete collars had to be placed around the tanks to keep them below ground. Before this precaution was taken, underground storage tanks, suddenly popped out of the ground when their flotation was increased sufficiently by the withdrawal of their contents.

During the summer of 1967 the port facilities in Dong Tam were improved and enlarged considerably. The 41st Engineer Company (Port Construction) built two LCU (landing craft, utility) ramps, an LST ramp, and a pontoon barge and finger pier during the summer. Forty-eight thousand square yards of warehouse stor-

INFLATABLE HOSPITAL BUILDINGS AT DONG TAM DAMAGED BY MORTAR ROUNDS

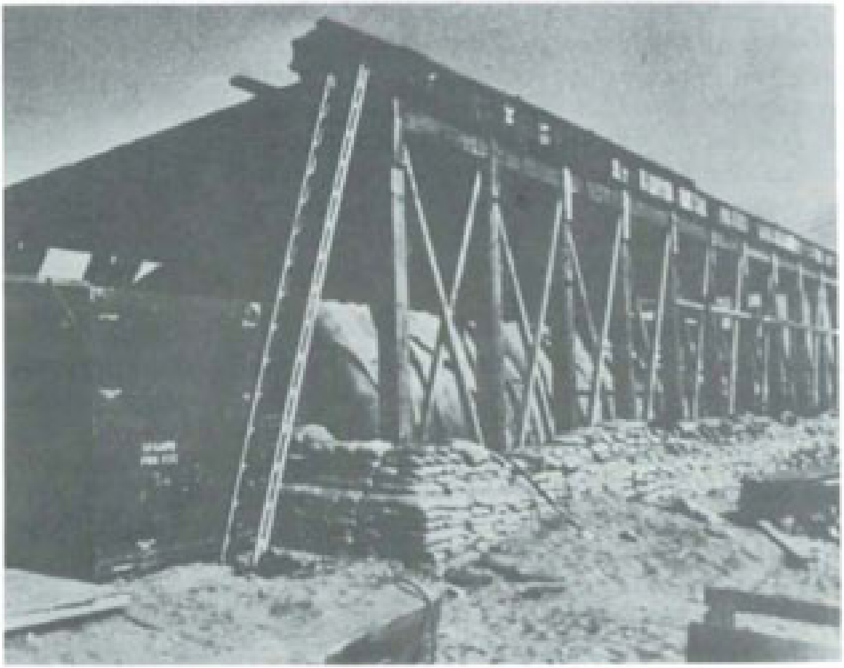
age, 30,000 square feet of hardstands, and 5,000 square feet of maintenance shops were also completed.

In December 1967 four Navy personnel air cushion vehicles arrived at Dong Tam. The vehicle site consisted of a stabilized ramp, an extensive hardstand area, and two maintenance buildings. The Army engineers completed all approved work on the Dong Tam project by the end of 1968. The engineers there made the first inroad into enemy activities in the Mekong Delta and provided an acceptable base of operations for the men of the 9th Infantry Division.

Move Into I Corps

Army engineer involvement in Vietnam had been limited initially to the II, III, and IV Corps Tactical Zones encompassing most of the southern three quarters of the country.

A substantial incursion into I Corps Tactical Zone developed when in early 1967 the Americal Division was dispatched to Duc



ENGINEERS' SHELTERS FOR INFLATABLE HOSPITAL STRUCTURES AT DONG TAM *could withstand a direct hit by an 81-mm. mortar shell.*

Pho, a brigade base site, and Chu Lai. To reach Duc Pho the troops conducted a tactical operation across the beach to their future base one mile inland. There, soon afterward, the 39th Engineer Battalion, which had left its long-established work site at Tuy Hoa and was now attached to the division as its organic engineer unit, worked to develop an airfield for C-130's and for Army helicopters as well as the associated cantonment and logistic support facilities. After a good start at Duc Pho, efforts were made to link up road connections with II Corps Tactical Zone to the south and the Marine and Navy elements to the north. The 45th Engineer Group had its support responsibility extended to include the Americal area of operations. By the end of 1967 new pressures resulting from increased North Vietnamese infiltration across the demilitarized zone forced engineer units to prepare for duty in I Corps. Before this time, troops north of Chu Lai in the northernmost provinces of the Republic of Vietnam had received their engineer support from engineers organic to Marine Corps units in the area and from Navy construction battalions (Seabees).

In January 1968 the 1st Cavalry Division (Airmobile) was alerted for immediate movement north. The 45th Engineer Group was given responsibility for the additional engineer support during the movement and for sustained support in the I Corps area. *(Map 10)* Located at Qui Nhon at this time, the group prepared to move north at the height of the enemy *Tet* offensive and in the midst of the monsoon season. The movement toward the base camp near Hue was complicated by weather that made helicopter flight unreliable and by enemy activities on the ground that made convoy travel extremely hazardous.

The first unit of the 45th to start north was the 35th Engineer Battalion (Combat). Its immediate mission was to move overland, preparing Route 1 for heavy traffic north. The operation was not an easy one considering the level of enemy activity in the northern provinces. The battalion left a landing zone thirty miles north of Qui Nhon on 8 February 1968 to begin the trip up Route 1 toward Da Nang. After reaching Da Nang, the battalion pushed north in an effort to open the Hai Van Pass and the road north of Da Nang as far as Phu Loc. On 12 February advanced units of the 35th reached Ap Nam O, five miles north of Da Nang. Movement farther north became more costly as each mile was opened. Bridges and culverts had been destroyed at many points on the road. Enemy sappers constantly disrupted repair efforts with sniper fire and random mines and booby traps. With assistance from units of the 101st Airborne Division and the 502d Infantry Regiment, the 35th was able to remove the obstacles and replace the damaged bridges by 24 February. On 29 February one company of the 35th linked up with elements of the 32d Naval Construction Regiment working to open the road south from Phu Bai. On 1 March convoys were rolling from Da Nang to Phu Bai for the first time since the beginning of the *Tet* offensive in early January.

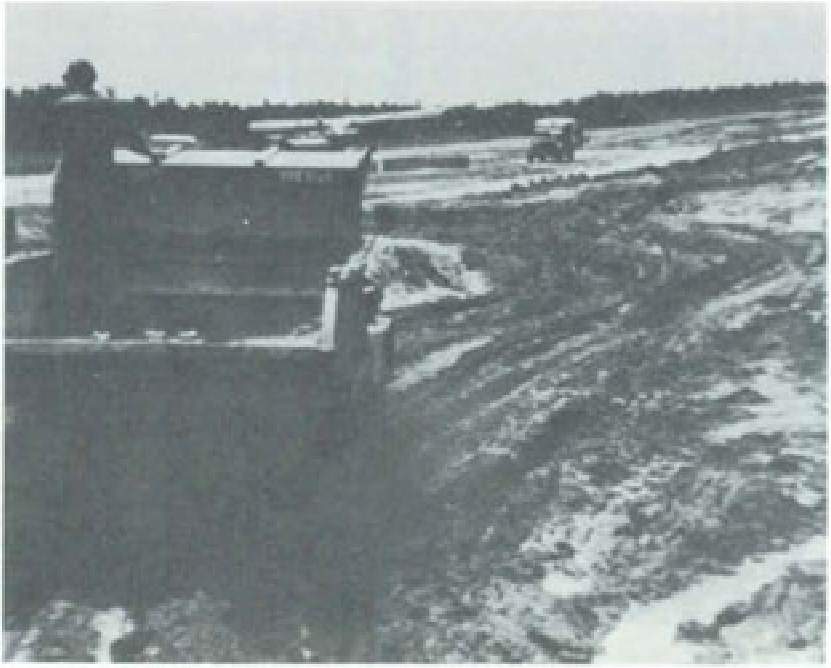
The 14th Engineer Battalion (Combat), located at Cam Ranh Bay, was withdrawn from the 35th Engineer Group to head north. The unit had originally been instructed to prepare to move by sea to Quang Tri where it was to provide support for an over-the-beach logistic operation, but plans had been changed when it was learned that conditions on the beach would not allow the landing of LST's. Fortunately, the 35th Battalion had already opened the road north of Da Nang enabling convoy travel to reach the northernmost areas of I Corps. The 14th was then ordered to travel by convoy to Wunder Beach, just south of Quang Tri. Once the battalion reached its destination, one company was sent inland to provide combat support for the 1st Cavalry Division located at Camp Evans. From the base camp, the remainder of the battalion built roads and

DOZER REDISTRIBUTES SAND DREDGED FROM RIVER

performed other engineering tasks essential for the movement of supplies in preparation for Operation PEGASUS, which was aimed at lifting the siege at Khe Sanh.

The 27th Engineer Battalion, the fourth and last engineer battalion to arrive in I Corps, was assigned the task of providing support to the 101st in the Hue area. Teaming up with the 591st Engineer Company (Light Equipment), the 27th prepared to move from a site known as Blackhorse, thirty miles east of Saigon, by any means of transportation available. Wheeled vehicles were moved by sea to Da Nang, where they were met by drivers flown there by C–130's. The vehicles then were driven in convoy to Gia Le, south of Hue, via the newly opened Hai Van Pass. Heavy equipment was moved by LST directly to Tan My and driven overland to Gia Le. The remaining troops of the 27th were flown directly from Saigon to the Phu Bai airfield near Gia Le. The entire unit reached Gia Le by the middle of April.

The first major task of the 27th Battalion was to support a joint operation by the 1st Cavalry, 101st, and a South Vietnamese airborne brigade up the A Shau valley on Route 547. This task included clearing and opening Route 547 for vehicle traffic and



DONG TAM AFTER A TROPICAL RAINSTORM

removing all jungle vegetation within three hundred meters of the roadway. The clearing was accomplished through the co-ordinated work of platoons of Rome Plows.

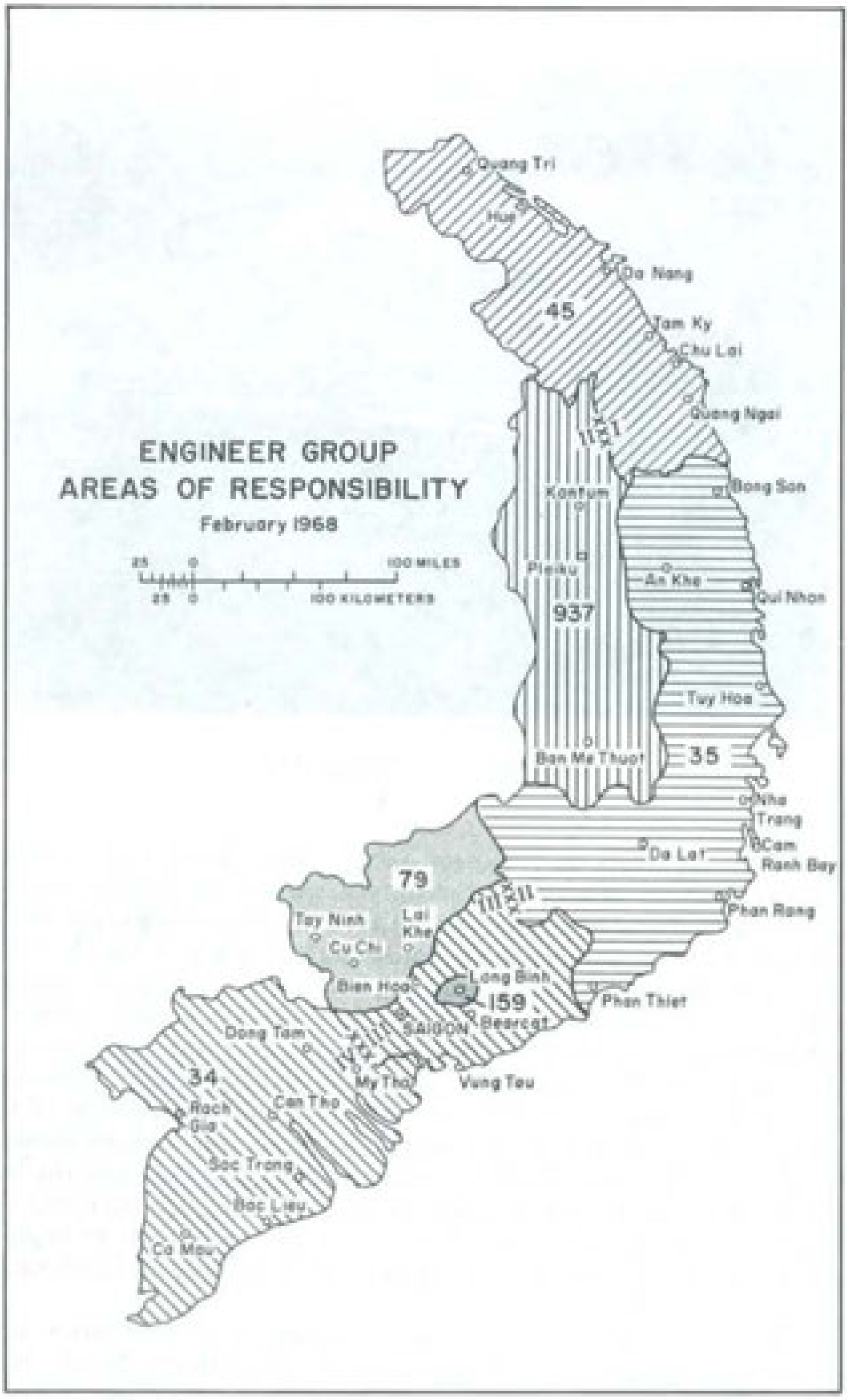
The construction of the winding, mountainous Route 547—known as the A Shau Expressway—is an excellent example of the co-operation and co-ordination involved in the lines of communication program. Route 547 was begun in March 1969 when I Corps tacticians decided the 101st Division needed an all-weather land supply link from the division's base camp near Hue into the A Shau valley, a notorious enemy stronghold. The 27th Engineer Battalion and seven attached companies were assigned to the project and designated the 45th Engineer Group's Tiger Task Force.

Various parts of the road construction job were distributed all along the proposed route. Company C of the 27th installed culverts behind the initial effort of the 59th Land Clearing Company, assisted by helicopters from the 101st Division. The culverts were assembled in the base camps where men and equipment could work freely, and then transported, dangling by hook and line from Chinook helicopters, to the construction site.

DONG TAM IN MARCH 1968

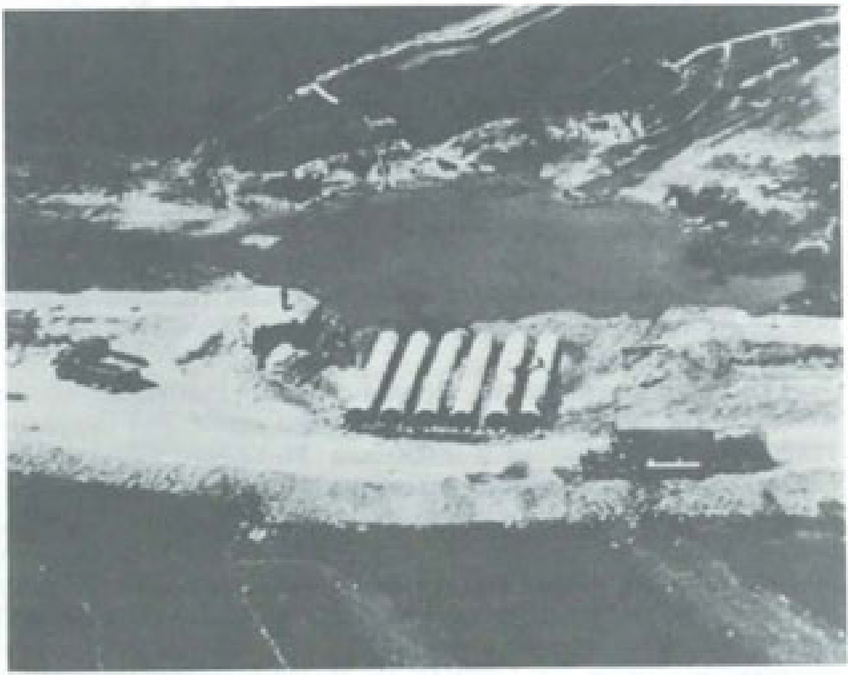
The engineers in Vietnam relied upon innovation and ingenuity, which often were the only means of solving the myriad construction problems they encountered. Land clearing teams along Route 547 had to clear areas bordering the roadway which sometimes dropped off sharply to 60-percent grades. Engineers devised an unusual method of tandem dozing to deal with this situation. Referred to as yo-yo dozing, this method used two dozers; one was positioned on the roadway as an anchor and the other was hooked to the first, rear end to rear end, then lowered over the edge of the slope with its plow pointed straight down to clear a swath through the trees and brush. When the dozer with the plow reached the bottom of the grade, the two dozers reversed their winches and the anchor dozer drew the second dozer back up the grade to begin a new cut. The procedure was repeated until the required 200-meter strip was cleared.

Farther down the road other elements of the battalion constructed a Bailey bridge spanning the Song Bo River. Nearly every facet of road construction was exhibited in the building of Route 547, which was a crucial link in the road system and not merely a



ENGINEER GROUP
AREAS OF RESPONSIBILITY
February 1968
25 0 100 MILES
25 0 100 KILOMETERS
Quang Tri
Hue
Da Nang
45
Tam Ky
Chu Lai
Quang Ngai
Kontum
Bong Son
Pleiku
An Khe
Qui Nhon
937
Tuy Hoa
Ban Me Thuot
35
Nha Trang
Cam Ranh Bay
Da Lat
79
Phan Rang
Tay Ninh
Lai Khe
Cu Chi
Long Binh
Bien Hoa
159
Phan Thiet
SAIGON
Bearcat
Dong Tam
34
My Tho
Vung Tau
Rach Gia
Can Tho
Soc Trang
Bac Lieu
Ca Mau

MAP 10



EARTH-FILL BYPASS FOR BRIDGE DESTROYED BY ENEMY. *Six-barrel culvert will replace bridge.*

military convenience. After the U.S. forces have left, 547 will remain as a valuable commercial artery for the city of Hue and the people in the surrounding areas.

Army engineer operations now encompassed every province in South Vietnam. From the marshy rice paddies of the Mekong Delta to the mountainous highlands along the demilitarized zone, engineers were hard at work applying their expertise in support of combat operations carried out by the allied military forces and in assisting the Vietnamese people in their efforts to build a nation.

Military Assistance Program

The military assistance program in the Republic of Vietnam was by no means limited to support from the United States. In response to an appeal by President Johnson in 1964, several nations of the Free World came to the aid of the beleaguered people of South Vietnam. The military and nonmilitary engineer contingents of these Free World Military Assistance Forces came from Australia, Thailand, New Zealand, the Philippines, and the Republic of Korea and contributed much independent engineer work. Of these countries, Korea furnished the largest engineer contingent. Each Korean division had its organic engineer battalion and one additional battalion known as the Dove Force, a title reflecting its peaceful mission. Based in Ben Hoa Province, this last unit systematically initiated a series of comprehensive local improvement programs oriented toward the improvement of public health, sanitation, rural development, and transportation. The Korean troops "proved themselves adept in establishing a rapport with the local population by stressing the kinship of aspirations and the brotherhood of the Asiatic peoples."

The commitment of the Republic of the Philippines to the welfare of the people of South Vietnam was manifested in August 1966 with the arrival of a 2,000-man Philippine Civic Action Group. Consisting of engineers and medical teams supported and protected by an organic security force, the group assisted the Vietnamese authorities primarily in Tay Ninh Province and to a less visible degree with small teams in several other provinces. During 1967–68 the civic action group cleared a large section of the Thanh Dien forest, long an enemy stronghold, and constructed a model resettlement village for 1,000 South Vietnamese families outside of Tay Ninh city.

Realizing that Thailand could be the next target of communist aggression if Vietnam should fall, the Thai government made its first commitment of combat forces to South Vietnam in early 1967. The Thai engineers, in addition to providing close combat support for the very effective Queen's Cobra Regiment and Black Panther Division, were especially active in civic action programs within their areas of responsibility.

Australia and New Zealand made significant contributions to the physical and social betterment of the Vietnamese people. Thousands of tons of construction materials were made available for local development projects as was the technical assistance necessary to train unskilled local inhabitants.

Before other Free World forces could contribute significantly to the struggle in South Vietnam, U.S. Army engineers laid the groundwork for their allies. Prior to their arrival U.S. engineers initiated construction of base camps and logistic facilities for their support and consistently contributed materials and effort to the allies when their own resources fell short.

Apart from the actual combat troops provided by Free World forces, no less than thirty-five other nations contributed food, medical supplies, equipment, technical advisers, and millions of dollars

THE A SHAU EXPRESSWAY *during upgrading by the 27th Engineer Battalion.*

in economic aid to support the Vietnamese war effort. The assistance provided by these nations represented a solid front united in the common purpose of resisting the destruction of one of their own by communist insurgency.

CHAPTER X

Sustaining Support and Phase-Down

On 8 June 1969, President Richard M. Nixon announced plans for withdrawing 25,000 troops from the Republic of Vietnam. On 1 September the 9th Infantry Division (less its 3d Brigade), twenty Reserve units, two engineer battalions, and one Hawk missile battalion returned to the United States. The systematic withdrawal and reduction of U.S. forces in Vietnam was under way. At the same time the armed forces of the Republic of Vietnam began to accept the full responsibility for the nation's defense. To help the Vietnamese take over and maintain the war effort, the United States created a so-called Vietnamization program in which Army engineers played an important part.

In recent years it has been the policy of the United States to encourage the military of underdeveloped nations to set up programs for using the countries' own resources for socioeconomic development. The concept implies not only developing the ability of governments to provide their people with goods, facilities, and services, but also, and perhaps of greater importance, developing the people's own capacities.

