United States Agency for International Development
Mission in El Salvador

INFRASTRUCTURE SECTOR ASSESSMENT

Final Report

Volume II
Transportation

Tech International, Inc.
Louis Berger International, Inc.
Edificaciones Choussy, S.A. de C.V.

February 1990

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

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INFRASTRUCTURE

SECTOR ASSESSMENT

VOLUMES

VOLUME I	SUMMARY REPORT
VOLUME II	TRANSPORTATION
VOLUME III	WATER SUPPLY & SANITATION
VOLUME IV	ELECTRIC POWER & TELECOMMUNICATIONS

This study is being prepared under contract between USAID/El Salvador and Tech International, Inc. under contract number 519-0177-C-00-9503-01.

The Consultants wish to thank the generous assistance and contributions provided by the staff of USAID/Salvador, the Government of El Salvador, its agencies and private firms. They were extremely helpful in providing data and clear explanations of Salvador and its infrastructure sector. Nevertheless, the Consultants remain solely responsible for all data, opinions, conclusions and recommendations.

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GLOSSARY

AASHO	American Association of State Highway Officials (now AASHTO)
AASHTO	Amrican Association of State Highway Officials
ADT	Average daily traffic
AIES	International Airport of El Salvador
ASTM	American Society of Testing Materials
BAILEY	Type of Temporary Bridge
BENKELMAN	Type of beam used to measure pavement deflections
CABEI	Central American Bank for Economic Integration
CBR	California bearing ratio, measure of soil strength used for pavement design
CEPA	Autonomous Executive Commission for Ports
CONADES	Commison Nacional de Los Desplazados
DGC	General Directorate for Roads
DHV	Design hour volume
EEC	European Economic Community
ESAL	Equivalent standard axle loads, used in traffic forecasting and pavement design
FENADESAL	Salvadoran National Railway System
FHWA	Federal Highway Administrtion
HDM-III	Highway Design and Maintenance Standards - III, World Bank Software package for highway engineering/enconomic analysis
IRR	Internal rate of return
KFW	Kreditanstalt fur Wiederaufblau
VAR	Vehicle availability ratio

SUMMARY AND RECOMMENDATIONS

a. Sector Planning

This sector lacks the proper planning to set its overall objectives and priorities. There is a transport committee headed by the Minister of Public Works with limited authority to carry out sector planning. There is a need for greater intermodal coordination in establishing and implementing tariff policies and modal financing.

Recommendations # 1

There is a need for a simplified national transport study designed to address.

- strengthening of planning mechanisms
- the preparation of a long range overview of regionalized development opportunities, including the potential impact of peace and changes upon Central American transport demand
- an analysis of sector finance
- a study of intermodal freight and passenger demand at the corridor level
- the definition of the roles of major highways, railways, ports and airports, and related studies
- financial policy and investment recommendations.

The study would not necessarily go below the corridor level. Specific projects would not be analyzed unless required.

The transport committee could be given the authority to define and manage this study.

b. MOP Organization

MOP does not have an efficient organization due to the following factors:

- inadequate staffing (too many people overall and lack of trained personnel in some specific areas), drawing away resources from achieving MOP objectives
- lack of internal and external controls

- weak procurement.

Recommendation # 2

We recommend a management study of MOP designed to address personnel levels by department and their possible reduction, the definition of job descriptions, training requirements and operating procedures.

c. Five-Year and Six-Year Highway Plans

(1) Rehabilitation and Reconstruction

The road network is in poor condition. Furthermore, several segments experience delays due to congestion.

Recommendation # 3

As presented in Section 9 (Consolidated Project Recommendations), we propose:

Funds be allotted to rehabilitation/reconstruction work for both paved and unpaved roads. The proposed US $197 million 5-year program will upgrade 291 km and rehabilitate 1,602 km of roads. This amount covers expected road improvement needs to the year 2000.

The Consultants also propose a six-year road rehabilitation program for 1995 - 2000. This program should address rehabilitation needs that were not included in the first five-year plan. Total expenditure should amount to $170 million.

(2) Maintenance

Resources for routine and major maintenance needs are scarce, and as a result maintenance is usually deferred. The limited available resources are inefficiently used. Major maintenance depends on international financing (roughly three quarters of current investment). Roads should be systematically maintained at adequate service levels.

Recommendation # 4

There is a need to:

- spend effectively twice as much on routine maintenance
- provide technical assistance and training in the areas of pavement management, contract administration and both routine and major maintenance activities
- the development of an integrated highway pavement and

maintenance management system. The proposed system should help in managing road maintenance and rehabilitation.

(3) Bridges

About one fourth of the Salvadoran bridges (69 out of 289), require repair or replacement.

Recommendation # 5

Due to more immediate and cost effective highway needs, the permanent replacement of damaged bridges should be postponed. Meanwhile, a bridge management system should be implemented for programming purposes. ISA Consultants have included US $21.8 million is recommended for bridge reconstruction/ rehabilitation for the 1995-2000 period based on a tentative list prepared by the consultants.

d. Rail

Railway traffic volumes are low due to the reduced production of traditional cargoes, safety, reliability and indirect subsidy to the highway sector. Due to the war, prospects for improvement are poor. The District 1 line (San Salvador - La Union) has the least prospects for significant improvement.

There is a lack of long-term goals, but two investment projects are under consideration. There are the Santa Ana - Santa Lucia - Guatemalan Border line and the Cutuco - Pueblo Viejo extension.

Recommendation # 6

No investments should be made without further study. Little can be done as long as the conflict continues.

