UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

EVALUATION OF THE DEMONSTRATION PROJECT ON ROAD MAINTENANCE

COSTA RICA

(USAID GRANT NO. 515-192)

Wilbur Smith and Associates

AUGUST, 1986

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August 15, 1986

Mr. H. Rodriguez, G.E.
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SUBJECT: Indefinite Quantities Contract
No. OTR-1406-I-00-2253-00
Work Order No. 9

Dear Mr. Rodriguez:

Under the terms of subject Work Order, we transmit herewith five (5) copies of the "Evaluation of the Demonstration Project On Road Maintenance", Costa Rica. That Demonstration Project was conducted under your AID Grant 515-192.

The evaluation was prepared by Marshall Pentecost during and subsequent to his travel to Costa Rica. We trust that the report furnishes the information needed, and fills the requirements of your program.

Mr. Pentecost and all here at Wilbur Smith and Associates wish to thank you and other participants in the Demonstration Project for the courtesy and assistance extended during the course of the work in Costa Rica.

Very Truly Yours,

WILBUR SMITH AND ASSOCIATES

R. A. Hubbard
President

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Demonstration Project on Road Maintenance,

Costa Rica

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Evaluation of the Demonstration Project on Road Maintenance

I - INTRODUCTION

Maintenance work of different kinds is required to keep roads open for use and in a condition suitable for the functions they serve. The activities vary according to traffic, surface type, climate, and other factors. They range from extensive and costly pavement surface renewals to simple hand-shoveling of silts from culverts.

Maintenance is almost always a response to observed changes in the road surface and adjacent areas. The changes may be rapid or slow, resulting from damage, wear, gradual re-balancing of earth masses, growth of vegetation, the intrusion of water and deleterious materials into the roadway elements, and so on.

Most maintenance needs can be anticipated (not all), and the repeated activities are generally predictable in their amounts, cost and broad scheduling. However, flexibility is always needed. Work may be aided or may be interrupted by weather; become easier or become impossible. Emergencies occur.

When ownership of the rights-of-way and the roads is vested in a public entity, it is most common for government to be charged with the maintenance of the roads. This follows naturally from the ownership, the investment of public funds in road construction, and the responsibility to

insure that the routes of travel are open to general public use under all normal circumstances. In the ordinary case an operating agency of government exists for this purpose and is provided with resources for the work.

Some agencies do essentially all of the required operations with their own forces. However, it is common to have some combination of the public and private capacities involved. Even the most self-sufficient government agencies may contract periodic seal coating, or may buy mixes and other materials from private sources. Many will also do long maintenance overlays by contract, or the periodic replacement of gravel surfacing. A few other activities are frequently carried out by the private sector.

A public entity with good efficiency and adequate equipment can do ordinary work at lower direct unit cost than a contractor, because it does not pay general taxes, does not return a profit on investment, and will normally have resources positioned in the area of the work. However, the total responsibilities of maintaining a large and varied road system are quite broad, and the entity may very well see advantage in using private contractors to do some types of work. It normally takes the initiative in deciding on such a course, in conjunction with higher authority.

Usually, the questions in deciding whether to do maintenance by contract are:

(1) Is there a need to do so because of a lack of personnel, lack of specialized equipment, or because of a backlog of work.

(2) Are funds available for contracting work.

(3) Is it feasible to do so; legally, functionally, and administratively.

Legality is a matter of law and regulation within the overall government structure. Administrative feasibility has to do with personnel and facilities for planning, going to contract, inspecting, testing and payment. Functional feasibility is more complex. The elements are:

(1) Can the work considered for contract be defined as to its nature, quality standard, location, amount, probable cost and time of completion.

(2) Is there enough work in a single project, or a delimited area, to attract competitive bids.

(3) Are there competent and interested bidders, in the area of the proposed work.

Affirmative findings indicate that it is practical to contract suitable activities. The findings may also indicate that it is imperative, as in the cases of special operations or large amounts of deferred work. For various reasons, government agencies sometimes find that contractors can do well defined programs at lower cost than their own forces.

This is usually related to deficiencies in the equipment and skills within the agency.

II - THE SITUATION IN COSTA RICA

A. Roads

Costa Rica has a reasonably well-developed highway system, described in official reports as consisting of about 7,000 k of principal highways (the Red Nacional) and another 21,000 km of secondary or local roads (Red Cantonal). The latter includes some 1,400 km (combined) of "metropolitan area" and "urban" streets. The principal routes of the national system are paved, with some multi-lane in the vicinity of the the capital and the rest two-lane with travelways six and seven meters in width (sometimes wider). The pavements are asphaltic concrete on high-traffic sections, and surface treatments on others. There is a very limited amount of concrete pavement.

B. Climate

Most areas of the nation have a high total annual rainfall, but the climate is pleasant, with moderate temperatures in the elevated areas. A majority of the days everywhere offer at least a few hours which are clear and dry enough for outside work. There is a well-defined "dry" season (with precipitation less than about 50 mm per month) which permits scheduling major asphalt work. These seasons are different for the Caribbean and Pacific slopes. In all areas rainfall is

frequent if variable, and ground water is ever-present, indicating that good, functioning drainage is absolutely critical to all roads and highways.

C. Road Jurisdiction

All of Costa Rica is divided into 'Provincias', but for road purposes the further subdivision into 'Cantones' appears to be more significant. The national government has responsibility for principal highways, and for an extensive network of lesser routes, paved and unpaved, reaching into rural areas. This authority is exercised by the Ministry of Public Works and Transport (MOPT). The Canton Capitals are organized local governments with jurisdiction over both town streets and rural roads (Caminos Vecinales). Cantonal officials have, or have assumed, a wide latitude and authority over their roads, although they have very limited resources for road work.

D. Road Conditions

The highway system in Costa Rica is deteriorating. Examination by car of about 900 km of main routes in July, 1986 showed extensive surface failure on many paved sections and a fair to poor function of drainage.

A recent plan of action prepared for the MOPT 1/ includes a graphic display of the "Levels of Condition --, National Road Network - 1984", indicating:

Condition	% of Total
Very good	5
Good	11
Regular	18
Bad	38
Very Bad	28

This same data source quotes a 1979 study as saying, "More than 50% of the National system has characteristics insufficient for present and future travel needs, both geometric and structural and because of accumulated maintenance deficiencies."

The most serious problems observed on about 50 km of rural side roads was inoperative drainage and a lack of, or failure to replace, all-weather surfacing.

It is apparent that the maintenance of the roads is not adequate, and has not been for many years. It is estimated that the current effort on main roads is not accomplishing more than 50% of the maintenance called for. The work not done continues to accumulate as deferred maintenance, and the patching, seal coating and overlays being postponed are converting into a need for major rehabilitations and reconstruction.

1/ See Attachment 1.

E. Correction Efforts

The deterioration of the road networks has been recognized for many years by the National Government, the public, and by the international lending agencies which participated in the development of the existing systems. In 1979 the MOPT engaged a local engineering firm to, " -- make an evaluation of the road network of Costa Rica, (and) establish the scope and carry out the first phases of a program of rehabilitation and maintenance." 1/ This led to an agreement with the World Bank known as the Fifth Highway Project, which included as a major part the development within MOPT of a system for the administration of maintenance (SAM), with training of Ministry personnel. Between December, 1982 and November, 1984 this effort was accomplished by consultants, a prominent international firm in association with the established Costa Rican engineering company which had done the earlier evaluation. The SAM project provided all the normal elements of maintenance management; a basic manual of procedures plus others on accounting, equipment management, spare parts control and more. The transmittal letter of the final report 2/ is dated November 27, 1984, and its executive summary says the program has established methods for, among other things;

2/ Ibid., see page II - 3

(1) Planning and programming

(2) Obtaining data on work execution

(3) Budgeting

(4) Obtaining cost data

(5) Rapid analysis of data for decision-making

(6) Analysis of costs

(7) Control of maintenance work

(8) Execution of programs

(9) Evaluation of quantity standards and costs

(10) Programming by priorities

(11) Coordination of betterment, maintenance and rehabilitation

The work of the consultants appears to be adequate and complete. However, the executive summary of the basic report conveys a deep concern regarding the lack of positive results within the Ministry:

Page 1 - 1; "The MOPT suffers from a series of profound problems which have impeded all efforts to speed up the administrative processes. There exists an administrative paralysis which blocks the execution of the designed maintenance programs--."