The objectives of the United States in Vietnam at this time were threefold. First was military security, which involved the use of combat units to defeat the Viet Cong and the North Vietnamese and required the destruction of their underground government; second was Vietnamization, improving the competence of the Vietnamese armed forces to provide continuing military security. This mission consisted of giving formal training to South Vietnamese military forces, providing new and modern equipment, and supervising on-the-job training in the use of that equipment. Third was pacification, promoting the socioeconomic development of the country in order to establish a local and national government responsive to the needs of the people and increasing the participation of the people in government. For the first four years of U.S. operations in Vietnam, the major objective was military success. By June of 1969, however, emphasis was being placed on pacification and Vietnamization. Much of the advisory effort of U.S. civilian agencies

CHILDREN'S HOSPITAL AT QUANG TRI

in Vietnam was directed toward the support and advancement of the pacification effort, called revolutionary development, which was sponsored by the government of Vietnam. Military activities in the area of pacification were directed and integrated by a deputy field force commander for Civil Operations Revolutionary Development Support, established by U.S. Ambassador Elsworth Bunker in May 1967. This mission assumed great importance with the decision to phase down U.S. involvement in Vietnam. The engineers fitted into pacification chiefly through civic action projects that used non-combat skills for the benefit of the civilian population. Included in the civic action program, for example, were the construction and repair of schools, religious buildings, communications facilities, hospitals, and other public buildings. The engineers also provided electric power, medical assistance, vocational training, and education classes. Through such construction and services the engineers made important contributions to national development.

In spite of the priority accorded civic action, most of the engineer troop effort remained committed to the support of units involved in tactical operations and to formal military construction; after June 1967 the engineers added to these the important duties of civic action in behalf of the pacification program, which was intended to free the people from the control of the Viet Cong guerrilla organization.

VILLAGERS AND ENGINEERS CONSTRUCT PUBLIC FISH MARKET AT RACH KIEN

Tactical Support

Army engineer tactical support fell into one of three categories: operational support, base development, or lines of communication construction. Operational support included combat support and engineer support to logistical operations. Base development included formal, funded construction projects and maintenance of facilities. Lines of communication construction involved the building and maintenance of all surface and air routes of communication. In the calendar year 1968 the distribution of engineer troop effort between these three activities was as follows: combat battalions operational support 44 percent, base development 33 percent, and lines of communication 23 percent; construction battalions devoted 12 percent of their efforts to operational support, 63 percent to base development, and 24 percent to lines of communication. The operational support rendered by combat battalions consisted mainly of land clearing designed to deprive the enemy of concealment along highways and trails over which combat units had to pass. Operational support by construction battalions consisted chiefly of revetment and bunker construction, airfield and bridge repair, and improvements in petroleum product storage, transfer facilities, and base camp defensive structures. Base development was still a large part of the engineer effort, a significant por-

VIETNAMESE BUILD A MASONRY GATE AT BAO LOC *for the agriculture school with the aid of the 116th Engineer Battalion.*

tion of which went toward providing physical accommodations for detachments. Effort directed toward lines of communication went chiefly into upgrading and making secure certain military essential roads and bridges throughout Vietnam. This last program had been successful and Viet Cong interdiction of surface traffic had been reduced substantially since 1965.

During 1968 control of national and interprovincial roads was transferred from the Vietnamese Ministry of Public Works to the Vietnamese Defense Ministry, and a more extensive and ambitious line of communication program was initiated by the joint military command in Vietnam. This program included those roads designated essential in support of military operations as well as those contributing to pacification and economic development. By 1969 the new surface lines of communication program was going well, as heavy commercial construction equipment arrived in South Vietnam. This equipment included larger dump trucks, more sophisticated compactors, and front loaders with nearly three times the capacity of the military standard front loader. Although the new equipment lacked certain tactically important characteristics such as blackout lights, it had a higher capacity. To provide spare parts not found in the Army system and to help in maintenance of the new equipment, a civilian contractor was hired.

U.S. ARMY, VIETNAM, LINES OF COMMUNICATION PROGRAM AS OF 1 MAY 1969

Status by Calendar Year	*Kilometers*
Completed to Central Combined Committee Standard	897
To be completed to Central Combined Committee Standard, 1969	441
Completed major and minor repairs	457
To be completed major and minor repairs, 1969	64
Construction programmed, 1970	943
Construction programmed, 1971	907

The revised program in May 1969 called for 3,709 kilometers of roads to be completed by the end of 1971. The program was reviewed quarterly and by February 1970 had been adjusted to 3,681 kilometers. The product was to be a two-lane highway built to U.S. highway standards which if constructed in the United States would reach from Washington, D.C., to Las Vegas, Nevada.

The new emphasis on road building dictated a redistribution of engineer troop effort. The proposed phase-down of U.S. troops in Vietnam caused a rearrangement of work priorities. Much of the effort that had been going into base development was rechanneled into the highway program, not only into actual road building but also into the support activities involved. Production plants operated by engineer troops but patterned after stateside industrial layouts produced 340,000 cubic yards of rock and 60,000 tons of asphalt monthly to support the highway program.

Base development programs completed during this period included more Military Assistance Command advisory sites and the improvement of aircraft protection facilities, a particularly high priority item in 1969. Expedient revetments for protecting parked helicopters were demanded beginning in the spring of 1967. Within a few months some form of protection by sandbags or earth-filled walls or drums had been provided for each of the more than four thousand Army helicopters in South Vietnam. The protection sometimes consisted of revetments arranged in an L-shape, sometimes parallel walls between adjacent helicopters and, in other instances, walled enclosures in the configuration of a square with one side missing. Many helicopters soon had revetments in two or more locations. The hurried effort marked an attempt to reduce damage from enemy long-range attacks by mortars and rockets. The long helicopter blades and the height over which protection was desired

EMPLOYMENT OF ENGINEER TROOPS, 18TH BRIGADE

	February 1969 Percent	March 1969 Percent	October 1969 Percent	January 1970 Percent
Operational Support	48	50	54	47
Base Development	25	18	8.5	6
Lines of Communication	20	32	37.5	47

EMPLOYMENT OF ENGINEER TROOPS, 20TH BRIGADE

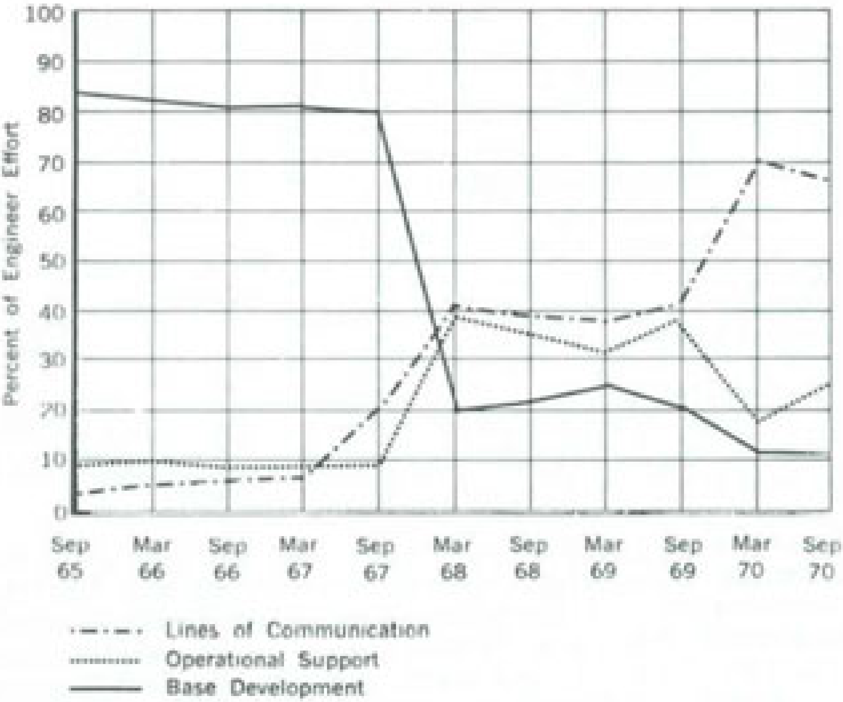
	February 1969 Percent	March 1969 Percent	January 1970 Percent
Operational Support	55	46	not available [a]
Base Development	24	23	not available [a]
Lines of Communication	19	31	62

[a] Breakdown is not available. The total for the two items is 38 percent. (*Chart 6*) The effort devoted to operational support included land clearing, which had become increasingly more important to the engineer command. Clearing was done not only in support of combat units but also to open up the countryside and give the Vietnamese farmer more arable land.

created serious problems for engineers, not the least of which was drainage. The standard revetment stood four feet high, but some reached twelve feet above the parking surface. Design was made more difficult by the aviator's insistence that the revetments allow the helicopter to fly out of them unimpeded. Size and height of maintenance hangars also posed difficulties. The first prefabricated hangar was built in 1966 and others were constructed in 1967 and 1968. By 5 May 1969 the 27th Engineer Battalion had constructed an 11,520-square-foot UH-1 maintenance hangar at Phu Bai; the 815th Battalion was constructing a 33,450-square-foot hangar at Pleiku; and the 554th Battalion was constructing an 11,520-square-foot hangar at Cu Chi.

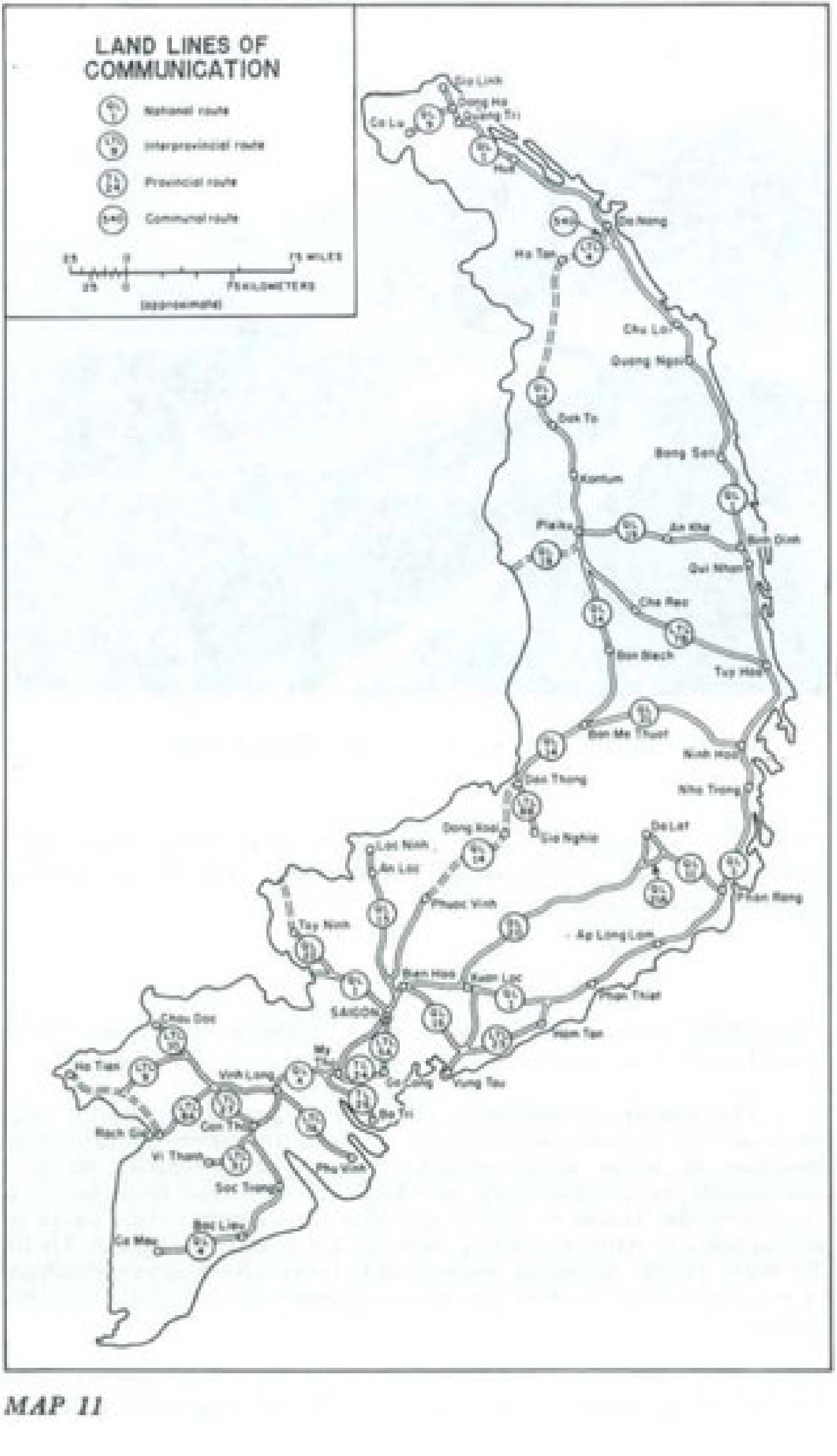
For the Army engineers 1969 was a year of transition in their support functions. The second half of the year saw the curtailment of many base construction projects and a consistently high emphasis on road construction projects. The lines of communication program for 1970 was even more ambitious than that for the year before. The effort expended by U.S. Army engineers on highway construction was markedly effective in improving military capability in Vietnam. It was also to be an important legacy to the people of Vietnam. The opening and upgrading of major highways and feeder roads provided the people in rural areas access to the cities and permitted transportation and commerce between cities. For example, in 1966 the little hamlet of Plei Xo clung tenaciously to its corner of the

CHART 6—DISTRIBUTION OF ENGINEER EFFORT, 1965–1970



Central Highlands like a ghost town that refused to die. Although this primitive settlement was only eighteen miles from the bustling city of Pleiku, there was no roadway and the farmers and charcoal makers of Plei Xo brought their merchandise to town on foot. Then the U.S. Army engineers began to cut Highway 19 west from Pleiku to Duc Co. By 1969 Plei Xo had a superhighway and a window to the outside world. Sturdy, thatched homes and bright shops and churches now line both sides of the highway at Plei Xo. Farmers trade their produce with the people of Pleiku for some of the comforts of modern life.

Thousands of communities like Plei Xo have been connected by the most ambitious road-building program in the nation's history and one of the largest single engineering projects ever undertaken by the U.S. military in a foreign country. *(Map 11)* When the project is completed, modern high-speed roads will tie together the major population centers of the country. These new asphalt lines of communication have changed traffic patterns immensely. Instead of an occasional oxcart, steady streams of traffic now fill the


LAND LINES OF COMMUNICATION
National route
Interprovincial route
Provincial route
Communal route
75 MILES
75 KILOMETERS
(approximate)
Gio Linh
Dong Ha
Quang Tri
Ca Lu
Hue
Da Nang
Ha Tan
Chu Lai
Quang Ngai
Dak To
Kontum
Bong Son
Pleiku
An Khe
Binh Dinh
Qui Nhon
Che Reo
Ban Blech
Tuy Hoa
Ban Me Thuot
Ninh Hoa
Nha Trang
Dao Thong
Dong Xoai
Gia Nghia
Da Lat
Loc Ninh
An Loc
Phuoc Vinh
Phan Rang
Tay Ninh
Ap Long Lam
Bien Hoa
Xuan Loc
Phan Thiet
SAIGON
Ham Tan
Chau Doc
My Tho
Ha Tien
Vinh Long
Go Cong
Vung Tau
Can Tho
Ben Tre
Rach Gia
Vi Thanh
Phu Vinh
Soc Trang
Bac Lieu
Ca Mau

MAP 11

HIGHWAY THROUGH HAI VAN PASS IN 1970

roads. This change alone has brought an economic uplift to Vietnam, and the peasant can see for the first time what the government and the military can do for him.

Civic Action

Brigadier General Harold R. Parfitt commented upon his return from Vietnam in November 1969 on the civic action program:

> . . . The special circumstances in this war have permitted the engineers to do a lot more work than ever before in nation building. Construction of major road networks, opening of secondary roads; a multiplicity of revolutionary development; all have contributed to improving the nation in such a way that the average citizen could see and appreciate what was being done by US troops to improve his lot. To many people reared in poverty and misery, this was as meaningful or more so than our efforts to prevent communist domination of their country.

Civic action was closely allied with the highway program. Roads, besides being essential to immediate tactical operations, were a necessity for the sustained economic development of the Republic of Vietnam.

There were other efforts by U.S. Army engineers that will have a more lasting effect than any road network. Engineers cleared land and canals and provided earth fills for schools and piers. They designed projects for water supply systems, electrical power systems, agricultural and logistical improvements, and irrigation. Although the engineers could devote their efforts to civic action projects only when their duties to tactical troops were fulfilled, their achievements in this field along with the civic action aspect of the highway program led Lieutenant General William R. Peers to comment: "The psychological impact upon the local population was tremendous. The outstanding support and cooperation given by the US engineers in this regard was most commendable."

Typical of the effort expended by the engineers was the rehabilitation of a small Vietnamese Army training camp near Qui Nhon. When young engineer Captain Eric A. Kevitz arrived at this training camp as an adviser, conditions were wretched. The mud-thatched buildings which served as barracks for the Vietnamese trainees were little more than crumbling ruins; the straw roofs leaked, and the winds blew sheets of rain through the windows and the broken walls. The captain decided that he would make every effort to rehabilitate the camp. His appeal to engineer units in Qui Nhon yielded the required construction material from surplus or salvage. He then persuaded elements of the 623d Engineer Construction Company of the Vietnamese Army to guide the trainees in construction of the new camp. Work began and the captain was everywhere—planning, manipulating, directing, organizing, and supervising. Within two months eight new barracks had been built and plans had been approved for twelve more, plus a kitchen, a dispensary, and two mess halls. A water pump was secured, and a generator and electrical distribution system began providing light for the camp. Twelve months after the captain had arrived, thirty barracks had been built. There was a 25-bed dispensary, two 300-man kitchens, four 200-man mess halls, a motor pool, an officers' quarters, and a theater. The dreary training camp had become thoroughly livable through the initiative and aggressiveness of one young engineer.

Vietnamization

In 1965 the Republic of Vietnam armed forces had very few engineers. In prior years some individuals who showed promise had been educated in higher schools of formal engineering, for the most part in universities in Hanoi or France. These graduates, highly proficient in technical engineering, were concentrated in national centers of engineering administration such as the office of the chief of engineers of the armed forces of Vietnam, but their number was small. Most South Vietnamese engineers were poorly trained and unfamiliar with modern engineer equipment; facilities to provide them with the training they needed were lacking. Units were poorly equipped and funds for procuring new equipment were inadequate. From this corps of unskilled and ill-equipped engineers, the United States sought to develop a well-trained, competent, and greatly expanded engineer force in South Vietnam.

The low skill level of Vietnamese Army engineer troops went deeper than a lack of training in engineering methods. Most Vietnamese simply lacked the education and experience to understand the rather sophisticated techniques used in modern military construction. The roots of the problem went back to the French educational system used in Vietnam. Only the best students reached high school and only the superior and the richest were educated beyond that level. As a result, most of the men in the armed forces had almost no formal education. It was therefore necessary for the United States to provide instruction in such basic subjects as reading and writing before undertaking any program of formal training in the engineering sciences. Communication between the instructor, if he was an American, and the Vietnamese pupil was also a problem. A basic knowledge of English was a necessity in grasping the more technical terms and concepts. There was also a psychological barrier to overcome, both in formal training and on-the-job training. Some American instructors felt that the Vietnamese were of inferior intelligence and unable to learn, a misconception that came about partly because of the language barrier, partly because the student lacked specialized training and was unfamiliar with U.S. engineer equipment and methods. These instructors might appear to be condescending; the Vietnamese naturally resented the implied superiority. Fortunately, such cases were the exception rather than the rule. Generally, the relations between representatives of the respective national engineer organizations were warm, pleasant, and mutually beneficial. On both sides there was no lack of willingness to co-operate.

Despite problems, by 1969 the Army Engineer School at Phu Cuong was training 3,000 Vietnamese officers and enlisted men a year in many specialized skills. However, the school was still unable to meet the need for engineers. To supplement the supply of well-trained troops, the Vietnamese chief of engineers ordered the development of an on-the-job training program at the unit level.

Selected instructors were assigned to units throughout the country to promote the proper training of engineer troops.

A few Vietnamese engineer officers and noncommissioned officers were sent to the U.S. Army Engineer School at Fort Belvoir, Virginia, to attend engineering courses. This program will contribute to an improved level of engineering competence throughout the Vietnamese Army in future years.

On-the-Job Training

The formal engineer training of Vietnamese soldiers was an ambitious and productive operation. A more important contribution to the training of engineer troops, however, was made through the joint participation of Americans and Vietnamese engineers in an extensive on-the-job training program.

Major General Joseph M. Heiser, Jr., commanding general of the 1st Logistical Command, proposed the so-called Buddy System in 1968 to help train the South Vietnamese soldier in logistical activities such as supply and maintenance. The program aimed at placing Vietnamese military units under U.S. unit sponsorship so that both the unit and the individual could benefit from observing and participating in operations by the corresponding type of U.S. unit. It was logical to apply the concept to engineer units engaged in formal construction projects. Help in combat support operations by engineer units also continued to be provided by the previously functioning unit advisers—U.S. officers and noncommissioned officers assigned to Vietnamese battalions and larger formations. Feeling that firsthand observation and experience on the job would be the best way to improve the skills of the Vietnamese Army, he predicted that the same success that had come out of the Korean Augmentation to the U.S. Army program in Korea would be derived from the Buddy System in Vietnam. General Creighton W. Abrams personally approved the Buddy concept in January 1969, and assigned to U.S. Army unit commanders the responsibility for military training assistance to the Vietnamese Army. Progress was slow at first, but the impetus provided when General Theodore J. Conway, the head of logistical activities on the staff at Military Assistance Command, Vietnam, established Instruct and Advise Teams to assist Vietnamese units was more than enough to get the project off the ground. The Buddy System gained momentum and became a tremendously effective program for modernizing the Vietnamese Army and increasing its combat and support capabilities. The concept was adopted with enthusiasm by the Army Engi-

BUDDY SYSTEM IN ACTION

neer, Major General William T. Bradley, and his subordinate units were soon deeply committed to the program.