The proposed national transportation study should also address the following issues:

- feasibility of the railway system
- value of the railway as an alternative to highways
- geopolitical importance of the railway
- review of the feasibility of projects now under consideration
- types of cargo on which the railway should concentrate
- acceptable levels of subsidy for the railway.

Due to the decline in the railway's market share before and during the conflict, revenues represent a very small share of operating cost, while personnel has not declined proportionately.

Recommendation # 7

After completion of the national transport study, we recommend a management study of FENADESAL in order to:

- determine personnel needs and actions for its reduction
- define job descriptions
- help create planning and marketing departments, develop central train dispatching and consolidate shops.

Technical assistance should be provided at the completion of this study.

e. Marine Ports

The steel cells of Pier "A" at the Port of Acajutla are highly corroded. This should seriously affect the pier's structural stability in the medium-term, precluding port operations.

Recommendation # 8

Repair Pier "A" steel cells ($15,000,000). On an emergency basis visibly-deteriorated cells should be filled with concrete or sand.

The port has limited capacity to handle more cargo. This is due to current port configuration rather than the lack of equipment or piers; as traffic increases (particularly container traffic), this problem will become critical.

Recommendation # 9

A port study should be conducted to develop a new pier layout or container pier according to modern port technology. The study and lay-out concept in Volume II provides guidelines for this project. Meanwhile, existing equipment should be rehabilitated, but no major investments should take place.

In addition to Acajutla, El Salvador has two secondary ports in the East, Cutuco and Punta Gorda, with very low traffic volumes.

Recommendation # 10

The proposed national transportation study should also address:

- Feasibility of Cutuco
- possible need for an alternative port to Acajutla
- possible need for a port to help revitalize the Salvadoran East
- Cutuco's relationship with Punta Gorda

f. Airports

The International Airport of El Salvador, is in good shape, except for its pavement structures (runways, taxiways and aprons). There is a need to improve its aeronavigation radio-control equipment and to obtain a new back-up electricity generator.

Recommendations # 11

ISA Consultants recommend:

- the rehabilitation of the pavement structure.
- New aeronavigation radio equipment and a generator.

The terminal and pavement infrastructure of the alternative San Salvador airport of Ilopango's have deteriorated. Heavier aircraft loads are for military traffic, while civilian traffic is almost exclusively for general aviation. Despite its closeness to the San Bartolo Free Zone, the altitude difference makes Ilopango non-competitive in the cargo market.

Recommendation # 12

Ilopango needs rehabilitation and repair. Civilian share should be estimated and its financial feasibility evaluated. At any rate, it is a low priority investment, and not recommended at this time.

II. TRANSPORTATION

a. General

The transportation sector involves a large number of public and private institutions. Section II.A.1 concentrates on institutions in the highway subsector, and Section II.B.1 describes CEPA, the institution in charge, of the rail, port and airport subsectors.

The present administration of El Salvador is in the process of redefining a set of policies and objectives for the transportation sector. The last public source of policy framework and development objectives for the transportation sector is found in "National Policy for the Transportation Subsector" (Politica Nacional del Subsector Transporte), prepared by the past administration. This report summarizes the sector's status for 1984 and 1985 and provides guidelines for its future development.

Transportation services are currently insufficient to meet demands. Highways have suffered from ten years of direct and indirect damages by insurgents and deferred maintenance. The railway system is operating well below its theoretical capacity. Heavy guerrilla attacks and lack of track maintenance prevent greater utilization of this mode, placing an even heavier burden on the road network.

b. Regional Overview

The Republic of El Salvador is the only Central American country without shores on the Atlantic Ocean. As a result of the country's (see Figure II.1) Atlantic overland trade, one of the functions of the transport network is to provide access to Eastern U.S. and Europe. However, the expansion of trade with the Pacific, especially Asia, will tend to shift this orientation.

As a result of the country's location, trade between other countries in the region does not necessarily transit through the country, especially in war time.

There are two important transport corridors running from East to West. The first extends along the Pacific shore through the Port of Acajutla and Cutuco. The second corridor runs through the center of the country from Guatemala City to Honduras, with a branch leading to the Atlantic Basin through the Port of Santo Tomas de Castilla in Guatemala. Of less importance is the corridor extending to the Atlantic basin

