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STUDY S-255

AIR-SUPPORTED ANTI-INFILTRATION BARRIER [u]

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PREFACE

In this report we discuss a possible air-supported barrier or interdiction zone that would help to isolate the South Vietnam battlefield from North Vietnam. The ideas are not unrelated to proposals in this area that have been made previously, but they are perhaps explored in more depth than such ideas have been explored hitherto, and operations on a larger scale than have previously been considered are envisaged. Both advantages and difficulties are discussed, on the assumption of a relatively long war lasting several years.

In Part I we first give some general views of the relation of such a barrier to the general course of the war; then in Part II we present a rough picture of the current infiltration system and of U.S. operations against the "Ho Chi Minh Trail," as it has been presented to us in briefings.

In Part III a system conception is described for an air-supported barrier. An initial system is discussed, that could be largely operational within a year or so from go-ahead using nearly-available weapons, aircraft, and equipment. Even for such a system some component engineering will be necessary. The design of the system, which implicitly takes account of some obvious countermeasures, is described, as are the essential components, what must be done to make them ready, the uncertainties in their contribution, and the numbers required or rates of usage to assure certain component probabilities of detection or kill. Possible improvements are then mentioned, which might be put into effect during the succeeding year or two.

In Part IV we give a partial analysis of how such a barrier might be deployed, its potential impact on the communist war effort, and of strategic measures North Vietnam could take to circumvent it if it is successful.

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SUMMARY OF THE RESULTS AND RECOMMENDATIONS
OF THE AIR-SUPPORTED-BARRIER STUDY GROUP

SUMMARY

An air-supported barrier system specifically designed against the North Vietnamese infiltration system through Laos, based on further development of components that in the main are available, may be obtainable in about a year after the decision to go ahead. The operating cost might be about \$800 million per year, exclusive of "sunk" costs in production plants and aircraft, or aircraft attrition. The system would be based on Gravel mines for area denial, profuse use of simple sensors constantly monitored to detect attempts at penetration, and air strikes with area-type weapons against detected targets. It is probable that countermeasures against the initial system may be developed in a few months so that installation of such a system would be indicated only if it were but the first phase of a constantly improving barrier.

The Enemy Infiltration System Through Laos

Many discrepancies and uncertainties exist in the available information concerning the infiltration system, but overall we have obtained the following impression of it. There are two distinct components: supply infiltration and troop infiltration. At present the supplies are largely transported in trucks, supplemented by river transport and porters using bicycles, animals, or carrying packs. These supplementary modes of transport could with major effort be expanded to take over the entire load, so that an interdiction system operating only against trucks could be countervened.

Both the supply and troop routes are, in principle, diversified and flexible. There is a great variety of secondary roads which could

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be improved into truckable roads, and several alternative main roads already exist. There are also many trails available, particularly in rolling hilly country and open U-shaped valleys. Nevertheless, at present and presumably simply for convenience, only two trails appear actually to be used for the majority of troop unit infiltrations. One of these passes directly through the center of the DMZ; the other just touches the northwest corner of the DMZ and then proceeds into Laos and south parallel to the South Vietnamese border. This more westerly trail is connected by feeder trails to the road network, permitting porters to carry supplies to the infiltrating troops in their preplanned bivouac areas.

Altogether, the degree of redundancy and flexibility in the system is so great that only an interdiction technique applied over sizable areas is likely to be effective.

Barrier System

We have concluded that it may be possible to design an air-supported barrier system to inhibit enemy operations on these infiltration routes, and we have evolved an as-yet imperfect conception of how such a system would work.

The barrier would have two somewhat different parts, one designed against foot traffic and one against vehicles. The preferred location for the anti-foot-traffic barrier is in the region along the southern edge of the DMZ to the Laotian border and then north of Tchepone to the vicinity of Muong Sen, extending about 100 by 20 kilometers. This area is virtually unpopulated, and the terrain is quite rugged, containing mostly V-shaped valleys in which the opportunity for alternate trails appears lower than it is elsewhere in the system. The location of choice for the anti-vehicle part of the system is the area, about 100 by 40 kilometers, now covered by Operation Cricket. In this area the road network tends to be more constricted than elsewhere, and there appears to be a smaller area available for new roads. An alternative location for the anti-personnel system is north of the DMZ to the Laotian border and then north along the crest of the mountains dividing

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Laos from North Vietnam. It is less desirable economically and militarily because of its greater length, greater distance from U.S. bases, and greater proximity to potential North Vietnamese counter-efforts.

The air-supported barrier would, if necessary, be supplemented by a manned "fence" connecting the eastern end of the barrier to the sea.

The construction of the air-supported barrier could be initiated using currently available or nearly available components, with some necessary modifications, and could perhaps be installed by a year or so from go-ahead. However, we anticipate that the North Vietnamese would learn to cope with a barrier built this way after some period of time which we cannot estimate, but which we fear may be short. Weapons and sensors which can make a much more effective barrier, only some of which are now under development, are not likely to be available in less than 18 months to 2 years. Even these, it must be expected, will eventually be overcome by the North Vietnamese, so that further improvements in weaponry will be necessary. Thus we envisage a dynamic "battle of the barrier," in which the barrier is repeatedly improved and strengthened by the introduction of new components, and which will hopefully permit us to keep the North Vietnamese off balance by continually posing new problems for them.

This barrier is in concept not very different from what has already been suggested elsewhere; the new aspects are: the very large scale of area denial, especially mine fields kilometers deep rather than the conventional 100-200 meters; the very large numbers and persistent employment of weapons, sensors, and aircraft sorties in the barrier area; and the emphasis on rapid and carefully planned incorporation of more effective weapons and sensors into the system.

The system that could be available in a year or so would, in our conception, contain the following components:

- Gravel mines (both self-sterilizing for harassment and non-sterilizing for area denial).

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- Possibly, "button bomblets" developed by Picatinny Arsenal, to augment the range of the sensors against foot traffic.*
- SADEYE/BLU-26B clusters,** for attacks on area-type targets of uncertain location.
- Acoustic detectors, based on improvements of the "Acoustic Sonobuoys" currently under test by the Navy.
- P-2V patrol aircraft, equipped for acoustic sensor monitoring, Gravel dispensing, vectoring strike aircraft, and infrared detection of campfires in bivouac areas.
- Gravel Dispensing Aircraft (A-1's, or possibly C-123's)
- Strike Aircraft
- Photo-reconnaissance Aircraft
- Photo Interpreters
- (Possibly) ground teams to plant mines and sensors, gather information, and selectively harass traffic on foot trails.

The anti-troop infiltration system (which would also function against supply porters) would operate as follows. There would be a constantly renewed mine field of non-sterilizing Gravel (and possibly button bomblets), distributed in patterns covering interconnected valleys and slopes (suitable for alternate trails) over the entire barrier region. The actual mined area would encompass the equivalent of a strip about 100 by 5 kilometers. There would also be a pattern of acoustic detectors to listen for mine explosions indicating an attempted penetration. The mine field is intended to deny opening of alternate routes for troop infiltrators and should be emplaced first. On the trails and bivouacs currently used, from which mines may--we tentatively assume--be cleared without great difficulty, a

*These are small mines (aspirin-size) presently designed to give a loud report but not to injure when stepped on by a shod foot. They would be sown in great density along well-used trails, on the assumption that they would be much harder to sweep than Gravel. Their purpose would be to make noise indicating pedestrian traffic at a range of approximately 200 feet from the acoustic sensors.

**CBU-24 in Air Force nomenclature.

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more dense pattern of sensors would be designed to locate groups of infiltrators. Air strikes using Gravel and SADEYES would then be called against these targets. The sensor patterns would be monitored 24 hours a day by patrol aircraft. The struck areas would be reseeded with new mines.

The anti-vehicle system would consist of acoustic detectors distributed every mile or so along all truckable roads in the interdicted area, monitored 24 hours a day by patrol aircraft with vectored strike aircraft using SADEYE to respond to signals that trucks or truck convoys are moving. The patrol aircraft would distribute self-sterilizing Gravel over parts of the road net at dusk. The self-sterilization feature is needed so that road-watching and mine-planting teams could be used in this area. Photo-reconnaissance aircraft would cover the entire area each few days to look for the development of new truckable roads, to see if the transport of supplies is being switched to porters, and to identify any other change in the infiltration system. It may also be desirable to use ground teams to plant larger anti-truck mines along the roads, as an interim measure pending the development of effective air-dropped anti-vehicle mines.

The cost of such a system (both parts) has been estimated to be about \$800 million per year, of which by far the major fraction is spent for Gravel and SADEYES. The key requirements would be (all numbers are approximate because of assumptions which had to be made regarding degradation of system components in field use, and regarding the magnitude of infiltration): 20 million Gravel mines per month; possibly 25 million button bomblets per month; 10,000 SADEYE-BLU-26B clusters* per month; 1600 acoustic sensors per month (assuming presently employed batteries with 2-week life), plus 68 appropriately

* These quantities depend on an average number of strikes consistent with the assumption of 7000 troops/month and 180 tons/day of supplies by truck on the infiltration routes. This assumption was based on likely upper limits at the time the barrier is installed. If the assumption of initial infiltration is too high, or if we assume that the barrier will be successful, the number of weapons and sorties will be reduced accordingly.

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equipped P-2V patrol aircraft; a fleet of about 50 A-1's or 20 C-123's for Gravel dispensing (1400 A-1 sorties or 600 C-123 sorties per month); 500 strike sorties* per month (F-4C equivalent); and sufficient photo-reconnaissance sorties, depending on the aircraft, to cover 2500 square miles each week, with an appropriate team of photo interpreters. Even to make this system work, there would be required experimentation and further development for foliage penetration, moisture resistance, and proper dispersion of Gravel; development of a better acoustic sensor than currently exists (especially in an attempt to eliminate the need for button bomblets); aircraft modifications; possible modifications in BLU-26B fuzing; and refinement of strike-navigation tactics.

For the future, rapid development of new mines (such as tripwire, smaller and more effectively camouflaged Gravel, and various other kinds of mines), as well as still better sensor/information processing systems will be essential.

It seems clear that because of the number of elements in the system, some coming from each of the Services, and because of the necessity of introducing new components as quickly as possible, a coordinated central direction of the entire project will be necessary.

Countermeasures and Effectiveness

It is difficult to assess the likely effectiveness of an air-supported barrier of this type. The initial system must be deployed quickly and on a large scale to produce the maximum disruption of the infiltration system. If the North Vietnamese are exposed gradually to small quantities of Gravel mines, the impact of the total system when it is finally emplaced will be much smaller, and effective countermeasures will already be understood.

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Assuming that surprise is not thrown away, countermeasures will of course still be found, but they may take some time to bring into operation. The most effective countermeasures we can anticipate are mine sweeping; provision of shelter against SADEYE strikes and Gravel dispersion; spoofing of sensors to deceive the system or decoy aircraft into ambushes, and in general a considerable step-up of North Vietnamese anti-aircraft capability along the road net. Counter-countermeasures must be an integral part of the system development.

Apart from the tactical countermeasures against the barrier itself, one has to consider strategic alternatives available to the North Vietnamese in case the barrier is successful. Among these are: a move into the Mekong Plain; infiltration from the sea either directly to SVN or through Cambodia; and movement down the Mekong from Thakhek (held by the Pathet Lao-North Vietnamese) into Cambodia.

Finally, it will be difficult for us to find out how effective the barrier is in the absence of clearly visible North Vietnamese responses, such as end runs through the Mekong plain. Because of supplies already stored in the pipeline, and because of the general shakiness of our quantitative estimates of either supply or troop infiltration, it is likely to be some time before the effect of even a wholly successful barrier becomes noticeable. A greatly stepped-up intelligence effort is called for, including continued road-watch activity in the areas of the motorable roads, and patrol and reconnaissance activity south of the anti-personnel barrier.

RECOMMENDATIONS

1. We should initiate urgent efforts to find out, in much more detail than is currently available, about the infiltration system, both how it operates and the terrain through which it operates, especially in the preferred barrier regions.
2. A task force should be established to carry out detailed design and planning of the barrier, to carry out experiments with and decide on modifications of present components, and to design and accelerate the development of modified and new components to be fed into

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the barrier. After a few months, if the prospects for the barrier still look promising, this task force should merge into a task force which has the additional responsibility of helping the operating forces implement the barrier system.

3. The effectiveness of the barrier is crucially sensitive to the speed with which new, hard-to-sweep air-delivered mines can be developed, and this effort should be pressed as urgently as possible. There are a number of other technological advances that must be pursued. These include sensors, communication between sensor and the monitoring aircraft, communication between the monitoring aircraft and the strike planes, and weapons specialized for the strike function.

4. Intelligence efforts to ascertain both barrier effectiveness and North Vietnamese efforts to evade the barrier should be built up with the barrier, as should planning for countermoves against potential strategic evasions.

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PART I - INTRODUCTION: FOCUS OF THE STUDY

The conflict in Vietnam has several facets, each of them further divisible:

1. Pacification of lowland areas heavily populated by ethnic South Vietnamese.
2. Main Force battles in the sparsely populated Central Highlands.
3. Overland flow of men and supplies from North Vietnam to Main Force (VC/PAVN) units in the Highlands, and efforts to interdict such flow, principally in Laos, North Vietnam, and South Vietnam.
4. Flow of rice and VC recruits from the Mekong Delta to the Highlands through South Vietnam and perhaps Cambodia.
5. Naval blockade to prevent supply to the VC over the coast by sea, and also by sea and river in the Delta.
6. Aerial bombardment of targets deep inside North Vietnam to interdict the supply flow, and to put pressure on the Hanoi Government.

In the study reported here we considered mainly the problem of overland supply and interdiction, for the following reasons.

We see the possibility of a long war. Under these conditions, there is likely to be a high and perhaps rising casualty rate from continuing Main Force battles in the Highlands of South Vietnam. The communist forces have recruits available to them from a population, of uncertain number, in the South, and from a much larger population in the North. The availability of recruits from the North vastly increases the manpower available to prosecute the war; moreover, North Vietnam appears to be the major reservoir of supplies on which the

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Main Force units depend in the organized fighting. If real constraints could be put on the ability of North Vietnam to move troops south, and to supply the Main Force VC/PAVN units, and assuming the Navy's Market Time operation will demonstrate and improve its effectiveness, it may then become possible gradually to reduce the scale of the fighting and the casualties in the Highlands, to dry up the VC and PAVN Main Force activity and the danger it presents to the Lowlands. If the war then drags on at a much lower level, it is less serious and the risk of further escalation and perhaps internationalization of the war should be less. It is also possible that deflation of Main Force activities could, in time, discourage internal guerrilla activities, thereby allowing the war to taper off.