Quite often in 1969 and 1970, South Vietnamese engineer battalions were assigned a joint project with U.S. Army engineer battalions. Operation SWITCHBLADE which began 15 December 1969 was one such operation. It involved three Vietnamese land clearing companies, the 218th, the 318th, and the 118th, and the U.S. Army's 62d Battalion, which was responsible for training the three Vietnamese companies. Vietnamese trainees were assigned to the several U.S. Army land clearing companies of the battalion and deployed with their counterparts to War Zone C for forty-five days of land clearing operations in support of various U.S. combat units. Equipment from U.S. land clearing companies recently inactivated was used to equip the Vietnamese units. Upon completion of the training, one Vietnamese land clearing company was assigned to each of the Vietnamese I, II, and III Corps.

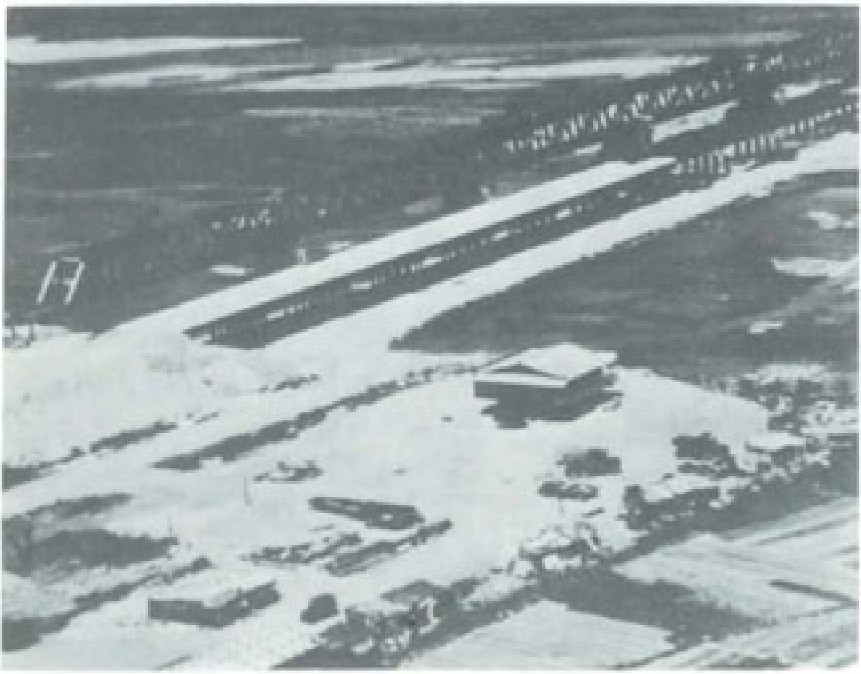
Working beside an American engineer soldier on a certain piece of equipment, the Vietnamese engineer soldier demonstrated that he could quickly learn to operate a new machine. Vietnamese

STUDYING D7E TRACTOR USED IN ROME PLOW OPERATIONS

accompanied Americans on many projects and learned all phases of engineer operations. The American engineer soon developed a great respect for the Vietnamese engineer and showed a sincere desire to convey to his "buddy" as much of his own knowledge as possible. Through maximum contact and training under the Buddy System, the Vietnamese engineer developed a noteworthy level of competence. On-the-job training reached all levels of the South Vietnamese Army and the lowest private developed skills that five years earlier he would not have even understood. The success of the engineer program of Vietnamization can be attributed to the adaptability of the Vietnamese soldier and the determination of the American engineer to convey his own knowledge and skill.

Equipment Transfer and the Logistic Legacy

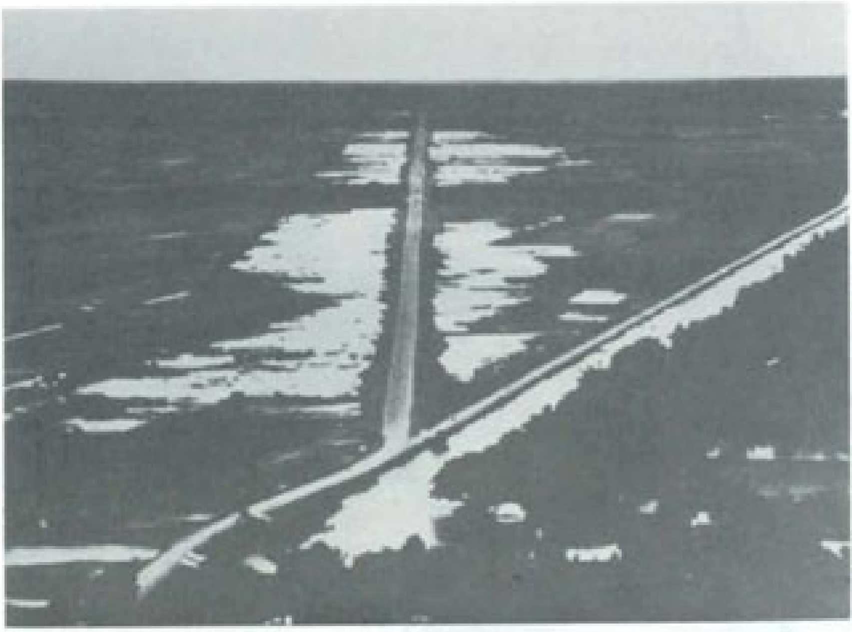
As the U.S. withdrew its forces from the Republic of Vietnam, it left behind a logistic complex of bases, airfields, petroleum product and ammunition storage areas, cantonment areas, warehouses, maintenance shops, utility systems, and lines of communication.



BRIDGE BUILT BY VIETNAMESE ENGINEERS NEAR TUY HOA

Some prefabricated buildings were dissembled and transferred from the sites of their original erection in Vietnam to complexes garrisoned by U.S. troops; other structures were dismantled and returned to the United States. For the most part, however, the products of millions of dollars worth of construction by the U.S. Army engineers remain in Vietnam for the use of the Vietnamese.

As withdrawal from Southeast Asia began, a typical unit marked for transfer or inactivation continued to perform its mission as long as possible, then turned over responsibilities and bases to the Republic of Vietnam armed forces. The transfer of equipment was one of the most important turnovers. In June 1969 U.S. engineer units began shifting equipment to Vietnamese engineer units on a massive scale. On 31 May General Abrams had set strictly defined criteria for the transfer of equipment under the Improvement and Modernization Program for the Vietnamese Armed Forces. These criteria insured that all used U.S. Army equipment was safe to operate, serviceable, and operable to the extent required for its intended purpose. Replacements for any missing or defective parts had to be on order for delivery to the Vietnamese armed forces be-



AERIAL VIEW OF HIGHWAY 4 AND FEEDER ROAD IN THE DELTA

fore a particular piece of equipment was considered transferable. During September 1969, units of the 18th Engineer Brigade transferred approximately 193 separate major items of equipment to the 40th Vietnamese Base Depot, the only engineer base depot of the Vietnamese Army. In the same month the 20th Engineer Brigade was involved in similar equipment transfers. The brigade was ordered to provide 200 major items; a single battalion was designated to co-ordinate all activities. Units of the brigade were to deliver end items in acceptable condition to a central collecting point at Long Binh. Once a substantial number of items was on hand and determined ready for transfer, a date was set for mutual inspection and receipt with Vietnamese Army representatives as well as Military Assistance Command advisers. This equipment was subsequently assigned to engineer units in the field. Some additional items went directly to the Vietnamese units. Similar arrangements proceeded meanwhile in the 18th Engineer Brigade. When the 63d Vietnamese Engineer Battalion was activated in December 1969 at Nha Trang, the U.S. Army's 35th Group provided it with equipment. The 864th Battalion assisted the new unit by instructing its men on operational and maintenance procedures required by their

VIETNAMESE ENGINEERS WORKING ON HIGHWAY 9 NEAR DUC HOA

new equipment. Some new equipment arriving in Vietnam was transferred directly to Vietnamese engineer units.

Vietnamese engineer construction units played a more active role in the highway construction program during 1970. A total of 165 kilometers of road was made the responsibility of the Vietnamese Army units along with 50 bridges totaling 2,879 meters in length. As Vietnamese engineers gained experience, additional segments of the highway program were assigned to them, but the lines of communication construction received a lower priority than the American engineers had afforded it. Concerned about morale, the South Vietnamese expended considerable effort on a program aimed at providing austere housing for military dependents, many of whom had no homes and existed in a state little better than that of camp followers.

Nevertheless, considerable progress continued to be made in the highway program. By February 1970, 467 kilometers of roadway had been completed in the I Corps Tactical Zone. In II Corps Tactical Zone half of the 1,400 kilometers scheduled for completion by the end of 1970 had been finished. In the Saigon region, 451

VIETNAMESE OPERATING ROCKCRUSHER AT NUI SAM QUARRY

kilometers of a planned 1,068 had been completed. An additional 379 kilometers were scheduled for completion in III Corps Tactical Zone by the end of the year. The Mekong Delta, hampered by unstable soil and a severe shortage of road building material, continued to lag behind the rest of the country in receiving major road improvements. Ambitious plans for the highway system, however, included support operations reaching beyond 1970 to overcome this gap in the country's total road construction.

The Vietnamization of the engineer support mission proceeded admirably during 1969 and 1970. Formal and on-the-job training programs enlarged the construction capabilities of the growing Vietnamese corps of engineers. The transfer of logistical bases and badly needed machinery to the Army of the Republic of Vietnam enabled its engineers to apply their new skills. Senior Vietnamese engineer officers, becoming confident of their ability, were informally suggesting that they could handle a greater share of the lines of communication program. The load was being passed to the Vietnamese and there appeared to be every prospect that they would handle it successfully.

Cambodian Incursion

For years North Vietnamese regulars and Viet Cong had enjoyed the immunity of retreat into sanctuaries established in Cambodia. To aid the Vietnamization process by depriving the enemy of these sanctuaries or by seriously impeding his use of them, U.S. and South Vietnamese forces attacked the strongholds during May and June 1970. U.S. Army engineers led the way. The area of operations in the south was generally in the portions of Cambodia known as the Parrot's Beak, the Dog's Head, and the Fishhook, and in the vicinity of Snoul, Memut, and Krek. In the highlands region the area of operation was along the axis of Highway 9, west of Pleiku.

Engineer support for the operation was assigned by the Commanding General, 20th Engineer Brigade, to the 79th Engineer Group. Engineer resources, in addition to the division battalions and the organic engineer company in the 11th Armored Cavalry Regiment, included the 31st and 588th Engineer Battalions (Combat) and the 554th, 92d, and 62d Engineer Battalions (Construction), as well as several separate companies and detachments. Priority was at first given to routes of advance and forward tactical airfields, and later to construction of forward logistical bases at the airfields and all-weather logistical support routes. The 62d Engineer Battalion was committed primarily to provide entry into suspected enemy supply and cache areas, a tribute to the tactical effectiveness of Rome Plow operations.

Accomplishments under tactical pressure were impressive. Engineer support elements built fifty-six kilometers of new road, plus twenty-three separate fixed bridges. In addition, twenty fire support bases were constructed for infantry, armor, and artillery units.

Of particular moment was the tactical delivery of bridging by CH–47's and Flying Cranes. From Quan Loi, where preassembled ramp and trestle sections had been stocked, helicopters lifted and placed at one bridge site both the center trestle and the two connecting spans to each abutment. The bridge was completed eight hours after the first engineer troops had arrived by helicopter. In another instance, Flying Cranes delivered a 38-foot bridge in two trips. These successful deliveries would have been almost impossible by ordinary means. At the time, all suitable surface transportation was deeply committed to other critical tasks.

The support operation was an outstanding success. Once again the engineer soldier, career professional and draftee alike, demonstrated the willingness and the ability to meet the challenge and overcome formidable obstacles to accomplish a mission. Seven 20th Brigade engineers were killed and 132 wounded in this campaign.

Major General John A. B. Dillard, the U.S. Army, Vietnam, Engineer and senior Army engineer in Vietnam, was killed when his helicopter was shot down while he was reconnoitering Highway 509 about ten miles southwest of Pleiku. Colonel Carroll E. Adams, Jr., Commanding Officer, 937th Engineer Group; Lieutenant Colonel Fred V. Cole, Commanding Officer, 20th Engineer Battalion; Captain William D. Booth, Aide-de-Camp; Command Sergeant Major Griffith A. Jones of U.S. Army Engineer Command, Vietnam; and five others also perished in the crash. Command Sergeant Major Robert W. Elkey was the sole survivor.

CHAPTER XI

Summary and Evaluation

Merely to declare, as have several senior U.S. commanders in Vietnam, that no operational mission failed for lack of adequate engineer support is to understate the many contributions of U.S. Army engineers to the tactical and strategic successes of the U.S. military forces. Myriad requirements, from issuing urgently needed maps to installing permanent bridges, were satisfied in timely and professional fashion throughout the varied regions of South Vietnam. Wherever their expertise or assistance was needed, the engineers were there. While individual commanders sometimes bemoaned an insufficient number of engineers at their disposal, those engineers who were available always seemed capable of doing the essential. Their responsiveness, eagerness, and competence in handling an overwhelming work load quickly earned the Army engineers the respect of every branch of the service.

American commanders, recognizing the history of success through an application of engineering to practically any type of problem, often called upon engineers to solve problems which probably could have been solved by other means such as changing logistical arrangements, modifying tactical deployments, or changing the timing or distribution of resources. While this tendency was usually evident to the engineer, it involved matters outside his responsibility, and his characteristic response in South Vietnam was to accept the resultant complications and heavy demands on his own resources.

An early example of a typical engineer response occurred during the initial development of the base camp at Cu Chi for the 25th Infantry Division. Within hours after some major elements of the division arrived at the cantonment site, a thunderstorm struck and lightning killed two soldiers. Engineers on their own initiative immediately went to work finding and emplacing long poles and copper conductors to act as lightning arresters.

The desired manner of performance of the engineer mission throughout United States Army, Vietnam, was established early in the fall of 1965 with publication of the objectives and standards of the 18th Engineer Brigade. *(See Appendix E.)* At a USARV staff meeting in late September General Norton, the deputy commanding general, asked his subordinate commanders to outline objectives and standards for each element of the command. A few days later an eight-paragraph letter was distributed to all units of the 18th Engineer Brigade over the signature of the brigade commander. The letter emphasized the engineers' primary responsibility to those whom they supported, and called attention to the importance of conservation of materials and equipment, safety measures, and respect for the local populace. This statement of command intent continued to be disseminated to all newly arriving engineers in South Vietnam and helped to provide basic policy guidance to them throughout their tour.

The Principle of Dual Responsibility

The policy of entrusting to one man the dual responsibilities of USARV staff engineer and command of all Army engineer units which were not organic to other commands received lively attention during the buildup of forces and beyond. When the 18th Engineer Brigade headquarters arrived in the Republic of Vietnam, General Norton elected to assign both responsibilities to the commanding general of the brigade. As Army Engineer, General Ploger, like his successors, was concerned with developing requirements, allocating materials, establishing priorities, and co-ordinating effort between divisional and nondivisional engineer units and other major Army commands such as the 1st Logistical Command. The USARV Engineer had an important voice in making decisions at staff level. Few problems, particularly in an underdeveloped country, are without engineer implications. As the engineer troop commander, the same individual had to cope with the problems of command, direct all of the operations of subordinate engineer elements, and insure lateral co-ordination with other Army forces, all of whom were subordinate to the commanding general of U.S. Army, Vietnam.

In South Vietnam this command responsibility eventually involved directing nearly thirty thousand engineer officers and enlisted men. To manage and co-ordinate all of the activities of such a large force obviously required a rather extensive staff. It soon proved desirable to have two different groups on the engineer staff, one serving the command function and the other serving the USARV staff function. Under a single engineer, the opportunities for overlap and duplication were effectively squelched. With the arrival in August 1967 of the second engineer brigade, after the establishment of the provisional Engineer Command, the reduced span of control made it comfortably feasible to operate with one man at the head of both the staff and command elements. Moreover, when the Engineer Command headquarters later was located along with Army headquarters at Long Binh the ease of co-ordination improved greatly and one staff was able to perform both functions. The dual responsibility arrangement precluded the possibility of technical or pseudotechnical battles between two distinct senior engineer elements, battles which then would require resolution by a nonengineer. Every engineer should seek to protect his commander, if the commander is not an engineer, from being put in such a spot. If the source of engineer authority both on the staff and within the command organization is vested in one man, a significant contribution is made toward consistency, fast response, and elimination of friction. Moreover, such authority can reduce requirements for multiple staffing by eliminating the need for specialists in all the fields of engineering at both the theater staff level and within the command itself. For a time in South Vietnam the engineer staff function of programming was placed under the direction of the Deputy Chief of Staff for Logistics, U.S. Army, Vietnam. In spite of the closest personal relationship between the engineer commander and the deputy chief, there was a tendency to redo the staff review of proposals within the higher headquarters whenever it came from the subordinate headquarters. Such a policy introduced inevitable delays in the execution of engineer work.

Value of Engineer Tasks Performed

Assessing the specific value of a particular engineer task to overall military success is difficult. Such an assessment would seem to demand answers to questions like the following: How many combat soldiers' lives will be saved by building a refrigerated warehouse at Pleiku? How much can the war be shortened by the installation of one, two, three, or fourteen culverts along the route from Qui Nhon to An Khe? How many dollars can be saved by placing concrete floors under the tents in a brigade base camp? In the interests of strategic efficiency, the sum total of work performed by all engineers in Vietnam on any one day should, theoretically, make the maximum marginal contribution on that day toward success in military operations.

One of the major problems that plagued the engineers during the first years of U.S. involvement was that of shifting local work loads. Pressure to work on those projects which provided the maximum marginal improvement was countered by the difficulty of shifting men and materials from place to place and from task to task. Such shifts were inefficient and time-consuming. Considerable local judgment was needed to avoid waste motion.

Construction priorities published in November 1965 afforded subordinate engineer commanders broad guidelines on what work to begin next while each headquarters was to insure that no area advanced too far beyond another in completed construction. This practice was contrary to that of normal civilian construction wherein effort is allocated to a project until it is completed. A hypothetical situation can illustrate the dilemma. Suppose a brigade cantonment is under construction and work has progressed to the point where plumbing and waterborne sewage systems are about to be installed. At that point a logistical unit arrives in an adjacent area and has no facilities. Should work on the brigade cantonment cease while minimum facilities are constructed for the newly arrived unit, or should the new unit be expected to fend for itself until work on the brigade cantonment is finished? Obviously there are many intermediate alternatives.

In the spring of 1966 the Army Engineer seriously attempted to obtain new answers to the questions of priority through the use of an operations research organization under contract to Headquarters, U.S. Army, Vietnam. At a briefing of the U.S. Army Chief of Staff, General Harold K. Johnson, the Army Engineer asserted that by the end of 1966 he expected to be able to present the finite value of each engineer project measured against future success in operations. After several months of concerted effort including development of detailed data, the operations research investigation produced inconclusive results which would have required the display of several hundred construction status reports. There still remains a need for a firmer determination of the relative sequence in which specific construction assignment should be performed in order to make the best use of engineers.

The Principle of Delegation of Responsibility

The tremendous work load with which the engineer was faced necessitated a wide dispersion of authority and responsibility among lower echelon engineer commanders. Seldom were responsibility and trust misplaced. Company officers and noncommissioned officers worked with a determination and sense of purpose that consistently produced outstanding performance. Mistakes resulted in some cases, but they generally could have been avoided if time had not so often been of the essence and if closer supervision had been more feasible. Fortunately, these mistakes were measurable in terms of dollars and not in terms of lives. Responsibility was delegated even outside the

Engineer Command to people whose competence the command relied upon. From time to time the Army Engineer was pressed to inspect the work performed by contractors under the supervision of the Navy's officer in charge of construction. A prohibitive number of technically qualified engineers could have been absorbed in such an inspection routine. The Army Engineer avoided such a commitment of manpower by establishing as policy a presumption of competence on the part of any federal engineer agency. While many individuals and organizations continue to decry and disparage the policy, the cost of providing sufficient supervision and inspection to insure against the slightest mistake would have dwarfed the cost of actual errors.

The Divisional Battalions

Although the Army Engineer retained responsibility for technical performance of engineer missions by the divisional battalions, any semblance of attempted control or supervision over the engineering activities within subordinate tactical elements was studiously avoided by the engineer command. Nondivisional engineers provided instruction and guidance to their divisional counterparts. In turn, elements of divisional battalions not fully committed to operational support frequently contributed to base development projects, even though such tasks rested primarily with the nondivisional support battalions.

The strict cost accounting procedures forced upon the engineer command were cumbersome, time-consuming, and totally out of place in Vietnam. Strenuous efforts were made to avoid embroiling divisions and their engineer components in the cost accounting quagmire that bogged down the nondivisional engineer units. The situation occasionally resulted in serious competition between divisional and nondivisional engineer units for scarce supplies and spare parts. Since the approved list of priorities for the allocation of manpower, equipment, and materials was used to control the application of engineer effort, subordinate Army engineer commanders occasionally took issue with the tasks being performed by divisional engineers. In such cases the Army Engineer again invoked the principle of presumption of competence and seldom attempted to delay or interfere with the internal activities of the divisional units.