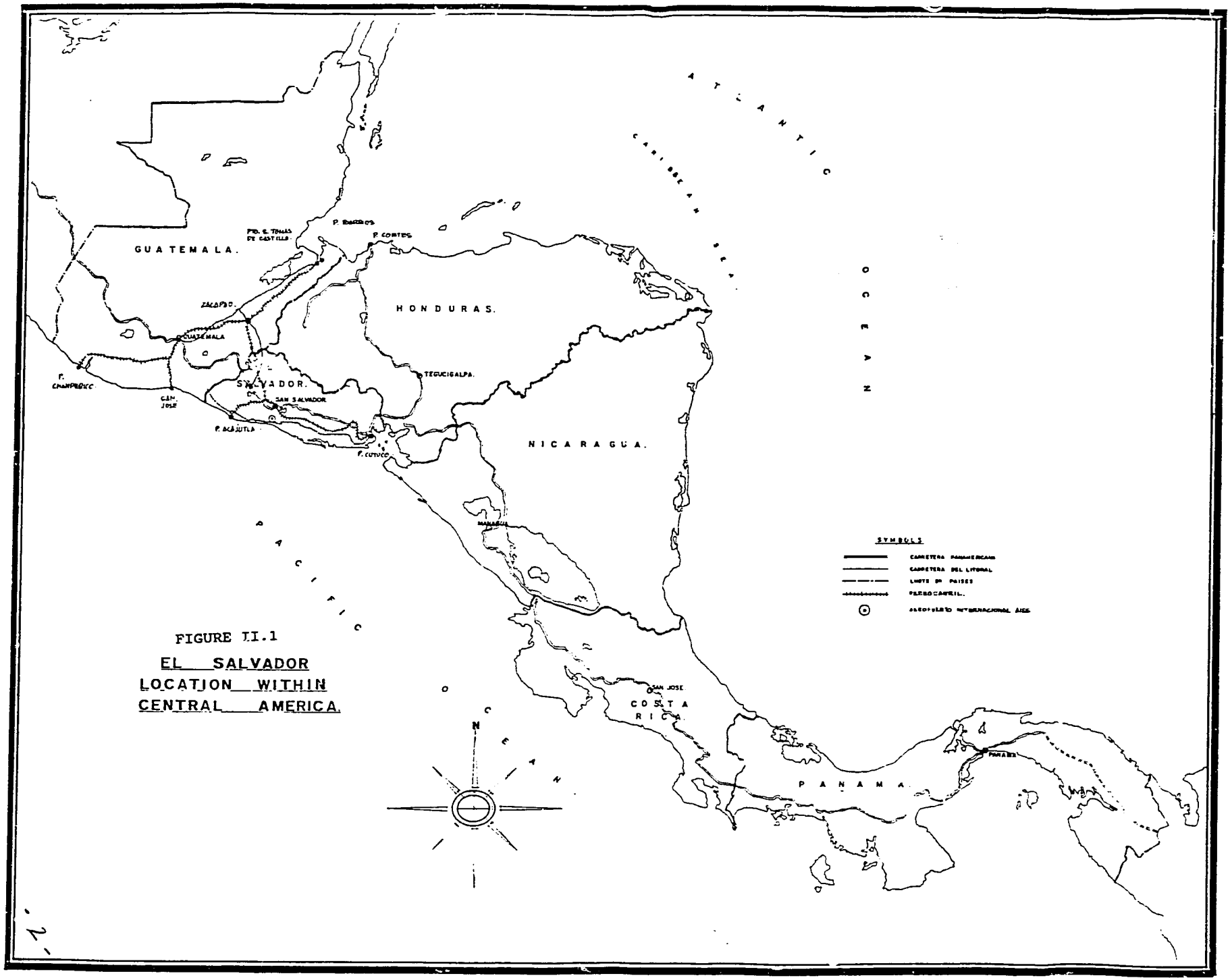


FIGURE II.1

EL SALVADOR
LOCATION WITHIN
CENTRAL AMERICA

through the Port of Cortez in Honduras.

The Pan American and Coastal Highways, as well as the Port of Acajutla, constitute the basic infrastructure of these corridors.

Currently the railroad permits a way out to the Pacific Basin through the Port of Acajutla and Cutuco in El Salvador, although this could be extended to other Pacific and Atlantic ports in Guatemala, who have a better infrastructure for handling containers. Given satisfactory bilateral agreements.

The present study covers the analysis of these main transport corridors, however, it does not consider urban bypasses along these corridors. These projects may be feasible as traffic grows in San Salvador, but they should require higher investment levels.

c. Sector Planning

The agencies involved with transport are shown in Figure II.2. Transportation sector planning and coordination is lacking in the country.

The Ministry of Public Works is responsible for the planning, construction and maintenance of the country's highway infrastructure. Because of the size of its staff and the budgets involved, MOP is the dominant institution in the transportation sector.

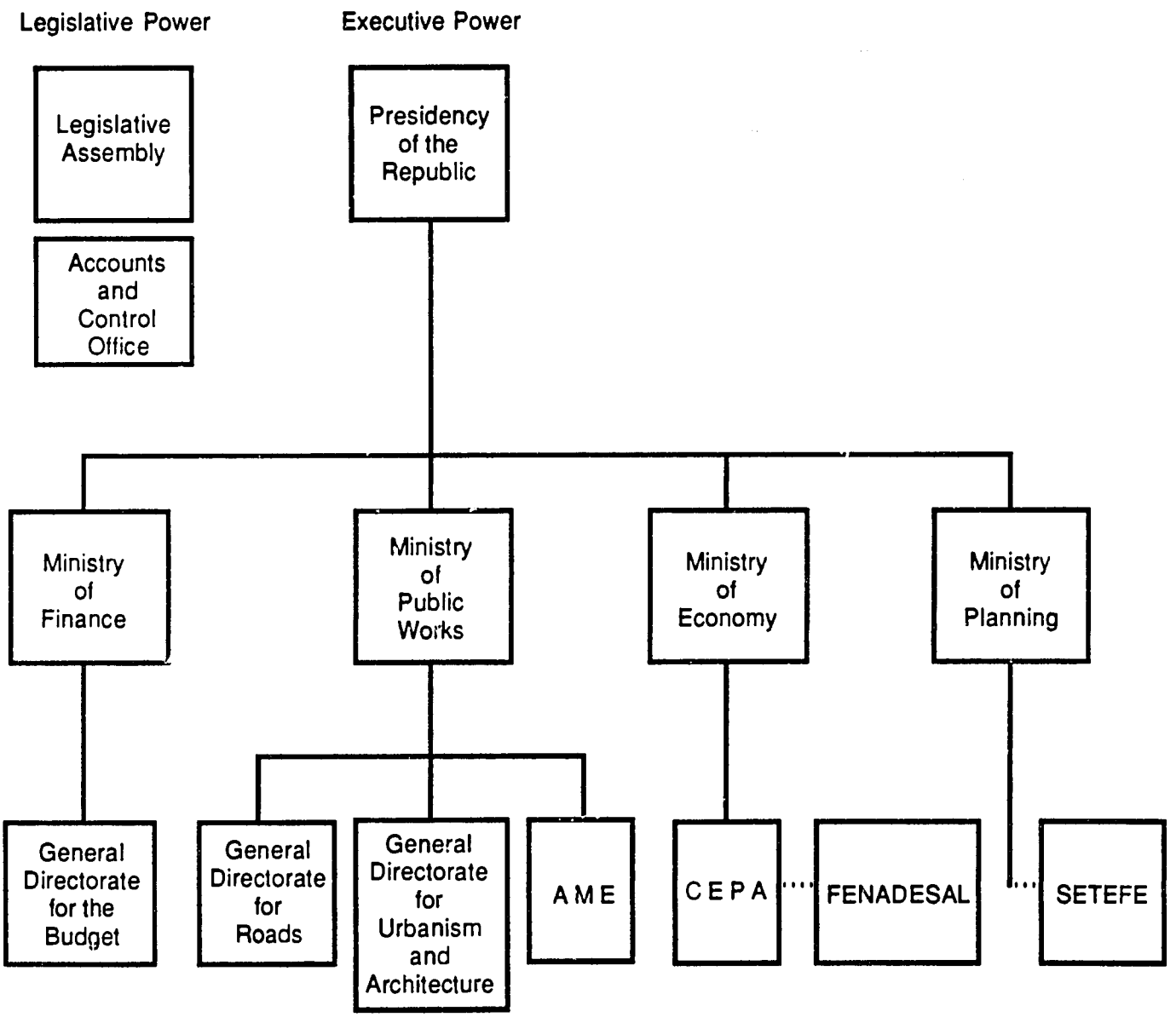
Legal truck weights and axle loads are set by a law, prepared by MOP. Public transport regulation, licensing and fee collection are under the responsibility of the General Directorate for Transportation (DGT) within the Ministry of Economy. The police, through its Transit Department, issues vehicle registration and driver licenses.