Page 1 - 2; "The Direccion General de Mantenimiento Vial (of the MOPT) still lacks the authority and resources to participate in the execution and control of its maintenance programs. The result is

that only a small percentage of the prepared programs are done, and with a very low efficiency--."

Page 1 - 4; "In spite of the design of good systems of equipment management, there is little evidence of positive effect in this division."

Page 2 - 5; "Nearing the end of the third year of availability of resources for the five-year plan of rehabilitation and reconstruction of 860 km, only a small fraction of this program has been realized."

The executive summary recommends the creation of a specific Division of Road Maintenance, with the authority and resources to do maintenance, having absolute autonomy over the maintenance of the road networks, both National and Cantonal, but prohibited from doing construction and betterment.

F. Results

As stated, observation of the roads today shows that MOPT road maintenance is still deficient. The current situation was examined in April, 1986 in a brief report written for the Minister-Designate of MOPT by the local engineering firm which was active in previous studies 3/. The report discusses previous criticisms and recommends that the MOPT, as required action:

3/ Ibid., see page II - 3.

" 1) Effect the structural reorganization recommended by the consultants BEL-Jorgensen in October of 1983 and arrived at in accord with the missions of The World Bank,

" 2) Honor the terms of all the agreements it has with the international finance agencies, to regain its professional image and take its place as the directing force of the transport sector, and,

" 3) Prohibit road construction, rehabilitation and betterment work by force account--."

The report further says that at the end of the fourth year after funds became available for rebuilding the 860 km previously identified, that program is still in the same state as a year earlier. It also states, "The formation of a maintenance institution hasn't been taken seriously; there have been some advances in systems of planning and programming, but implementation in the field has not been achieved."

Individual engineers of the MOPT have agreed that the maintenance accomplishment of the agency is not sufficient. Lack of resources and dispersion of their resources by higher authority have been cited as factors preventing a more successful program.

G. Contract Maintenance Demonstration Project

Because of the failure to meet the goals in maintenance improvement, a modification of terms of the Fifth Highway Project was agreed between the MOPT and the World Bank in an 'Aide Memoire' signed in December, 1983. Among other matters this included a decision to:

> "Do periodic maintenance by contract on about 200 km" of road and,
>
> "do a pilot program of routine maintenance by contract--."

The specific programs were to be defined by the consultants. Originally, the maintenance by contract was to be financed by the National Government, but due to budget problems a grant agreement was made between Costa Rica and the U.S.A., through its Agency for International Development (AID), to utilize available local funds for the purpose. The document for the AID Project was signed August 1, 1984, with an original amount in Costa Rican Colones of 218,750,000, which was equivalent to approximately five million U.S. dollars.

The 'Demonstration Project on Road Maintenance' is described in later sections of this report. Essentially, it was organized between November 1, 1984 and mid-December of that year. The first steps to inform contractors were taken in December, bids on the first

part of the work were received January 22, 1985, and the bids on the last of three distinct sub-projects were received April 16, 1985.

By June 30, 1986 about 92% of the work had been accomplished, as measured by the expenditure of funds designated for payments to contractors. At that time an asphalt recycling demonstration program had been completed, and routine maintenance continued in two areas, as programmed. The project is scheduled to end January 31, 1987.

The very rapid initiation of the program and its high productivity to date have been a source of satisfaction to those promoting, directing and accomplishing the project, as well as to the general public.

III - EVALUATION OF THE DEMONSTRATION PROJECT

A. Initiation and Time

With most of the contract maintenance completed, and with the program in place for about one and one-half years, AID wanted an independent evaluation of procedures and results. It therefore hired a separate consultant, an international engineering firm not previously involved in the project, to do a one month study. This was conducted in July, 1986, resulting in this report.

B. Evaluation Steps

The method adopted for the evaluation was simply to talk to the participants, review reports on the work along with other file material, and to look at roads and activities in the field. These provided:

(1) A rapid introduction to the program.

(2) Representation of all points of view on maintenance by contract.

(3) Frank discussions of how the existing situation arose and the possible routes to solutions.

(4) An understanding of project details, through reading the very clear and comprehensive reports which have been written by the executors of the demonstration projects.

(5) A review of preparations, field procedures, accomplishments, and analyses as described by the executors.

(6) A direct look at the roads of the programs and the results obtained. Also, at comparison roads outside the programs, and some field operations in progress.

The main data sources are listed in Attachment No. 1. In addition to these Costa Rica Reports, a review was made of maintenance management studies from other areas, and of technical literature on various aspects of highway engineering and road maintenance.

Attachment No. 2 lists the persons who contributed to the evaluation, with their titles and, briefly, fields of expertise, to the extent these are known and are pertinent. The roles they played in the evaluation are also mentioned.

IV - THE PROJECT

A. Structure

In broad terms, a program was devised in which private-sector contractors would do maintenance and rehabilitation on existing public roads, under the control of a private, non-profit association, using AID local funds. This arrangement has several novel aspects. Contractors are doing work which in some ways is quite different from their usual operations. Their work is supervised in detail by a private engineering firm, sometimes to the point of giving direct instructions to contractor workmen on the road. The engineering firm is hired by an entity which is independent of any government. The entity and its engineering consultants have been authorized and requested to exercise administrative control over work on designated sections of public roads, which remain in public use. From its conception in 1983, the idea of doing maintenance by contract was to test whether this offered a practical means to get necessary work done in a more direct way.

One stated objective of AID in participating in the project was to try this means of repairing roads as an alternative to public sector force account work. It was felt that a contractor's profit incentive would promote efficiency, that the method would offer a more flexible

response to changes in resource demand, and would make it easier to determine real costs. Use of a private organization as administrator was intended to simplify the processes for contracting and payment, as compared to government procedures.

In the limited areas where it has been applied, the program has been highly successful in achieving urgently needed improvements in road conditions, and has avoided any serious problems of inter-relationships. This is due in large part to the care taken in establishing the relationships, and the measures for control and participation written into the structure. Credit for success is also due to the individuals involved in the program; their energy, acumen and motivation.

B. Executing Agency

The 'Association of Highways and Roads of Costa Rica' (Asociacion de Carreteras y Caminos de Costa Rica, or ACCCR) is described as a service organization, non-profit and without political affiliation, founded in 1952 for the purpose of promoting the development and improvement of the country's road systems. Its past activities to this end have been fairly broad, often directed toward specific highway expansions and improvements, but also including such efforts as arranging for and contributing to engineering scholar-

ships for general, post-graduate and special training. The ACCCR has organized national and international meetings and seminars related to highways, and contributed to other general advancement in the field.

The ACCCR currently has 75 members, mostly businesses but with some individuals. It operates under an elected, rotating Board of Directors. Those members from the business sector are primarily equipment dealers, consulting engineers and construction contractors. These have an obvious monetary interest in general highway programs as an industry, but it appears that the Association's important place in the current project derives mainly from its genuine concern about the deteriorating condition of Costa Rica's roads, and the continuing failure of the normal routes to solutions. Nevertheless, it is apparent that in this and any similar future programs using funds other than its own, the ACCCR will have to exercise great care to assure that there is no basis for criticism of its actions or motives.