Divisional commanders constantly feared the consequences of inadequate engineer support from nondivisional units which were not under their direct control. Though these fears reportedly never materialized, certain divisional battalions, particularly those in fixed base camp areas, accumulated large amounts of engineer equipment from various sources outside the normal supply channels. With equipment far in excess of their organic allotment, these battalions had to accept the increased burden of operating the equipment. Further, divisional maintenance men found themselves swamped with the maintenance needs of this unauthorized equipment. One engineer battalion commander within a division was taken to task by the U.S. Army Chief of Engineers for building his unit's equipment up to nearly that of an engineer group without a corresponding increase in manpower and spare parts to support the equipment. While such practices undoubtedly increased the capability of certain divisional battalions, the diversion of manpower and spare parts had repercussions on the over-all effectiveness of nondivisional engineers. In general, however, the performance of divisional battalions showed the same flexibility and responsiveness that was a hallmark of the nondivisional organizations.

Effectiveness of Resources

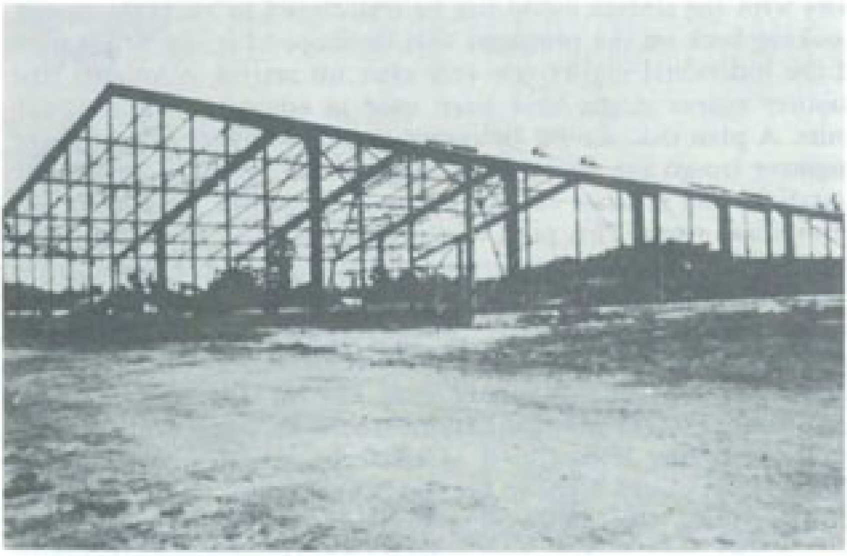
The decision not to employ the vast resources of the Army Reserve in the expansion of the active duty Army in 1965 stripped from the active Army engineer structure a source of skilled craftsmen that engineer planners relied upon heavily. Until that decision Engineer Reserve units filled with civilians skilled in construction crafts had been looked upon as the prime source of engineer troops in the event of a military buildup. Suddenly the Army faced the necessity of training soldiers and officers of its Regular Army engineer units to supervise and build major construction projects far more complex than any they had undertaken in the past.

Government regulations related to military construction in the United States have long restricted the size and complexity of construction tasks that could be assigned to active duty Army units. These regulations severely limit the opportunity for on-the-job training of highly skilled engineer craftsmen. The same regulations inhibit the training of unit commanders and equipment operators in the activities and procedures that are necessary for the operation of men and machines over prolonged periods at very high rates of production. Nevertheless, when the need for a higher level of training became known and the requirements for new plateaus in engineer proficiency were realized, the engineers reacted promptly. The responsiveness of both men and machines to the innumerable demands and requirements placed upon them in a combat zone rife with adverse physical conditions was both remarkable and gratifying.

The introduction of the first engineer troops to South Vietnam magnified the already large requirement for engineer support. Impeded by obstacles of every variety, engineer soldiers and officers often reacted with heightened originality, inspired by impatience, in an effort to meet the demands placed upon them. In the early, hectic days of 1965 and 1966, it was not unusual for engineer maintenance and supply officers and equipment operators to write directly to companies and military installations in the United States for specific parts needed to keep pieces of equipment operating. Before the red ball system became fully effective and the spare parts pipeline from the United States became operable, the U.S. mails served as a supply route for many of the smaller products so necessary for early construction at installations like Cam Ranh Bay and Qui Nhon.

After the 18th Brigade headquarters arrived in South Vietnam and the magnitude of the task facing the engineers was fully appreciated, steps were taken to insure the highest level of engineer performance throughout the country. The role of the infantryman required that he spend two, three, or four days at a time trudging through steaming jungles or muddy rice paddies in sweltering heat and torrential rains. In their support capacity, the engineer soldiers could not allow their efforts in base camp construction to stop at a level less than that exerted by the infantrymen in the field. The need for construction equipment and the ever-increasing pressures of work requirements also demanded that procedures be developed to insure the largest degree of productivity possible per man and machine available in Vietnam. The result was a decision that every engineer soldier would work ten hours a day every day of the week except for time allowed for religious services, and that equipment would be kept working at least twenty hours a day, leaving four hours for maintenance.

Though plagued by a severe shortage of developed skills, the first engineers in Vietnam were quick to respond to the pressures placed upon them. At Phu Loi, the 588th Engineer Battalion (Construction) was given the responsibility for building an aircraft hangar with a prefabricated steel superstructure. When the concrete foundations were in place, the battalion commander discovered that he had only one soldier, a noncommissioned officer, with any experience in structural steel erection. However, within a matter of days a large number of engineer soldiers had learned from the sergeant how to mount, balance on, and connect members of a steel skeleton for a building. Before the towering steel structure was half-built, they were climbing about and working with safety, confidence, and growing competence.



AIRCRAFT HANGAR UNDER CONSTRUCTION AT AN KHE

The on-the-job training of the soldiers of the 588th was typical of the programs that made the performance of engineers throughout Vietnam remarkable. Working through the self-help program, individual soldiers with little more than basic combat engineer training often found themselves advising and supervising large groups of infantry or artillery soldiers as they erected billets or barracks for their own use. The labor for mixing, pouring, and finishing concrete slabs was provided by the unit that was to use the building, but the entire construction project was carried out under the watchful eye of an engineer soldier.

Engineers also found themselves instructing and guiding Vietnamese workmen unfamiliar with the intricacies of construction as practiced in the western world. The patience and perseverance of these men contributed greatly to the mutual respect and confidence that usually existed between American engineer soldiers and the Vietnamese.

The problems associated with troop training were compounded by the practice of limiting duty assignments in Vietnam to one year. The turnover at the conclusion of a unit's first year in South Vietnam was particularly traumatic. Commanders were often faced with a nearly 100-percent turnover inside of one or two months. The knowledge a soldier had acquired during twelve months of dealing with Vietnamese local policies and practices and his familiarity with the terrain could not be transferred to his replacement. Looking back on the problems that developed because of rotation of the individual soldier one year after his arrival, it appears that another system might have been used to advantage for engineer units. A plan that should be considered if substantial numbers of engineer troops are sent overseas again is the rotation of complete battalions and separate companies into the combat zone for a predetermined time. This plan would allow units to work and train together in the United States, thus increasing their efficiency on the job. Equipment needed for construction would not be rotated with parent organizations. Rather, incoming units would assume responsibility for all equipment on the construction site until they were replaced by a newly rotated unit. The time lost in the transfer of personnel of entire organizations would be more than compensated for by the higher level of efficiency a well-trained and organized unit would bring to the combat zone.

The Army needs to do more in the future to equip each engineer soldier with the best background possible in construction skills to meet the kinds of pressure put upon engineers in such an environment as Southeast Asia. Nevertheless, engineer officers, noncommissioned officers, and soldiers proved in Vietnam that they could respond to the demands placed upon them both in the finest tradition of engineer workmanship and with a great team spirit.

The Engineer Support System in South Vietnam

The command and control of nondivisional engineers was a matter for debate and discussion between tactical and engineer commanders from the moment the first engineer units disembarked in Vietnam. The engineer command structure that developed corresponded closely to the principle of general support used by artillery units in past wars. The need for engineer troops in critical tactical circumstances was given first consideration in this centralized system, while requirements of key construction projects remained the determinant for unit locations and distribution. The system was designed to cope with the unusual situation in South Vietnam, and cannot be recommended for different circumstances.

Unquestionably, in South Vietnam every division commander felt the shortage of engineer troops from the time he arrived. His organic engineer battalion was not designed, either in manpower or equipment resources, to deal with the problems of base development. Yet adequate facilities for his troops had to be provided. Merely to move the equipment of a division or a brigade from a road into a bivouac area or base camp required substantial engineer effort and materials, particularly rock, sand, culverts, and fill material, beyond the reach of any organic engineer battalion.

Experience soon indicated that at least one battalion-month of construction was needed to prepare a given piece of land for occupation by one division. The 70th Engineer Battalion's attempt to prepare the base camp for the 1st Cavalry Division in less time pointed out the necessity for additional engineer troops both for site preparation and for continued assistance to organic engineer units. The 70th remained in the An Khe area long after the arrival of the 1st Cavalry Division, improving facilities and generally upgrading the layout and environment of the division. In time, as additional engineer battalions arrived in Vietnam, a division often found a nondivisional engineer battalion located at or near its base camp. However, as in the case of the 70th at An Khe, the nondivisional battalion remained assigned to the engineer brigade.

The reason for this disregard of the traditional practice of assigning engineer units in support of tactical organizations grew out of the peculiar combat situation in Vietnam. The new concept of airmobility that played a key role in the tactical operations of divisions and brigades simply could not be matched by airmobile engineers. Although troops were located at a specific base camp, tactical operations, relying heavily on helicopters, sent brigade-size elements in any direction at a moment's notice and sometimes for a very short time. Engineer equipment, even that specifically designed for airmobile operations, was not capable of that kind of mobility. Attached as direct support units, engineers would have spent more time traveling about the countryside than working as engineers.

When initial computations in the late fall of 1965 disclosed that some 490 battalion-months of engineer construction work would be needed to meet existing requirements, it was clear that no time could be wasted. With an assumed complement of ten battalions of engineers, the work would take more than four years, even without deducting time for tactical operations. Consequently, every hour and every day engineer troops spent away from the work site constituted a serious waste. The centralized engineer support system dictated that the engineer battalion closest to a tactical operation should support that operation.

Engineer battalions were deployed throughout South Vietnam at locations determined by construction work loads. Most projects were located near base camps or at logistical centers where troops were located. However, the building of roads, pipelines, airfields, helicopter landing fields, and waterfront facilities both on ocean frontage and inland waterways required that some units be stationed at a considerable distance from major troop centers. Though the distribution of troops seldom bore any relationship to projected tactical operations, the knowledge of local terrain and conditions gained by engineer units working at a given location over a period of time did benefit mobile tactical units operating in their area of responsibility.

The centralized control of engineer battalions by the 18th Engineer Brigade greatly reduced the need for engineer units to be moved over great distances, thereby giving the enemy fewer opportunities to stage ambushes against the slow-moving convoys carrying construction equipment. Engineers were also able to benefit from extended stays in an area. Knowledge gained from weeks and months of work in the Mekong Delta, for instance, would not be negated if the tactical situation required the movement of the parent division to another place. The Army engineer battalion already based near the new home of the relocated division could provide valuable local intelligence while the engineer battalion in the delta could continue to apply its experience in that particular terrain to the benefit of the tactical organization near it.

The final factor in the determination of engineer control centered around the requirement for cost accounting on all construction projects. Accounting procedures specified that an accurate record be kept indicating the dollar value of material installed and the number of man-hours expended on a given project at any point in time. This latter figure was particularly important because it was used to measure the state of completion of a particular project. Keeping a running account of total costs and manpower used on a project was a difficult procedure even when handled through the unit reports passed up the engineer chain of command. If this function had been carried out by divisional battalions or organizations assigned to divisions or corps, separate reporting chains would have been necessary. Along with this responsibility would have gone the problems of verification and enforcement which would only have complicated the already stringent demands put upon tactical organizations in the field.

Though tactical commanders needed more engineer support at their disposal, they were not willing to accept the added responsibility of cost accounting. Even in the construction of self-help projects the engineer unit providing supervision and guidance assumed responsibility for all cost accounting. This was made possible by limiting the flow of construction materials to the supply channels of the engineer structure, allowing accurate bookkeeping with little duplication of effort. The magnitude of the paper work that would have been necessary if the material accounting procedure had been placed outside the engineer command would have been an intolerable burden on U.S. Army, Vietnam, tactical commanders, and the engineer structure.

The implementation of the kind of engineer command and control structure utilized by the U.S. Army in South Vietnam should be considered only under similar circumstances. When combat areas are more clearly defined and rear areas are only incidentally entered by tactical forces on tactical missions, the traditional deployment of engineer battalions and brigades in support of divisions and corps should be followed. The method of employing engineer troops in Vietnam should be the exception, not the rule, in planning large-scale tactical and engineer operations in the future.

Construction Accounting

Because Military Construction, Army, was the source of funds for the engineers' construction program in Vietnam, strict accounting requirements were placed upon the Engineer Command. Although the accounting system was devised to eliminate any need for cost accounting at platoon, company, and even battalion level, the necessity for counting man-hours, which were applied to each project to measure the state of completion, brought every engineer commander into the accounting picture. The number of men needed to follow such accounting procedures can never be determined precisely but it was certainly substantial.

In spite of the remarkable amount of work completed by the engineers, even more could have been done had it not been for the detailed bookkeeping procedures. The problem was compounded by the necessity to retain projects on the books even when effort had been totally diverted to more urgent tasks. As new organizations arrived in Vietnam, they required immediate engineer support. Some construction battalions, for instance, had to abandon a particular project temporarily to help establish a base camp for a newly arrived unit. The partially finished construction project, however, was retained on the books of the battalion until it was completed. Projects often remained on the books for months, and in some cases even years, before they were completed and scored out.

Some idea of the magnitude of the accounting problem is exemplified by the fact that in July 1967 a complete report of projects in progress by nondivisional engineers in South Vietnam required 266 pages from an IBM computer. The summary printed below covered one-third of a page of that report. It is obvious that considerable engineer effort was expended in compiling such extensive accounting computations. Although the accounting procedure above was a simplified one specifically designed for Vietnam, it was still far too complex. Such accounting appears to contribute little or nothing to military success and creates a significant drag on manpower resources. It represented the minimum effort possible in response to laws and regulations. The matter of devising an expedient, efficient, accounting system for the engineers in a combat environment deserves close attention at the highest military levels. A possible solution might be the development of field service regulations applicable to engineer operations in a combat zone or in a combat support zone outside the continental United States.

Summary of Extract from Construction Accounting Report, July 1967
United States Army Engineer Command

Ammunition Storage Area
- Number: 8720808 T5s
- Location: Vung Tau
- Priority: (unspecified)
- Construction Unit 69 — Using Unit 148

Component Facility
- Pads with apron, 30 each
  - Scope: 300,000 square feet
  - Unit Cost: 6¢ per square foot
  - US Manhours expended to date: 25310; this month: 6885
  - US Manhours remaining 15,900
  - Beneficial Occupancy Date 15 June 1967
  - Estimated date of Completion 21 October 1967
  - Percent Complete 62%
- Administrative Space
  - (Similar data as contained under "Pads")
- Road Network
  - (Similar data as contained under "Pads")

Totals: Manhours to date	US	Vietnamese
Manhours this month	US	Vietnamese
Scheduled	US	Vietnamese
Manhours remaining		
Scheduled next month		
Total current working estimate		
Total work in place		
Percent engineer effort completed		
Percent last month		
Percent by end of next month		

Advance Planning for Base Development

The fallacy of the contention that U.S. involvement in the war in Vietnam was inspired by the military is probably nowhere more evident than in the utter inadequacy of initial U.S. base development plans in support of American troops. It was plain from the outset of the buildup of U.S. forces in early 1965 that there had been little advance planning for the arrival of men, materials, and equipment in South Vietnam. Initial supply channels were inflexible and material moved sluggishly, causing frustrating delays in construction projects. Even civilian contractors, trained and organized for the procurement and shipment of materials, were unable to secure delivery of certain necessary materials sooner than five months after they were ordered. When large quantities of construction materials were involved, the Army's logistical system met with similar delays.

The first engineer units should have arrived in Vietnam at the head of a pipeline full of materials—enough to insure continuous constructive engineer activity. It is essential to optimum employment of engineer resources that the pipeline be kept full, that materials needed first arrive first, and that successive increments follow in the proper sequence. Such a system would have allowed construction in Vietnam to proceed step by step and would have helped to eliminate the disruptive suspension of projects which occurred when materials were not available when needed.

For such a supply system to function properly it is essential that the theater commander define his requirements and specify the sequence of construction. Facility requirements must be translated by the staff engineer in terms of material, equipment, and manpower, which must be appropriately balanced if they are to be utilized efficiently.

Ideally, a sequential supply system would eliminate storage requirements for construction supplies in the theater and promote the optimum commitment of resources to the desired end. Theater commanders would have to take care to program a certain degree of flexibility into their statements of requirements to allow for unforeseen modifications that might become necessary between the time of the original requisition and completion of the project. However, the more flexibility demanded by a commander, the greater the need for storage of construction materials in the theater. It should be the job of the engineer to advise field commanders in keeping demands for flexibility within reasonable bounds and maintaining storage requirements at lower levels.

Geographic Area Responsibility for Engineers

In the combat zone, Army engineers have responsibility for both advising commanders and carrying out projects being built in support of the combat effort. The key to proper exercise of this responsibility is the collection and evaluation of engineer intelligence relating to the physical and military environment of the area under consideration. Since the accurate forecasting of engineer requirements in a theater of operations is difficult at best, it is important to establish in every tactical area a repository of information capable of supplying engineer intelligence throughout the area.

The absence of significant prior planning for engineer operations in Vietnam made it especially important that engineer units be given geographic areas of responsibility with the mission of accumulating information pertaining to possible engineer operations in their sector. In South Vietnam this responsibility for collecting and evaluating local engineer intelligence was given to engineer commanders of groups whose areas of responsibility combined to cover every square foot of the country. By keeping close tab on engineer activities within their sectors, even on work being performed by agencies not under their immediate control, group commanders were able to co-ordinate the engineer effort down to the lowest level. This system also guaranteed against costly duplication in support operations.

The construction of the base development complex at Nha Trang affords an excellent example of the difficulties that can arise from inadequate co-ordination and control of engineering tasks during the development of a major base. Over an extended period of time, the tightly constrained area available for construction in and around Nha Trang saw the building of a port, a major airfield serving both the Army and Navy as well as Vietnamese armed forces, and a major Army logistic base with its associated cantonments.

Beginning in 1965 Army engineers designed and began installing the depot complex. During the construction phase many weeks were devoted to providing deep drainage ditches to conduct the normal expected rainfall away from the areas chosen for depot use. Several months later a contractor serving the Air Force was charged with developing an airport adjacent to the depot. Before the onslaught of the rainy season, it was discovered that the drainage designed to accommodate the airfield almost completely negated the effectiveness of the previously installed depot drainage system. Only the crash allocation of equipment and manpower to relocate the drainage facilities prevented a major disaster from flooding which would have occurred with the first heavy rains.

While ultimate co-ordination between the respective services resided in Military Assistance Command headquarters, some engineer should have been at the local level with authority to control work there. The inherent interrelationship of all engineering works in a given area, particularly where drainage and utilities are involved, makes it important that the Army continue to assign geographic responsibility to specific engineer commanders, at least at the group and possibly at the battalion level.

Future Engineer Training Requirements

The Vietnam experience demonstrated a clear need for the revitalization of training procedures for construction specialists in the active Army. With the reservoir of skilled men at a low in the civilian construction industry, the active Army can expect a decreasing number of competent engineer tradesmen. Yet the Army provides few formal advanced individual training courses for engineer soldiers, preferring to rely instead upon on-the-job training programs. Such programs are probably the cheapest method of providing advanced skill training to construction engineers, but the training cannot be done properly without rather extensive expenditures.

From experience in South Vietnam it was found that a construction battalion, when fully employed, consumed approximately a quarter of a million dollars worth of materials during each month of operation. Assuming that two months of annual training for each skilled soldier would be adequate, every installation commander with a construction battalion assigned to his station should seek an annual appropriation of half a million dollars for construction materials to be consumed by the battalion. The resulting construction should remain as a permanent facility of the installation and not be dismantled upon conclusion of training. Properly programmed, the funds and the facilities could be derived from ongoing Military Construction, Army, appropriations.

The over-all competence of individual engineer soldiers must also be considered in future training programs. In Vietnam engineer troops found themselves in advisory and supervisory positions in the self-help program as well as in instructional roles training Vietnamese in modern construction methods. Support of this concept, however, will require that engineer soldiers receive instruction on teaching American practices and on the supervision, control, and administration of small crews. If adequately trained and directed, indigenous labor forces could substantially reduce the need for highly trained American soldiers in any overseas area of operation. With the proper preparation, engineer troops could play an important role in reducing the number of American soldiers committed to engineer support.

Special Areas of Engineer Expertise

Three particular areas of special engineer expertise merit close attention in peacetime against future contingencies. Port development, power sources and distribution systems, and subsurface water resource development are areas in which the Army must retain a complement of skilled and experienced men. Special equipment such as the DeLong piers which served so effectively in South Vietnam should be retained and exercised by troop units to insure the capability of Army engineers to install or employ it without forcing dependence on contractor assistance.