According to Salvadoran practice, taxes, including fuel tax, are set by the Ministry of Finance. Note that tolls are considered a tax, and therefore, regulated by the Ministry of Finance. Had they been considered a tariff, the Ministry of Economy would have had responsibility.

There is a need for greater intermodal coordination in establishing and implementing tax, tariff policies and modal financing. Also, there is a need to set overall sector objectives which would lead to the selection of priority investments. An intermodal transport committee already exists and is headed by the Ministry of Public Works, but has limited authority.

Figure II.2

Agencies Concerned with Transport Sector



The GOES should strengthen this Transport Committee by charging it with the responsibilities mentioned above.

A. HIGHWAYS

1. Introduction

a. Overall Institutional Description

At present, institutions in the highway subsector do not perform efficiently, due in part to the war and earthquake, but mostly because of lack of coordination and resources. The road system is in poor condition and even national priority roads, such as the airport road, are not maintained to acceptable standards. Flaws were observed in design and construction of the highway infrastructure, despite the fact that national engineering and construction capabilities are among the best in Central America.

b. The Ministry of Public Works (MOP)

(1) General

The Ministry of Public Works (MOP) is in charge of planning, construction and maintenance of the highway infrastructure. The Ministry also participates in the development of other types of infrastructure. It comprises the General Directorate for Roads (DGC), the Directorate for Urban Planning and Architecture (DUA), and the Administration for Machinery and Equipment (AME).

In the preparation of project AID-320, an institutional evaluation of MOP was carried out by Booz-Allen & Hamilton. Booz-Allen has "serious doubts about (MOP's) present ability to effectively manage AID project 320". Reasons for this conclusion include:

- lack of internal controls and absence of internal or external audits
- weaknesses in the procurement area
- weak operative performance and inadequate staffing.

The latter point is emphasized by Booz-Allen and rightly receives most attention in its study. Staffing is MOP's main constraint. Any institutional change which does not affect

staffing will not significantly improve MOP's performance.

The situation is so critical that it has already led to a self-perpetuating cycle. For example, because of MOP's poor record, financing organizations demand the creation of independent units for their projects, such as AME or the "coordinating units". These units permit existing MOP hierarchy to be by-passed, to ensure project success. They also add to an already high number of staff and to the lack of coordination within the ministry.

MOP will only be in a position to reject such demands when it has demonstrated its capacity to manage projects and funds effectively and efficiently. It should strive to reach such a status in the shortest possible time.

(2) Human Resources

In comparison to US standards, MOP employs about five times as many people per km, without being able to maintain its network. For example, DGC has a field staff of between 7 and 8,000 people. The state of Indiana has about 1,500 people for a similar network length.

Overstaffing such as this draws resources away from the performance of the tasks for which MOP was created. In effect, MOP is a tool of the government's social policy instead of the government's infrastructure development policy. The effects are:

- absence of qualified MOP personnel. Because it cannot afford to pay competitive salaries. Management feels that despite its large payroll, they still lack human resources

- little career advancement possibilities for MOP staff

- the lack of resources for equipment and materials

- almost no flexibility in budgeting.

The solution to this problem cannot be an easy one. MOP employs over 17,000 people which means it directly provides revenue for about 75,000 people. Too sudden a change could result in serious political problems.

MOP should integrate its human resource policy into the country's infrastructure development plan. Most project work, whether rehabilitation or construction, should be contracted out. This will increase staffing requirements of the private sector, offering employment alternatives to MOP personnel.

(3) Institutional Changes at the DGC

The DGC is the directorate in charge of interurban highways. Its functions include the planning, construction and maintenance of public highways in the country.