C. ACCCR Official Standing

In order to authorize the Association to act in its present capacity, a memorandum of understanding was signed October 25, 1984 between the MOPT and the ACCCR, defining the nature and scope of the Demonstration

Project and its estimated cost, and describing the relationships of the two parties. This document was also approved (and signed) by the AID office for Costa Rica. The memorandum authorized the ACCCR to execute the described work, but stipulated the Ministry's right to prior approval of the bidding steps and contract awards. In eleven brief clauses of the agreement the ACCCR obligated itself to a proper administration of the work, including:

(1) Keeping records suitable for and subject to outside audit.

(2) Contracting for the required engineering services.

(3) Naming a three-man construction committee to contract the actual work and oversee its progress. This was composed of representatives from AID, the MOPT and the ACCCR.

(4) Presenting a program budget for AID approval.

(5) Reporting regularly to MOPT and AID.

The memorandum of understanding was modified in April, 1986 to revise the extent of work and increase the funding amount.

D. Project Scope

As established in the ACCCR/MOPT/AID agreement, the project consisted of three parts, each in a separate geographic area. The purpose was to demonstrate

different aspects of maintenance work. Following modification in the early phases, the three parts were:

(1) Resurfacing of 26 km of asphalt paved highway near San Jose, using the technique of recycling.

(2) Routine (and some periodic) maintenance, for two years, of about 100 km of important roads in the central part of the country, mostly asphalt paved.

(3) Rehabilitation and maintenance, during two years, of some 90 km of roads in a principal populated area of the Southern part of the country.

More length was later added in the third area of the project. All sections of road to be included were selected by agreement among the participants (with some trade-offs), and were neither the best nor the worst examples of road condition, but rather were chosen to be representative of different surface types and standards in the area.

E. Focus of Evaluation

This report is not intended to record the details of how the work was accomplished, or of the technical problems encountered and solved. These are amply supplied in the report 4/ of the Project Manager retained by ACCCR, in the 1985 report by the engineering consultants 5/, and in progress reports. Instead, the major purpose of this review is to examine the methods used

4/ Ibid., see page II - 3.

5/ Ibid., see page II - 3.

to plan and execute the program, the results obtained, lessons learned, and indications of the project's value as a guide to of maintaining roads by contract.

V - PLANNING OF PROJECTS

A. Types and Quantities of Work

The engineering firm retained by the ACCCR for the project had access to all the data and manuals developed in the maintenance management study done for the MOPT by outside consultants in 1983 and 84. This 'System for Administration of Maintenance' (SAM) covered all the familiar ground of such studies, including inventories, lists of activities, performance standards, estimates of annual work quantities, methods of control, and elements of cost. The Demonstration Project engineers therefore had an established procedure for making up programs of ordinary maintenance for the selected roads of the project. Of course, much effort was necessary to put these in a form suitable for contracting. Naturally, the SAM material did not cover the recycling of asphalt pavements, a special and infrequent kind of maintenance, and there was no previous experience with recycling in Costa Rica to offer standards and specifications for this work. The assistance of outside specialists (from the U.S.A.) was obtained by the ACCCR, with cooperation from the International Road Federation.

In maintenance management, inventories permit the classification of roads by surface type and the identi-

fication of necessary maintenance activities. This is followed by the calculation of road elements subject to maintenance, such as surface areas by type, shoulder areas along pavements, the summation (or estimation) of ditch lengths, numbers of culverts, and so on. In conjunction with further data on condition, traffic and climate, estimates can then be made of the required frequencies and quantities of the different activities, resulting in projected programs of work. If generalized methods are then assumed (crew size, equipment, materials) in 'performance standards' for each of the activities, the work programs can be used to compute resource needs.

For practical economy, inventories are usually made from moving vehicles, stopped at intervals for measurements. Most of the data files referred to as inventories also contain, from other sources, information like traffic volumes, pavement and seal coat ages, pavement structures, etc.

Performance standards developed in SAM studies are, and are intended to be, averages of methods and materials which will apply reasonably well to whole road systems. They may also serve as guides toward better and more standardized practices, but it is recognized that there have to be variations in their use. The work programs derived from the application of general performance

standards to inexact inventories are usually satisfactory for whole systems, but workload factors and crew productivity figures which are statistically adequate for those road systems may have to be adjusted for the indiviudual routes of more limited networks, and inventories of special form may be needed.

B. Project Experience

The demonstration project had problems in using the SAM information, developed for the MOPT, as a basis for defining and carrying out specific programs by contract. The most notable difficulties were:

(1) The SAM inventory method gave no indication of accumulated, deferred maintenance.

(2) The inventory standard notes on 'Estado' (condition) of drainage did not give nearly enough information to indicate the volume of work which was needed.

(3) Similar notes on condition of surfaces were not an adequate guide to estimating required work on asphalt pavements and unpaved roads.

(4) The SAM inventories did not distinguish between pavements types (asphaltic concrete, surface treatment, etc.)

(5) The inventories did not identify specific problem locations, such as slide areas or unstable drainage crossings on unpaved roads.

(6) The inventory item of "approximate thickness -- of -- surface.", while a useful guide to programming general regraveling, was no help in forecasting the reinforcement needed to stabilize individual short sections of road.

(7) The annual work programs generated by the SAM procedures needed a time scheduling within the year according to annual weather cycles (wet and 'dry' seasons).

(8) The SAM estimated productivity rates were less than those achieved by project contractors.

(9) "Level of Service" was a concept difficultto apply.

SAM methods are used to quantify regular maintenance programs. What was desired in the Demonstration Project was a trial of doing these kinds of regular activities, plus some rehabilitation and betterments (addition of culverts and granular surfacing), plus the special experimental recycling, all using private-sector contractors. The two maintenance demonstrations were originally intended to be much larger, and the executors (ACCCR and the engineers) discovered early that both programs would have to be scaled back drastically in

scope. Funding was also increased. Presumably, these modifications were due in part to low preliminary estimates of regular work quantities and costs. However, project reports cite as a basic reason for the changes the fact that major work and cost was required to rehabilitate elements of the selected roads, before normal maintenance could begin.

The pavement recycling program was set up independently of any SAM procedure, and in cooperation with outside experts and with Costa Rican contractors who were potential bidders. This provided a firmer basis for setting the costs of this work, or for scaling the scope to fit the allocated funds. The program was completed very nearly within its budget.

The project executors made some new inventories in the preparation stages of the programs, but have mentioned a need to improve these, also. Specifically, they state that more and current information on surface condition has to be gathered, and that field observations of drainage function should be made in the wet season.

Review of file information and discussions with supervisors of the project did not disclose any problems in deciding the priorities of maintenance (and rehabilitation). When roads were closed at specific points because drainage facilities were lacking or not

functioning, that was tackled first. For roads in use, condition of the travelway was of first concern, patching and spot repairs taking precedence. Routine and periodic activities were in third order. There is no indication that economic return on different activities was considered in following these natural priorities.

For the two maintenance sub-projects, quantities of work were estimated by using (or adjusting) the factors of the SAM study, intended to achieve a high "level of service" on the roads, according to their class. In general, it was found that these estimated quantities were too low. In fact, in some cases, the highest level of work (or cost) judged to be acceptable was not enough to obtain the defined level of service, which was therefore allowed to decrease.

In the matter of drainage cleaning, the estimated workload for most roads was far below the crew-days actually required to restore those facilities. It is stated often in the project reports that many culvert inlets and ditches (including lined ditches) were buried so deeply that there was no sign of them on the surface. It was that volume of abnormal excavation, shaping and clearing which was largely responsible for changes in project scopes and schedules.