The DeLong piers saved months of the time required to erect conventional piers. In allowing the early operation of deep-draft ports, they more than proved their value to support and logistic military operations in foreign countries. The utilization of the DeLong pier and the extensive port development program in South Vietnam brought to light a shortage of U.S. Army staff officers competent in port construction. Many officers with such competence were produced and will continue to be produced through the civil works function of the Corps of Engineers. In light of experiences in Vietnam, it might indeed prove desirable to keep records on all individuals in the Army who have gained experience in port development. The importance of such experience is underscored by the fact that in 1966 the inadequacies of South Vietnam's ports became a matter of personal concern to the Secretary of Defense of the United States.

Another area that demands extensive study and preparation before any conflict arises is the training of men in the installation of power generators and their associated switching stations and distribution lines. While all tactical organizations carry organic power sources with them, such sources are generally inadequate for anything but tactical operations and local support. Procurement of any major piece of electrical generation equipment requires long lead times. In late 1965 the engineers of U.S. Army, Vietnam, computed total future power requirements to be approximately 290 megawatts. Generators of 1,500-kilowatt capacity and greater were seldom available in less than eighteen months and very large units might require several years to fabricate and install.

Without high capacity generation equipment, the distribution of electrical power throughout South Vietnam promised to be a complicated operation. Again, few officers and enlisted men were skilled and fully knowledgeable in the field of power production and distribution. As commander of the U.S. Army Materiel Command, General Frank S. Besson, Jr., sought to resolve the problems he foresaw through the employment of seven ships of the T–2 tanker class. His proposal called for the ships to be taken out of mothballs, sent to South Vietnam, and anchored offshore near major installations where their generators could provide a substantial portion of the total electrical power required. However, initial estimates of time required for placing the tankers on line proved optimistic and the first electric power from the tankers became available only a short time before that from some large capacity generators ordered at the same time.

The complexity of the electrical power problem is perhaps best reflected in the residual difficulties experienced by the Vietnamese in taking over American power installations for their own use. The marginal competence for operation, maintenance, and repair of major power generation systems in the U.S. Army far exceeds that within the Vietnamese armed forces. For the future, the entire question of generator equipment, spare parts, and development of supporting skills within the Army merits careful attention.

The third area of engineer responsibility deserving particular attention with regard to adequate preparation for future contingencies is water resource development systems. The tactical situation in South Vietnam dictated that water sources be developed within the defensive perimeters of base camps and logistical installations. Water sources isolated in the countryside were vulnerable and inviting targets for the enemy. Early efforts were made to develop wells within each military installation in South Vietnam. While drill rigs with two-man operating teams appear among the lists of U.S. Army detachments in South Vietnam, there was a general lack of training in the proper procedure for locating suitable drilling sites. Moreover, the available well-drilling teams were not equipped with the materials they needed. Each prospective well required casing, screens, and pumps, but it was months after the arrival of the first drilling detachments before these materials were available in Vietnam. Even then there were few engineer officers or noncommissioned officers who possessed the necessary knowledge and experience to locate the best sites for drilling productive wells. The U.S. Army deserves something better than the equal of a divining rod for selection of a deep well.

Properly trained, such units as well-drilling detachments can contribute greatly to obtaining acceptance by the local populace of allied military forces. Their abilities could be and were ultimately applied in the civic action program to finding and developing local sources of water for the indigenous population. From the point of view of pacification and civic action as well as from the obvious necessity to support the troops, additional effort should be devoted to water resource development in the Army training program.

Future Real Estate Implications

Many military planners are prone to incorporate in the preamble of a set of contingency plans a statement to the effect that "it is assumed that maximum use will be made of all existing facilities in the area." To assume today that any existing facility will not be already fully utilized or that it can be successfully requisitioned for use by U.S. forces indicates either an unwillingness to address a complicated problem or extreme naïveté.

In Vietnam even the projection of possible future operational sites for tactical activities frequently became a real estate exercise. With the continuous growth of population in all parts of the world and with the growing commitment of land resources to personal or economic use, a more reasonable presumption would be that few if any facilities adequate for U.S. military purposes will be available. It is also realistic to assume that future bivouac areas, tactical dispersal sites, and tactical airfields will have to be situated in the least desirable real estate in any region. Unless the implications of such prospects receive the detailed analysis they deserve, some future engineer may find himself less prepared to protect his commander's forces from an unfriendly natural environment than his predecessors in South Vietnam.

Conclusion

It has been charged in the past that the Army enters each new conflict prepared to fight the one before. There appears to be little basis for the charge in South Vietnam, and there is little sentiment in Army circles to build the future Army solely around experiences in South Vietnam. Certainly the engineer contingent of the Army translated lessons from World War II and Korea to the advantage of our military. One can look to the employment of the DeLong piers and our beginning posture in mapping as examples of applied developments. *(See Appendix G.)* It would be most imprudent, however, to deprive future engineers of an appreciation of the nature of engineer contributions in South Vietnam. Thus, while recognizing the unique character of warfare in which we were engaged between 1965 and 1970, the engineers of our Army should address themselves to the applicable features of the conflict with the objective of making further improvements in any future operation where their expertise may be needed. It is hoped this monograph will spur attention to the subject.

In spite of restraints in manpower, finance, management, and materials, the Army engineers have added new laurels to their history of support. All Americans can again take pride in the flexibility of thought, the responsiveness to need, the ingenuity, the diligence, and the adaptability of their engineer soldiers and units. That pride should extend to those elements of the Army outside of the forces assigned duty within South Vietnam: the planners, trainers, advisers, researchers, designers, purchasers, and shippers who fought their war at desks within the United States in an essentially peacetime environment. Their dedicated efforts made possible the tremendous accomplishments of the engineers in particular, allowing the latter to give substance to the motto of the Corps of Engineers: "Essayons."

Appendix A

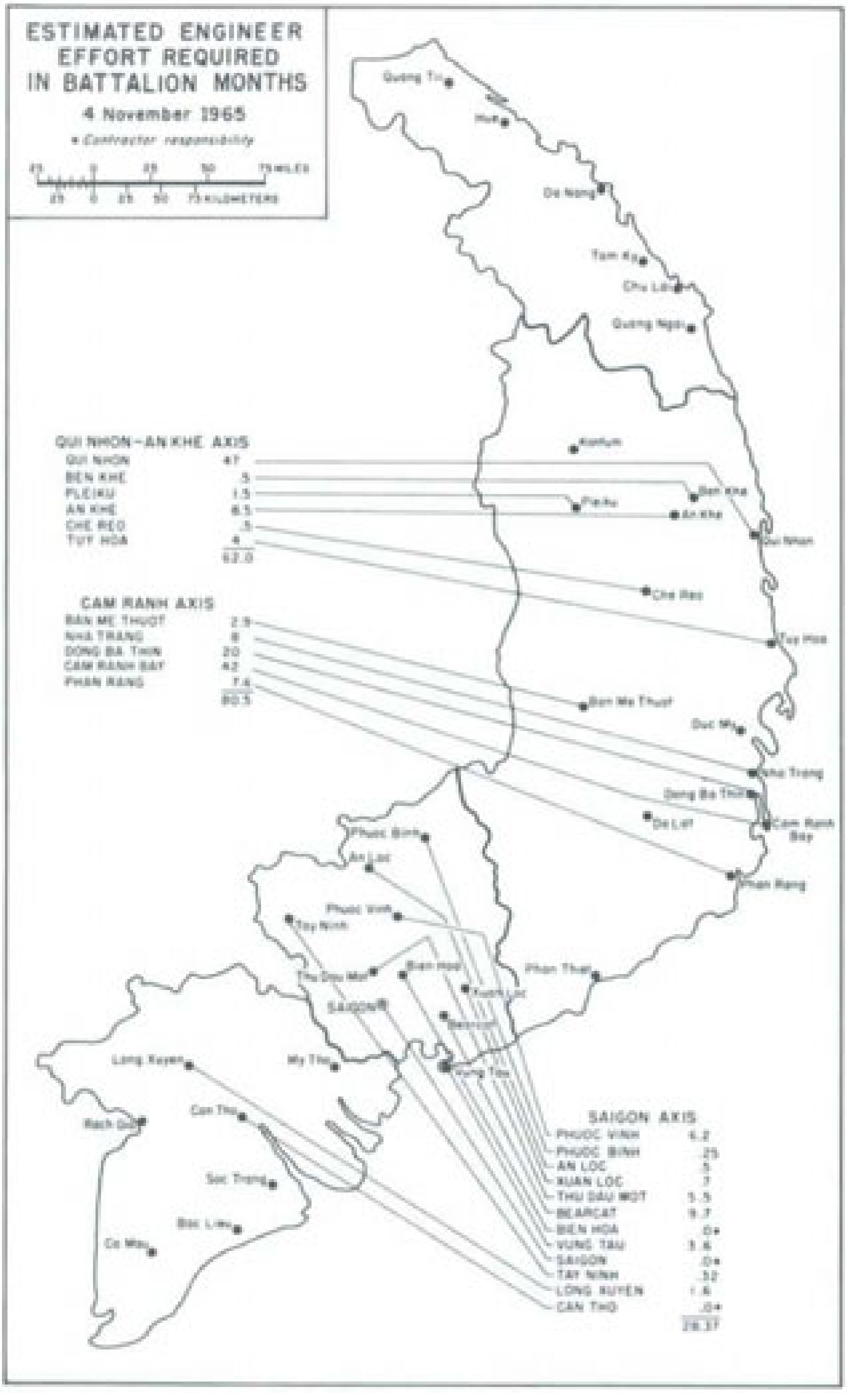
MAJOR GENERAL ROBERT R. PLOGER'S BRIEFING OF GENERAL WILLIAM C. WESTMORELAND, 4 NOVEMBER 1965
(Reproduced May 1971 from notes of the original briefing cards.)

General Westmoreland, General Norton, Gentlemen:

In the following briefing I shall cover four separate points. First of all I shall present an appraisal of the engineer situation as it appears for the United States Army, Vietnam. Second, I shall address some peculiar aspects of the engineer environment in South Vietnam. Third, I shall present the logical conclusions and follow with my recommendations.

First, then, a summary of the engineer situation. The mission of the engineers as I see it may be briefly stated as follows: Within allocated engineer resources, it is the mission of the engineer organization of the United States Army, Vietnam, to enhance and promote the capabilities of USARV to win in South Vietnam. This mission is performed through three distinct types of activities: First, by providing support to tactical operations; second, by constructing the required logistical facilities; and third, by making the environment amenable to our interests.

To determine the requirements, then to meet our mission, the first element calls for a certain amount of engineer support. This is an indefinable quantity; we are unable, at any given point in time by way of forecast, to determine precisely how much of the total available engineer effort must be allocated to the tactical situation. The second part of our mission, that of constructing logistical facilities, is more easily estimated. On this map is a presentation of our geographical distribution of engineer effort required for construction of facilities which currently have been identified as necessary. *(Map 12)* Note that in the Saigon axis area we have a total requirement of approximately 28.37 battalion-months of engineer effort. In the Cam Ranh Bay axis it is estimated that a total of 80.5 battalion-months of effort will be required and in the northern Qui Nhon–An Khe axis it appears that we require a total of 62 battalion-months of work. One battalion-month comprises the expected output of either one construction battalion or one combat battalion plus a light equipment company as applied against the already identified items in the construction program for fiscal years 1965 and



ESTIMATED ENGINEER EFFORT REQUIRED IN BATTALION MONTHS
4 November 1965
* Contractor responsibility
MILES
KILOMETERS
QUI NHON-AN KHE AXIS
QUI NHON 47
BEN KHE .5
PLEIKU 1.5
AN KHE 8.5
CHE REO .5
TUY HOA 4
62.0
CAM RANH AXIS
BAN ME THUOT 2.9
NHA TRANG 8
DONG BA THIN 20
CAM RANH BAY 42
PHAN RANG 7.6
80.5
SAIGON AXIS
PHUOC VINH 6.2
PHUOC BINH .25
AN LOC .5
XUAN LOC .7
THU DAU MOT 5.5
BEARCAT 9.7
BIEN HOA .0*
VUNG TAU 3.6
SAIGON .0*
TAY NINH .32
LONG XUYEN 1.6
CAN THO .0*
28.37
Quang Tri
Hue
Da Nang
Tam Ky
Chu Lai
Quang Ngai
Kontum
Ben Khe
Pleiku
An Khe
Qui Nhon
Che Reo
Tuy Hoa
Ban Me Thuot
Duc My
Nha Trang
Dong Ba Thin
Da Lat
Cam Ranh Bay
Phan Rang
Phuoc Binh
An Loc
Phuoc Vinh
Tay Ninh
Phan Thiet
Thu Dau Mot
Bien Hoa
Xuan Loc
SAIGON
Bearcat
Long Xuyen
My Tho
Vung Tau
Can Tho
Rach Gia
Soc Trang
Bac Lieu
Ca Mau

MAP 12

1966 already presented to Department of the Army. Thus, we have a total for the Army of 170 battalion-months of work ahead of us and please note that this omits any requirements for formal construction for the Air Force. A substantial portion of this total is devoted to cantonments and since our total engineer work load will be dependent on the standards that we accept for ourselves, I would like at this point to outline precisely what are the several standards for cantonments. First of all for a proposed cantonment area, Standard 1, there is merely an access road from the highway into a bivouac area. Standard 2 provides tentage without floors, cleared areas, and pit latrines. Standard 3 adds floors to all housing and provides fixed buildings with electricity for kitchens, administration, and showers. For Standard 4, all housing (still tents) and latrines are provided with electricity, a building is furnished for eating, an elementary water disposal system of sewer pipes leads from the kitchen and showers, and the surface of the access road is stabilized. Standard 5 provides for a bituminous road into the area from the main route and the addition of waterborne sewage facilities doing away with the latrines. The development is progressive from Standard 1 to Standard 5, Modified, for each cantonment area. *(See Appendix B.)*

Turning now to our capabilities, our present engineer strength in-country is in the order of 7,900 officers and men. Looked at another way this is equivalent to 8.4 battalions when the capabilities of our mix of engineer units is appropriately weighted. It is apparent then, that we have a total work load of 170 battalion-months with only 8 plus battalions, leaving a total time requirement of almost 2 years to accomplish all of the Army work *if* there is no commitment of engineer troops to the support of tactical operations. Obviously, with much to be done and little with which to do it, the question of priority must be addressed. The 18th Engineer Brigade headquarters has developed a proposed program of priorities. These are based upon the need of American troops to be able first, to fight; second, to move; and third, to maintain themselves. I call your attention to the listing of priorities for allocation of engineer troop effort and construction material, running from number one, clearing and grubbing of troop areas (largely an equipment effort), through field fortifications, clearing fields of fire, preparation of water supply points beyond the capabilities of tactical units, installation of LST ramps and bollards, on through to chapels, the final item listed. *(See Appendix F.)* I shall later request you to approve this priority listing for use throughout the Republic of Vietnam.

Let me now turn to some additional aspects of the engineer situation. With reference to equipment, I wish to raise two points. First of all, engineer effort is intimately tied to equipment which, in turn, is dependent on maintenance and the availability of spare parts. Without adequate spare parts support, our equipment becomes deadlined with a resultant delay in accomplishing our mission. At this time, with a total of 1,218 pieces of construction equipment we have some 190 which have been deadlined for more than 7 days. We have been making and will continue to make strenuous efforts to overcome this problem. A second point with reference to equipment is that engineer equipment has good tactical flexibility but little strategic flexibility. That is to say, it is easy to move engineer equipment between local points over short distances—we can move them at a fast rate of speed. When long distance movement is required the major items of equipment must be packed, and since they are heavy and bulky, transport is difficult and time-consuming. This is particularly true in South Vietnam where it is impossible to move by road between the several axes of effort, from Saigon, for example, to Qui Nhon or Cam Ranh Bay. It is a major effort to prepare such things as earthmoving scrapers, rockcrushers, or float bridge trucks for movement by water between two ports, as from a location in the south of Vietnam to the central area or farther north. Thus, it becomes important to predetermine the best initial location of equipment as it arrives from the United States in order to insure that it is most effectively used over a long time.

The next major matter of concern to all engineers is that of construction material. Some 25 million dollars of building materials have been ordered. They have not yet been delivered. We are faced then with universal shortages in all areas. Local materials are almost nonexistent. Possible exceptions are lumber, rock, and sand, although each of these requires major effort to get the material into a usable form. There is little available lumber which is not required for use in the local economy. I estimate that we require a total of 325 thousand tons of materials for accomplishment of the fiscal year 1965 and 1966 construction program. As is borne out by past experience in previous wars, about 15 percent of a total theater tonnage will be required for delivery of construction materials. Translated into terms of shipping this means that one out of every seven ships arriving at South Vietnam should be loaded with construction materials.

Like major items of engineer construction equipment, engineer materials are highly immobile, difficult to move, and this immobility creates a serious handicap. To avoid multiple handling, careful scheduling must be observed in determining how much of each shipload should be offloaded at each port.

An additional serious problem marks your engineer construction operations in South Vietnam. A fundamental difference exists between operations in this theater and those in the normal theater. Previously, construction supplies at the time of their departure from the United States were considered as expended. Accountability for them in terms of cost was discontinued. They were treated as operational materials just like ammunition. In this theater we find that construction materials are not expendable. We must account for how they are used and where they are used. We have an approach to this problem which will allow full accountability of Military Construction, Army, funds and still insure that funds will not dictate supply levels. I call the approach the limited war construction accountability program and I will be prepared to brief you on this subject at a later time if you wish. So much for the engineer picture in South Vietnam.

Let me now turn to the engineer environment. In a physical sense our engineers will be operating in tightly confined spaces . . . carefully limited in the area in which they operate. Within this area they are faced with serious problems of drainage. In general, engineers from the United States are not acquainted with the tremendous quantities of rainfall typical of tropical climates. We find also a very high water table, particularly in the southern regions, as for example in the delta, which create construction problems for foundations. Also, our lines of communication are highly vulnerable to disruption not only by enemy action but also by severe monsoon rains. With a high rate of water runoff the numerous bridges and culverts will require substantial engineer effort to retain them in operation. With reference to political environment we find some new circumstances. We are faced with the necessity to obtain real estate through governmental operations before we may begin building. Since the operation of normal economics has absorbed all prime real estate, we may expect any well-drained land or that which has been farmed will generally be denied to our troops and to construction for all elements of the Army. We shall be expected to do our building on land which is ill-suited for construction. A Public Works Ministry has responsibility for road work throughout the country. It has little capability and yet we must conduct careful liaison on our works in connection with the road system. In another area, looking to the long range future, the addition of systems of waterborne sewage will require easements for passing through private land from our construction sites to the nearest waterways. Here once more we have a requirement for close co-ordination with the governmental authorities of our host nation. In the economic realm we find a very small work force of any competence in construction skills as we know them. And resources even to meet the needs of local people are totally inadequate. With the influx of large numbers of Americans in recent months our soldiers have proceeded individually to buy in the local market construction materials such as lumber, nails, cement and the like. The result has been a startling inflation. Aggregate, that is, broken-up stone which the Vietnamese provide largely by hammer and individual "elbow-grease" has increased in price by 135 percent in the last 90 days. Nails have increased in cost 35 percent. Lumber prices today are double what they were 3 months ago. Even the military environment is unusual from an engineer point of view. Military requirements for base construction include such things as floodlights for security with the intent of lighting up the battlefield at night instead of seeking to camouflage or hide our installations. This prospect promises to introduce new requirements for electric power. We must co-ordinate our activities with the Army of South Vietnam and its activities. The intermixing of our respective organizations promises to complicate our operations. We find our operations and requirements seem to be unrelated to our capabilities. There are cries from all directions for engineer assistance, and yet, as I pointed out, we are severely constrained in our ability to respond. Your own military commanders have great expectations of what they wish to receive in the way of engineer support. One major installation commander has informed me that he expects his base to be developed to the equivalent of Fort Benning before he will be satisfied. Every commander expects early delivery of materials, money, and allocation of any available effort and yet we find inadequacies in all of these areas. The inescapable conclusion is that engineer operations for the foreseeable future will be a continuous allocation of shortages. Nonetheless, we shall attack our problems with vigor and seek to provide assistance where it will most benefit your mission. I have the following recommendations: First, I request that you approve the priorities as they have been presented here today. Second, I request you to emphasize to all commanders that they must lower their expectations at least for the near future. For my part, I shall seek to inform them of our capabilities and lend all possible assistance. Third, I ask your support in encouraging your commanders to do as much cantonment construction as possible through self-help on a gradual scale of upgrading rather than relying entirely on engineers. I would propose that for the present we set Standard 4 as our objective in our cantonment construction. This concludes my briefing.

(NB: At the conclusion of the meeting, after the briefing by General Ploger, Engineer, United States Army, Vietnam, General Westmoreland approved the priorities as presented and accepted the principle of gradual upgrading to Standard 4 as an initial objective.)

Appendix B

Standard of Construction for Troop Cantonments

Standard 2

Class IV tents pitched by using troops; engineer effort for roads and site preparation.

Standard 3

Buildings with floors for administration, bath houses, infirmaries, storehouses, and kitchens. Class IV tents with floors for housing and with earth floors for all other purposes. Roads within the installation are stabilized with local materials. Water piped from central storage tank to infirmaries, bath houses, and kitchens. Electric distribution to buildings. Tent-covered latrines with 55-gallon drum burn-out receptacles.

Standard 4

(Upper limit to standard of cantonment construction for units expected to be based in a given location for less than twelve months.) Buildings with floors for all purposes except housing; Class IV tents with floors and wood frames for housing; roads within the installations are stabilized with local materials; water piped from central storage tank to infirmaries, bath houses, kitchens; camp exchange electric distribution to buildings and tent housing; latrine as in Standard 3.