As part of the reform promoted by the present Salvadoran administration, the DGC was recently restructured. The organizational charts before and after the restructuring are presented in Figures II.A.1 and II.A.2. The restructuring consisted mainly of the addition of a hierarchical layer between the director and the department heads. Departments have been grouped into what is now called divisions.

The new divisions could permit the concentration of several departments' activities into single-unit activities, facilitating a reduction in staff numbers. For example, all the functions in the planning division can be undertaken by individuals with the same background. A smaller core staff of well trained engineers, planners and economists could handle planning, project development and project supervision.

Even if the departments have different functions, as is the case of construction and maintenance, many of the top engineers can operate at a divisional level, being assigned to tasks in both departments based on need. This would add flexibility to the system and reduce staff requirements.

However, if none of the above is carried out, MOP will have added one more layer to its structure, with its accompanying costs in personnel, office space and vehicles, making worse the current organizational problem.

(4) Pavement Management at DGC

DGC lacks an adequate system for road maintenance and rehabilitation management. The Maintenance and Operation Division has been performing planning programming and evaluation functions, as well as executing maintenance work. Alternative arrangements may be appropriate and should be studied, such as a centralized pavement management unit, at a division level within the DGC. This unit could be in charge of pavement evaluation, setting priorities for rehabilitation work, programming and controlling rehabilitation work, and traffic load control.

An integrated pavement and management system should be developed to help in these activities. The pavement management component should help in rehabilitation work planning and decision making, and could be a responsibility of a future pavement management unit.

The pavement in management sub-system should include systematic pavement evaluation (functional and structural, with the use of non-destructive testing devices, such as Benkelman beams) and a prioritization routine for selecting