C. Comments on Planning and Programming

1. Inventories and Kinds of Work

The Costa Rica demonstration project is a new and interesting experiment. Overall, it appears to have achieved impressive results. Although the original objectives were limited to maintenance, by the time of signing of the 'Memorandum of Understanding' (October, 1984), rehabilitation had been added to the description of work in one of the areas (Southern). What became clear as the program advanced was that actually three kinds of work were involved (excluding recycling). The three were:

1. Routine and periodic maintenance
2. Deferred maintenance
3. Rehabilitation

In similar projects of the future, it will be necessary to recognize and separate these, in order to isolate the requirements and costs for ordinary maintenance, and to program the deferred and rehabilitation work necessary to get to a condition for ordinary maintenance. Presumably, the selection of roads would eliminate any sections requiring significant reconstruction, thus avoiding that further complexity.

When the road system to be considered is small and a better definition of work is needed, then a more

detailed inventory is warranted. This is especially true when quantities and costs are to be estimated carefully in engineering format, as for work to be contracted. Even when the contract documents state that quantities are approximate and payment will be made on measured units of work, contractors can be expected to demand higher unit prices if there is large variation from the bid quantities. There is some justification for this because of the way in which contractors have to organize and assign their work forces, equipment and financing.

If a decision is made to catch up deferred maintenance which has accumulated, the work has to be identified as a project. There is no practical way to program some higherlevel of routine activities which will gradually return the road elements to a 'normal' state. Pavement failures grow if they are not repaired, and they often grow rapidly. Drainage either functions adequately or it does not. If not, then other damages result.

2. Defining Work For Contract

Programs of deferred maintenance or rehabilitation to be done by contract should be prepared with care. Simple engineering surveys may be needed. For extensive asphalt patching programs, the existing pavements can be classified in two, three or more types and stages of

distress. Representative short sections of each can be chosen as samples for projecting total work.

If reconditioning of drainage is needed then new drainage and slopes can be designed. If the presence of lined ditch or hidden culverts is suspected, enough investigation should be done to determine what can be salvaged.

For the purpose of setting up work programs of contract maintenance, special inventories or surveys should note the location and scale of slide areas and fill failures (hundamientos) so provision can be made for correcting these conditions, or at least anticipating the workload of keeping the road open at these places. The mountain and heavy rolling areas of Costa Rica are also high rainfall areas, which contributes to these problems. Reports of the demonstration project (cited earlier) recommend that inventory of drainage function be carried out during rainy periods. Obviously, slides and settlements are also more active at such times, as are surface weaknesses. Pavement cracking and some kinds of base failure are also more visible during certain stages between wet and dry surface condition. However, in general, rolling vehicle inventories should be made in dry weather, when visibility is better and unpaved roads are open to travel.

As noted before, the work quantities were underestimated in several cases, but this was not the fault of the procedure used in quantifying, which remains valid if the factors are adjusted. The contractor productivity which was higher than expected in relation to the SAM standards helped to offset the effect of the increased amounts of work.

3. Productivity

The higher rate of work of contractors is not to be disputed. A contractor offers bids on defined items of work because he believes he can do them at a certain minimum price and still make a profit. In execution, his interest is directed toward insuring that his personnel and machinery reach or surpass the rate of accomplishment which he assumed in computing his bid. (It is up to the owner's inspector and engineer to demand that he meet the quality standards agreed on in the contract.) In hiring workers, the contractor will look for people of demonstrated skills, among applicants who are seeking the best pay they can find.

In contrast to this, the competent maintenance supervisor of a government agency always has three principal objectives before him:

(1) Carry out all the work which is his responsibility.

(2) Reach an acceptable quality standard with the resources at his disposal.

(3) Keep all his forces occupied in useful work.

The maintenance supervisor usually has his workers assigned to him by a personnel office of government, though he may be allowed to hire directly or at lest have a say in personnel choices. In either case, the applicants will probably be those looking for security of employment and indirect benefits even at lower pay. New employees will normally have a lower range of skills, or require training. This pervasive difference in worker capabilities is important in estimating productivity rates as programs are set up for work by contract.

4. Level of Service

The SAM manuals for Costa Rican road maintenance by the MOPT use the idea of 'levels of service', meaning condition, for the roads of different classes and usage. This results in factors which predict or establish, for the maintenance activities of each class of road, the annual amount of the activity (e.g. spot regraveling in m^3 per km), or the number of repetitions per year (e.g. vegetation control), or the interval in years between repetitions (as for seal coating). SAM procedures in other countries use 'workload models' to set these factors directly but always, whether stated

or not, there is some implied standard ofcondition which determines the numerical value of the factors.

Some 20 years ago the World Bank and other financing agencies began to observe that governments of developing countries were finding it difficult to maintain road improvements which had been constructed at high cost with external financing. In a few cases paved surfaces were reverting to gravel. The benefits projected in feasibility studies to justify the improvements were not being realized. This led to more programs of assistance in maintenance for nations with problems, intended to preserve the original investments and other important roads. It also led to questions of which roads should be saved first (the priorities of rehabilitation and maintenance), and what would be the economic results of new expenditures on the deteriorating roads. The latter studies were, in effect, a second look at the road's feasibility, under new circumstances.

Road improvements (and maintenance) produce a variety of economic and social benefits, but an important part of such benefits always appears as reduction in vehicle operating cost (VOC), whenever there is an existing road or an alternate route of travel. This is partly because of its real importance, but also because the

VOC reduction can be quantified with reasonable confidence. It is usually more difficult to put numbers, monetary values, to other kinds of benefits. Adequate maintenance prevents large increases in VOC on existing highways. This is one of the functions of maintenance, in addition to just preserving the physical elements of the road.

It is easy to understand that maintenance costs on a proposed road can be minimized by building to very high standards in the original contruction - flat slopes, over-designed drainage, very strong pavements. After construction of any road, the VOC level for users can be kept low by generous expenditures on maintaining the smoothness of the travelway. From studies of these relationships, and with the impetus of some some failing highways, there arose the idea of the HDM computer model. Developed under the auspices of the World Bank, the original long title was "Highway Design and Maintenance Standards Model". Now in its third version, it is actively being refined and further developed today.

The original concept of the HDM program was to seek, for a proposed highway investment over its assumed life, the lowest total combined cost of construction, maintenance and operation (in VOC). This was a very interesting and useful idea, and its applications have

shed a lot of light on some of the questions of highway philosophy. Obviously, it is a large computer program which requires extensive data manipulation for all the alternatives of design standards, traffic volume (and composition), maintenance effort, and other factors. The model has been found most useful on relatively low-volume rural roads.

Regarding existing highways, it can be seen that a successful use of the HDM programs might (with construction costs fixed) indicate what scale of VOC decreases should result from increasing the levels of maintenance effort. Probably this is possible, and valuable comparisons could be generated of benefits versus costs for various alternate standards of maintenance. Some selected variations might be: for pavements, the percentage of holes to be patched of the total number of holes which develop on a specific section of road; for unpaved roads, the effects on VOC of different frequencies of grading.

While it is likely that the HDM (or some other process) could be used for this purpose, there is a question of the practical worth of the findings in the developing nations which have serious maintenance problems. Basically, the question is whether 'level of service' is an applicable concept in their circumstances. There

may be a legitimate field for such investigations when there are large volumes of high-speed traffic. Then, the effects of pavement distress are pronounced (including higher accident rates and congestion) and rather small variations in surface condition should cause large cumulative changes in total VOC, if there is good enough data to quantify the relationship. On the more rural two-lane, medium-traffic networks such as most of the kilometraje in Costa Rica there is certainly a bad effect on VOC when surfaces deteriorate, but there may be no real option to select a level of maintenance which will optimize the balance between that cost and VOC, because of the generally poor state of the roads.