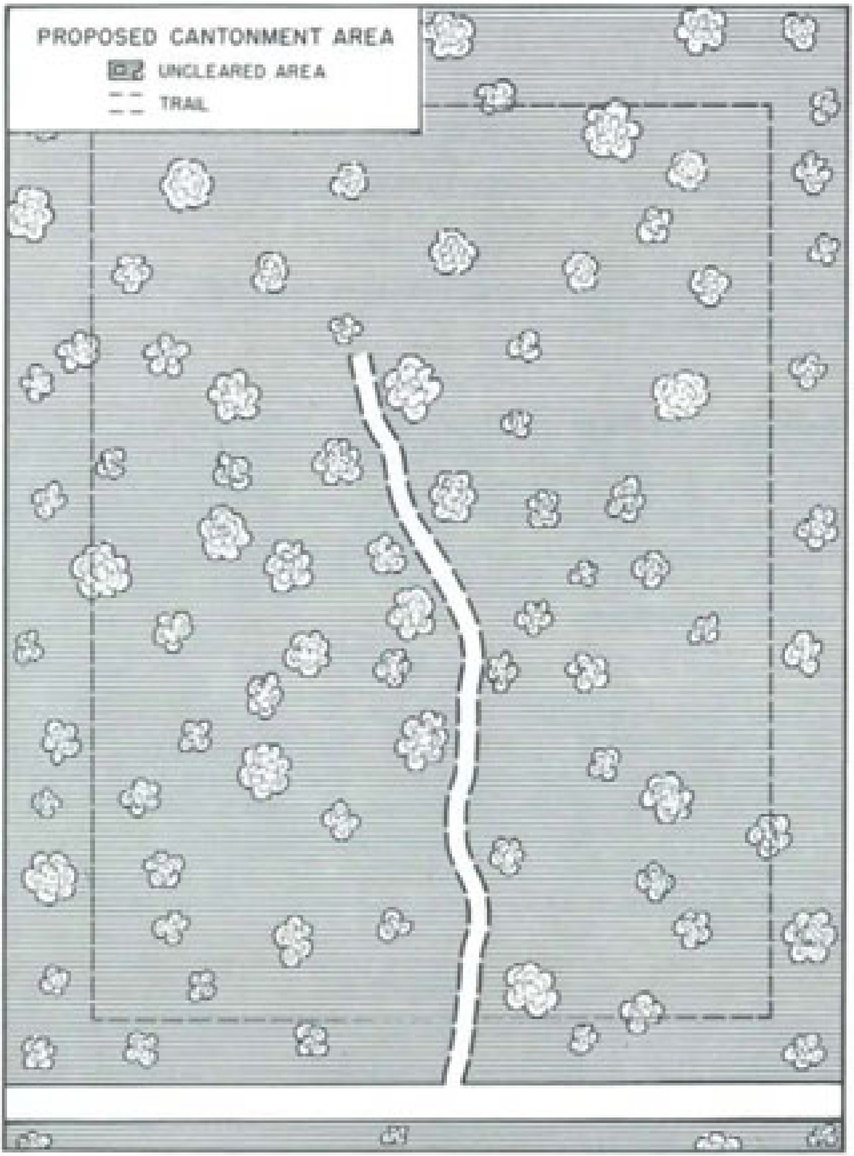
Standard 5

(Authorized by self help or engineer troop or contract efforts. Normal upper limit to standard of cantonment construction for units expected to remain based in a given location for more than 12 months. Complete design drawings required. Installation of utilities permitted only under approved technical supervision.) Buildings with floors for all purposes. Roads, water supply, and latrines are the same as Standard 4; electric distribution to all buildings.

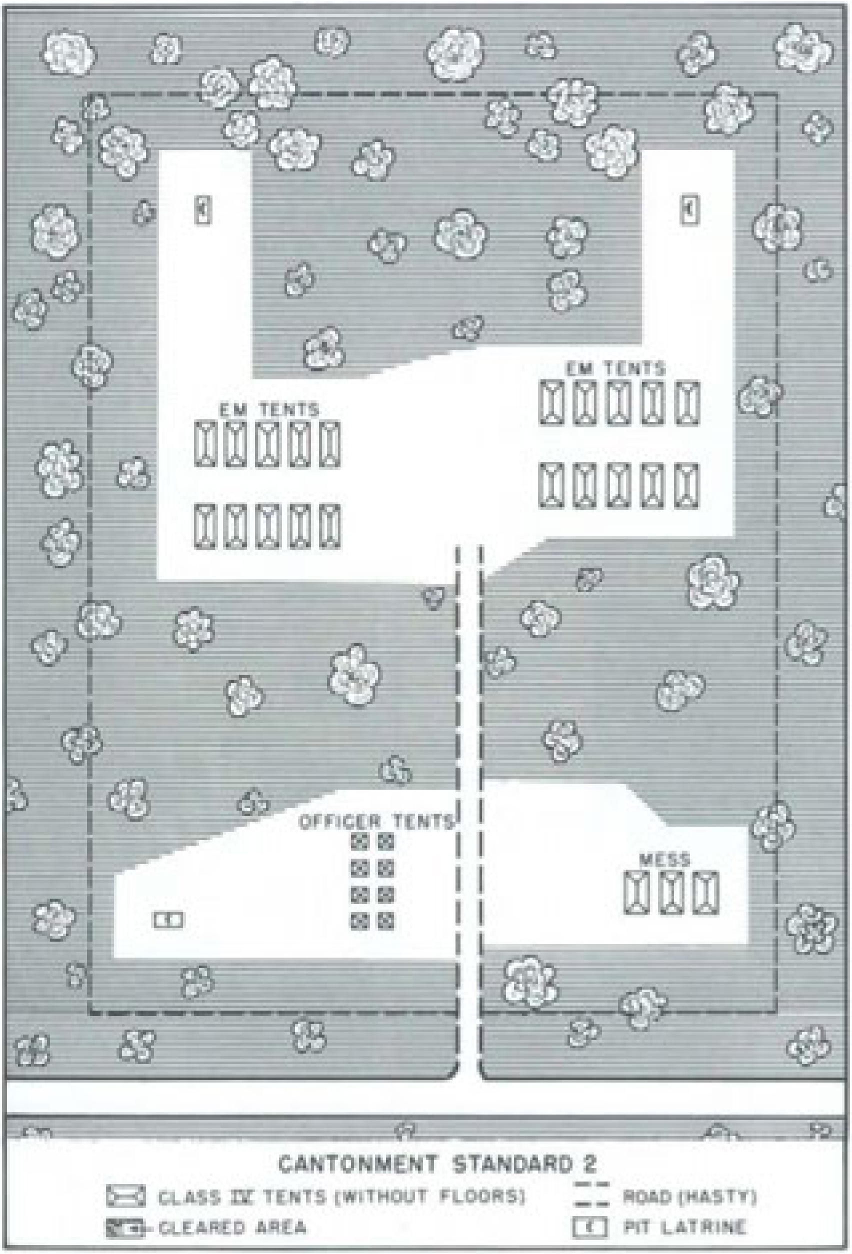
Standard 5, Modified

Same as Standard 5, except for addition, as conditions permit, of waterborne sewerage systems.

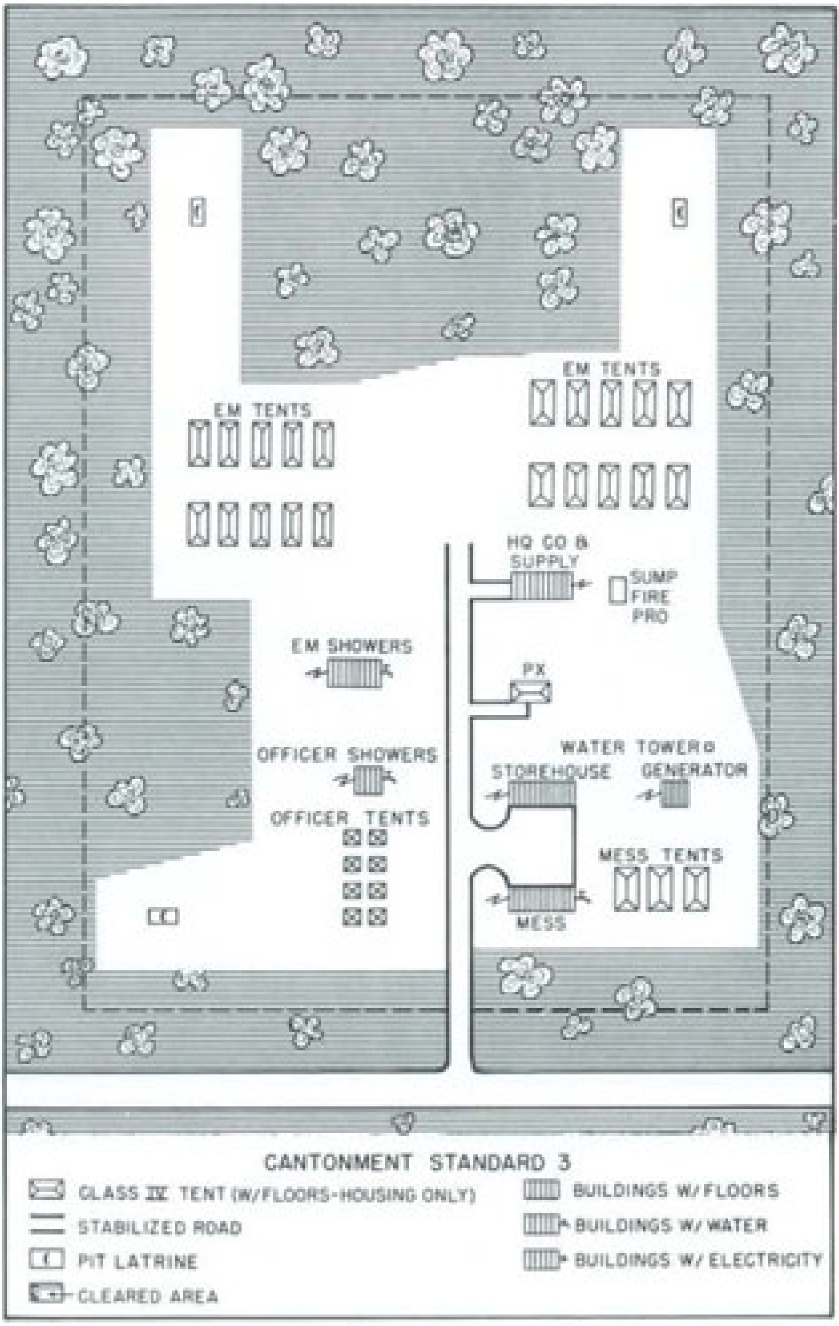
Appendix B–1—Proposed Cantonment Area



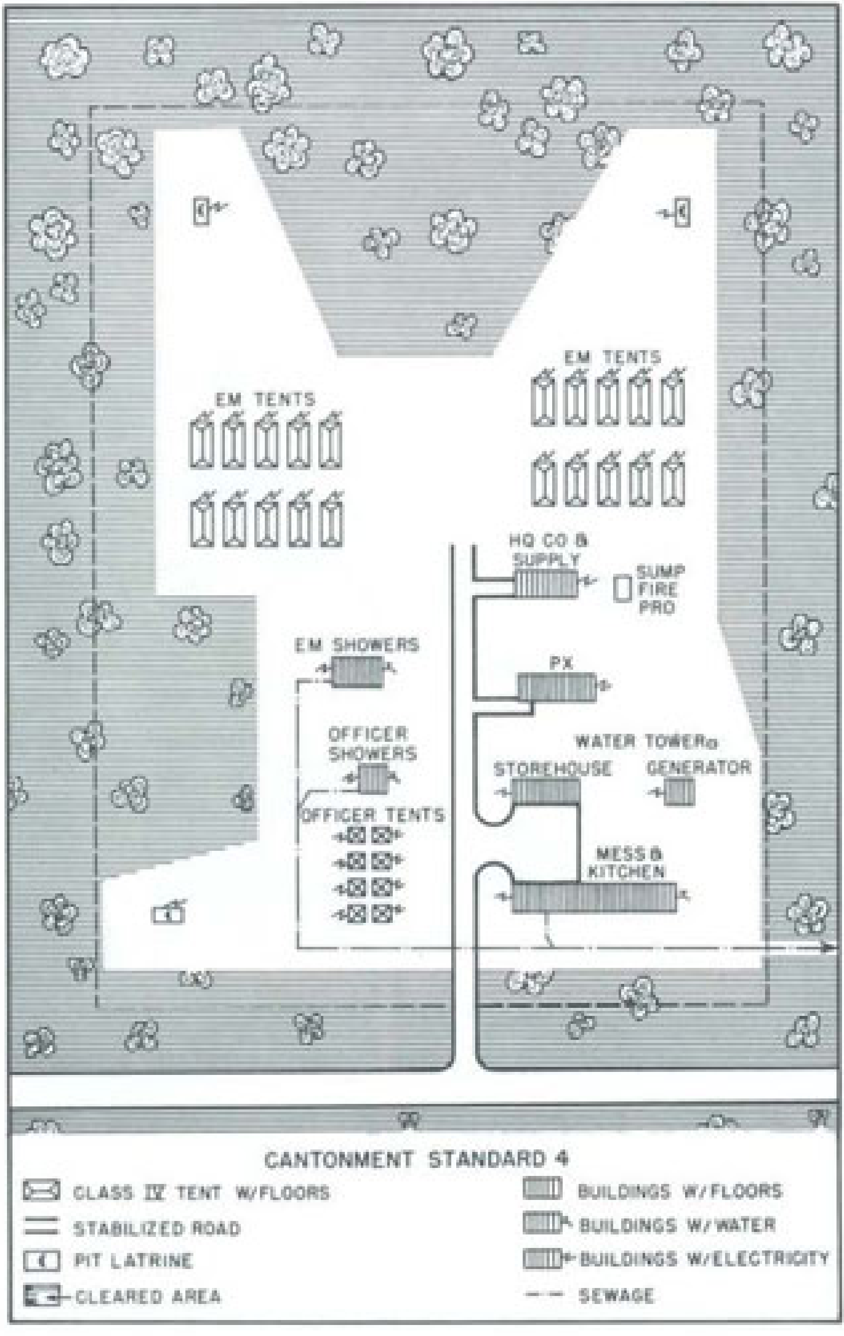
APPENDIX B-2—CANTONMENT STANDARD 2



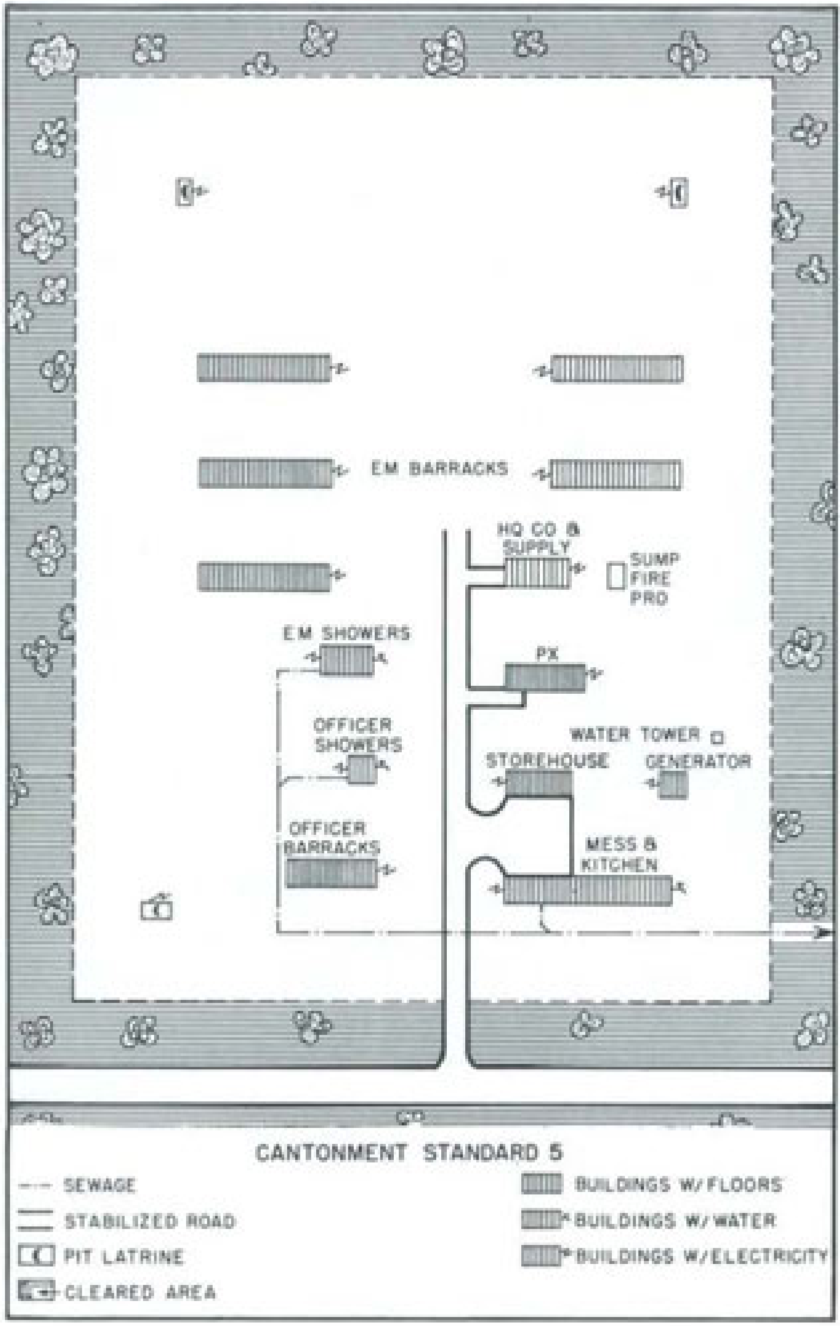
APPENDIX B-3—CANTONMENT STANDARD 3



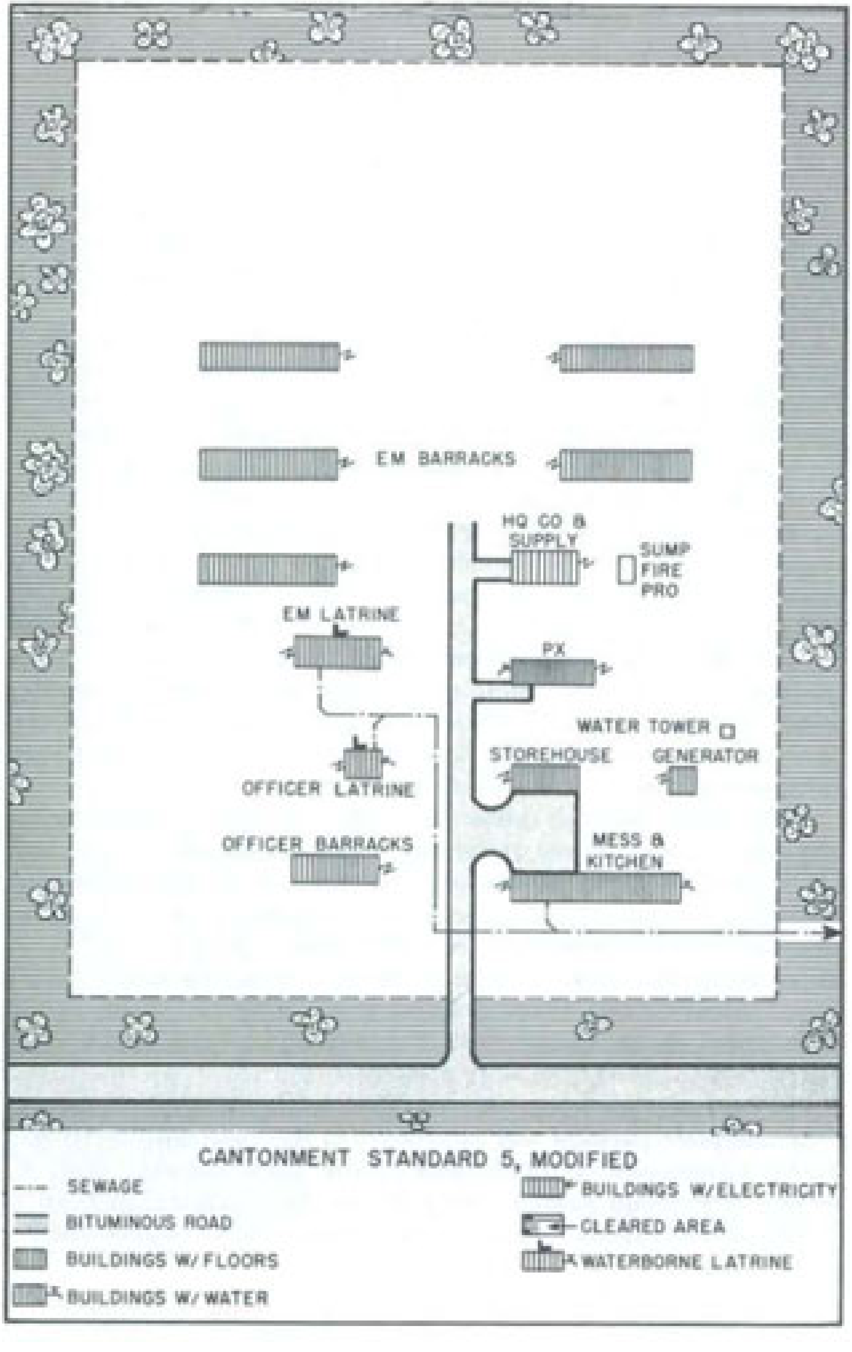
Appendix B-4—Cantonment Standard 4



Appendix B–5—Cantonment Standard 5



APPENDIX B-6—CANTONMENT STANDARD 5, MODIFIED



Appendix C

Real Estate Acquisition

The responsibilities and procedures that eventually evolved for acquisition of real estate were promulgated in U.S. Military Assistance Command, Vietnam, Directive 405-1, 3 November 1966, of which the following is a paraphrase.