Overland supply from North Vietnam through Laos to South Vietnam is said to be the largest and most important component of the supply system to the South; therefore we concentrated on that problem. If that problem is successfully solved, the other routes could become much more important; this is discussed further in Part IV. A final consideration is that, if the United States can, with massive resources, successfully interdict North Vietnamese support for operations in the South, the time "bought" thereby can be used to create a system for protecting its borders that South Vietnam can support after U.S. disengagement.

THE INTERDICTION ZONE

The battles in the South Vietnamese Highland area and the overland flow of men and supplies from the North involve almost exclusively the use of difficult and remote terrain, much of it heavily wooded, and mostly sparsely populated. Our forces in South Vietnam are engaged in search-and-destroy operations in such areas. Special Forces teams and various agents maintain positions or move around here as well, and air activity operates against supply lines, depots, and diverse enemy concentrations in North Vietnam, Laos, and South Vietnam. All of this has kept the VC and PAVN Main Forces from descending to the South Vietnamese Lowlands and seizing the cities or gaining firm control over populated regions. But in the long run this only denies the enemy forces

fulfillment of their strategy. To advance our own strategy, more must be done, and a more effective interdiction of the supply and troop flow appears to be an essential part of the added effort.

It appears to us that an interdiction zone such as we discuss in this report can best be placed where the supply system narrows and the pipeline includes restrictions on alternate routes. Such a zone of interdiction could run more or less along the North Vietnamese border (along the Demilitarized Zone (DMZ) and north along the North Vietnam-Laos frontier), keeping North Vietnam at home; or it could follow the Laotian frontier (DMZ, south along the South Vietnam-Laos frontier, then across the Laos-Cambodian frontier); it could be a longer one following the South Vietnam-Cambodian frontier to the Mekong Delta (and perhaps through the Plain of Reeds along the South Vietnam-Cambodian border); or, the simplest and shortest possibility, roughly following route 9 from the South Vietnam Lowlands across to the Laotian Lowlands at the Mekong (Savannakhet).^{*} In any of these cases, the interdiction zone, like the zone of battle against the Main Force units, is likely to be far from centers of population, and operations in such areas avoid antagonizing sizable populations.

One of the possible interdiction techniques which could be used is a physical "fence," mined, patrolled, and otherwise suited to the military situation, along the national boundary. A group working in parallel with Jason in this effort studied the boundary fence. Although their work did not reach the stage of completion warranting a final report, it did proceed far enough to show that the installation time, the extreme character of the terrain, the omnipresence of opposing troops and their skill and experience in ambush operations, and the objections to involving more U.S. troops and suffering more U.S. casualties than might otherwise be necessary, make the physical national boundary barrier a much less desirable operation in Vietnam than it might be in other wars. Therefore, we concentrated our attention on the problem of an air-supported barrier, on the presumption that the

^{*} See Part IV for a more detailed discussion of these alternatives.

U.S. could, with proper integration of known aerial interdiction techniques into a comprehensive system, make more effective use of its air power for this purpose than it is now doing.

To summarize the above considerations, we conclude that the interdiction zone should be in a region where the supply system "necks down" relative to the system in North Vietnam and across the South Vietnamese border, and that it should be primarily air-supported, based on the general idea of area denial, and hopefully making more effective use of our air power for interdiction than may currently be the case.

SOME COMMENTS ON THE ORIENTATION OF THE STUDY TEAM AND THE TASK

A number of challenging technical problems are presented by the air-laid barrier; we have not, however, concentrated our attention on trying to devise new technology that might be useful for such a barrier, even though that would have made good use of the talents of some of our people. We believe that there are important reasons for emplacing such a barrier as early as possible, and we have concluded that completion of many of the promising developments currently in progress, or new inventions that might be suggested, would (if they took, for example, two to three years) arrive too late for maximum strategic impact. If it took several years to emplace an effective infiltration barrier, the war might by then have escalated or changed in character sufficiently to render such a barrier neither useful nor relevant.

Therefore we have spent most of our effort in the more prosaic task of trying to see how one could assemble hardware that will soon be available, with some minor modifications, into a system that could begin to function within about a year from go-ahead. It is to be hoped that during succeeding years (and our whole study is based on the hypothesis of a long war) items under development (such as the tripwire mine) and new inventions can make the system much better and overcome the countermeasures that will doubtless be applied by the other side.

Our air-laid mine barrier is not a particularly new idea; with the restriction we have imposed of working with hardware soon to be

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available, one can probably not find a wholly new idea. The new elements of what we have done, relative to past efforts, are:

- a. to take the idea quite seriously (i.e., to start with the idea that this could be done);
- b. to make the depth of the denied zone and the number of weapons used much greater (e.g., mine fields kilometers deep instead of the conventional 100-200 meters);
- c. to envisage a widespread system of sensors, patrolled all the time, to report penetrations;
- d. to envisage large-scale operations of reseeded and bombing with area-type weapons (cluster bomblets) in reply to penetrations.

We are not sure the system will make the interdiction zone nearly impenetrable, but we feel it has a good claim of being the foundation of a system that will, over the years, make it very much harder than it would be otherwise to keep building up the scale of Main Force operations in South Vietnam, provided other methods of infiltration are kept under control. During this long period, there would no doubt be played a complicated game of measures and countermeasures, and considerable cleverness will no doubt be required to keep up our end, since we are pitting a technical system against highly determined and ingenious human beings on the ground.

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PART II - THE INFILTRATION SYSTEM

The system to be defeated is enormously diverse and in many respects elusive in its fine details. We turned our attention, first, to an attempt to elucidate its workings, so that we would know how to design a system to work against it. We spoke with many people about the enemy infiltration system, and obtained many different views of it. Those who briefed us included General Goodpaster; the Service Chiefs of Staff (Vice Chief, in the case of the Navy); representatives of the CIA; representatives of the DIA, and those at the working level in DIA who are responsible for analyzing intelligence about the Ho Chi Minh Trail complex; Mr. Leonard Sullivan, of ODDR&E, who is responsible, in part, for development of new interdiction technology; Dr. Frederick J. Brandtner, of Research Analysis Corporation, a geologist, who, under ARPA sponsorship, has spent many months studying POW reports and aerial photography to reconstruct a general picture of the personnel infiltration routes and their evolution; Dr. Ellis Rabben of WSED, who has explored extensive aerial photography of the entire region of the infiltration system in Laos; Ambassador W. Sullivan, our Ambassador in Laos; a Captain (USAF) who had responsibility for road-watch and pilot rescue operations in Laos; a Lieutenant (USAF) who had studied in detail (on the spot) the area around Chu Pong Mountain; a Marine Intelligence officer who had been in the field with Operation Hastings; and Colonel Donald Blackburn, who had commanded the SOG, Vietnam, until June 1966.

We found that, because of some critical details (e.g., sweepability of mines) on which the success or failure of the interdiction system can depend, we needed information in great depth about the system; but that at this level of detail there were many gaps or contradictory items of qualitative information. Thus, for example, trucks do/do not drive with lights on; troops do/do not ride on trucks through

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Laos; trail surfaces are/are not clear earth; infiltrating troops do/do not have a very hard time, with regard to health, etc.; supply depots along trail are/are not well stocked with food; way stations and overnight biv. cs are/are not easily moved and constantly shifting; sea infiltration does/does not exist; military supplies (not food) do/do not come through Cambodia; troops, presumably wounded, do/do not dead-head North in trucks. Each of these contradictory statements may be true for different parts of the system, or for a given part at different times. Because of this confusion, the outline of the infiltration system given below represents a sort of consensus, and is evidently subject to considerable uncertainty that will have to be resolved.

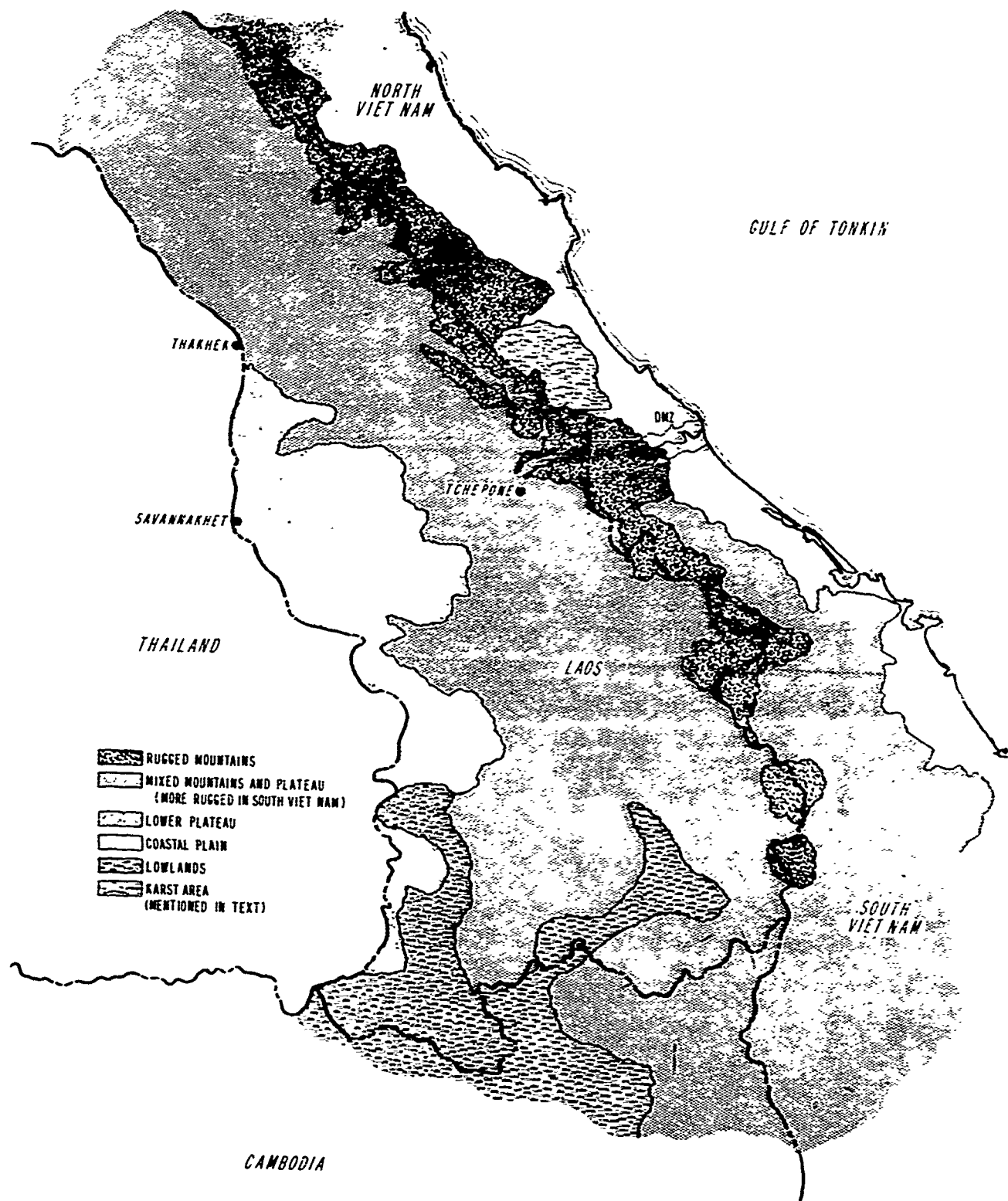
For purposes of system design we used a range of ^{300T} 30-300 tons/day of vehicle-borne supplies, and 4500-7000 troops/month, moving through the system.

NATURAL TERRAIN, VEGETATION, GEOLOGY, ETC.

We discuss here mostly the region from the sea to the Mekong Plain in the general latitude of, and just south of, the DMZ.

1. Terrain. On the South Vietnamese side of the Laotian border, there are fairly steep sided (about 30 percent slope) V-shaped valleys with high (up to 5000') mountains, out to the coastal plain which comes inland to about 10 miles from the coast. Between the mountains and the plain are hills. On the Laotian side there are mostly rolling hills all the way to Tchepone, where the relief is quite a bit less and valleys are generally broader (U-shaped), except for a rugged band of mountains which lies north and south of the broad East-West Bang Hsiang River valley. (See map 1) The bedrock is covered by an overburden of red clayey silt, which is quite slippery when wet. Well north of route 9, but south of Mu Gia Pass, and straddling the border, there is an extensive karst region, i.e., very steep limestone mountains, but with flat clay-filled alluvial valleys between. This does not extend south as far as the route 9 region.

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MAP 1: General Schematic of Terrain

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2. Vegetation. On the South Vietnamese side, there is generally heavy second-growth evergreen forest (virgin forest exists only in forest reserves; there are two of these in the east end of two valleys south of the DMZ in South Vietnam). The trees make a dense canopy 80-90 feet high; they are soft-wooded, fast-growing trees, with trunks up to 3 feet in diameter. There is a second canopy of smaller trees, usually a continuous mass of vegetation from the ground up to at least 10 feet, but even up to the upper canopy in some cases. The lowest level of vegetation consists of vines, ferns, etc., and a dense growth of small trees, including bamboo and banana. This is almost impenetrable. The hills between the coastal plain and the mountains in South Vietnam have, in some places, elephant grass instead of forest. This is quite dense, and up to 10 feet high.

On the Laotian side, south of the latitude of the DMZ and the two mountainous regions mentioned, there is mostly low dense scrub forest, 10 to 20 feet high. There is higher forest in patches and along streams. Trails are generally visible through this in aerial photography.

3. People. There are very few people (≈ 20 /square mile) in the entire region. All are Montagnard tribes (mainly Bru) except for some Lao and Tai in the valleys around Tchepone and further west. Many Montagnard villages in the region are now deserted.

INTELLIGENCE ON THE FOOT-TRAILS

It appears that nearly anyone who walks does so on trails; the terrain and vegetation are too difficult for cross-country travel.