In reality, the only road element in the Costa Rican systems which allows an option in maintenance level is the condition of the travelway. In rainy climates drainage, including shoulder drainage, has to be adequate or the road will be cut or destroyed. If funds are scarce no one is likely to do excessive maintenance on drainage, merely improving the appearance of the roadsides. In climates which favor plant growth, vegetation has to be controlled or it will choke the drainage and any unpaved shoulder areas. No one is likely to do more of this than is necessary, although it is possible. Although neglect of either of these

activities can eventually halt the operation of vehicles, extra effort and expense beyond what is adequate will not reduce vehicle operating cost.

The condition of the travelways can, obviously, be allowed to vary, affecting VOC. However, when pavements reach the poor condition which is now common on Costa Rican highways, there is really no option there either. Every surface failure which appears must be patched, repaired or reinforced, and as early as possible. The objective is not to minimize VOC (although that is a valuable result), it is to prevent destruction, to slow the deterioration until general reinforcement or reconstruction is possible. Considering unpaved roads, there may be areas of the nation where lower rainfall and the presence of granular surfacing materials would permit some choice in frequency of grading. This seems to be the case in the north-western zone, and there some standard could be set in relation to traffic volume, perhaps to grade after every 8,000 to 10,000 vehicle passes, on stabilized surface roads. However, choosing a similar 'level of service' would not seem to have much meaning in the central and southern areas of the current demonstration project. In these zones of higher elevation, lacking alluvial gravels, the executors of the project have had to resort to quarrying tufa and calcareous stone for all-weather surfacing. Reduced to

about 7.5mm maximum size in a primary crusher and combined with a high-clay matrix, these materials have provided very stable and resistant surfacing. They have rough textures, however, and local residents who are now delighted with the all-weather qualities may, in the future, begin to complain of the roughness. if they are well-informed by the ACCCR publicity, they may bring up the matter of VOC in arguing for smoother surfaces. The surfacing materials will be hard to grade, because of their blockiness and stability, and will probably have to be scarified and re-shaped at intervals, with rolling for compaction. The cost of this operation should certainly limit the frequency of repetition, probably to once annually, or less often. Once more, there will be little choice available in varying the maintenance level in order to improve VOC.

Summarizing, 'levels of service' can be described for Costa Rican roads, but will not have much meaning except on the travelways. Variations in travelway maintenance, corresponding to the 'levels of service', would produce effects, which would have to be quantified in terms of vehicle operating costs, the only established means of measuring the effects. The HDM program might be used to predict changes in VOC with declining surface condition. (Substantial amounts of local data would be needed, on road conditions and on

cost factors for vehicle ownership and operation) The 'optimum maintenance levels' derived in this way would be interesting as guides to programming, but it is probably true that physical conditions would still dictate the amounts and timing of maintenance.

VI - ADMINISTRATIVE SERVICES FOR CONTRACT MAINTENANCE

The impression gained of the administration of the demonstration project is very favorable. It appears that the participants have been both wise and fortunate in establishing the administrative structure, staffing it, and insuring against serious problems. The supervisory functions for such a project might be listed as:

(1) Setting policies and goals.

(2) Providing for the management of operations.

(3) Reviewing and approving programs.

(4) Arranging funding.

(5) Insuring proper use of the funds.

(6) Watching the progress of operations.

(7) Seeing the programs through to completion, with proper records of work done and money spent.

In highway matters, it is customary for these responsibilities to be discharged by some branch of government, even if the work is contracted. In this case, the ACCCR has accepted the role of administrator, as defined (and shared) in the Memorandum of Understanding (MOU) mentioned earlier. While it is certainly unusual, this substitution seems to be very successful, and such utilization of a non-profit, non-governmental institution for an experimental project independent of public agencies may be of interest in other countries which are considering maintenance by private

enterprise. The arrangement has some advantages, and should be applicable elsewhere so long as basic criteria are met:

(1) The institution must be willing to take on the task, and must have an organizational structure which permits it to take decisions in an orderly way, to hire staff and delegate authority to it, and to contract for necessary professional services. The institution should preferably have some part of its membership drawn from the road construction, engineering or equipment fields, so there will be familiarity with highway terms, methods and problems.

(2) The public agency which has vested authority over project roads, or some superior level of government, must agree to the operations on the public roads, supervised by an outside institution. Moreover, it would seem to be critically important that the public agency not only accede to the program but participate in it, and actively.

In the present case the ACCCR, acting through its elected board of directors, administers the demonstration project. using project funds allocated for the purpose, the board has hired a project manager to run the program, local engineering consultants to formulate and execute it, and independent accountants to audit its books twice a year.

Under the terms of the MOU, there is a 'Construction Committee' established by the ACCCR, presently consisting of the ACCCR Project Manager and one representative each from the MOPT and AID. This serves as a second-level administration.

The use of a private association as administrator might not be suitable for long-term programs. The current enthusiasm of ACCCR members, brought about by the novelty and accomplishments of the program, could be expected to fade after several years of repetition. The project is now scheduled to end in January, 1987, but one of it's unstated goals is that it will lead to continuing road maintenance by the private sector, perhaps in an expanded use of contractors by the MOPT.

Whatever the entity continuing or taking over the job of administration, the seven functions listed previously will have to be carried out, hopefully as well as they are now.

VII - BIDDING AND CONTRACTING PROCEDURES

A. Process Used In Project

The methods and format used in the Demonstration Project to call for bids and proceed to contract are complete but brief, and substantially simpler than regular government procedures. That was one of the objectives of the experiment.

Because ordinary road maintenance by contract was a new idea in Costa Rica, the ACCCR publicized the project as soon as its reality was assured.* Potential contractors large and small were contacted informally and invited to pre-bid meetings for discussions of the proposed work and for field visits to the sites. These were conducted separately for the three areas of the project. Each sub-project was then advertised once in at least three newspapers, calling for bids and indicating where bid documents were available. The publicity, meetings and advertising were designed to attract maximum bidder interest.

Although advertising dates varied, about three weeks were allowed between that event and formal bid opening,

*Publicity and dissemination of project news were basic to the whole program, agreed to by all participants and provided for in the Memorandum of Understanding and subsequent budgets.

which bidders could attend. Regarding analysis of bids and decision to award, the bid documents stated that this would take place within a period of five calender days from the date of bid opening. Bidders were advised that the selected contractor should be prepared to begin work within seven calender days after issuance of a notice to proceed. Naturally, this notice was issued only after formal notification of award to the lowest bidder, post-bid meetings, and contract signing.

Bid documents for the maintenance sub-projects contained essentially all of the familiar elements for this purpose, including:

(1) A description of the work (with map). Also, due to the new aspects, a brief account of the relationships between the MOPT and the ACCCR, plus the status of the engineering consultant, and the objectives of the project.

(2) An invitation to bid, with conditions for bidding (form and place; contractor qualification).

(3) General and special conditions (contractor insurance, measurements and payment, price indexing, performance bond, bid and award procedures, etc.)

(4) General (by reference) and special specifications.

(5) Bid forms.

(6) Special annexes, including a guide to maintenance procedures, details of methods of payment and activity performance standards.

Bid documents for the asphalt recyling project were basically the same but, of course, had special features related to the nature of that work. Considerable negotiation was required to reach contract signing with the low bidder and, in the execution of the work, there was significant controversy over quality control.

B. Comments on Bid/Contract Procedures

1. Effectiveness

Measured by the speed in selecting a contractor, the absence of challenges, and success in prosecuting the work, the procedures developed by ACCCR and its engineers were indeed effective. For the maintenance sub-projects, the time from advertising for bids to notice to the contractor to proceed with the work was remarkably short (42 and 44 calendar days). It should be observed that this was aided by access to the maintenance management manuals of the MOPT-SAM STUDY, with their descriptions of activities and their performance standards. These were found to be, in part, illusory

for contracting, but at least provided an initial skeleton. The general specifications of MOPT were also at hand, and familiar to contractors, for setting the quality standards of materials to be used, construction practices, and so on.