Figure II.A.1

Previous DGC Organization Chart

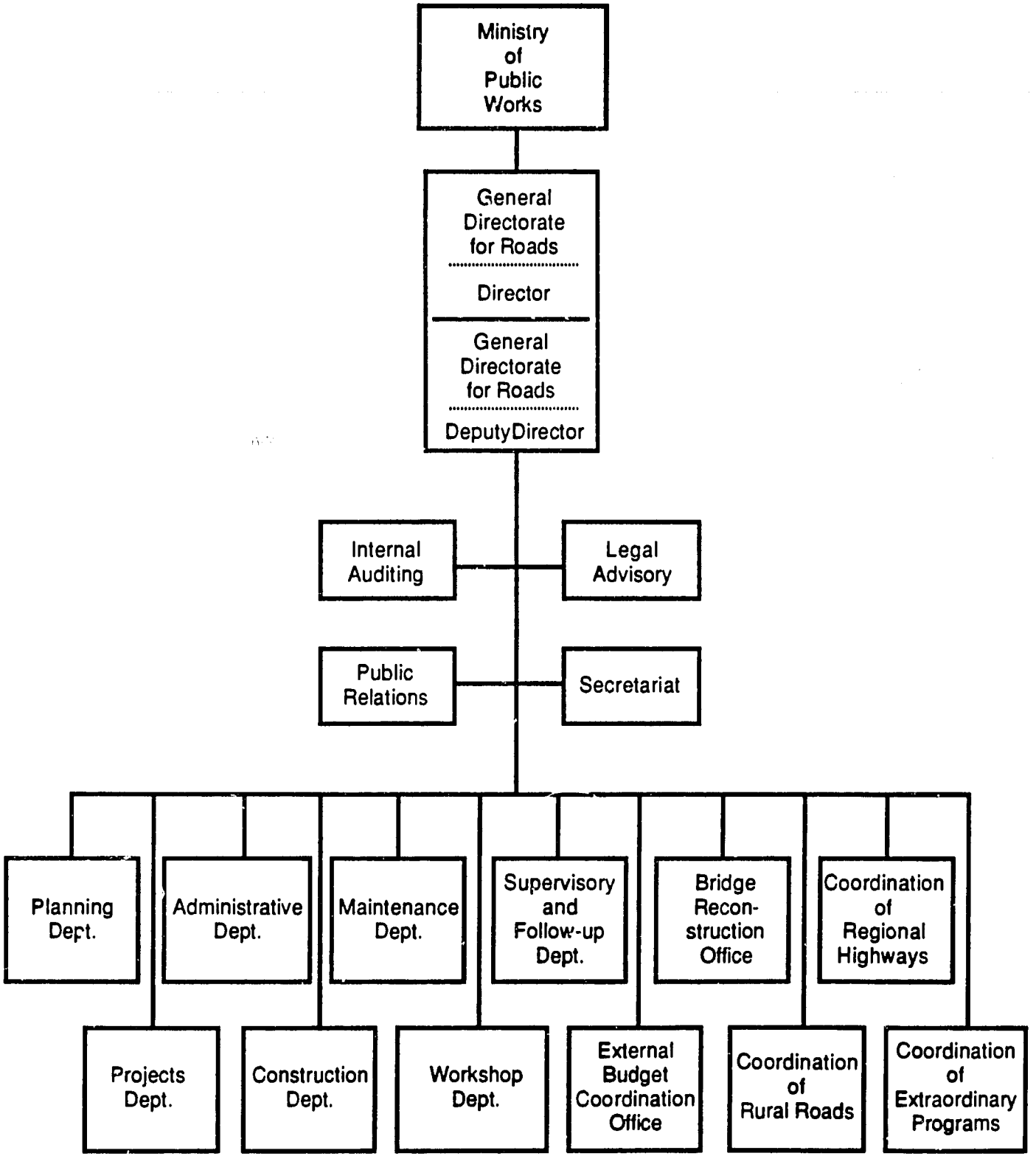
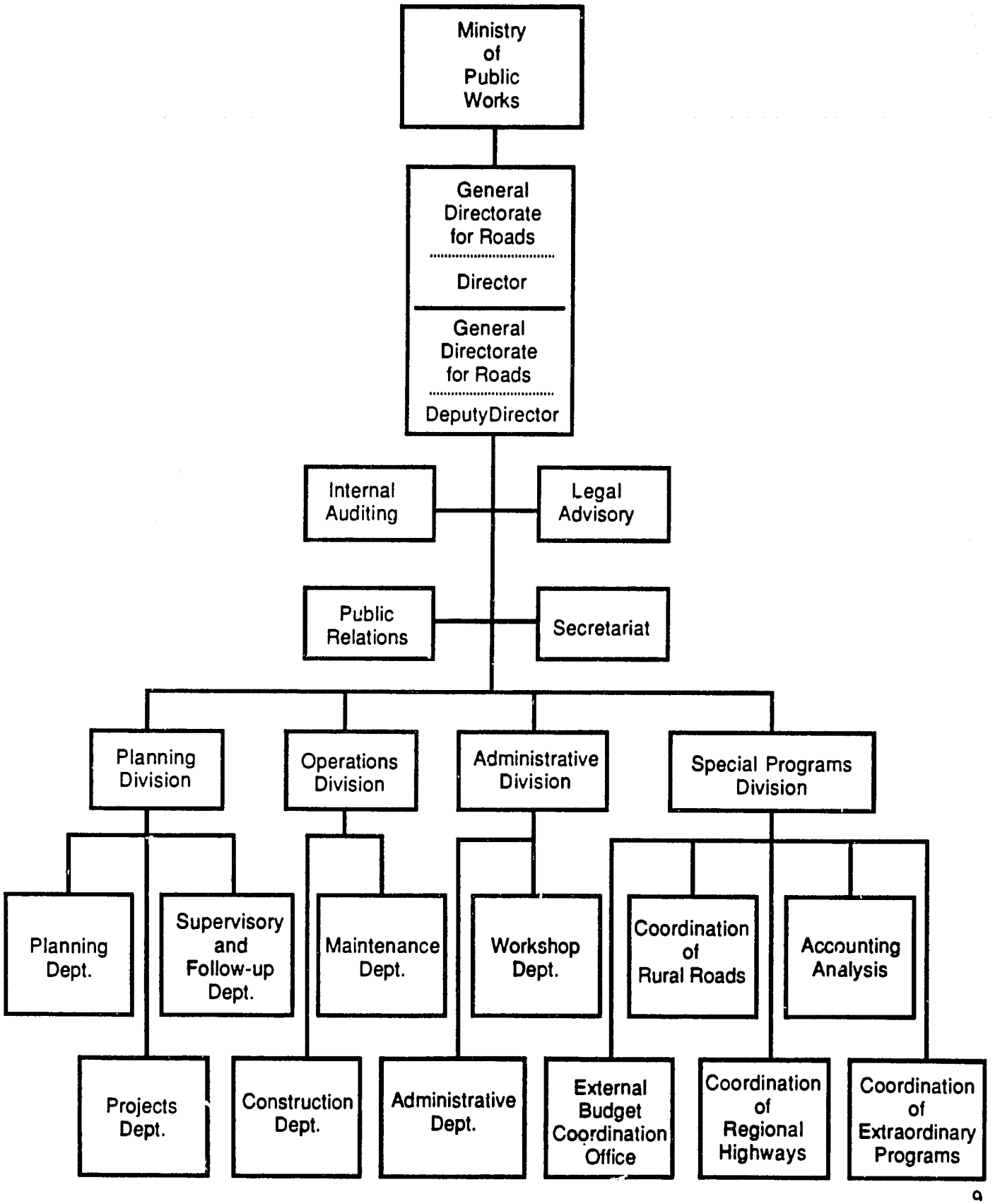


Figure II.A.2

Present DGC Organization Chart



rehabilitation project candidates.

The maintenance management sub-system should be operated by staff at the Maintenance and Operations Division. This sub-system should address all phases of routine maintenance work: planning, programming, execution and control. Efficient administration of resources, coupled with availability of spares from either AME or the DGC, should prevent bottlenecks.

c. Assessment Approach

The study's approach to highway assessment includes:

- a review of the overall road sector
- a selection of part of the network for more detailed evaluation.

2. Inventory of Facilities

a. Physical Inventory

This section presents a definition and description of the Salvadoran road network. The present road classification scheme is described together with typical cross sections. Current pavement and roadside conditions are analyzed in relation to the network's capacity to adequately handle current and expected traffic loads.

ISA proposes to analyze a road network of approximately 9,600 km, which comprises all interurban roads being maintained by the DGC. Table II.A.1 shows the network by class and location. Table II.A.2 presents the portion of the national highway network maintained by the DGC, broken down by paved and unpaved roads. Table II.A.3 summarizes changes in the network over time, by different road categories.

DGC classifies roads by means of an eight-character alphanumeric code. Table II.A.4 shows an explanation and an example of these codes. A complete inventory of interurban roads has been provided separately.

The study includes only interurban highways, as requested in the terms of reference. Urban roads, including urban segments of interurban roads, are under the jurisdiction of the Directorate for Urban Planning and Architecture (Direccion de Urbanismo y Arquitectura - DUA -) and are not included in this infrastructure assessment.