1. Physical Description. The trails are generally wide (3 to 6 feet) hard-packed cleared earth, if they are well used.* Steps are cut on steep grades; sometimes there are rope handrails, and the steps may be reinforced by logs. There is some leaf cover on the surface if the trails are less well-used; still less-used

* This is a consensus of opinion we have heard. We did not see ground photographs of the relevant trails.

trails are overgrown with grass and shrubs. Overall, much of the trail network is visible from FAC planes; even more is visible on stereoscopic photography. However, trails in the more heavily forested areas in South Vietnam and west of the DMZ are not visible. Moreover, it is very hard to see people on trails from planes even when the trails themselves are visible. Occasionally a trail coincides with a stream bed for some distance. There are usually single or few trails in steep (V-shaped) valleys; there are considerable interlocking nets of good trails in wider (U-shaped) valleys or in rolling terrain. We infer that only one trail in such a net is usually used for infiltration, and has the necessary facilities. However, others could easily be used if necessary. River crossings are likely to be constraining (i.e., there may be few alternatives, troops may need ropes to cross in the rapid current) in steep terrain.

2. Rest Camps. Rest camps are 4 to 6 hours (about 8-10 Km) apart. They consist of a few huts for the staff, which usually consists of 3 to 10 men (guides, communications people, sometimes a nurse). Camps contain food stocks (rice, canned meat, and shrimp paste), and sometimes medicines. Sometimes there is agriculture (row farming, corn, manioc) to help supply the staff. Sometimes cows, pigs, and chickens are kept in corrals as added food. Usually there are no radios. (At least, we heard no evidence of any from anyone, but stripped tall trees which could be radio antennae can be seen on aerial photography.)

3. Troop Infiltration. Troop units are coherent; they walk in battalions, broken into companies or platoons about 1 day apart. They regroup into battalions each 3 to 4 days. They rest about 1 day out of each 3 or 4. They bivouac near but not at the rest camps; food is brought to them from the camps. They are usually resupplied each day. They have little contact with local Montagnards. They are guided on parts of the route; otherwise they follow maps. Individuals carry 60 to 70 lb packs (1 or 2 spare uniforms, weapons and ammunition, hammocks, rolled cloth

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with 1 to 2 days' rice, mosquito headnet). The battalion carries all its own heavy weapons (machine guns, mortars, etc.) with it. Occasionally (e.g., on route 92 south of the Xe Pon River) troops walk on a truck road, but usually they do not. There appear to be only two main routes in use now. (See map 2) Troops go by truck to just north of the DMZ in North Vietnam. On the western trail, which is said to be the more heavily used, troops reach a large camp in Laos in about 14 days ("pine forest camp") where they may stay months. Here they train, farm, and are indoctrinated. They live in huts--there are at least 11 areas of huts in the "pine forest camp."

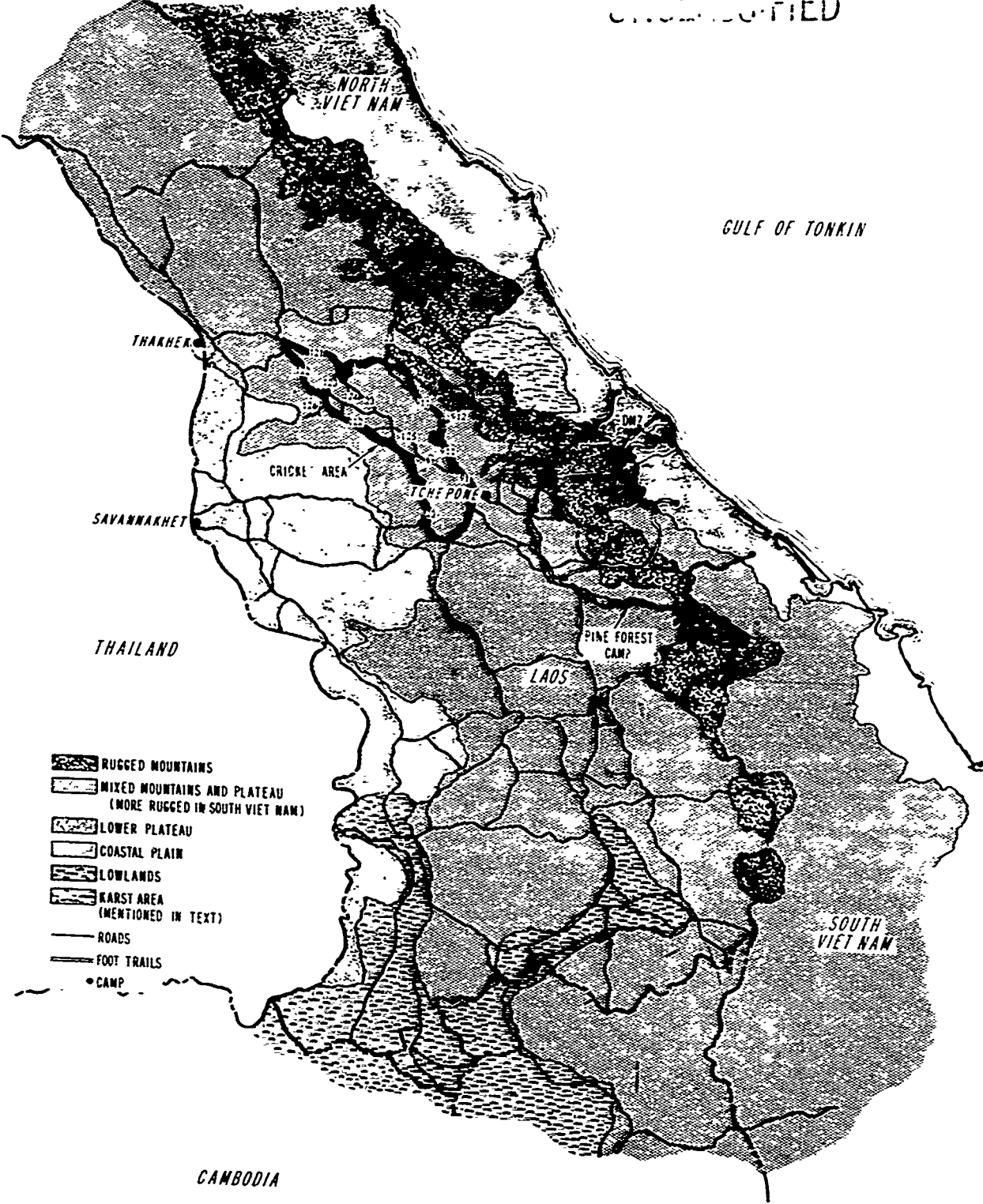
4. Supply Infiltration. (The amount moving this way is unknown.) Porters, usually Montagnards, are hired or impressed in southern Laos, but there are also North Vietnamese in the northern part of the panhandle. Porters travel in groups of about 10. They use backpacks (\approx 100 lbs) or bicycles (\approx 500 lbs), and also ox-carts (horses or mules, and elephants occasionally). They supply the rest camps as well and carry ammunition and war materiel. Supply columns usually have armed men at the front and rear. We are told they are very noisy--they sing and shout--signifying no fear of attack. Supplies to the rest camps on the main infiltration route are carried over auxiliary trails from the truck routes. Supplies which are not moved are stored in caves, holes in the ground, huts, under trees in the open; many small supply dumps are scattered over very large areas. All of this portage system can, with effort to conscript and organize enough porters, be made to replace the trucks.

5. Control System. As far as we could determine, the command, control and bookkeeping system for the whole network is unknown to U.S. intelligence. This is surprising, since it appears obvious that extensive accounts would have to be kept.

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MAP 2: Roads and Trails of Infiltration System

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INTELLIGENCE ON TRUCK ROUTES

1. Physical Description

Main Roads. (See map 2) Usually these comprise an unpaved one-lane road, which may have a grass strip in the center. Some parts of the roads are wider, some are gravelled, some have corduroy, some have had a trellis with vegetation cover built overhead. However, approximately 80 percent of the road lengths are visible from the air. During the dry season, the trees alongside the roads are dust covered. In the wet season some roads are impassable because they are under water. They are mainly invisible at night (except, perhaps, on appropriate side-looking radar in open places). No roads other than route 9 enter South Vietnam. There are many alternate routes (e.g., there are seven bypasses to Mu Gia Pass), and no single choke points. However, the availability of alternate routes may tend to be more limited in some areas (e.g., the Cricket area - see below). There are truck parks (wide areas criss-crossed by "driveways") along the roads every few kilometers, and many short turnouts for hiding from aircraft, in some cases every half kilometer or so. The truck parks and turnouts take advantage of tree cover along the roads.

Secondary Roads. These are generally roads on which jeeps might travel; basically, they are large trails. There are great numbers of them at the ends of the main roads, and also along and between the main roads at frequent intervals, especially where there are supply dumps. These can be upgraded to main roads.

2. Use of System

Trucks, (perhaps 10 percent of the fleet is diesel, with the proportion growing), move largely at night. They work in "blocks" of 3 to 4 hours' drive per night; it is uncertain whether trucks cover given road sections in relays, or whether drivers work in relays on trucks that move through the length of the system. Truck speed on main roads is approximately 5 to 10 mph. They move in convoys of approximately 10 trucks; up to 50 in a convoy have been seen. When planes approach

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trucks stop or turn off the road, and switch off their lights. (There was conflicting information on the use of lights, but it appears to us that at least some form of illumination would be necessary to traverse roads of this kind at night.) There are many supply dumps along the roads; these are widely dispersed, and may be miles across, including caves, huts, and underground burial. We were told that there are approximately 600 trucks operating in Laos at any time, and it was estimated that these might require about 120 tons of POL per month.

The system includes many support personnel--estimates run as high as 60,000, of whom about 10,000 may be PAVN. These are supplemented by locally acquired porters; materiel is moved by porters and river transport where necessary. There are many load transfer locations from road to river, and boats are lightly laden for shallow draft. Usable waterways are all visible from the air, but craft can hide under vegetation along the shore.

There is little, but growing, anti-aircraft, except at the passes (e.g., Mu Gia Pass has a SAM site nearby in North Vietnam) and what exists is light--up to 37 mm, but mainly machine guns.

Southbound trucks carry weapons, ammunition, clothing, some food, medicine, POL, and on occasion, troops. Northbound trucks carry empty POL drums, possibly wounded and sick troops, or they move empty. The average truck load is approximately 2½ tons.

In general, there appears to be no single sensitive point or component in this system, but we believe that an attack on the whole system or a substantial coherent part of it could be effective in interdicting this element of the overall infiltration system in its present form. Again, we were given no description of any inventory control or bookkeeping system for this elaborate network, although one must surely exist.

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PRESENT ATTEMPTS AT AERIAL INTERDICTION

"Isolation of the battlefield" is an important part of present U.S. strategy and there is already much activity to that end in Laos, as follows:

1. Barrel Roll. This encompasses operations over Northern Laos and is irrelevant for the present discussion.
2. Steel Tiger. Covers the entire Laotian Panhandle, including the area from Keo Nua (Napé) Pass south to Cambodia, and about half way from the Vietnam border to the Mekong. Steel Tiger, including armed reconnaissance missions, flew approximately 500 sorties/month in 1965, and has flown approximately 5000/month in 1966. Targets attacked are trucks, truck parks, bridges, ferries, houses, gun positions, supply depots, barges, and other water craft. The number of trucks destroyed was 46 in 1965, 421 in the first quarter in 1966. There have also been some attempts at road cratering with ordinary and delayed action bombs. The latter has been largely unsuccessful because of (i) bombing inaccuracy, (ii) speed of repair by the large number of road repair crews available, (iii) a depth/width ratio of craters that is too low to create real difficulty. We heard of some cases where craters are left unfilled, but are covered by temporary bridging at night, for deception. The presence of delayed-action bombs appears to be ignored by moving trucks.

There have been some night operations with flareships, but these have not been extensive enough for successful interdiction.

3. Cricket. The area covered is the route 911-route 23 complex from route 91 north to where 23 turns East-West. (See map 2) The technique is to use FAC planes (O-1's) operating in cooperation with ground watch teams, calling in strikes when targets are found. Strikes are made by Laotian Air Force T-28's; both patrol and strike will soon be (or have been) augmented by B-26's. The operation provides continuous cover over the Cricket area by day, and there have been attempts to do some of the same at night.

Cricket has been successful in stopping all daytime traffic, but it is unclear whether this is because of damage done, or simply as a matter of convenience for the North Vietnamese to avoid any losses at all. There is watching at night, but no bombing; truck and truck park locations are pin-pointed for daytime strikes wherever possible.

4. Tiger Hound. This is an operation overlapping the Steel Tiger area, but rather more constrained to the region adjacent to the South Vietnamese border. Strikes are made against installations (supply dumps, rest areas, etc.) that are first identified on photography and in some cases confirmed by helicopter--emplaced ground reconnaissance teams (in the Shining Brass area, approximately 50 Km long and 10 Km deep along the lower Laos-Vietnam border north from Cambodia). There are also sorties against the road system in the southern part of the Laotian Panhandle. Tiger Hound has destroyed about 1400 trucks thus far (mid-August 1966), largely in truck parks (trucks rarely move by day, and moving trucks have not, in general, been successfully found by hunter-killer flareship operations at night). We have been told that trucks ceased large-scale operations in the lower Panhandle during midsummer, 1966; this might be attributed as much to the onset of the rainy season as to the effects of interdiction. The Tiger Hound effort has, therefore, been shifted to the Tally Ho area.

5. Arc Light. This encompasses the B-52 strikes in South Vietnam. Some of these have also been used in Southern Laos just across the border in the Shining Brass area. They seem to have been largely ineffective in the interdiction role (two strikes observed later on the ground had missed the target area entirely). There have also been two strikes on the Mu Gia Pass, which closed the road only 18 to 48 hours.

6. Plane Losses in Laos. There were a total of 18 lost in 1965, and 20 in the first quarter of 1966, in Laos. In 1966, the loss rate is approximately 10^{-3} /sortie--quite low. At present there

is little anti-aircraft except at special locations such as Mu Gia Pass. FAC planes have been fairly safe until recently, when the AA in Laos seems to have been expanded.

7. Effect. Our understanding from the many briefings given our group is that the U.S. is not interfering appreciably with the infiltration of military personnel on foot or with the delivery of rice to the personnel trails. Truck travel in the daytime has been greatly reduced and some fraction of the trucks travelling at night are hit, but enough trucks are getting through to support the war.