More than for other reasons, however, the simplification of the bid/contract process was probably made possible because the ACCCR project manager, the engineers, and various members of the ACCCR itself had wide experience in the contracting field. This enabled them to simplify and still avoid the problems which inherently follow from poor contract documents.

2. Prompt Payment

One really important factor which must be given great credit for the rapid prosecution of all sub-projects, and the overall freedom from litigation in the program, was the ACCCR commitment to pay contractors without delay. The Project Manager states that all contractor monthly billings approved by the Executive Engineer have been paid within five calender days of presentation. Since the Executive Inspector and the contractor representative compared work quantities daily and monthly inspectors reports were immediately available to the Engineer, there was no waiting period for the approval. Although the bid documents do not promise to

pay inside a stipulated time, the practice of doing so has been welcomed with enthusiasm by contractors who, on other projects, have been accustomed to wait for months.

Obviously, this very rapid settlement of authorized billings is possible because the funds are on deposit, and disbursement by the ACCCR Project Engineer is direct and simple. This may not be applicable everywhere, but its positive effects can hardly be exaggerated.

3. Minor Deficiencies Noted

The procedures used appear to have the essentials needed for this type of project. However, there is no provision for a bid bond, which might be a prudent addition to insure that the low bidder will proceed to contract signing.

There is no statement in the bid documents of the time period of the contracts, which were for one year, with provision for negotiated extensions for a second year (maintenance sub-projects only). While this was presumably made clear in the advertising for bids and in the contract itself, it would be desirable to have it indicated in the description of the work. Also, if a blank contract form were included with the bid documents it would inform bidders of the contract language,

and bind them to its acceptance.

If contract maintenance programs are made larger in the future, there might be some trouble in analyzing bids within the five calendar days used in the present case. This could be eased by pre-qualifying potential contractors, in a separate, earlier stage, to establish a list of acceptable bidders who wished to offer on such projects.

4. Changes Being Considered

a. The ACCCR project report for 1985 states that future bid documents should include a 'Maintenance Manual', presumably to put all the work descriptions, methods and standards in one place, with revision of some values of the MOPT-SAM standards.

b. The report also proposes some changes in methods of payment, with even greater emphasis on unit price work items.

c. In the MOPT, there is interest in simplifying its own bid and contract processes, in light of the results achieved in the Demonstration Project. Some of its periodic maintenance and rehabilitations are now contracted, and plans are being made to expand this.

For routine maintenance, the Sub-Director of maintenance of the MOPT, also a member of the 'Construction Committee' of the Demonstration Project, favors the use of small contractors. He expressed the idea that they might be given some advantage in a (pre-qualification' process, or that direct contracts of limited amounts might be negotiated through an existing MOPT provision for "Licitacion Privada."

5. Wider Use of ACCCR Bid/Contract Methods

It is likely that most large government agencies which contract for services have accumulated clauses of law and regulation which are out-of-date, over-cautious and ineffective. Simplification in such cases could save time and controversy, to the benefit of all. Nevertheless, the methods of obligating and disbursing public funds by government entities can never be as simple as the direct arrangements between a private owner and his chosen contractor or, as another example, between a contractor and his sub-contractors. In the case of the public agency there is a valid need to insure, and to display in public records, the proper use of public monies. After all, in the history of expenditure of tax funds, the venal public official and the conniving supplier of goods and services have been with us since the days of Babylon. This accounts in large measure for the complexities of government's multiple reviews,

formal fixing of responsibility, and certifications of actions. These are designed, not always successfully, to make sure that public funds are used in the public interest.

In the demonstration project, the ACCCR is allowed to act, by agreement among the principals, much as an owner would. This makes possible some short-cuts. The safeguards put into the Memorandum of Understanding are probably adequate to avoid any questions of impropriety. The good character of the individuals now carrying on the project guarantees against impropriety for the present. The bid and contract procedures used have quickened the pace of getting work underway. This argues in favor of using semi-public entities such as the ACCCR as administrators of similar programs elsewhere, if such entities exist. The simplified bid and contract procedures probably could not be implanted directly into a branch of democratic government.

VIII - OPERATIONAL PROCEDURES AND MANAGEMENT CONTROLS

There seems no reason to question the efficacy of the engineering supervision exercised in staring up and controlling the project work. The amount (and cost) of supervision was more than is normal for contract construction, or in force-account maintenance. This was necessary because the maintenance operations, though simple in nature, were in some respects new to the contractors. A different contractor-engineer relationship was required.

The consulting firm retained by ACCCR for the project supplied an Executive Engineer and an Executive Inspector for each of the maintenance sub-projects. (In a similar way for the recycling demonstration, but with a more normal contract supervision.) The Engineer set up the work programs (for 8 or 10 maintenance activities) and, in accord with the contractor, established schedules for them. The Engineer personally marked the limits of all work, including individual pavement patches. Monthly programs were developed, but naturally work at a specific site might occupy only a few days. Written work orders for these were issued to the contractor on a standard form, filled in and signed by the Engineer. By the terms of the contract, he was also required to visit each work site twice daily. When special activities were done on a 'cost plus' pay basis, the Engineer would give direct instruction to the contractor's workers.

The Executive Inspector visited all work sites daily, measured and recorded all accomplished work daily, and directed the work of three or more 'basic labor crews' furnished by the contractor. These were three-man crews (one acting also as pickup truck driver) not supervised by the contractor. The Executive Inspector also made up a daily work report form and, later, a monthly report which could be compared with the contractor's monthly billings, prior to review and approval by the Executive Engineer.

The assignment of an Engineer and an Inspector, with the duties established for them, represented a high level of supervision and control for the projects. This was, no doubt, to make sure that the new programs would get started right and produce good results. As it turned out, the quantity of unexpected rehabilitation work that had to be done, and other necessary adjustments in the programs, utilized this available supervisory capacity in full degree.

IX - DISTRIBUTION OF PROJECT FUNDS

The manner in which funds were expended can be looked at in several ways; by area, by activity, or by budget category, as examples. Also, the division between paved roads and unpaved, or that between national and local systems. There are many others. The three which would seem to be most pertinent are discussed below.

A. Geographic Distribution

The participants in the Demonstration Project chose, for various reasons, two central regions for subprojects and one Southern, reaching the border with Panama. for the recycling there were few alternatives, if one objective was to demonstrate this process on multilane highways with large volumes of traffic. There are no other areas in Costa Rica comparable to the one selected. The Alajuela-Heredia region offered a concentration of national routes with different characteristics, good for testing a variety of maintenance activities with minimum travel distances for work forces, administrators and officials. The third region provided a different concentration, a network of local rural roads dense enough for good efficiency of work distribution, and important to the nation's economy for its coffee production. The latter would permit an estimate of the benefits from improved road conditions.

All of these are good enough reasons, and the choices seem to be suitable. Other selections or future demonstrations, on roads more widely spaced or with fewer closed circuits will impose higher costs for crew travel time, and some increase in overhead expense for travel and per diem.

B. Types of Work

The maintenance portions of the project were first intended to demonstrate only normal, regular maintenance, to be done by private sector crews. The activities were the standard ones of routine and periodic work, familiar around the world. This changed as work progressed, to include heavy rehabilitation of ditches, shoulders and slopes and, to some extent, of pavements. Substantial sums were also spent to add new culverts and subdrain systems where there had been none before. Thus, in the end, deferred maintenance and betterments were added to the classes of expenditure.

The participants in the project could spend the available funds in any way that conditions demanded, the only requirement being that they agree among themselves. The course they chose was apparently the best one for the circumstances they faced. There are many maintenance agencies elsewhere who could make good use of some of the same kind of flexibility in deciding

what needs to be done, as opposed to the rigid definitions of work imposed on them. There are, however, good reasons to explain why those definitions have so often been set. They are to prevent maintenance forces from making costly improvements without engineering control, or from doing expensive rehabilitations on road sections being considered, at higher planning levels, for reconstruction or for replacement by an alternate route.