The Commander, U.S. Military Assistance Command, Vietnam, was responsible for the acquisition of real estate for U.S. forces and Free World Military Assistance Forces in Vietnam. The director of construction was responsible to the commander for performing these functions. Component commanders in Vietnam were directed by the MACV commander to co-ordinate real estate functions and activities of all U.S. and Free World forces within their areas of responsibility. Their duties were discharged through their field real estate officers who negotiated with Vietnamese officials for required real estate and maintained a central record of all real estate utilized by U.S. and Free World forces within their areas. Real estate requirements were submitted to the appropriate field real estate office, where it was determined whether the requirements could be met. If a requirement could not be met, the request was prepared for consideration by the Vietnamese government.

The initial point of contact for U.S. real estate requests was the appropriate Vietnamese government official—district chief, province chief, or mayor. A land-use concurrence document was submitted to the appropriate official for his approval. This document described the requested property and, when signed, granted to the allied forces the exclusive use of the real estate for as long as the requirement existed. If approval could not be obtained, the reasons were noted on the disapproval. The request and the land-use concurrence document then were forwarded through support channels to the component commander and then to the MACV commander. The complete package was submitted to the Interministerial Real Estate Committee, a subelement of the Joint General Staff, Republic of Vietnam Armed Forces. When the committee granted approval of the request, the component commander assigned the real estate to the original requestor.

If the requested real estate included privately owned property such as houses, crops, and graves, indemnification was necessary.

The local district chief, mayor, or province chief made a tabulation by name, item, and amount for each person to be indemnified. The amount was based on a process established at meetings between the local province and district officials and the working subcommittee of the Interministerial Real Estate Committee. Tabulations were forwarded to the Joint General Staff for verification by the committee. Upon approval, the committee forwarded the funds to the site. Actual payment was made by the local district chief, mayor, or province chief.

The problem of moving graves was a particularly serious cause of major delays in acquiring real estate. During the 2,000-year history of Vietnam, the countryside had become virtually covered with individual graves—in marked contrast to the well-defined graveyards of the western world. Cultural, religious, and legal precepts required the permission (and frequently the indemnification) of the descendants of those interred before the graves could be relocated.

The procedure for acquiring land on which graves were located involved determination of ownership; through the landowner, determination of the names and locations of the descendants of those interred; and when the relative had been contacted, removal of the remains or the granting of a waiver authorizing the contractor to proceed without removing the remains. Because many grave sites were ancient, it was frequently difficult if not impossible to determine the proper persons from whom to seek such permission. Because the religion of many Vietnamese contains elements of ancestor worship, tampering with grave sites could have caused serious complications. For example, when the contractor uncovered graves during the preliminary construction of his camp at Phu Cat, the village chief initiated a protest via the district and province chiefs that resulted in a letter of protest from General Vien, Chairman of the Vietnamese Joint General Staff, to General Westmoreland. Delays ranging from one day to one month resulted from the need to relocate the graves. The runway construction at Phu Cat was stopped for approximately one month because of graves at the construction site. The local Vietnamese officials were consulted, and the province chief agreed to have the graves moved and granted approval for the contractor to proceed after approximately four weeks even if the graves had not been relocated. Four weeks later, the contractor commenced construction.

The real estate problem was further complicated by the fact that within a three-year period there had been nine changes in the government in Vietnam; each change had caused a shift in the central government. The relative independence of province officials, who had a strong voice in land acquisition, had compounded the difficulty. Continuity at both central and province levels was virtually nonexistent. Although real estate acquisition procedures were established in the latter part of 1965, delays in actual procurement continued to be a common and persistent problem. The inability of the Vietnamese government to provide land in a timely manner definitely hampered the development of facilities.

The prime civilian contractor for construction in South Vietnam listed the acquisition of real estate as a major and continuing problem throughout the life of the contract. Inability to obtain real estate in a timely fashion hampered his work on projects and on physical plants, especially quarry sites.

Appendix D

Types of Engineer Units and Their Functions [1]

Combat Battalion, Army or Corps (TOE 5–35D)

Thirty-three officers, 586 enlisted men. Headquarters and headquarters company, three combat companies. Authorized a minimum of light equipment (two cranes, three graders, three scooploaders, and seven dozers). This unit was capable of forward area construction, obstacle preparation and removal, demolition work, and fighting as infantry. The battalion was 100 percent mobile.

Combat Battalion, Army or Corps (TOE 5–35E)

Thirty-nine officers, 755 enlisted men. Headquarters and headquarters company, four combat companies. This unit differed from the TOE 5–35D battalion in the addition of the fourth combat company and a significant amount of light equipment. The battalion was authorized three cranes, four graders, thirteen scooploaders, one sixteen-cubic-foot concrete mixer, and ten dozers. The headquarters company was sometimes authorized a vertical construction section as a special augmentation. The basic capabilities of the battalion were the same as those of the TOE 5–35D battalion. The battalion was 100 percent mobile and was air transportable in heavy aircraft.

Construction Battalion (TOE 5–115D)

Thirty-one officers, 850 enlisted men. Headquarters and headquarters company, engineer equipment and maintenance company, three engineer construction companies. This unit provided for basic general construction of buildings, structures, roads, airfields, bridges and pipelines, paving operations, and reconstruction of major facilities. Equipped with twenty-four scrapers, thirteen dozers, six con-

[1] Engineer units in Vietnam operated under many tables of organization and equipment and modified tables of equipment. The information provided in this appendix is based on the tables of equipment that most nearly represent the typical situation.

crete mixers, eight cranes, one 75-tons-per-hour crusher, nine graders, and considerable vertical construction machinery, the battalion possessed both a vertical and horizontal capability. The battalion was also authorized a direct support maintenance section. The unit was 95 percent mobile.

Construction Battalion
(TOE 5–115E)

Thirty-eight officers, 867 enlisted men. Headquarters and headquarters company, engineer equipment and maintenance company, three engineer construction companies. This battalion was generally similar in capabilities and organization to the 5–115D construction battalion with the exception of a reduction in the number of authorized scrapers (twenty-four to twelve) and the deletion of the maintenance capability for ordnance vehicles from the direct support maintenance section. The unit was 87 percent mobile.

Engineer Battalion, Airmobile Division
(TOE 5–215T)

Thirty-eight officers, 582 enlisted men. Headquarters and headquarters company, three combat engineer companies. The battalion, organic to the airmobile division, provided direct support to tactical elements in removal or emplacement of obstacles and fortifications, construction of bridges, fords, culverts, and airfields for medium cargo aircraft, and fought as infantry when required. The battalion was equipped with lightweight and sectionalized earthmoving equipment (four sectionalized scrapers, forty-two ¾-ton dump trucks, six sectionalized graders, four sectionalized combination grader scrapers) and was 100 percent air transportable with Army aircraft.

Engineer Battalion, Infantry Division
(TOE 5–155E)

Forty-six officers, 901 enlisted men. Headquarters and headquarters company, four combat engineer companies, bridge company. The battalion, organic to the infantry division, was capable of construction and repair of bridges, roads, airfields, emplacement or removal of obstacles and fortifications, dry gap and float bridging, and fighting as infantry when required. This unit was equipped with 560 feet of aluminum balk (floor pieces) float bridge, twelve dozers, four cranes, four graders, and twelve scooploaders. The basic vehicle within the battalion was the five-ton dump truck (fifty-eight authorized). The unit was 100 percent mobile.

Headquarters and Headquarters Company, Engineer Brigade, Army of Corps or Engineer Brigade (Construction) (TOE 5-101E)

Twenty officers, 64 enlisted men (Army), or 34 officers, 110 enlisted men (construction). This unit provided the overhead necessary to command and co-ordinate the activities of subordinate engineer groups and battalions. When organized as an army or corps brigade, the unit was augmented by personnel to staff the appropriate engineer section. When organized as a construction brigade, the unit was authorized additional engineer planning and design personnel. In its army or corps organization it was capable of controlling two or three combat groups; in the construction organization, three to four construction groups. In either configuration, the unit was authorized two utility helicopters.

Headquarters and Headquarters Company, Combat Group (TOE 5-52D)

Twenty-five officers, eighty-six enlisted men. This unit provided the overhead for command and control of three to six combat battalions. The emphasis within the unit rested with planning and co-ordinating combat support activities. The unit was not authorized an engineer design section. It was 100 percent mobile and was authorized six fixed wing aircraft and six helicopters (four observation, two utility).

Headquarters and Headquarters Company, Construction Group (TOE 5-112D, TOE 5-112E)

Twenty officers, seventy-eight enlisted men. This unit provided the overhead for command and control of three to five construction battalions. The unit also possessed the capability to design, plan, and supervise construction of routes of communication, buildings, airfields, minimal petroleum storage facilities, and minimal port facilities. In the 5-112D configuration the unit was authorized both an operations and an engineering section and two aircraft. In the 5-112E organization, the unit was authorized only a combined engineer operations section. It was authorized three utility helicopters.

Construction Support Company (TOE 5-114D)

Six officers, 158 enlisted men. This unit, organized with quarrying, asphalt paving, and specialized equipment support capabilities, provided general support to combat and construction battalions engaged in earthwork and surfacing operations. The unit possessed direct support maintenance capability for its organic equipment. The unit was 50 percent mobile.

Dump Truck Company
(TOE 5–124D)

Four officers, 104 enlisted men. Equipped with forty-eight five-ton dump trucks, the company provided haul support to units engaged in moving gravel, sand, dirt, and crushed stone. The unit was 100 percent mobile.

Light Equipment Company
(TOE 5–54E)

Eight officers, 207 enlisted men. This unit provided equipment support to engineer combat battalions and produced aggregate through company quarrying operations. The company was authorized six cranes, nine graders, four scooploaders, two concrete mixers, nine eighteen-cubic-yard scrapers, and four dozers. The unit was 100 percent mobile.

Port Construction Company
(TOE 5–129D)

Thirteen officers, 208 enlisted men. This company was capable of supporting port construction and rehabilitation and beach construction. Provided with a variety of marine equipment and authorized a diving section, the unit was capable of operations on both land and water. The unit was 50 percent ground mobile.

Appendix E

ENGINEER OBJECTIVES AND STANDARDS

HEADQUARTERS
18th ENGINEER BRIGADE
APO US Forces 96307

7 October 1965

OUR OBJECTIVES AND STANDARDS

1. To serve the combined arms teams, to support the "man with the rifle", to make his environment more responsive, secure and comfortable, so that the team can better devote attention to its principal mission.
2. To produce, through competent design and construction, fully adequate physical facilities. To fulfill the responsibility of quickly providing compact, efficient and well organized facilities—with special consideration to drainage, roads, and associated utilities.
3. To insure that engineer skills and talents are applied to give the greatest benefit to the operational effectiveness of the "man with rifle".
4. To maintain high standards of workmanship, and to promote economic use and conservation of equipment and materials.
5. To carry out a self-help program at a pace consistent with, but never faster than, the development of facilities of all supported elements.
6. To drop our tools if necessary, pick up our weapons and aggressively engage and counter any enemy threat to accomplishment of our assigned mission.
7. To be ever mindful of our most precious national resources, our people: To that end be alert in practice of safety.
8. To remember that we are seeking to establish a temporary lodging in the homeland of others; that we owe to our host country and our fellows-in-arms every reasonable assistance in development of a sound economy and an improved environment.

Robert R. Ploger
Brigadier General, USA
Commanding

Appendix F

Senior Engineer Commanders in Vietnam, 1965–1970

Command	*Assumption or Duration of Command*
U.S. Army, Vietnam, Engineer	
Major General Robert R. Ploger	September 1965
Major General Charles M. Duke	August 1967
Major General William T. Bradley	May 1968
Major General David S. Parker	July 1969
Major General John A. B. Dillard [1]	December 1969
18th Engineer Brigade	
Colonel C. Craig Cannon	September 1965
Brigadier General Robert R. Ploger	September 1965
Colonel Paul W. Ramee	December 1966
Brigadier General Charles M. Duke	April 1967
Brigadier General Andrew P. Rollins, Jr.	September 1967
Brigadier General Willard Roper	November 1967
Colonel John H. Elder, Jr. (P)	September 1968
Colonel John W. Morris (P)	May 1969
Brigadier General Henry C. Schrader	May 1970
35th Engineer Group	
Colonel William F. Hart, Jr.	June 1965
Colonel William L. Starnes	June 1966
Colonel Gilbert H. Newman	February 1967
Colonel John A. Hughes, Jr.	June 1967
Colonel Delbert M. Fowler	July 1968
Colonel William L. Barnes	December 1968
Colonel Harry A. Griffith	July 1969
Colonel Richard A. Chidlaw	April 1970
Colonel John S. Egbert	November 1970
45th Engineer Group	
Colonel George M. Bush	June 1966
Colonel Kenneth T. Sawyer	May 1966
Colonel George B. Fink	December 1967
Colonel John G. Waggener	July 1968
Colonel Carroll N. LeTellier	July 1969
Colonel William R. Wray	December 1969
Colonel Kenneth E. McIntyre	September 1970
937th Engineer Group	
Colonel Roland A. Brandt	August 1965
Colonel William W. Watkin	January 1966
Colonel Ernest P. Braucher	August 1966
Colonel Robert C. Marshall	November 1967

[1] Killed in action, May 1970.

(P) Selected for promotion before assuming command.

SENIOR ENGINEER COMMANDERS IN VIETNAM, 1965–1970—Continued

Command	Assumption or Duration of Command
Colonel William J. Talbott	March 1968
Colonel Jesse L. Fishback	August 1968
Colonel William G. Kratz	February 1969
Colonel Carroll E. Adams, Jr.	January 1970
Colonel James C. Donovan	May 1970
Colonel William J. Schuder	September 1970
20th Engineer Brigade	
Brigadier General Curtis W. Chapman, Jr.	August 1967
Colonel Harold R. Parfitt (P)	November 1968
Brigadier General Edwin T. O'Donnell	November 1969
Brigadier General Kenneth B. Cooper	October 1970
34th Engineer Group	
Colonel Joe M. Palmer	March 1967
Colonel William G. Stewart	March 1968
Colonel Ernest Graves, Jr.	September 1968
Colonel Alton G. Post	January 1969
Colonel John E. Sterling	July 1969
Colonel Wayne S. Nichols	July 1970
79th Engineer Group	
Colonel David C. Clymer	July 1966
Colonel Walter C. Gelini	November 1966
Colonel Joseph A. Jansen	November 1967
Colonel John H. Elder, Jr.	February 1968
Colonel Richard L. West	July 1968
Colonel Charles R. Clark	January 1969
Colonel Amos L. Wright	August 1969
Colonel Ernest J. Denz	February 1970
159th Engineer Group	
Colonel James H. Hottenroth	October 1965
Colonel Richard McConnell	September 1966
Colonel Richard H. Groves	November 1967
Colonel Harvey C. Jones	January 1968
Colonel Bates C. Burnell	July 1968
Colonel James E. Devine	February 1969
Colonel Joseph K. Bratton	August 1969
Colonel Levi A. Brown	August 1970
921st Engineer Group (never operated as a command organization in South Vietnam)	
Colonel Walter C. Gelini	June 1966
Lieutenant Colonel William P. Gardiner	September 1966
14th Engineer Battalion (Combat)	
Lieutenant Colonel William F. Brandes	5 June 1966–22 February 1967
Lieutenant Colonel James L. Lammie	20 June 1967–14 January 1968
Lieutenant Colonel Ralph A. Karst	18 July 1968–27 August 1968
Lieutenant Colonel Arthur J. Gow	27 August 1968–21 February 1969
Lieutenant Colonel Ted E. Bishop	21 February 1969–3 August 1969
Lieutenant Colonel Drake Wilson	4 August 1969–11 April 1970
Lieutenant Colonel George R. Vavra	12 April 1970–9 September 1970
Lieutenant Colonel Byron N. Schriever	9 September 1970–7 January 1971

SENIOR ENGINEER COMMANDERS IN VIETNAM, 1965–1970—Continued

Command	Assumption or Duration of Command
19th Engineer Battalion (Combat)	
Lieutenant Colonel Amos C. Mathews	30 June 1965–16 July 1966
Lieutenant Colonel Nolan C. Rhodes	16 July 1966–23 July 1967
Lieutenant Colonel Andrew C. Remson, Jr.	23 July 1967–2 March 1968
Lieutenant Colonel James L. Sutton	2 March 1968–2 September 1968
Lieutenant Colonel Donald A. Wisdom	7 September 1968–7 February 1969
Lieutenant Colonel Gilbert L. Burns	7 February 1969–10 July 1969
Lieutenant Colonel Wilson P. Andrews	11 July 1969–14 February 1970
Lieutenant Colonel Pleasant H. West	10 June 1970–3 November 1970
20th Engineer Battalion (Combat)	
Lieutenant Colonel Richard L. Harris	16 December 1965–13 July 1966
Lieutenant Colonel Robert L. Gilmore	14 July 1966–5 July 1967
Lieutenant Colonel James H. Phillips	31 January 1968–25 February 1968
Lieutenant Colonel Maurice H. Leiser	25 February 1968–29 September 1968
Lieutenant Colonel John F. Wall, Jr.	11 October 1968–19 June 1969
Lieutenant Colonel Morris L. Gardner	23 June 1969–12 January 1970
Lieutenant Colonel Fred V. Cole	13 January 1970–12 May 1970
Lieutenant Colonel Richard T. Robinson	24 May 1970–6 December 1970
27th Engineer Battalion (Combat)	
Lieutenant Colonel Charles R. Roberts	9 September 1966–21 April 1967
Lieutenant Colonel Allen P. Richmond	23 April 1967–5 October 1967
Lieutenant Colonel Kent C. Kelley	16 October 1967–11 April 1968
Lieutenant Colonel Malcolm D. Johnson	10 July 1968–24 June 1969
Lieutenant Colonel Stuart Wood, Jr.	25 June 1969–11 January 1970
Lieutenant Colonel Harlan W. Johnson	11 January 1970–15 August 1970
Lieutenant Colonel Russell L. Jorns	23 August 1970–15 August 1971
31st Engineer Battalion (Combat)	
Lieutenant Colonel Edwin D. Patterson	15 February 1967–16 October 1968
Lieutenant Colonel Gerald P. Kelley	17 October 1968–25 April 1969
Lieutenant Colonel George N. Andrews	26 April 1969–14 January 1970
Lieutenant Colonel Gwynn A. Teague	15 January 1970–8 July 1970
Lieutenant Colonel Richard H. Gray	11 July 1970–16 January 1971
34th Engineer Battalion (Construction)	
Lieutenant Colonel John C. Ogilvie	28 July 1966–3 June 1968
Lieutenant Colonel Edward P. Stefanik	3 June 1968–31 March 1969
Lieutenant Colonel Charles D. Millward	1 April 1969–17 December 1969
Lieutenant Colonel Donald E. Sells	17 December 1969–21 July 1970
Lieutenant Colonel Dale K. Randels	22 July 1970–21 February 1971
35th Engineer Battalion (Combat)	
Lieutenant Colonel Wesley E. Peel	7 November 1966–30 April 1967
Lieutenant Colonel David N. Hutchison	1 July 1967–18 January 1968
Lieutenant Colonel John V. Parish, Jr.	19 January 1968–10 July 1968
Lieutenant Colonel Joseph A. Yore	16 July 1968–12 January 1969
Lieutenant Colonel Lawrence R. Smith	13 January 1969–7 July 1969
Lieutenant Colonel James W. Ray	8 July 1969–24 June 1970
Lieutenant Colonel Robert F. Thomas	25 June 1970–13 September 1970
36th Engineer Battalion (Construction)	
Lieutenant Colonel Thomas C. Hunter, Jr.	13 July 1967–15 April 1968