The use of teams of men for observation, in combination with air strikes near the frontier of South Vietnam and Southern Laos under Shining Brass and Tiger Hound, seems to have been effective in discouraging the flow of men and supplies over the border in that area, and shifting it elsewhere. The question naturally arises whether a combination of ground teams and air operations should not be extended to cover the entire interdiction zone. It appears to us that if the Shining Brass/Tiger Hound type of operation were applied to the whole border of South Vietnam, the system would no doubt provoke vigorous penetration of the interdicted area. Moreover, an air-laid barrier depending on area denial, and teams of friendly people, cannot be used simultaneously in a given area. Given the rather short lives of the mines that would be used for area denial, the two techniques could be used alternately, or in complementary locations.

POLITICAL CONSTRAINTS

It is relevant at this point to mention the political constraints that exist with respect to operations against the infiltration routes.

1. Laos. Everything we do must satisfy the principle of deniability, to give the Soviet Union the opportunity to close its eyes to our operations. This is in the hope that some vestige of the 1962 Geneva Agreements will remain as a convenience to both

parties, preferable to an escalation of ground war into Laos. To this end, the North Vietnamese have never publicly admitted their infiltration operations in Laos, nor have we officially admitted the air or ground reconnaissance operations in all their scope.

2. Cambodia. Currently we cannot do anything about supply movement in Cambodia; we were told that our forces do not even take aerial photographs of Cambodian territory. Hence we must isolate Cambodia to prevent it from being used as an alternate infiltration region, if Laos can be successfully interdicted. How this can be done any more successfully than in Laos, in the presence of greater constraints is not clear. Perhaps the international inspection suggested by Cambodia offers an answer. But if it is ineffective, it could provide an even better "cover" for such supply operations.

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PART III - AIR-SUPPORTED ANTI-INFILTRATION BARRIER

The following is a preliminary concept for an air-supported barrier system designed to operate against the infiltration system previously described. It is designed to use early modifications of existing components. It should be stressed that what is described is simply what has been stated: a preliminary concept that can claim for itself only the virtues of indicating general feasibility and magnitude of effort. This concept appears to us to be a useful starting point for the design of a barrier system of sufficient sophistication to operate effectively, for a reasonable time, against the most obvious countermeasures the enemy can take.

The objective of the barrier as conceived herein is to place a significant obstacle to the North Vietnamese overland support for the war in the South. By "significant obstacle" we mean a great reduction in the numbers of men and amounts of supplies that can be infiltrated; with some high probability these must be insufficient for the enemy's needs. We assume that the enemy will take strong measures to overcome the barrier, and that given enough time he would be successful. Therefore the barrier should have the following continuing effects:

- a. in any case, men who do get through should have a much tougher time of it than they do now;
- b. changes in the infiltration system to overcome the barrier must impose severe logistic, military, economic, political, and morale penalties on the enemy; and
- c. changes the enemy may try to institute must take enough time to be detectable, so that the barrier can be modified to

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anticipate them, i.e., a dynamic "battle of the barrier" is undertaken in which we have the continuing initiative.

The system concept as described below is based on a projection of infiltration and supply rates that could exist at the time the barrier is installed. The size (and cost) of the system can vary in "modules" as the required extent of the system increases or decreases with these numbers; as will be seen, the system costs will vary roughly linearly as the number of modules, and hence ammunition use rate, expands or contracts. Also, it can be expected that if the system is successful, ammunition use rates will decline with time.

The overall system uses most elements in common. These are applied differently in two subsystems that cover the two essentially different areas: one designed to inhibit troop infiltration, and one designed to inhibit movement of vehicles containing supplies or troops.

Before the system is described, a number of points should be made. Even though the system that could be put together early is conceived to use "off the shelf" equipment, some changes need to be made even in that equipment. These will be pointed out. Also, various fairly obvious countermeasures can be used against the system itself (other than strategic countermeasures to evade it altogether, which are discussed in Part IV). The counter-countermeasures are implicit in the system design wherever possible. But some means will inevitably remain by which the system can be defeated, or at least made much more expensive or less effective. For this reason an "off the shelf" system is not worth installing unless specific follow-on improvements or new system developments are programmed at the same time.

The system as we conceive it is very simple in the sense that it has few components. A number of available sensors and weapons whose potential integration into the system has not been considered in detail might be added, at the expense of complication, but perhaps with increased effectiveness. This must be worked out in

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detailed engineering design. In addition, as a general matter, the air-supported barrier would not necessarily replace current efforts aimed at reducing infiltration and supply; it would most likely be added to them. Newly developed sensors and weapons, even if not now intended for explicit use in the barrier, might find such use as the barrier evolves. (See pp. 51-54)

SYSTEM DESCRIPTION

The basic design of the system is as follows:

With the munitions available, it must be assumed that air-sown anti-personnel mines can be swept from well-used roads and trails; and current bombing accuracy precludes air emplacement of anti-vehicle mines in roads with any reasonably high efficiency. Emplacement of anti-vehicle mines by ground teams can be done on a sporadic basis, but as a frequent and routine procedure the magnitude of ground force operations required would exceed the bounds of "deniability" (Part II, p. 25). The system must attack troop infiltration and vehicle movement equally and interchangeably because of potential interchangeability between the two on the part of the enemy.

Based on these considerations, a broad band of terrain, the wildest and least populated through which the troop infiltration routes pass, is selected for area denial. It is seeded with anti-personnel mines, in sufficient profusion and depth to deny penetration with high probability. This covers the area of alternate foot trails, and is intended to deny these alternatives to the enemy. An associated acoustic sensor system, continuously monitored, permits action against determined penetration attempts.

For the two well-used trail routes - those indicated by the intelligence reports, which we accept - and the roads, an acoustic sensor pattern, constantly monitored, is installed to detect, with high probability, movement of marching troop units and moving vehicles or convoys. (Acoustic sensors are selected for early availability and continuous, quasi-clandestine, all-weather, day and night

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performance without the need to see the targets, which are likely to be deliberately masked or hidden.) All detected targets are struck, using area-type weapons to account for uncertainty in target location and bombing accuracy. Target acquisition is by vectoring from the patrol (sensor-monitoring) aircraft, with some external navigation aid. Target acquisition is aided, where possible, by infrared sensors on the patrol aircraft, or the fighters' radar interacting with corner reflectors or beacons on the sensors.

The system is designed for probability $\ll 1$ of a small group penetrating the denied area; for probability ≈ 1 that all moving targets on roads or well-used trails are detected; and for ≈ 0.3 kill of the moving targets, on the presumption that the enemy will not continue to "run the gauntlet" at that price. All probabilities are for the basic system design in the absence of countermeasures.

A detailed description of the system must depend first on knowledge of the available components. These are described below. The system description follows, on p. 33 ff.

1. Major Components

a. Gravel mines. Standard Gravel mines, with sterilization components removed (XM-22 version), dispensed from XM-47 dispenser. There are three major uncertainties in the use of these weapons:

- Will they fall to the ground through rain-forest or jungle canopy? A well-designed experiment in equivalent terrain is needed to determine this. (We learned of one experiment in this area, performed in Panama, but were not certain that its results, alone, were convincing.)
- Will they survive about 30 days on the ground in the moist climate of the barrier area? This, too, can be tested by experiment. If they will not survive, a modification may be needed to insert a plastic liner permeable to the freon in which they are stored but much less permeable to water.

--Can they be dispersed with the proper density? The density inherent in the present technique is too high. Experimentation and perhaps further development is needed here, too.

Gravel mines should be colored approximately to blend with the predominant color of the trail (i.e., red clay; dried leaves) where they are used.*

b. Button Bomblets (XM-). A small charge (aspirin-size) designed to give a loud report when stepped on. Currently in limited production, but no dispenser available. It is assumed they can be made to be dispensed from the XM-47 Gravel dispenser. These are used to extend the range of the sensors with respect to detecting people walking on trails; and it is further assumed that they will be much harder to "sweep" than Gravel.

c. Acoustic Sonobuoy. Modification of the standard ASW Sonobuoy, currently being tested by the Navy. Modifications consist of replacement of the hydrophone with a microphone, and the use of standard dry-cell batteries. The microphone is at present designed to hear vehicles, and may need modification to respond to explosion pulses. It is dropped with a 7-foot parachute that hangs in treetops; it can be made to stick in the ground on a spike. Based on preliminary tests, the range is taken to be 2,000 feet for trucks, and is estimated at 200 feet for people stepping on the button bomblets. The transmission is triggered by noise, and the battery life two weeks under such usage. The battery life might be extended by the use of mercury batteries. The aircraft (below) has dispensing accuracy of about 100 foot CEP and has an "on-top" indicator; the transmitter can be heard

*Our group was aware of the Dragontooth mine as well. We judged that its shape might make it easier to see and sweep than the XM-22; and also, we were told that changes necessary for dispensing without explosion on impact might both accentuate sweepability and delay production. To the extent that these fears are not borne out, Dragontooth and Gravel could be considered interchangeably.

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at 25-30 miles. It will also be necessary to use an aluminized parachute, or to build a corner reflector onto the 'chute, to assist in target location by radar-equipped tactical fighters. A small transponder beacon can also serve this purpose. To be most useful, the transmitter should be equipped with a coding signal, and possibly a capability for extended (few minutes) broadcast of received sound pulses. The readout system (see Aircraft, below) should also be equipped with a visual indicator of active carrier broadcast, and with a direction indicator to show which Sonobuoy is broadcasting, when there are more than one on the same frequency.

d. S-2 Aircraft. This ASW carrier aircraft is equipped with readout system for 16 FM/VHF Sonobuoy channels; (the latter are being modified for 31 channels). It has 16 racks (wing or bomb bay) for 500-lb Gravel dispensers, and a 4-hour loiter time. Approximately 1,000 are in the inventory. It would also have to be equipped with downward-looking IR scanner to find cooking fires and warm vehicles. Or:

P-2 Aircraft. This is a Navy ASW patrol bomber of which approximately 100 are in storage. It would have to be refurbished, and equipped with a Sonobuoy readout system to permit reading about 100 sensors with code frequency separation in groups of 16 or 31 as available. It should also be equipped with an IR scanner, as above. It can loiter 12 hours, and has 16 wing racks which can carry 500 lb Gravel dispensers.

The speed of either aircraft while on patrol is 160 knots.

e. SADEYE (CBU-24) Bomblet Dispenser Weapon. Loaded with ~600 BLU-26B anti-personnel/anti-vehicle bomblet weapons. Weapon currently in production approaching 500-1000 per month; 750 lb weight with above loading.* Bomblets to be fused with time-delay fuse for canopy penetration (either existing 4-second

*Data on this weapon were obtained at NOTS/China Lake.

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delay fuse, or ARPA jungle-penetration fuse currently coming into production). Gives nominal circular pattern 800 feet in diameter (with a 400 foot "hole" at center) assuming cluster opening from appropriate altitude. Complete area coverage obtained by dropping in "sticks" with appropriate overlap; the "hole" can also be filled by degrading the spin on some of the bomblets in the cluster.

This weapon was selected as the "canonical" weapon for all attack applications in this system, on the basis that area coverage with high kill probability will be needed to compensate for uncertainties in target location; other CBU-type weapons do not have a large enough pattern for the desired efficiency, but are roughly equal in cost to the CBU-24 system.

f. Strike Aircraft. A-1 Aircraft can be used for attack or for dispensing Gravel or Button Bomblets. These can carry 8 XM-47 dispensers, or 9 SADEYES. F-4 Aircraft can also be used for attack and can carry 24 SADEYES if not limited by carrier catapult constraints.

Aircraft other than these can be used for strikes, with some variation of the number of sorties required. These were used as illustrative, and also because the other alternatives (F-100, F-105, A-4) were judged to be less available for various reasons, or of insufficient combat radius or load-carrying capacity. Of this set, only the A-1 can dispense Gravel, by virtue of its low speed.*

g. C-123 Aircraft. This would be more economical for dispensing Gravel and Button Bomblets, on the assumption that it could be equipped to carry 20 dispensers, either on wings or stacked to discharge at the rear-loading door of the cabin, within its payload capability.

*A high-speed Gravel dispenser is under development for the F-4C, but it is judged that the F-4C is too valuable an aircraft for use in the routine, continuous seeding operations envisaged for this system.

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h. Reconnaissance Aircraft. For continuous (possibly daily, but certainly weekly) photo-surveillance over the barrier area, with sufficient resolution (\approx 1 foot on the ground) to positively identify signs of the development of new roads and portage trails. This part of the system must include appropriately trained photo-interpreters familiar with the area and terrain. A U-2 aircraft, properly equipped, could cover the entire area (\approx 2500 square miles) in one sortie.

2. Anti-Troop Infiltration Barrier

This barrier is intended to cross the South Vietnam and Laos mountains, generally just south of the DMZ and extending westward into Laos (see map 3). It is assumed that the eastward extension into the coastal plain can be secured by a manned fence-and-mine barrier if necessary and desired; and that the westward extension through the Mekong Plain to Savannakhet will, for various political reasons, remain secured by Laotian army troops.* The area covered by this part of the air-supported barrier is essentially unpopulated.