Having an engineer assigned to each of the sub-projects of the ACCCR program should prevent this kind of thing from happening, especially with the added factor of MOPT participation. It should also be clear that the fundamental purpose of the ACCCR project is to find a better way of doing ordinary maintenance. If it is found possible to amplify the program to a much larger scale, however, or its methods are considered for adoption elsewhere, then it might be prudent to set some constraints, or at least guidelines, for this distribution of funds. Deferred maintenance is a problem in many places, certainly on many of the roads in Costa Rica, and it has to be dealt with in quantified programs.

A summary statement was prepared by the ACCCR project manager in July 1986, for the updated project report. It showed the status of funds as of end of June, 1986. Extracted from that and shown below is a generalized presentation of budget categories and portions spent.

Combined Budget Category	Percent of Revised Total Funding	
	Budgeted	Spent
Administration (includes PR and Audit)	4.66	3.12
Preliminary Engineering (completed)	1.60	1.60
Engineering and Inspection	11.80	9.56
Other Consulting Services	2.60	0.14
Contracts (including contingencies and estimated price indexing)	79.32	69.64

The above figures are based on a revised funding of ₡ 268,750,000. Not taken into account is another ₡ 12,000,000 earned on invested project funds, and not yet budgeted.

2. Comments

The percent of total funds budgeted to engineering seems high at first, and especially the increasing amount in relation to other categories. This no doubt explained by the extent of the duties programmed for

the Executive Engineers and Inspectors, the large amount of rehabilitation work which had to be defined and controlled, and the complexities of the recycling experiment.

The final revised amounts budgeted for the individual sub-projects (exclusive of contingencies and price indexing) were:

Recycling	₡ 70,000,000
Central Zone Maintenance	₡ 62,000,000
Southern Zone Maintenance	₡ 65,000,000

Thus, the recycling demonstration was the most costly of the three efforts, despite the fact that such work is not usually a part of ordinary maintenance. The reasons given for this division of available funds are that the size of the sub-project had to be substantial in order to attract bidders, and that it is expected that profiling and recycling may have a wide application in Costa Rica, as an alternative to overlays or reconstruction of failing pavements.

X - PROJECT RESULTS

A. Benefit of a Well-Planned Contract

In the context of highway administration "well-planned" translates into better efficiency, which means lower costs. Good planning includes clear definitions of work, practical but efficient scheduling of operations, and the marshaling of resources to be where needed at the right time.

Government maintenance forces get into problems because, sometimes, they do not plan well, but usually because they cannot carry out the other two elements. SAM procedures, such as those developed for the MOPT, furnish all the guidelines necessary to quantify maintenance activities and make up work schedules, with all the necessary resources identified (labor, equipment, materials). The thing that SAM's cannot do is to insure that all the resources are available for those schedules: That materials are purchased and delivered, or produced, hauled and stockpiled; that machines are repaired, serviced and moved into place; that workers are shifted smoothly from one site to the next, without confusion or delay. The most common problem in developing countries is that materials (asphalt, cement, crushed aggregates, etc.) fuels, and repair and service elements for equipment cannot be obtained in a timely

way because of lack of money, or because of the reluctance of suppliers to furnish these things when payment is, or has been, long delayed. This leads to makeshift methods in maintenance, broken schedules, and wasted time. Field supervisors are then reduced to "getting the men out of the yard in the morning", to keeping them employed in some kind of substitute useful work, or some activity which, hopefully, will give the appearance of being useful.

One of the crucial advantages of having maintenance done by the private sector is that the marshalling of resources is the responsibility of the contractor and, if he is a qualified contractor, he can be depended on to do it well. His continued existence in the general field of contracting depends on his ability to do so. He has to hire reasonably competent people, but he must also have machines that run and funds and credit for operating. If there is financing available to do maintenance by contract, then the problems of resource supply are solved.

In such a case, the benefit to road users is very large. It consists not only of general savings in vehicle operating costs through better surfaces, fewer time delays and less vehicle damage, there is also better preservation of the public investment in roads, and the number of accidents is decreased.

Regarding optimal service level, it has been stated previously that this concept is elusive. With good information it is possible to distinguish changes in VOC as the condition of the road travelway varies, related to different amounts of maintenance effort. This requires good VOC tables and a means of measuring surface quality (roughness), unless it is to be estimated. To calibrate the analysis model, several fairly long test sections have to be established, with some of them given low maintenance and allowed to deteriorate to poor condition. A measuring device is needed to quantify the condition, and accurate maintenance cost data is then necessary for economic analysis to indicate the best balance between the two sets of costs.

For deteriorating pavements, with the investment in jeopardy, this doesn't seem to have much meaning. For gravel and earth roads, the ranges in roughness are more pronounced and, consequently, so are those of the VOC, but since traffic volumes are almost always lower, the total monetary effects of maintenance imbalance (more of less than optimum) are not large. Mechanical quantification of roughness is even more important than for pavements, but is also more difficult. In most circumstances, unpaved roads have to be re-shaped twice per year to keep them usable. This sets the minimum

maintenance level. In rainy climates, more frequent maintenance may be needed just to repair the damages from erosion of the surface, especially in rough topography. However, there may be few times during the year when a combination of clear weather and acceptable moisture content in the travelway (and ditches) will permit re-shaping to a good quality standard. In most of Costa Rica, there will be little chance to schedule surface maintenance activities for best economic balance.

B. Permanent Effects of the Project

The demonstration project has had a significant impact in Costa Rica, causing important changes which will have effects for many years. Some of them are discussed below.

1. Physical Improvements

The roads in the sub-project areas are in much better condition than before, with functioning drainage, improved travelways, augmented traffic capacities (some much increased), and all-weather standards. While continuing maintenance will be neccessary to preserve these effects, they will in any case be felt for many years.

2. Financial Effects

Reduced vehicle operating costs, although not measured closely, can be assumed in all three areas. The contribution to coffee production in the southern zone is assessed in the engineers' report for 1985. The recycling project has added to the life of the pavements which were treated, at a lower cost than for normal reinforcement. These effects are also transitory, and may not be repeated, but the savings and gains to date have been real, and to that extent they are permanent.

3. Demonstration Effects

It has been shown that maintenance can be organized and carried out promptly, that there are no mysteries in getting regular work done. The rehabilitation and strengthening of existing pavements by recycling has been demonstrated successfully, using established procedures and equipment. In the author's opinion, the standards of joint and edge finish on that project are entirely acceptable, and the surface appearance is good.

4. Effects on the MOPT

The government maintenance forces have recognized the significance of the project. If the ordinary employees of the MOPT see a threat to their future security, they also see what can be accomplished

if energy is applied and good procedures are followed. High officials of the MOPT maintenance division have stated that the project has demonstrated to the public and to their own superiors that maintenance can be done if the resources are supplied, if the agency is supported with funding, and if their programs are not interrupted by higher officials dispersing their efforts to non-system projects. The Minister has said publicly that the existing level of maintenance by contract will be increased, using MOPT funds.

5. Effects on Local Governments

Cantonal governments in the two maintenance sub-project areas have reacted with enthusiasm, and with real assistance and participation. They recognize not only the value of the work done, but also the possibility of better road maintenance in the future, through continued contracting or by change in the national agency. These enhanced local interests in better maintenance are not likely to disappear soon.

6. Effects on the General Public

Because the demonstration project has been widely publicized, there is now a general interest in finding ways to improved maintenance. The

recycling project, and its good results, were observed by thousands of motorists in the central zone. The poor state of the main highways has been a source of complaint against the government for years, and the chance for partial solution is now seen.