TABLE II.A.1

1989 SALVADORAN ROADWAY NETWORK

(INCLUDING LOCAL ACCESS ROADS)

DEPARTMENT	TOTAL LENGTH (KILOMETERS)	HIGHWAYS				ROADWAYS		
		SPECIAL	PRIMARY	SECONDARY	TERTIARY	RURAL (A)	RURAL (B)	LOCAL ACCESS
AHUACHAPAN	982.91	0.00	39.16	41.20	150.35	130.00	352.00	270.20
SANTA ANA	1,134.39	24.79	59.90	104.26	52.14	165.80	360.00	367.50
SONSONATE	858.02	0.00	87.80	81.34	88.78	86.80	193.40	319.90
LA LIBERTAD	876.35	35.00	104.00	38.00	183.70	89.40	172.75	253.50
CHALATENANGO	1,078.70	0.00	37.00	60.64	180.96	171.80	367.10	261.20
SAN SALVADOR	638.85	27.40	0.00	129.10	62.15	92.40	255.10	72.70
CUSCATLAN	732.42	0.00	0.00	51.70	83.65	79.43	377.33	140.31
CABANAS	852.78	0.00	0.00	42.52	117.66	82.90	373.30	236.40
SAN VICENTE	676.70	0.00	14.40	82.55	154.40	76.65	227.30	121.40
LA PAZ	967.81	20.05	36.00	85.42	109.24	130.60	494.60	91.90
USULUTAN	1,065.90	0.00	42.00	103.60	164.30	194.00	384.70	177.30
SAN MIGUEL	925.24	0.00	42.34	135.97	110.30	321.79	270.20	44.64
MORAZAN	519.80	0.00	14.00	58.20	125.50	22.90	230.85	68.35
LA UNION	943.30	0.00	101.10	42.70	153.40	62.20	316.30	267.60
TOTAL (Km)	12,253.17	107.24	577.70	1,057.20	1,736.53	1,706.67	4,374.93	2,692.90

TABLE II.A.2

1989 HIGHWAY NETWORK

MAINTAINED BY THE DGC

DEPARTMENT	TOTAL LENGTH (KILOMETERS)	PAVED HIGHWAYS			GRAVEL / EARTH ROADS			TOTAL PAVED	TOTAL UNPAVED
		SPECIAL	PRIMARY	SECONDARY	TERTIARY	RURAL (A)	RURAL (B)		
AHUACHAPAN	712.71	0.00	39.16	41.20	150.35	130.00	352.00	80.36	632.35
SANTA ANA	766.89	24.79	59.90	104.26	52.14	165.80	360.00	188.95	577.94
SONSONATE	538.12	0.00	87.80	81.34	88.78	86.80	193.40	169.14	368.98
LA LIBERTAD	622.80	35.00	104.00	38.00	183.70	89.40	172.70	177.00	445.80
CHALATENANGO	817.50	0.00	37.00	60.64	180.96	171.80	367.10	97.64	719.86
SAN SALVADOR	566.15	27.40	0.00	129.10	62.15	92.40	255.10	156.50	409.65
CUSCATLAN	592.11	0.00	0.00	51.70	83.65	79.43	377.33	51.70	540.41
CABANAS	616.38	0.00	0.00	42.52	117.66	82.90	373.30	42.52	573.86
SAN VICENTE	555.30	0.00	14.40	82.55	154.40	76.65	227.30	96.95	458.35
LA PAZ	875.91	20.05	36.00	85.42	109.24	130.60	494.60	141.47	734.44
USULUTAN	888.60	0.00	42.00	103.60	164.30	194.00	384.70	145.60	743.00
SAN MIGUEL	880.60	0.00	42.34	135.97	110.30	321.79	270.20	178.31	702.29
MORAZAN	451.45	0.00	14.00	58.20	125.50	22.90	230.85	72.20	379.25
LA UNION	675.70	0.00	101.10	42.70	153.40	62.20	316.30	143.80	531.90
TOTAL (Km)	9,560.22	107.24	577.70	1,057.20	1,736.53	1,706.67	4,374.88	1,742.14	7,818.08

TABLE II.A.3

EVOLUTION OF THE SALVADORAN ROAD NETWORK OVER TIME
(KILOMETERS)

YEAR	ROAD TYPE			
	PAVED	UNPAVED ALL-TIME	UNPAVED DRY-SEASON	TOTAL
1963	1056	3256	4215	8527
1964	1056	3256	4215	8527
1965	1113	3247	4105	8465
1966	1176	2953	4425	8554
1967	1184	3013	4444	8641
1968	1197	3016	4429	8642
1969	1207	3083	4405	8695
1970	1209	3098	4396	8703
1971	1244	4868	4622	10734
1972	1310	4905	4622	10837
1973	1373	4978	4622	10973
1974	1373	4978	4622	10973
1975	1373	4978	4622	10973
1984	1730	NA	NA	12149
1985	1705	NA	NA	12164
1986	1720	NA	NA	12164
1987	1738	NA	NA	12164
1988	1742	NA	NA	12253
1989	1742	6136	4375	12253

TABLE II. A. 4.