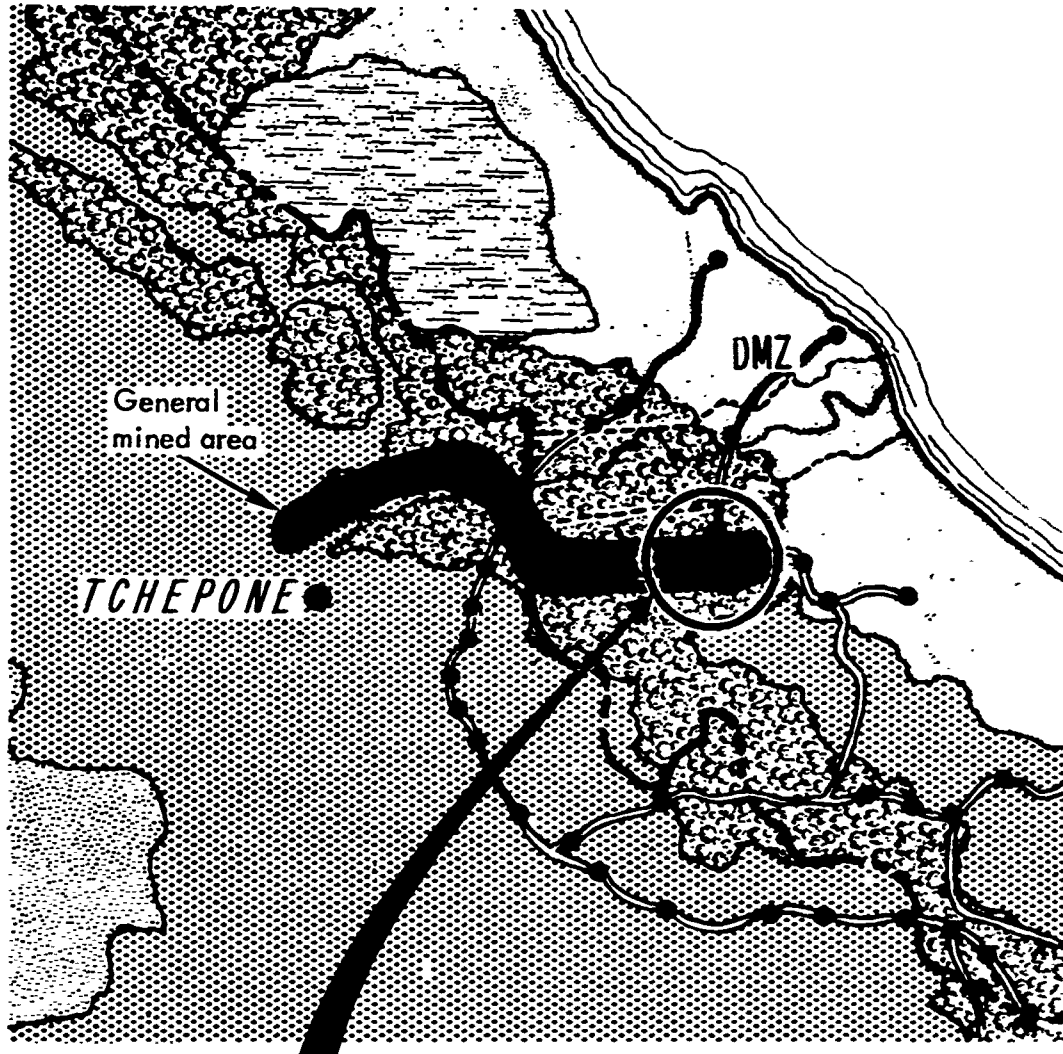
To plan the layout of this barrier in detail, an extensive survey of the trail configurations and dispositions through the narrow valleys is needed. Aerial photography and ground penetration would be required.

In the absence of precise knowledge of the ground, it must be assumed that Gravel can be seen and swept from the two main trail systems currently presumed to be in use. The barrier is therefore intended to prevent opening of new or currently unused trails (which will be overgrown) through different valleys. The two main trail systems are then to be kept clear by continual air strikes against detected moving groups, assumed to be of platoon size (40-50 men).

*A more extended discussion of the reasons for placing the barrier in this area is given in Part IV.

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Detail showing mined valleys and slopes (schematic)

MAP 3: Location of Mine-Field Part of Barrier

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The "denial" barrier consists of Gravel mines sown in the valleys and slopes along these two trail systems; the nominal depth (i.e., the most likely dimension of crossing) of sowing is $2\frac{1}{2}$ Km, but may be much longer if the terrain configuration causes the mines to be sown along the length of trails. Nominal $2\frac{1}{2}$ Km strips of Gravel are also to be sown on connecting and alternate valleys and slopes - it is assumed, based on preliminary map study, that about 20 valleys all told are covered, with a barrier having an equivalent length of 100 Km, equivalent width of 5 Km, half of the area covered by mines. The nominal density of mines is $5 \times 10^4 / \text{Km}^2$, giving a probability (P) of successful penetration of about $e^{-3.5}$.

In the same area, Button Bomblets are sown with a density of $10^5 / \text{Km}^2$, giving a P of successful noiseless penetration of about e^{-3} .

The mine and bomblet field are renewed every month, on the assumption that most of the mines that are non-self-sterilizing will last this long in the environment.

The mine field is also sown with sensors (acoustic Sonobuoys, throughout); 100 sensors for each 10 valleys, distributed to give an expected value of signals such that $P \approx 1$ of detecting someone trying to penetrate the sown area (by signal of mine explosion) within 2 days of patrolling, assuming a continuous attempt to penetrate a new area that has been seeded with mines, and assuming that signals are made only by penetrators stepping on mines.

The mine field is patrolled 24 hours per day by two P-2 aircraft (or equivalent in S-2's), one for each 10 valleys. If new attempts to penetrate or newly opened trails are found, the strike tactics, below, are applied.

For trails that are heavily used, the tactic is to find where groups of the enemy are walking, or make a strike against them, designed for kill probability within the group (P_K) = 0.3, as follows:

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On a 20 Km stretch of trail or network of trail passing through the mined area, presumed known within a 1 Km wide strip, sow 100 sensors in 17 strips of 5 or 6 across the 1 Km width, the strips to be 1.2 Km apart along the length. (See diagram.) This group of 100 is patrolled at all times by one P-2 aircraft (or equivalent S-2's); $P \approx 1$ that a marching platoon will be discovered before it traverses the 20 Km length, and can be isolated within an area ≈ 1.2 Km long and ≈ 0.4 Km wide (3 sensor-spacings across). The P-2 patrol aircraft drops Gravel to pin the marching group (density determined by the load carried and expected number of contacts per day), and calls in a strike. The half-square kilometer area within which the group is known to be is covered by SADEYE weapons in a pattern designed to give $P_K = 0.3$. As an alternate use in this part of the system, the IR scanners could give location of overnight bivouac areas, which can also be struck in the same manner. The assumed average number of strikes/day on which sortie and munitions requirements are based includes those on the trails or bivouac areas.*

Navigation to weapon release is accomplished by flying the strike aircraft to the patrol aircraft, thence to vectored coordinates given by the patrol aircraft based on its knowledge of sensor location (sensors are planted by patrol aircraft within a few hundred feet and can have their locations confirmed by aerial photography). By day the strike area is defined by visible sensor chutes in treetops and by a smoke marker dropped by the patrol aircraft; by night, it is defined by coordinates marked by either a flare marker, or smoke used in conjunction with flares, aided, if possible, by radar returns from the aluminized chutes, beacons, or corner reflectors.

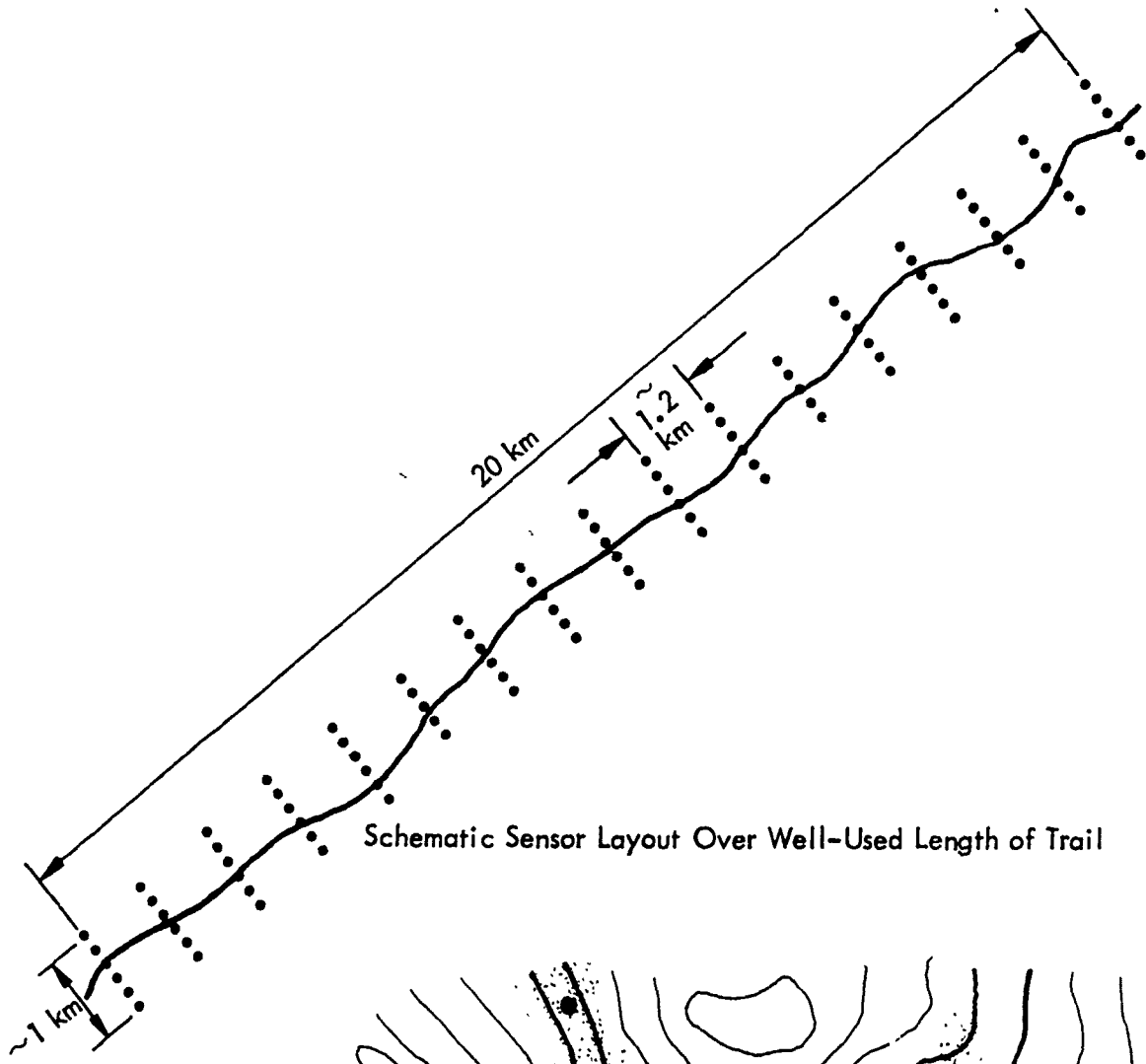
Based on a movement of 7,000 men/month, an average of six contacts/day with platoon-sized groups may be expected on the average. We assume that the strike system works on two 20 Km x 1 Km trail lengths simultaneously, requiring two patrol aircraft in the air all the time.

*Note: Patterns of explosions, rather than single signals, are needed to trigger a strike.

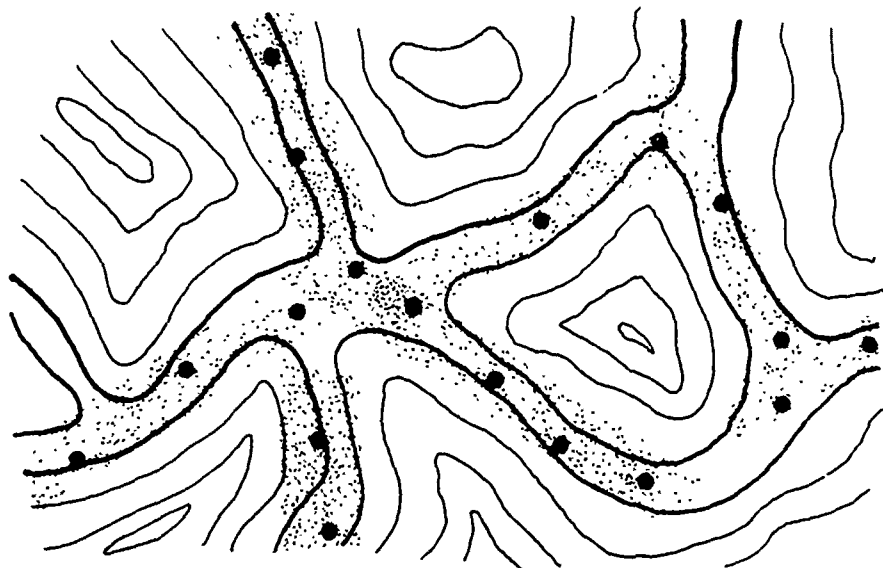
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Schematic Sensor Layout Over Well-Used Length of Trail



Typical Sensor Allocation in Mined Valleys

Schematic of Sensor Layouts on Personnel Trails and Barrier Areas

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Possible countermeasures to this system include:*

- a. Spread men out and march as individuals. This reduces the vulnerability to air strikes, but greatly reduces the probability of penetration, and makes guiding and enforcement of political and military discipline difficult. It may therefore slow down infiltration rate. On the other hand, once it is known that areas adjacent to the trails are mined, defection becomes less probable, so that spreading out becomes more feasible.
- b. March groups of porters ahead of military groups. This would make "sweeping" easier; but would not defeat the strike system. It is likely to cause porters (local tribesmen) to flee the area, thereby making recruitment of porters more difficult.
- c. Use decoy corner reflectors in treetops. This could be done; it would be difficult for individuals to penetrate seeded areas safely, for this purpose.
- d. Move and re-use Sonobuoys. It is likely to be difficult to get enough of them to reproduce a shifted pattern. This also suffers the difficulty of (c) above.
- e. Move at night. This is more dangerous for the North Vietnamese, since Gravel is then harder to sweep. It may not affect the strike system appreciably.
- f. Extend a bamboo "bridge" in sections along the trail. This could work until detected by aerial photography and attacked by the strike system. Activity could be picked up by sensors - but their range is uncertain.
- g. Spoof the system by continually firing (e.g., mortar) into the mine field. This is probably hard to do convincingly

*Potential changes in the system to help obviate these countermeasures are discussed on pp. 48-54.

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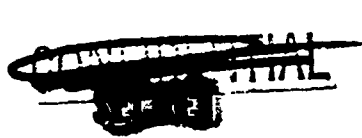
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over the whole field for a protracted period, and the sensors may distinguish firing from mine explosions. However if successful, this could run the number of strikes up beyond support, depending on the criterion to trigger strikes. We would need, for example, aerial photography to show new trails developing, in the absence of reliable sensor information.

- h. Dig foxholes at frequent intervals along interdicted trails to reduce munition effectiveness. However the interdiction zone can be shifted somewhat; since the extent of it is not known to the enemy. In addition this countermeasure can eventually be partially overcome by appropriate bomblet fuzing.
- i. Relocate mines. This is theoretically possible, especially over short distances, by carefully soaking them in gasoline. We are convinced, however, that this would be both a dangerous and unprofitable operation over the distance from the barrier to friendly forces. It would be very difficult if the moisture resistance of the mines were increased. Moreover, the Viet Cong have demonstrated a local mining capability that seems to serve them adequately.
- j. It may prove possible to sweep the Button Bomblets, in which case the sensors are likely not to work against the personnel infiltration trails. For this reason every effort should be made to improve the sensor so that this system component becomes less essential (see p. 49, below).
- k. Infiltrators can try to run a few tens of meters off the trail and take cover when they hear aircraft approaching. Therefore the areas adjacent to the well-used trails must be seeded even more heavily than the basic denied area; seeding by the patrol aircraft when a contact is made is also designed to help meet this problem.