C. Local Capacities Being Developed

The enthusiasm and participation of the cantonal governments in the Demonstration Project has led to increases in their efforts to improve the condition of town streets and of rural roads not in the programs. The local entities receive some allocated funds from the national governments, but in very limited amounts. Through assistance channels of various kinds the cantons have acquired some basic equipment such as trucks and loaders. Interest has quickened and been given direction in the two sub-project areas, and also in other cantons which are aware of these programs. Some results can be listed.

1. Increased Awareness

Townspeople and rural residents have gained a better definition of the MOPT networks and responsibilities, and of their own relationship with the national agencies. Maintenance

obligations have been established, along with a desire to see better care of the roads.

2. Political Experience

Local leaders have had increased contact with MOPT officials, to the level of minister, in local meetings and in visits to the capital. By means of the public-oriented activities of the ACCCR and the Executive Engineers and Inspectors, local leaders have gained experience in forming and serving on committees, arriving at decisions, considering technical matters and representing their communities and other groupings.

3. Better Knowledge

Residents and officials have certainly gained in knowledge of road elements, maintenance activities and work methods. They will be better qualified critics of poor work, supporters perhaps of effective methods, and more productive in their own, local programs. Area dwellers who have been employed by the project contractors have been trained in more efficient methods, and given a view of good equipment and how it is cared for.

4. <u>Management Gains</u>

Through the examples of the ACCCR project manager and the engineering consultants, cantonal leaders should be much more capable in making up programs and estimating money and time requirements. They are no doubt more informed about outside sources of funds, and how they can draw on their own resources.

The gains mentioned above will not be lost no matter what happens with the current Demonstration Project. Knowledge and experience are always useful, and are always used in some manner. They lead to setting goals and to efforts to get things done. These should be encouraged, through organized programs and local meetings to convey information and discuss local conditions. Costa Rica lacks an effective program of providing basic maintenance for rural roads not under the jurisdiction of the MOPT. Some facets of the ACCCR programs offer a guide to progress in that direction.

Attachments

ATTACHMENT NO. 1

Sources

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3/ Mantenimiento Vial. Resumen ejecutivo de la situacion actual del Ministerio de Obras Publicas. Ing. Ricardo Echandi Z., BEL Ingenieria S.A., Abril, 1986. (Spanish)

4/ ACCCR Informe de Labores 1985, Programa Demostrativo de Mantenimiento y Rehabilitacion de Carreteras, Ing. Carlos Hernandez, Gerente de Proyecto. Prepared in early 1986 and updated in July, 1986. (Spanish)

5/ Informe Anual de Labores, Programa Demostrativo de Mantenimiento de Carreteras por Contrato. BEL Ingenieria S.A. enero de 1986. (Spanish)

6/ An Appraisal of Highway Maintenance by Contract in Developing Countries, by Clell Harral and Ernesto Henriod, The World Bank, and Peter Graziano, Consultant. June, 1985 (Second Edition of the report dated March 3, 1982).

ATTACHMENT NO. 2

CONTRIBUTION TO THE EVALUATION

1. Ing. Carlos E. Hernandez

   Title: Executive Director, ACCCR, and Manager of the "Demonstration Project on Road Maintenance." Member of the Construction Committee of the Project.

   Field: Civil engineering and management, contract construction of highways and other, maintenance by contract.

   Role: Presentation of entire project history; organizer-guide of field trips; arranged contacts; offered and gathered new information; participated in most discussions; generous with his time and facilities.

2. Ing. Ricardo Echandi Z.

   Title: Principal Partner of BEL Ingenieria S.A., engineering consultants to the Demonstration Project.

   Field: Civil engineering, highway engineering, maintenance management.

   Role: Antecedents of project; details of BEL-Jorgensen System for the Administration of Maintenance (SAM) developed for MOPT; discussions of Costa Rica history, road development, MOPT structure and operations; provided data and facilities.

3. Ing. Manrique Lara T.

   Title: Vice President, BEL Ingenieria S.A. Main consultant to the project.

   Field: Civil engineering, highway engineering, maintenance management.

   Role: Collection and presentation of project information; explanation of technical details; participation in most discussions and some field travel; provided extensive data and assistance.

4. Mr. H. Rodriguez

Title: Engineer and Project Manager for AID. Member of the Construction Committee for the Demonstration Project.

Field: Engineering. Manager of AID Projects Office, Costa Rica.

Role: Administrator of project for AID; participated in discussions of project details and results.

5. Ing. Marcos Tioli

Title: Director, Direccion General de Mantenimiento Vial (DGMV) of the Ministerio de Obras Publicas y Transportes (MOPT), Costa Rica.

Field: Highway Maintenance Administration.

Role: Discussion of MOPT organization, maintenance and rehabilitation; exchange on programs and problems; discussion of SAM procedures developed by consultants.

6. Ing. Enrique Molina

Title: Sub-Director, Direccion General de Mantenimento Vial, of MOPT. Member, Construction Committee of the Demonstration Project on Road Maintenance.

Field: Highway maintenance, administration and operations.

Role: Discussion of Costa Rican highway maintenance, and management details of the Demonstration Project.

7. J.W. Bonniville

Title: Vice President, Wilbur Smith and Associates, Columbia, S.C.

Field: Engineering. Administrator of international consultant services.

Role: General administration of the evaluation. Discussion of scope and substance.

8. H. Jack Leonard

Title: Principal Associate, Wilbur Smith and Associates, Columbia, S.C.

Field: Engineering. Administrator of international consultant projects.

Role: Manager of the evaluation study. Discussion of study procedure and participant relationships.

9. Mr. Robert J. Zuelsdorf

Title: Transportation Economist, Wilbur Smith and Associates, Columbia, S.C.

Field: Economic analysis of transportation systems and projects. Systems analysis of highway programs, including maintenance.

Role: Provided background on computer analysis of highway maintenance.

10. Author of this Evaluation Report:

H.M. Pentecost

Title: Highway Maintenance Specialist, Wilbur Smith and Associates.

Field: Maintenance management studies and maintenance operations.

In addition to the contributors listed above there were direct conversations and brief technical discussions with some contractor personnel, a few MOPT employees in the field, with Ing. Adrian Peralta of BEL Engineering (Executive Engineer of the Alajuela/Heredia part of the project), and with Mr. Alfonso Jarquin, also of BEL (Executive Inspector of the Coto Brus area of the project). Further contact included discussion with members of the ACCCR Board of Directors, during part of one of the Board's regular meetings, chaired by Mr. Rodolfo L. Arce, President.

ATTACHMENT NO. 3
Scope of Work

		Refer to Section
1.	The efficiency of the planning process for road maintenance including road inventory, ranking of road maintenance, and amount of work (level of service)	V
2.	Standards for administrative services of maintenance by contract	VI
3.	Efficiency of simplified bidding and contracting procedures	VII
4.	Efficacy of operational procedures and management controls of the contract in the field	VIII
5.	Distribution of project funds	IX
6.	Benefit to users of a well-planned contract at an optimal servicelevel	X
7.	Provide comments and specific recommendation to improve the effectiveness of the project as presently carried out	Executive Summary
8.	Identify priority areas and provide recommendations for future investment opportunities, primarly with the private sector	Executive Summary
9.	The development impact of the project. This section should clearly present the development benefits resulting from the project.	Executive Summary
10.	The project's lessons learned. These should describe the causal relationship factors that proved critical to project success or failure, including necessary political, policy, economic, social and bureaucratic preconditions within the host country and AID. These should also include a discussion of the techniques or approaches which proved most effective or had to be changed and why. Lessons relating to replicability and sustainability will be discussed.	II, and Executive Summary
11.	What project benefits are likely to be sustained after AID funding ends?	X
12.	What local institutional capacities (management, technical, financial, provisions for maintenance and the replacement of capital equipment) are being developed to continue project benefits. Will they be in place once AID financing ends? What policy conditions are required to facilitate continued long-term impact?	X