SENIOR ENGINEER COMMANDERS IN VIETNAM, 1965–1970—Continued

Command	Assumption or Duration of Command
Lieutenant Colonel Richard E. Leonard	15 April 1968–27 March 1969
Lieutenant Colonel Vito D. Stipo	28 March 1969–7 March 1970
Lieutenant Colonel Early J. Rush III	8 March 1970–7 September 1970
39th Engineer Battalion (Combat)	
Lieutenant Colonel Ernest E. Lane, Jr.	26 December 1965–16 May 1966
Major John H. Shultz	17 May 1966–4 July 1966
Lieutenant Colonel Taylor R. Fulton	5 July 1966–1 July 1967
Lieutenant Colonel Joseph F. Castro	2 July 1967–9 December 1967
Lieutenant Colonel James M. Miller	9 December 1967–22 June 1968
Lieutenant Colonel Tenho R. Hukkala	22 June 1968–3 June 1969
Lieutenant Colonel Thomas A. Ghormley	4 June 1969–12 December 1969
Lieutenant Colonel Hugh G. Robinson	13 December 1969–30 July 1970
Lieutenant Colonel James G. Ton	31 July 1970–31 January 1971
46th Engineer Battalion (Construction)	
Lieutenant Colonel George G. Hagedon	15 September 1965–17 January 1966
Lieutenant Colonel George Mason	17 January 1966–9 December 1966
Lieutenant Colonel William V. McGuinness, Jr.	9 December 1966–7 September 1967
Lieutenant Colonel George B. Gray, Jr.	7 September 1967–19 May 1968
Lieutenant Colonel Pendleton A. Jordan	19 May 1968–18 November 1968
Lieutenant Colonel John E. Gray	20 November 1968–10 June 1969
Lieutenant Colonel Marion F. Meador	10 June 1969–31 May 1970
Lieutenant Colonel Joseph L. Spruill	1 June 1970–12 December 1970
62d Engineer Battalion (Construction)	
Lieutenant Colonel Paul D. Triem	3 August 1965–28 June 1966
Lieutenant Colonel Andrew J. Waldrop	8 July 1966–31 May 1967
Lieutenant Colonel Robert E. Crowley	31 May 1967–16 July 1968
Lieutenant Colonel Valentine Carrasco	16 July 1968–12 January 1969
Lieutenant Colonel Maximiano Janairo	13 January 1969–6 July 1969
Lieutenant Colonel Paul C. Driscoll	7 July 1969–4 July 1970
Lieutenant Colonel Robert P. Monfore	5 July 1970–10 June 1971
70th Engineer Battalion (Combat)	
Lieutenant Colonel Leonard Edelstein	5 December 1964–17 July 1966
Lieutenant Colonel John R. Redman	17 July 1966–2 March 1967
Lieutenant Colonel Philip D. Sellers	2 March 1967–3 October 1967
Lieutenant Colonel Robert E. Ayers	30 October 1967–22 April 1968
Lieutenant Colonel Charles G. Willard	22 April 1968–28 September 1968
Lieutenant Colonel Robert K. O'Connell	28 September 1968–25 June 1969
Lieutenant Colonel James E. Hays	25 June 1969–31 October 1969
84th Engineer Battalion (Construction)	
Lieutenant Colonel Joseph J. Rochefort	11 June 1965–22 January 1966
Lieutenant Colonel James G. Madison, Jr.	23 January 1966–4 August 1966
Lieutenant Colonel William A. Rank	14 August 1966–20 September 1967
Lieutenant Colonel James F. Fraser	20 September 1967–28 February 1968
Lieutenant Colonel Ralph T. Garver	1 March 1968–5 September 1968
Lieutenant Colonel Robert J. Corley	5 September 1968–1 March 1969
Lieutenant Colonel William Y. Epling	1 March 1969–30 August 1969
Lieutenant Colonel Richard M. Wells	31 August 1969–16 August 1970

SENIOR ENGINEER COMMANDERS IN VIETNAM, 1965–1970—Continued

Command	*Assumption or Duration of Command*
86th Engineer Battalion (Combat)	
Lieutenant Colonel Colin M. Carter, Jr.	2 June 1966–25 April 1967
Lieutenant Colonel James F. Miley	25 April 1967–26 September 1967
Lieutenant Colonel Clyde A. Selleck, Jr.	26 September 1967–29 August 1968
Lieutenant Colonel Ernest D. Peixotto	29 August 1968–13 July 1969
87th Engineer Battalion (Construction)	
Lieutenant Colonel John J. McCulloch	28 June 1965–4 September 1966
Lieutenant Colonel William L. Durham	4 September 1966–28 February 1967
Lieutenant Colonel Robert L. Moore	1 March 1967–22 June 1967
Lieutenant Colonel Charles J. Fiala	29 June 1967–26 May 1968
Lieutenant Colonel William R. Needham	27 May 1968–7 January 1969
92d Engineer Battalion (Construction)	
Lieutenant Colonel Harry W. Lombard	1 May 1967–30 April 1968
Lieutenant Colonel Robert L. Crosby	1 May 1968–31 October 1968
Lieutenant Colonel Bruce W. Jamison	1 November 1968–27 December 1968
Lieutenant Colonel Anthony A. Smith	28 December 1968–19 June 1969
Lieutenant Colonel William A. Anderson	19 June 1969–20 January 1970
Lieutenant Colonel Beaufort C. Katt	20 January 1970–19 July 1970
Lieutenant Colonel Charles E. Eastburn	19 July 1970–7 July 1971
93d Engineer Battalion (Construction)	
Lieutenant Colonel Carrol Guth	27 May 1967–9 January 1968
Lieutenant Colonel James Dorman	10 January 1968–7 July 1968
Lieutenant Colonel Ralph H. Sievers, Jr.	8 July 1968–28 March 1969
Lieutenant Colonel John J. Plunkett	28 March 1969–16 January 1970
Lieutenant Colonel Michael E. Kallman	17 January 1970–14 July 1970
Lieutenant Colonel Windle E. Kirk	14 July 1970–4 February 1971
168th Engineer Battalion (Combat)	
Lieutenant Colonel Manley E. Rogers	8 November 1965–27 April 1966
Lieutenant Colonel Edwin F. Pelosky	28 April 1966–17 May 1967
Lieutenant Colonel John R. Manning	17 May 1967–7 May 1968
Lieutenant Colonel John E. Schweizer	7 May 1968–19 January 1969
Lieutenant Colonel Albert L. Romaneski	19 January 1969–30 August 1969
Lieutenant Colonel Harry M. Roper, Jr.	31 August 1969–1 April 1970
169th Engineer Battalion (Construction)	
Lieutenant Colonel Marvin W. Rees	15 April 1966–30 April 1967
Lieutenant Colonel William R. Wray	1 May 1967–20 January 1968
Lieutenant Colonel Louis W. Prentiss	20 January 1968–18 July 1968
Lieutenant Colonel Raymond J. Eineigl	18 July 1968–11 January 1969
Lieutenant Colonel Clifford Flanigan	12 January 1969–18 June 1969
Lieutenant Colonel Robert S. McGarry	19 July 1969–4 January 1970
Lieutenant Colonel Nick J. Andre	4 January 1970–1 August 1970
Lieutenant Colonel Connelly Sanders	4 August 1970–10 September 1970
299th Engineer Battalion (Combat)	
Lieutenant Colonel Reuben L. Anderson, Jr.	27 September 1965–17 April 1966
Lieutenant Colonel Richard M. Connell	29 April 1966–27 October 1966
Lieutenant Colonel Walter G. Wolfe	29 October 1966–14 October 1967
Lieutenant Colonel Domingo I. Aguilar	14 October 1967–4 January 1968
Lieutenant Colonel Max B. Scheider	4 January 1968–4 July 1968
Lieutenant Colonel Joseph A. Schewski	5 July 1968–26 January 1969

SENIOR ENGINEER COMMANDERS IN VIETNAM, 1965–1970—Continued

Command	Assumption or Duration of Command
Lieutenant Colonel Newman A. Howard, Jr.	29 January 1969–16 July 1969
Lieutenant Colonel Robert L. Ackerson	31 July 1969–11 January 1970
Lieutenant Colonel Joseph P. Franklin	11 January 1970–30 July 1970
554th Engineer Battalion (Construction)	
Lieutenant Colonel Harry W. Wilkinson	31 March 1967–22 March 1968
Lieutenant Colonel Joe H. Sheard	22 March 1968–29 September 1968
Lieutenant Colonel Charles L. McNeill	30 September 1968–3 April 1969
Lieutenant Colonel Elbert D. H. Berry	3 April 1969–29 September 1969
Lieutenant Colonel James E. Lynch	30 September 1969–14 March 1970
Lieutenant Colonel Clarence D. Gilkey	14 March 1970–9 October 1970
577th Engineer Battalion (Construction)	
Lieutenant Colonel James L. Kelly	17 January 1966–23 December 1966
Lieutenant Colonel Carl P. Rodolph, Jr.	23 December 1966–10 September 1967
Lieutenant Colonel John R. McDonald	11 September 1967–5 July 1968
Lieutenant Colonel Richard S. Kem	5 July 1968–27 July 1969
Lieutenant Colonel Charles E. Edgar	2 November 1969–9 June 1970
588th Engineer Battalion (Combat)	
Lieutenant Colonel William T. Moore	1 April 1965–18 June 1966
Lieutenant Colonel James F. Boylan	1 August 1966–17 July 1967
Lieutenant Colonel Frederick G. Rockwell, Jr.	18 July 1967–20 February 1968
Lieutenant Colonel Coleman C. Clement	20 February 1968–5 October 1968
Lieutenant Colonel John C. Levanger	6 October 1968–8 April 1969
Lieutenant Colonel John A. Poteat, Jr.	8 April 1969–7 October 1969
Lieutenant Colonel Thomas A. Stumm	7 October 1969–14 May 1970
Lieutenant Colonel Nelson P. Conover	14 May 1970–13 November 1970
589th Engineer Battalion (Construction)	
Lieutenant Colonel Myron D. Snoke	29 July 1966–21 October 1967
Lieutenant Colonel Allen F. Grum	23 October 1967–1 June 1968
Lieutenant Colonel Albert C. Costanzo	1 June 1968–15 December 1968
Lieutenant Colonel Al S. Rosin	15 December 1968–3 June 1969
Lieutenant Colonel Donald A. Ramsay	4 June 1969–21 May 1970
Lieutenant Colonel Byron N. Schriever	21 May 1970–9 September 1970
815th Engineer Battalion (Construction)	
Lieutenant Colonel Charles A. Melton	24 March 1967–8 December 1967
Lieutenant Colonel Ames S. Albro, Jr.	9 December 1967–16 June 1968
Lieutenant Colonel Donald D. Gabe	19 June 1968–14 August 1968
Lieutenant Colonel Charles A. Debelius	18 December 1968–11 August 1969
Lieutenant Colonel James C. Donovan	11 August 1969–15 April 1970
Lieutenant Colonel Charlie L. Blalock	15 April 1970–11 October 1970
864th Engineer Battalion (Construction)	
Lieutenant Colonel James E. Bunch	5 July 1964–17 January 1966
Lieutenant Colonel Robert A. Seelye	17 January 1966–5 September 1966
Lieutenant Colonel Ray S. Hansen	5 September 1966–31 July 1967
Lieutenant Colonel Laurence L. Heimerl	1 August 1967–8 March 1968
Lieutenant Colonel Donald C. Wisdom	8 March 1968–7 September 1968
Lieutenant Colonel Authur Daoulas	7 September 1968–5 July 1969
Lieutenant Colonel Russell A. Glenn	5 July 1969–24 January 1970
Lieutenant Colonel Jack W. Martin	25 January 1970–30 July 1970

Senior Engineer Commanders in Vietnam, 1965–1970—Continued

Command	Assumption or Duration of Command
Lieutenant Colonel Phillip D. Engle	30 July 1970–26 July 1971
1st Engineer Battalion (1st Division)	
Lieutenant Colonel Howard L. Sargent, Jr.	20 September 1965–16 August 1966
Lieutenant Colonel Joseph M. Kiernan	16 August 1966–3 June 1967
Major Edwin C. Keiser	3 June 1967–25 July 1967
Lieutenant Colonel Thorwald R. Peterson	25 July 1967–8 July 1968
Lieutenant Colonel Robert Segal	9 July 1968–5 June 1969
Lieutenant Colonel Rodney E. Cox	5 June 1969–3 April 1970
4th Engineer Battalion (4th Division)	
Lieutenant Colonel Gerhard W. Shulz	9 July 1966–17 February 1967
Lieutenant Colonel Norman G. Delbridge	18 February 1967–10 July 1967
Lieutenant Colonel Emmett C. Lee, Jr.	10 July 1967–18 July 1968
Lieutenant Colonel Elvin R. Heiberg	18 July 1968–6 April 1969
Major Robert H. Easton	6 April 1969–19 May 1969
Lieutenant Colonel John R. Brinkerhoff	19 May 1969–13 May 1970
Lieutenant Colonel Richard L. Curl	13 May 1970–5 December 1970
8th Engineer Battalion (1st Cavalry Division)	
Lieutenant Colonel Robert J. Malley	16 August 1965–19 June 1966
Lieutenant Colonel Charles G. Olentine	19 June 1966–26 May 1967
Lieutenant Colonel Edwin S. Townsley	26 May 1967–18 May 1968
Lieutenant Colonel Francis J. Walter	18 May 1968–6 May 1969
Lieutenant Colonel Andre G. Broumas	6 May 1969–19 September 1969
Lieutenant Colonel Scott B. Smith	19 September 1969–4 July 1970
Lieutenant Colonel Homer Johnstone, Jr.	4 July 1970–1 April 1971
15th Engineer Battalion (9th Division)	
Lieutenant Colonel William E. Read	7 October 1966–29 September 1967
Lieutenant Colonel Thomas C. Loper	30 September 1967–2 September 1968
26th Engineer Battalion (23d Division)	
Lieutenant Colonel Matthew W. Hoey	14 June 1968–4 March 1969
Lieutenant Colonel Harry V. Dutchyshyn	4 March 1969–1 March 1971
65th Engineer Battalion (25th Division)	
Lieutenant Colonel Carroll D. Strider	22 February 1966–16 February 1967
Lieutenant Colonel Avery S. Fullerton	16 February 1967–17 November 1967
Lieutenant Colonel Henry A. Flertzheim	17 November 1967–17 June 1968
Lieutenant Colonel James W. Atwell	17 June 1968–15 November 1968
Lieutenant Colonel Edward C. Gibson	7 December 1968–7 December 1969
Lieutenant Colonel James L. Trayers, Jr.	7 December 1969–1 June 1970
Lieutenant Colonel Forrest T. Gay III	1 June 1970–5 December 1970
326th Engineer Battalion (101st Division)	
Lieutenant Colonel William F. Reilly	23 November 1967–16 November 1968
Lieutenant Colonel Henry J. Hatch	25 May 1969–10 July 1969
Lieutenant Colonel Carl P. Rodolph, Jr.	6 July 1970–28 June 1971

Appendix G

Mapping in Vietnam

Maps and topographic information are basic to military operations, and the changing nature of warfare creates requirements for new types of mapping. During the late 1950s and early 1960s when the American advisory role was becoming established in Vietnam, the old French maps, drawn during French colonial rule in Indochina, were still the best available. But these maps were out of date and failed to meet the accuracy requirements of modern weapons systems.

The U.S. Army Map Service (later the U.S. Army Topographic Command) made co-operative mapping agreements in 1956 with the Republic of Vietnam, on the basis of which joint large-scale mapping programs were undertaken. These operations included cartographic aerial photography as well as the survey of geodetic ground control needed to position large-scale maps, and the collection of information on geographic names and natural and cultural features to be symbolized on the maps. The steady increase in Communist activity in Vietnam was a major obstacle to the completion of the field survey work, and the project had to be abandoned in 1962.

Despite the problems, the Army Map Service and U.S. Army, Pacific, were able to produce in the years 1959 to 1965 1:50,000- and 1:250,000-scale maps of the Republic of Vietnam. This marked the first time that the American military mapping agencies had completed large- and medium-scale mapping of an area in advance of a major commitment of combat forces.

When American participation in the Vietnam War reached a full combat role, requirements for new maps increased accordingly. During the first year of the buildup, 1965–1966, the large-scale coverage of Vietnam, both north and south, was updated on the basis of new aerial photographs taken from 1965 to 1966.

It soon became evident to American operational planners that standard military 1:50,000-scale topographic maps were not adequate for the unusual battle in Vietnam. Tactics developed in previous wars had to be blended with new concepts such as the use of the helicopter as a weapons system. The wide range of changed tactical operations necessitated maps drawn at larger scales, with more detail and greater reliability in the positioning and identification of features. A new development, the pictomap, represented the first attempt to deal with the problem of feature identification. Drawn at a 1:25,000 scale, the pictomap, which is a photomap with the imagery reproduced in approximate natural color and the major features also annotated in color, made excellent use of aerial photography and constituted an efficient map supplement.

As the American buildup continued through 1968, there was an increase in requirements for the normal topographic support to meet local operational needs. Included were topographic and geodetic surveys for artillery use; cartographic and reproduction work, including map revisions and production of photomaps; and maintenance of operational stocks and maps. To provide these specialized services, Army topographic companies were sent to Vietnam. Army surveyors completed major ground control projects in selected areas for the production of very large-scale coverage. The resulting geodetic control, plus low-level photography procured by the U.S. Army, is being used by various agencies for military purposes and for internal development demands. Work of the Army topographic units included overprinting 1:50,000-scale maps with intelligence information and producing special planning photomosaics, large-scale stereocompilations, and 1:10,000-scale photomaps of selected urban areas.

The excellent state of mapping readiness for operations in Vietnam existed because of long-range topographic planning and the availability of trained topographic troops for prompt deployment. The contributions of these topographic units were a very basic factor in allied military successes.

Appendix H

Engineer Priorities in Vietnam

1. Clearing and grubbing of troop areas
2. Field fortifications
3. Clearing of fields of fire
4. Water supply points
5. LST ramps and bollards
6. Materials for pit latrines (self-help project)
7. Flight strips with access roads
8. Roads and hardstands at ports
9. Hospitals
10. Ammunition storage areas and access roads
11. Communications facilities
12. Storage facilities for petroleum products (tank farms)
13. Ramps and parking areas for flight strips
14. Jetties at ports
15. Dispensaries for tactical units (at least one per base)
16. Internal axial roads
17. Distribution systems (depots) for petroleum products
18. Maintenance buildings for flight strips
19. Administration buildings (not more than one in any area, subarea, or camp at any one time, with priority to major operational headquarters)
20. Kitchen pads
21. Mess halls (no plumbing)
22. Dispensaries (one per base or subbase other than those for tactical troops)
23. Warehousing space and open storage area depots
24. Maintenance facilities for weapons
25. Maintenance facilities for communications equipment
26. Road improvement
27. Off-loading and feeder pipelines for petroleum products
28. Piers at ports
29. Bridge strengthening
30. Field maintenance facilities for vehicles
31. Fire protection sumps
32. Covered storage space
33. Internal tributary roads

34. Shop maintenance facilities for vehicles
35. Shower points
36. Warehousing space (reefer storage)
37. Post offices and post exchanges
38. Bakeries
39. Laundries
40. Service clubs
41. Wharves at ports
42. Enlisted billets for combat elements capable of only intermittent self-help because of engagement with the enemy
43. Unit maintenance facilities for vehicles
44. Enlisted billets for combat elements other than those to which item 42 applies
45. Enlisted billets for combat support units
46. Stabilized access roads
47. Enlisted billets for general support units (including engineers of the 18th Brigade)
48. Road surface treatment through villages
49. Bridge replacement
50. Stabilized parking areas for vehicles
51. Bermed ammunition storage areas with stabilized pads
52. Officer billets for combat units
53. Officer billets for combat support units
54. Officer billets for general support units
55. Chapels [1]

After initial approval, the list was amended by insertion of the following items:

New No. 14. Post exchange storage buildings with latrines (one per base area), after ramps and parking areas for flight strips

New No. 17. Wire and floodlights for security lighting, after dispensaries

New No. 55. Generator sheds for security lighting, after officer billets for general support units

New No. 56. Covered storage areas for ammunition, after chapels

[1] The expectation was that unit structures such as mess halls and service clubs would also serve as places for religious assemblies.

Glossary

AID	Agency for International Development
AM2	Aluminum matting used on airstrips
Bailey bridge	A bridge designed for rapid construction from interchangeable latticed steel panels that are coupled with steel pins
"Buddy System"	Program initiated in 1969 which placed South Vietnamese units under U.S. unit sponsorship for on-the-job training
C–123	Cargo-transport aircraft
C–130	Cargo-transport aircraft
CEDAR FALLS	Joint operation carried out by the 1st and 25th Infantry Divisions, 173d Airborne Brigade, 11th Armored Cavalry Regiment, and South Vietnamese Army units against Viet Cong Military Region 4 headquarters in the Iron Triangle, 8–26 January 1967
CONARC	United States Continental Army Command
CONUS	Continental United States
DeLong pier	Prefabricated pier used extensively in South Vietnam in developing port quays and ships' berths; these piers could be installed quickly and reclaimed when no longer needed
ESSAYONS	Operation in which the 62d Engineer Battalion phased into Phan Rang, September 1965
Hardstand	Hard-surfaced area for parking an airplane or a surface vehicle or supplies
Horizontal construction	Engineering term to differentiate construction activities at or near ground level from those associated with structural or finish work normally above ground; included are earthmoving, pav-

	ing, and simple drainage features involving much heavy equipment but few building trade skills
Huey	UH–1D helicopter
JUNCTION CITY	Operation conducted in War Zone C (Tay Ninh Province) and bordering provinces by twenty-two U.S. battalions and four South Vietnamese Army battalions, elements of the U.S. 1st, 4th, and 25th Infantry Divisions, 196th Light Infantry Brigade, 11th Armored Cavalry Regiment, and 173d Airborne Brigade, 22 February–14 May 1967
LST	Landing ship, tank
MACV	United States Military Assistance Command, Vietnam
One-Buck	Code designation for units held in readiness in the United States for deployment on 48-hour notice
PEGASUS	Operation conducted by the 1st Cavalry Division (Airmobile) with U.S. Marine and Vietnamese Army airborne battalions to relieve the siege of Khe Sanh, 1–15 April 1968
POL	Petroleum, oils, and lubricants
Red ball system	Shipping system designed to expedite the movement of specific urgently needed items from the United States to Vietnam
Rome Plow	Specially equipped bulldozer capable of heavy-duty land clearing
Seabees	Navy construction battalions
STRAF	United States Strategic Army Forces
SWITCHBLADE	Joint project begun on 15 December 1969 in which three Vietnamese land clearing companies were assigned to the U.S. 62d Engineer Battalion for training and deployed with their counterparts to War Zone C for forty-five days of land clearing operations in support of various U.S. combat units

T17 membrane	A tough, rubberized fabric used as an expedient airfield surfacing material on runways, taxiways, and parking areas
USARV	United States Army, Vietnam
Vertical construction	Engineering term to differentiate construction activities above ground level from those associated with earthmoving or paving; it includes efforts by carpenters, masons, steelworkers, plumbers, electricians, and other building tradesmen. Vertical construction is characterized by high commitment of manpower and hand tools while horizontal construction employs a preponderance of heavy equipment.

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