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Summary of Requirements for This Part of the System

1. Fleet of 34 P-2 aircraft to keep four on station 24 hours per day (or, 72 S-2's).
2. Fleet of 45 A-1's with ≈ 1400 sorties/month to sow Gravel and Button Bomblets, or fleet of 18 C-123's with ≈ 550 sorties/month for same purpose. (Field sown in two weeks; renewed every 30 days.)
3. 13×10^6 Gravel Mines/month with appropriate dispensers.
4. 25×10^6 Button Bomblets/month.*
5. 800 Acoustic Sonobuoys/month (assuming 2-week battery life).
6. 3,250 SADEYE/BLU-26/month.
7. Fleet of nine A-1's with 360 sorties/month, or 3-6 F-4C's with 180 sorties/month, for strikes.

Total cost \approx \$28 million/month or \approx \$340 million/year of which \approx \$25 million/month is in Gravel and SADEYES.**

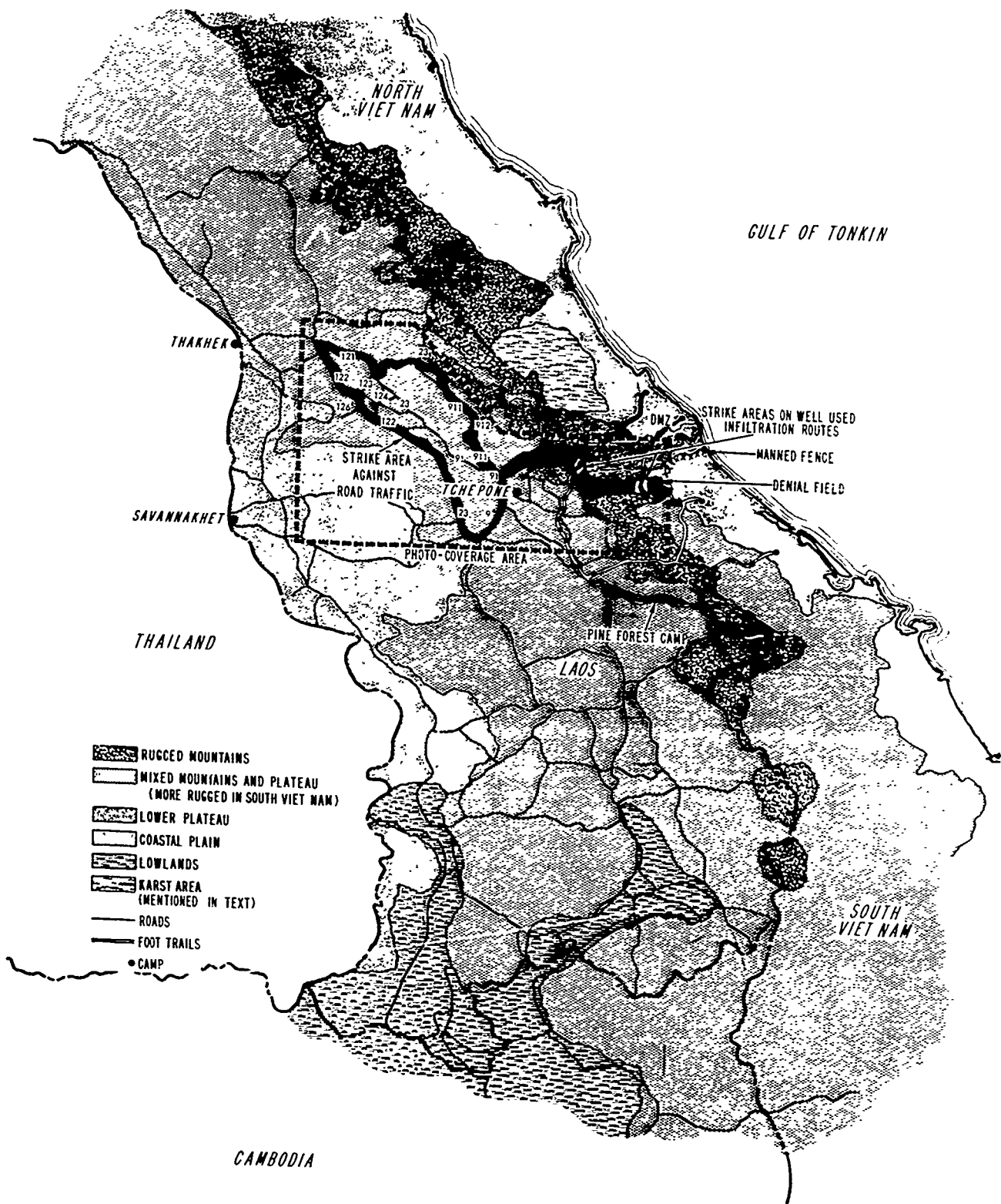
3. Anti-Vehicle Infiltration Barrier

This is generally applied in the road area bounded by Routes 121, 911, 122/23, 9 (See map 4). This is the narrow "waist" of the road system, constrained by the terrain so there are relatively few alternate routes. It is a stretch 120 Km long and 30 Km wide, which has

*This requirement was initially obtained on the basis of seeding the denied area uniformly with a density of $10^5/\text{Km}^2$. It may be argued, correctly, that the system design calls for seeding only on the well-used trail routes. However, the uncertainty in canopy penetration and sweepability is so great that the larger amount has been carried to account for the likely "efficiency factor." The effect on cost is negligible, although the production quantities can become important.

**We are indebted to Mr. Murray Kamrass and Dr. W. Scott Payne, of IDA/RESD, for gathering much of the background information on costs and sortie capability that made these estimates, and those on p. 46, possible.





MAP 4: Barrier Layout

critical intersections at the northern and southern ends, with relatively few alternate north-south water routes. It is the portion of the road system where Operation Cricket is currently in effect in the daytime.

Again, accurate surveys of the area are needed, to enable patrol aircraft to locate the roads and to find point coordinates accurately.

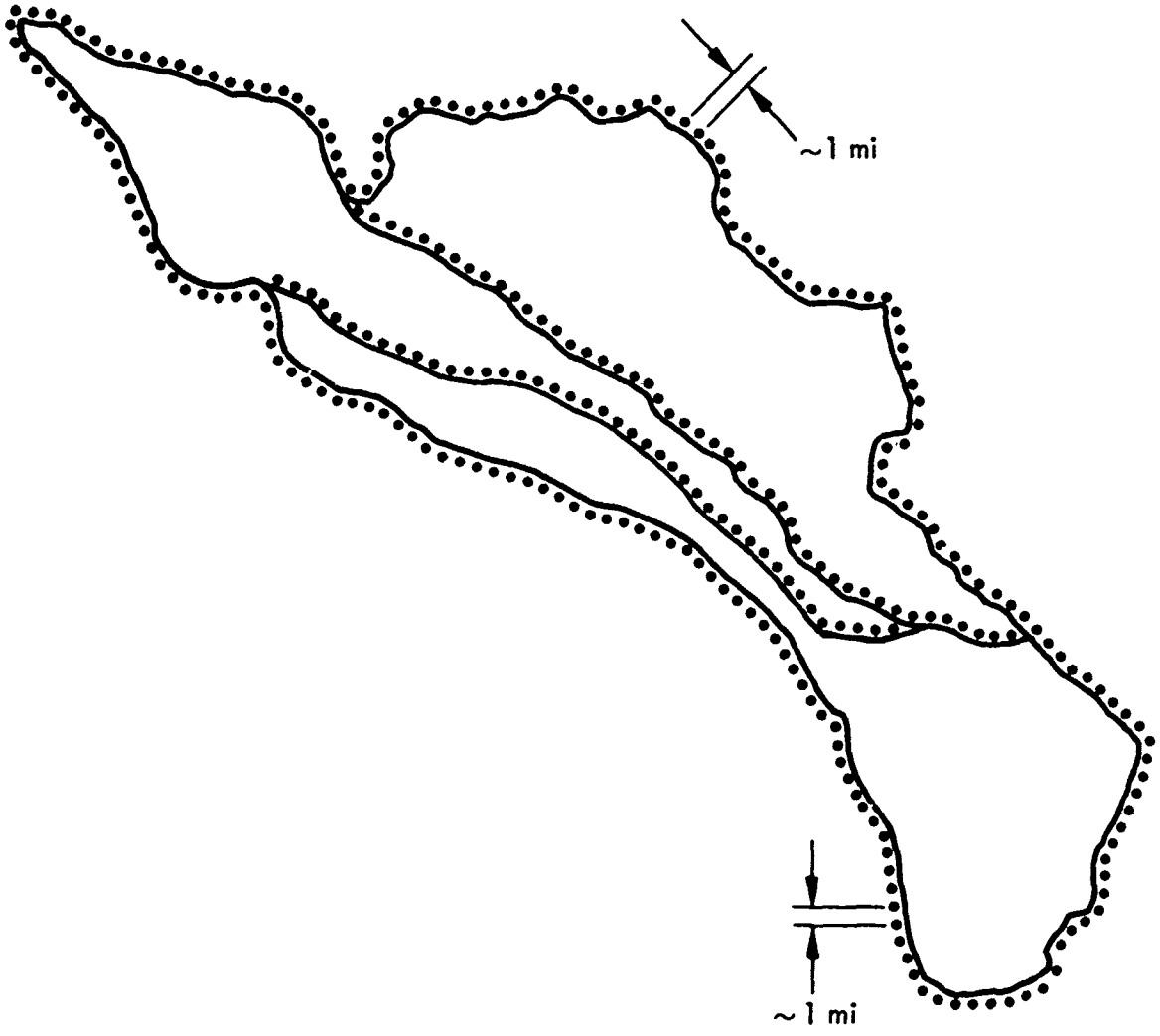
For purposes of estimating system requirements it is assumed that this road net is the equivalent of 4-130 Km stretches of main road. Each of these is patrolled by one P-2, in the air 24 hours/day (or equivalent S-2's). Each length of main road is seeded with sensors approximately one mile apart (on the average), $\approx 1,000'$ offset from the road (see diagram). This gives $P = 1$ of finding a truck or convoy on the road, and (if sensor location along the road is known within a few hundred feet) locating the convoy within a Km. (The nominal convoy is assumed to have 10 trucks over a 2,000 foot length.)

When a truck or convoy is found, a strike is called in, as for the troop trails. Navigation and target location are performed in the same way; it may be found that the addition of the CODAR noise-source location system to the Sonobuoy readout is desirable for more precise target location; appropriate IR scanners in the patrol aircraft, as for the anti-personnel system, may help find warm trucks more precisely.

As an added effect, each patrol aircraft sows Gravel along a stretch of road at last light; the location is random, the purpose is for harassment, slowing down the progression of convoys and making it difficult for people to leave the trucks, especially if they turn off the road. The XM-47 Gravel, which sterilizes in 24 hours may be used here, to maintain access for ground teams.

The size and number of strikes depends on the number and size of convoys moving, on target location error, and desired P_K . For purpose of estimate, it is assumed that the number of convoys moving is roughly that required by the average of low and high estimates of

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Schematic of Sensor Layout in Anti-Vehicle Area

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supply movement. That is, the daily movement of nine convoys, 10 trucks each, 2 tons/truck, gives 180 tons/day, requiring nine strikes per day on the whole road system. It is assumed, also, that F-4C's are used because of their large store carriage (24-750 lb SADEYES), rapid response, and radar to acquire sensor locations for offset bombing.

One load of 24 SADEYES will destroy the 10-truck convoy, with $P_K \approx .4$, if CEP = 1,000 feet (assuming appropriate tactics of number of passes and clusters/pass). Bombing is done to coordinates and vectoring by the patrol aircraft, using sensor location as for the trail strike system, with area coverage. The individual trucks are assumed not in view. The figure of one sortie/10 trucks holds for convoys of various sizes, assuming a minimum of 3-4 trucks/convoy over a 200 meter length. Within this constraint, the number of sorties required goes linearly with the number of tons moving per day.

Another essential part of the system requires frequent (daily to weekly) photo-reconnaissance over the barrier area (say, 2,500 square miles), with immediate interpretation of each day's "take" to determine when secondary roads and trails are being expanded to become main motorable roads. Effort is shifted to the new routes as appropriate. This is estimated to require (for example) a single U-2 for weekly operation, and a crew of about 10 photo interpreters. The latter must be of first quality, well trained, and familiar with their assigned terrain areas. This is likely to be one of the most difficult requirements to meet in the entire system.

As a further development of the tactics, one can decrease effort over the initial target area after it is known to be successfully interdicted, and extend concentrated effort north and south along the road net, thereby attempting to close the whole road system. This will add cost, which may be taken to increase somewhat with added 130 Km road "modules" for patrolling, and almost directly with the number of strikes (since SADEYES are the largest cost item).

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Possible countermeasures are:

- a. Do not run trucks in convoy, but send them through singly at intervals. This may not stop the system from working, but can make it much more expensive by requiring many more strikes, which would be made against individual vehicles with less certain location. This tactic also permits running a truck up and down the roads to confuse the system. Again, this could add to the cost, but a convoy moving at the same time should be distinguishable from a single truck. Not many single trucks may get through, since the strike against one truck will have $P_k \approx 1$.
- b. Use decoy corner reflectors and sensors. This faces the same considerations as for troop-trail system.
- c. Open new main roads. Counter-countermeasures are implicit in the photo-coverage part of the system.
- d. Take to A-frames and bicycles over trails, exclusively. This would make the job much more difficult for the PAVN, but it could be done. It would require extension of the anti-troop infiltration barrier to the supply system, perhaps at great expense if the area covered and trail alternatives are sufficiently large. It would take the enemy some unknown time to abandon the existing system and shift to a portage system. But there appears to be little doubt that, if necessary, he could do it.
- e. The system may be inhibited in bad weather, because of the difficulty of weapon delivery. But so too would truck travel, and mine sweeping.
- f. Move extensive anti-aircraft into the area, including radar-directed guns against the patrol and strike aircraft. There is inherent difficulty in covering large sections of road, and patrol aircraft can stand off. But flak-traps could be set up, using spoofed sensors as bait. This is probably

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the most effective potential countermeasure, and means to defeat it need much more thought. Addition of flak-suppression sorties, and strike aircraft losses, would run up the real costs of the system. (See discussion of future system growth, pp. 51-54.)

- g. If sensors can be found, they can be "jammed" by running stationary-truck engines near them. Other sensors would then be needed. But it would appear at first glance hard to find the entire sensor array; and operating hundreds of truck engines all day long would not be easy. The problem would become one of separating a true signal array from a false one, presenting an information processing problem of some difficulty.

Summary of Requirements for This Part of the System

1. Fleet of 34 P-2 aircraft to keep four on station 24 hours (or, 72 S-2's).
2. 5×10^6 Gravel mines/month (XM-47-type).
3. 800 Acoustic-Sonobuoys/month.
4. 6,500 SADEYE/BLU-26B/month.*
5. Fleet of 5-10 F-4C aircraft with 270* F-4C sorties/month, for strikes.
6. 1-3 U-2's, for 4-30 sorties/month (as an example of a reconnaissance aircraft).
7. 10-40 PI's for daily interpretation of photography.

*Could become 2,160 SADEYES and 90 sorties, if 30 tons/day move; or 10,800 SADEYES and 450 sorties/month if 300 tons/day move. Although such numbers are given as a continuing average, they should obviously decrease if the system works. Sensor and patrol costs would remain fixed, however.

Note also that the achievement of equivalent results with standard 750 lb bombs would, for the mean value assumed, require about 200 times more bombs and 200 times more sorties (on the basis of ≈ 1 sortie/convoy with SADEYE, and 750 lb bomb covering $\approx 1/200$ the area of a SADEYE with equivalent P_K).

SUMMARY OF SYSTEM REQUIREMENTS

Item	No./Mo. Anti-Troop Sub-System	No./Mo. Anti-Vehicle Sub-System	No. of A/C in Fleet		Sorties/Mo.		Cost/Mo. \$ x 10 ⁶ Anti-Troop Sub-System	Cost/Mo. \$ x 10 ⁶ Anti-Vehicle Sub-System
			Anti-Troop	Anti-Vehicle	Anti-Troop	Anti-Vehicle		
Gravel Non-Sterilizing	13x10 ⁶						13	
Button Bomblets	25x10 ⁶						.25 ^a	
Gravel Self-Sterilizing		5x10 ⁶						5
Sensors	800	800					.2	.2
F-2 A/C or S-2 A/C			34 or 72	34 or 72	240 or 720	240 or 720	1.1 or 1.25	1.1 or 1.25
SADEYE (BLU-26)	3240						13	
SADEYE (BLU-26B)		6500 ^b						26
A-1 A/C or C-123 A/C	} For Gravel and Button Bomblets		45 or 18		1350 or 530		.6 or .25	
A-1 A/C or F-4 A/C		} For Strike		9 or 3		360 or 180		.2 or .13
F-4 A/C	} For Strike			5 ^b		270 ^b		.4
U-2 A/C ^c				3 ^d		30 ^d		.3
PI's		50 ^d						.1
TOTAL COSTS ^e							23x10 ⁶ /mo 340x10 ⁶ /yr	33x10 ⁶ /mo 400x10 ⁶ /yr

^a Assumed.
^b Based on assumed tonnage of supplies moved; could increase by factor of 1.67 or decrease by factor of 3. See text.
^c If these are selected.
^d If daily coverage; 10 PI's and 4 sorties if weekly coverage.
^e Approximate; variations introduced by using various A/C alternatives are on the order of 3%.

4. Development Requirements

The cost summary, above, is limited to the operating cost of the "immediate" system, once installed. It does not include costs of the necessary initial developments or aircraft modifications, or expansion of production facilities. We had no opportunity, in the time available, to investigate these potential "sunk costs."

The following discussion summarizes the urgent development requirements for the "immediate" or first-phase system that would emerge from the incompletely conceived system structure described above. The types of system components that should be developed for future phases of the system are then listed briefly.

Immediate System

Infiltration System. Accurate and detailed surveys and description of the enemy infiltration system, and the terrain it moves through, are needed - especially concentrating on the regions where the barrier is to be installed. This calls for an immediate and extensive review of all available data, and intensified intelligence efforts to fill the gaps - including ground penetration if necessary.

Gravel. Preparation is required for production of both the XM-22 (non-sterilizing) and XM-47 (self-sterilizing) Gravel mines, in the quantities called for. This production will (according to discussions with Picatinny Arsenal) be limited by facilities for producing lead azide, requiring activation of additional explosives plants. Using data from the above intelligence surveys, it will be necessary to change the color of the cloth appropriately. Tests of "sweepability" on appropriate terrain analogues are required, to anticipate likely area deniability in the presence of active attempted countermeasures. Experiments to determine canopy penetration and active life of the XM-22 in a moist environment will be necessary; these may have to be followed by appropriate modifications. Especially,

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control of active life may have to be adjustable, so that if production cannot reach the desired level early enough, the quantities required can be reduced by building an appropriate backlog of long-lived mines and seeding less frequently. Experiments in aerial dispensing are also required, to develop the tactics (altitude, speed, and flight path) for dispersion with the desired density. It may be found necessary to modify the XM-47 dispenser to control dispersion pattern by controlling the velocity of the ejector piston, and to make other adjustments (to the mine or dispenser) leading to greater lateral dispersion than is now obtained (30 m. currently).

Button Bomblets. Production facilities for the requisite number must be established. A dispensing capability must be developed, hopefully capitalizing on the XM-47 Gravel dispenser. As with Gravel, experimental attention must be given to dispersion pattern, moisture resistance, canopy penetrability (which is likely to be less than for Gravel), and sweepability. Appropriate "fixes" may be required. It may be found desirable to increase the size somewhat. It should be noted, also, that the Button Bomblet requirement interacts with that for sensor development, in that if the sensor can be appropriately designed (see below) the need for the Button Bomblets could conceivably be obviated.

C-123. Although the system cost is not affected appreciably by alternative use of A-1 or C-123 aircraft for Gravel and Button Bomblet dispensing, the numbers of either aircraft required could become important. Therefore an attempt to fix the C-123 aircraft to perform this task (if it cannot already do so) is warranted.

Sensor/Patrol Aircraft Subsystem. The sensor package must be designed and tested for delivery accuracy desired, in terms of delivery altitude, and for ability to rest in treetops or on a spike in the ground. Presumably, it can be camouflaged somewhat to make it more difficult to detect than a pure aluminum

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container. Battery life needs to be extended, and presumably can be done with mercury batteries. The microphone may need to be modified to be able to hear either vehicles or the mine explosions, but exclude background noise such as birds. (There should be noise measurements in the area of interest.) An attempt should be made to see whether sufficient range to detect walking groups without the Button Bomblet explosions can be achieved. Rebroadcast of detected signals should, if possible, have a coded identifier, and also the ability for delayed, on-call, or repeated rebroadcast for some period of minutes. A simple guard against jamming on a given frequency by a captured sensor would be desirable. The readout system in the aircraft (with 16 or 31 frequencies) should have a directional as well as "on-top" indicator, permitting variation of the pattern by code, location, and frequency, to make spoofing difficult. Dial indicators with push-button listening activation are needed to show when particular Sonobuoys are broadcasting; the CODAR acoustic location computing system should be attached in case of ultimate need. A tape to permit repetitive listening to one signal, and some form of plotting board with map overlay are needed. For target location, the parachute should have a corner reflector installed, and/or a small (UHF) transponder beacon on appropriate frequency. Smoke and flare marker as well as area parachute flares are needed on the aircraft. The top of the sensor parachute should be visible to aerial (color) photography, from the canopy top.

SADEYE/BLU-26B. Production in appropriate quantities needs to be prepared. A jungle-canopy penetration (delay) fuze should be installed in the BLU-26B bomblet. Some (to be determined) number of bomblet fins should be degraded in manufacture to permit filling some of the "hole" in the pattern while not degrading spin arming of the fuze (if possible - needs experimentation). Experiments are needed to determine the degradation due to vegetation, so that appropriate production numbers can be

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established. Alternative bomblets might be desirable (according to NOTS, a bomblet-only version of the DENEYE II tripwire mine, or a BLU-26 with modified casing, would each give a better particle size and pattern for higher effectiveness area, especially in the presence of vegetation, and would be obtainable in less than a year of concerted effort).

Reconnaissance Subsystem. An appropriate aircraft-camera combination, able to see the necessary detail of trail and portage systems developing on the ground, must be made available. The U-2 would have the advantage of covering the required area in one sortie, and would not be detectable, but other systems could serve the purpose. Most important, a training program for the required number of photo-interpreters must be instituted.

Attack Subsystem. Appropriate communications and navigation tie-ins must be made to permit the patrol aircraft to vector the attack aircraft to acquire an identification point, (perhaps one of the sensor reflectors or beacons, for offset bombing approach to the target). Smoke and flare markers may need improvement to assure hanging in the treetops. A considerable amount of field experimentation would be needed to perfect these tactics. It is also possible that experimentation would be required to refine the tactics of SADEYE delivery over mountainous terrain at night and in bad weather, to assure against bomblet pattern degradation.

Future System

Although each of the countermeasures listed earlier can, in theory, by itself defeat all or part of the barrier system described herein, the degree to which any of them can or will be used to degrade the entire system after it is refined by the above developments is certainly open to argument. In our view the argument boils down to the time that it will take to make some combination of countermeasures effective against the entire system rather than to whether or not

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individual countermeasures will be taken or will work. It is necessary, therefore, to plan a dynamically changing system that poses new problems before developing countermeasures can become completely effective. Some or all, and more that we have not considered, of the following new weapons and subsystems are or can be under development to provide this dynamic evolution of the barrier system, in steps, within a reasonable time after it is installed.

Improved Anti-Personnel Mines. New versions of Gravel (or the functionally similar Dragontooth), with better disguise, better controlled life, anti-disturbance features, and perhaps some fragmentation, may be possible and are certainly desirable. Development and use of the forthcoming tripwire mines in combination with Gravel/Dragontooth would make an area-denial mine field much harder to penetrate or sweep. New types of hard-to-sweep anti-personnel mines might be developed for use on cleared earth areas.

Anti-Vehicle Mines. Ability to implant influence-fuzed mines in roads and railroads from the air much more accurately than is now possible would make extensive road denial by aerial mining feasible. Possibilities that come to mind are adaptations of WALLEYE, and mine warheads for BULLPUP. Although at first glance such weapons would appear expensive relative to unguided weapons, they would appear to become cost-effective when compared with the number of free-fall weapons wasted when dropped with 200-300 foot CEP against linear targets.

Other Weapon Developments. A family of fuzes is needed (and some are under development) to give much better control of bomb-let burst height for penetration of 2- or 3-level canopies, and for more efficient kill against entrenched personnel and vehicles. Development of the BLU-26 cluster warhead for stand-off BULLPUP will permit safer flak suppression. Use of toss-bombing techniques with SADEYE (now possible with the A-4) can be extended to other aircraft, and would be indicated also for flak-avoidance

when improved target acquisition techniques (below) are available. Bomblets optimized for vegetation penetration by fragments would also be important.

Sensor/Attack Systems. It appears to us possible to develop a much more sophisticated sensor capability than the one described for the immediate barrier. In addition to the long-term developments possible with the acoustic sensor (continuing in the directions outlined for the immediate system, above), the use of broadcasting seismic sensors (a combination of both air- and ground-emplaced) with long battery life would give a measure of diversity against spoofing. A sensor coding and readout system (for appropriate numbers of sensors) should be developed on the basis that sporadic or sectional sensor relocation, spoofing, and jamming will occur. The system should, by information processing/pattern-recognition techniques, elicit the enemy operation pattern from the noise or distorted signal pattern he or natural events may create. This readout system might be installed in the patrol aircraft, but that aircraft could also act simply as a relay, with data processing performed at some remote station on the ground where necessary computer capacity could be available. The patrol aircraft could still be used to vector strikes, or the target location information could be used to aim a NIKE-HERCULES/BLU-26B SSM combination - relative cost/effectiveness of the two techniques needs to be explored. Installation of LORAN-D in Southeast Asia will assist in the navigation and sensor-plus-target location problem, making the vectoring of strikes with toss-bombing, or use of NIKE-HERCULES, easier and more accurate. For target acquisition by strike aircraft, the current developments of improved forward looking radar with MTI; Forward Looking Infrared Scanners, and Low Light-Level TV, under the Air Force's Project SHEDLIGHT, the Navy's Project TRIM, and the Army's PROVOST-MOHAWK, will be useful. It is clear, also, that with such developments, the patrol aircraft, currently the most vulnerable element of the

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system to flak, need not approach close to the target area, and therefore should not be vulnerable to flak traps. (Presumably, if SA-2 sites appear in the barrier area, they can be attacked (i) as currently in North Vietnam or (ii) by seeding unoccupied site areas with sensors and Gravel-type mines and attacking them, as any other part of the infiltration system, when they are occupied.)

Finally, the use of laser-scanner night photography, currently in development, should improve our ability to learn what the enemy is doing to diversify his system.

The addition of all the above elements, and others not mentioned or not yet conceived, to the barrier system, over a period of time that may be several years, would appear to increase the operating cost of the barrier system. This potential increase will be balanced, in some degree that we have not calculated, by increased efficiency in weapon delivery, sensor life, and anti-personnel mine life, requiring fewer of the items that represent the bulk of system cost. In addition, if the barrier continues to be successful, the weapons used for strikes should decrease markedly, leaving the sensor/patrol aircraft and area denial mine field as the major cost items.

System Implementation

A final remark about the implementation of such a system seems in order, although it is perhaps self-evident. The individual items of equipment must be drawn from current development efforts of all the Services. Integrating them into a system will require combined developments and multi-component experimentation on a fairly large scale. Such an effort would have difficulty proceeding in several organizations independently, with assurance that high priority will be uniformly assigned; that they will all meet the necessary time schedules; and that the flow from individual component developments to integration and testing of component combinations, to production and system implementation, can be performed on the relatively short

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time scale that the strategic condition of the war demands. We therefore urge that, if the air-supported barrier idea is to be implemented, this be done on the basis of central direction of a tri-Service effort.

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PART IV - SOME ADDITIONAL STRATEGIC CONSIDERATIONS IN EMPLOYMENT OF THE AIR-SUPPORTED BARRIER

In this part we discuss in somewhat greater detail than could be given in the Introduction, the reasons for and against various locations that were suggested for the air-supported barrier. We then explore some strategic problems associated with it, including that of knowing whether the barrier is successful, and the options open to the North Vietnamese if it does work.

LOCATION OF THE AIR-SUPPORTED BARRIER

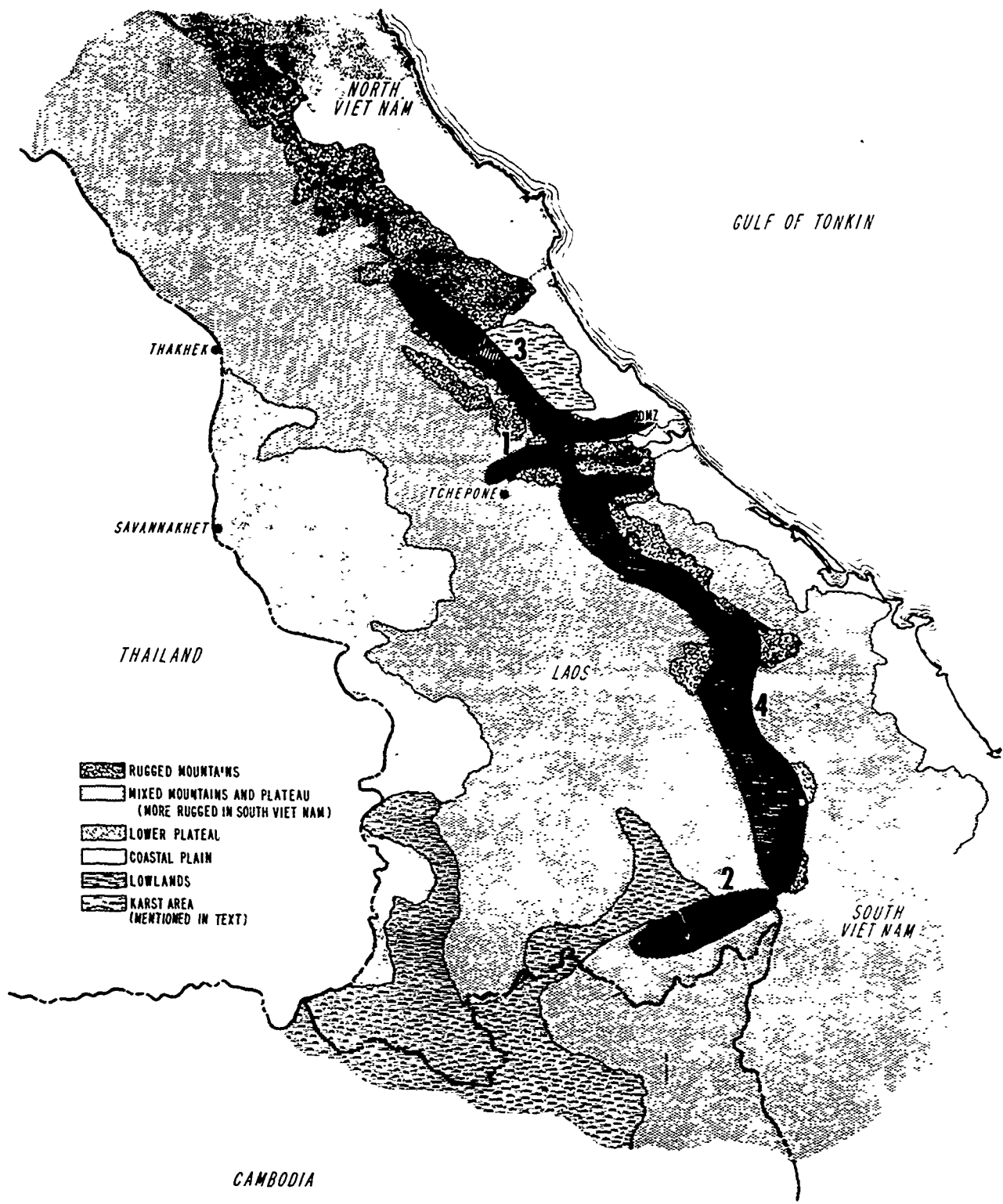
A barrier system such as described in the previous section can be used in a number of areas. We considered several, and weighed their advantages and disadvantages as described below. (See map 5)

1. Generally follow North to route 9 from the foothills in South Vietnam to roughly the area of Muong Phine. The advantages of this route are that it is generally the shortest barrier region of those considered; there is little indigenous population; it cuts the infiltration routes high enough in the system to insulate all of South Vietnam from the Laotian corridor (assuming the sanctity of the Laotian Mekong Plain); and it meshes into the southern part of the preferred truck interdiction region (Cricket area). Its disadvantages are, the difficulty of deniability of such a large system in Laos; it splits Laos in two; it encourages North Vietnam to move into the Mekong Plain to bypass the barrier.

2. Follow across route 16 from The Plateau des Bolovens east to the South Vietnam border. Advantages of this location are its short length, and its isolation of Cambodia from North Vietnam supply routes in Laos if the barrier higher up doesn't altogether stop traffic. It cuts the rice supply route from Cambodia through Laos to South Vietnam's

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MAP 5: Possible Locations for Denial Area

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Highlands. Its disadvantages include leaving the South Vietnam-Laos border open for the entire stretch north of the barrier. That stretch is too long for the barrier to be economically emplaced; therefore, the interdiction problem for that area would not have been solved.

3. Along the DMZ to Laos (perhaps on the Northern edge); then North along the North Vietnam-Laos border beyond the Napé Pass. Advantages are, this takes advantage of the terrain, because few passes exist across the Annamite chain; there is virtually no indigenous population; and it keeps all of Laos on our side of the barrier. Its disadvantages are, length; distance from bases in South Vietnam would make backup by ground teams more difficult; if it were concentrated on the passes, a way could be found (for foot traffic at least) to cross the Cordillera directly; it could be bypassed in the North of Laos, leaving all of the current system in Laos open, without posing political problems for the North Vietnamese; and it is much better situated for them to marshal resources into countermeasures.

4. Along the DMZ to Laos; then South along South Vietnam-Laos border. The advantages are, ease of access by our forces; the area is relatively unpopulated; it does not split Laos in two. The disadvantages are, its length; it does not take advantage of the terrain very well--there are many crossing points, in terrain that is not too difficult and already has a vast multiplicity of well-used trails.

On balance we have concluded that location (4) seems least valuable and most difficult. We prefer locations (1) or (3), perhaps supplemented by (2). Location (2) by itself doesn't seem complete enough. Placing the barrier in location (3) is more difficult than location (1), but the advantage of having all of Laos on our side of the barrier is considerable. However, it was indicated that there may soon be as many as 8 truckable routes across the Annamite chain. The North Vietnamese can easily defend these routes if they wish, as shown by their defense of Mu Gia Pass. If truckable routes can cross the mountains, then foot trails can, even more easily, and it is at least possible that it is already too late to place the barrier in location (3). Location (1) would seem to take better advantage of the current

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situation of the infiltration system, with the main disadvantage being its existence in Laos. But that part of Laos is under North Vietnamese control already, so this would not seem to be too great a loss unless we hope to take action to recover that area later.

From all these considerations we concluded that location (1) would be best for the type of barrier concept we are talking about. It must be pointed out, however, that in the time available, we did not give extensive attention to the problems of the passes, which may constitute genuine choke areas worthy of added effort. An analysis of that problem should be part of any later barrier effort.

MONITORING THE BARRIER'S PERFORMANCE

If the barrier works, then it will have achieved an important objective: sealing off the battlefield from outside support. Assuming for the moment that the North Vietnamese do not decide immediately to open a wholly new strategic route (as discussed below), the strategic situation of the war will have been changed in our favor. This advantage could be transitory--until the communists figure out what they wish to do, and take action accordingly--and therefore it would be important for us to know early that the barrier is working so that our own strategy can be suited to the new situation. For example, added pressure to negotiate, or heavily increased military pressure in the Highlands, or both, might be indicated steps.

The problem of monitoring the success of the barrier is not a simple one. With respect to troop infiltration, information on use of the trails is obtained from ground watchers. Such information is not very reliable, and is obtained only on a small sampling basis. If there are approximately 100,000 men on the VC/FAVN side, an infiltration rate of 5000 men/month gives 20 months as the replacement time of the current Main Force in South Vietnam. The amount of stockpiling within South Vietnam is not known, but it can be assumed to be extensive. Therefore the effects of the barrier could take months to observe, unless the enemy chooses immediately and visibly to alter his

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tactics. There are then two possibilities of failure: the system will work, but its long time constant will discourage us from persisting with it because of lack of visible effect; or the enemy will gradually exploit other alternatives, to the same time scale, without making it obvious. We would then not react to his alternative system until it is well emplaced and therefore much more difficult to dislodge.

The solution to this problem is not easy. It must probably depend on upgrading the observer system for some period before the barrier is emplaced, so that we could have it operating afterward. This would require extensive patrol activity in the regions south of the anti-personnel part of the barrier. In addition, intelligence efforts to ascertain if the North Vietnamese are opening different strategic alternatives should be greatly increased.

Determination of the effectiveness of the anti-truck part of the barrier is presumably easier. Truck counting should be maintained before and after the barrier operation is initiated. Otherwise, the same considerations apply as for anti-personnel infiltration. An important part of the entire monitoring system is the determination of a possible shift from trucks to portage. The aerial photographic observation part of the system is designed to seek such information, and would be an important contributor to monitoring the barrier's effectiveness.

STRATEGIC ALTERNATIVES FOR THE NORTH VIETNAMESE

Once all its components are made ready, the air-supported barrier--really representing a great consolidation and intensification of anti-infiltration activities even now under way--can appear across the VC/PAVN logistic system within the space of two weeks from "go." In terms of the time constants for most strategic changes in the Vietnam war--e.g., our troop buildup, or the onset of a VC/PAVN offensive--this is sudden. The North Vietnamese would then be faced with a number of alternatives:

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1. They could admit privately that they cannot continue to support the war in the South without themselves escalating politically by widening the war to new territory, and could therefore agree to try to find some resolution of the war through negotiation. Their past history doesn't indicate that they are likely to come to such a conclusion immediately; we might hope they would be forced to it after their other alternatives have been tried and have failed.

2. They could try to defeat the barrier in detail. This is likely to be the first approach tried, until they learn (hopefully) that it is not easily penetrable. Then they could settle down to the lengthy business of trying to divine its components and how to overcome them; this is precisely the game of measure and countermeasure that the constantly evolving barrier is designed to defeat. The Main Force units in the Highlands could meantime go on fighting for an unknown period using stockpiled materiel and food. If the barrier remained successful, these forces would gradually be squeezed into more and more dependence on locally furnished supplies, as distinct from stockpiled supplies. At this point it is quite possible that some step-down in activity would be required; in that case the barrier would have achieved one of its major objectives (see p. 10). But we found, in the briefings our group received, that little thought has been given to the question of whether the VC/PAVN can achieve any sort of equilibrium in a step back from "Phase III" to "Phase II," or to what we would do should they try it. This appears to us to warrant some extensive attention as part of the strategic problem of implementing the barrier.

3. At the same time that the North Vietnamese try to defeat the barrier, or after they find this difficult (assuming they do), they could give attention to various "end runs." Assuming that they are determined enough, and the Soviet Union agrees to accept the political consequences of some of these, we see four options open to them:

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a. By Sea. At present, we were told, seacoast landings and movement are confined primarily to an internal redistribution system within South Vietnam. But the effectiveness of Market Time seems uncertain; all junks and sampans are not searched, and a clever underground can fairly easily deceive a system that depends heavily, as Market Time does, on checks of licenses and papers. It is hard for us to believe that about 100 men per day could not be smuggled across the shore via the fishing fleet; and if Main Force supply requirements are as low as 10 tons per day, then one shipment per month over the shore could provide this. The problems are two: do the VC/PAVN have an internal distribution system from the shore to the Highlands, or could they develop one; and is Market Time verifiably effective, or can it be made so? It would probably also be necessary for the US/GVN forces to exert much more extensive control over long lengths of shoreline--especially in the northern provinces--then they can now do.

b. Via Cambodia. Goods can presumably be innocently packaged and shipped to Cambodia, either up the Mekong or directly to Sihanoukville; and thence to the Highlands. One ship per month of several thousand tons draft, mixed with other shipping, would suffice; and under current conditions any redistribution through Cambodia would be harder to monitor. Infiltration of several thousand men per month this way would be hard to mask, and would require Cambodian complicity; the need for this could lead to increased North Vietnamese and Chinese pressure to involve Cambodia more deeply in the war.

c. Via the Upper Mekong. The Pathet Lao/North Vietnamese now hold Thakhek, on the Mekong, from which they can reach around the northern end of the barrier in its location described in Part III. It should not be very difficult to move at night down the Mekong to the extreme southern end of Laos or Cambodia and thence to South Vietnam. Although both sides of the river are nominally in friendly hands, portages where necessary could probably go undetected both in Laos and Thailand.

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d. Via the Mekong Plain. The North Vietnamese could decide to push the Royal Laotian Government forces aside and reestablish their supply lines in the relatively flat and open terrain west of the barrier. Such a move presents political problems for them and the Soviets, because neither has admitted to the current operations in Laos. But the emplacement of the barrier could give them an excuse to "respond" if they needed one, and the entire war could be expanded into a part of Laos that is now in equilibrium.

We call attention to these strategic options open to the North Vietnamese to stress that even an effective barrier of the kind we describe would not necessarily solve the problem of communist infiltration and supply. Just as the barrier itself must be dynamic and constantly changing in nature to have any chance of continuing effectiveness, the strategy of using it requires prior planning and attention to find ways to deny--as much as possible--the strategic alternatives of "end runs" to the enemy. And the intelligence system which monitors the effectiveness of the barrier must also watch for enemy development of these "end runs."

Finally, we must note that if the enemy is determined enough not to be defeated, emplacement of an effective barrier over the Ho Chi Minh Trail complex, and an effective Market Time operation, give him the choice of escalating ground war into Laos, and of more openly involving Cambodian and even Thai territory in his operations.

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