D. G. C. ROADWAY CODIFICATION

NUMBER	CODE	PROJECT NAME	LENGTH (Km)
3	M A 3 1 0 0 0 3 (1)(2)(3)(4)(5)(6)(7)(8)	INTERCONEXION CA:1-CA:8-SANTA ANA	17.70

(1) ALWAYS "M"

(2),(5) AND (6) VARY WITH THE DEPARTMENT IN WHICH THE ROAD IS LOCATED

(2) VARY FROM "A" TO "N"

(5) AND (6) VARY FROM "00" TO "13"

(3) ROAD CLASS; VARY FROM "1" TO "7"

1.- SPECIAL HIGHWAYS
2.- PRIMARY HIGHWAYS
3.- SECONDARY HIGHWAYS
4.- TERTIARY ROADS
5.- RURAL "A" ROADS
6.- RURAL "B" ROADS
7.- LOCAL ACCESS ROADS

(4) DEPENDING ON THE AREA OF THE COUNTRY WHERE THE ROAD LIES, VARY FROM "1" TO "3"

(7) AND (8) REPRESENT THE RECORDED ORDER OF THE ROAD WITHIN EACH MAINTENANCE DISTRICT

b. Functional Classification of Roads

As shown in Tables II.A.1 and II.A.2 the functional classification of the roadnet includes the following DGC categories (adopted by the Consultants in this study):

- Special Highways
- Primary Highways
- Secondary Highways
- Tertiary Roads
- Rural-"A" Roads
- Rural-"B" Roads
- Local-Access Roads

A definition of these categories is presented in Table II.A.5. Table II.A.6 and Figure II.A.3 show the geometric design requirements and principal characteristics of these road categories. Appendix II.A.1 presents geometric design characteristics for all highway classes.

c. Current Condition of the Network

(1) Method

Updated pavement condition survey results are necessary in providing a current picture of the road network and also estimate routine and major maintenance needs. The levels of required routine maintenance vary with road conditions. Routine maintenance "quantity standards" are a function of pavement and roadside conditions. Investment needs in pavement rehabilitation or reconstruction are a function of current functional and structural conditions as well as economic capabilities.

Basically, the objectives of pavement (functional or visual evaluations) condition surveys are to:

- Gather, process and review pavement distress information in order to forecast its future effects on road condition and to recommend appropriate corrective measures.

- Systematize, in a well-defined inventory procedure, the collection of pavement data for planning purposes.

- Define a routine maintenance work program based on current needs.

- Define a pavement condition index which summarizes a road's current condition from a road user point of view.

TABLE II.A.5

FUNCTIONAL CLASSIFICATION OF ROADS

- Special Highways (Carreteras Especiales): Divided highways with partial or full access control, typically with four or more or lanes and high geometric design standards.

- Primary Highways (Carreteras Primarias): Paved two-lane two-way roads with high design standards, with 3.65-meter lanes and 2.35-meter shoulders. These highways typically carry traffic volumes higher than 2,000 vehicles per day.

- Secondary Highways (Carreteras Secundarias): Paved two-lane two-way roads with 3.25-meter lanes and 1.50-meter shoulders. Traffic volumes are in the 500 to 2,000 vehicles-per-day range.

- Tertiary Roads (Carreteras Terciarias): Gravel two-lane two-way roads with cross-section widths of approximately 6.00 meters. These roads carry traffic volumes ranging from 100 to 500 vehicles per day.

- Rural-"A" Roads (Caminos Rurales "A"): Five-meter-wide roads, typically graveled, with traffic volumes less than 100 vehicles per day.

- Rural-"B" Roads (Caminos Rurales "B"): Five-meter-wide roads, typically earth roads, with traffic volumes less than 100 vehicles per day. Roads constructed by the Central Government which do not meet the preceding geometric requirements are nevertheless included in this category.

- Local-Access Roads (Caminos Vecinales): Earth roads constructed by local jurisdictions to provide access to local communities or farms (not included in DGC's network).

TABLE II. A. 6

CURRENT ROADWAY DESIGN STANDARD

D E S I G N S T A N D A R D S

CLASSIFICATION : PRIMARY
(A.A.D.T. > 2000)

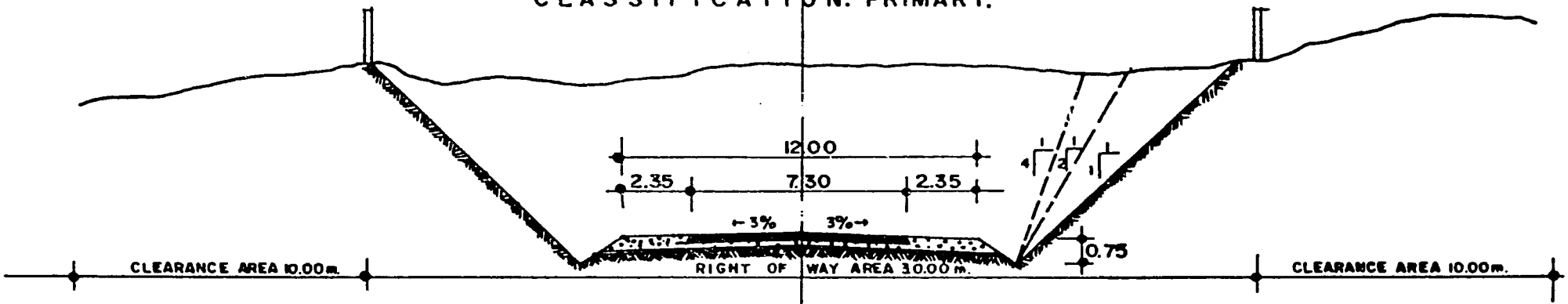
DESIGN CRITERIUM	LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAINOUS TERRAIN
DESIGN SPEED	90 k/h.	70 k/h.	50k/h.
MAXIMUM GRADE	5 %	6 %	7 %
MINIMUM RADIUS	250.00m	200.00 m.	80. 00 m.
MINIMUM DISTANCE BETWEEN HORIZONTAL CURVES	60.00m.	60.00m.	60.00m.
MINIMUM SIGHT DISTANCE	160.00m.	130.00m.	100.00m.
ROADWAY WIDTH	12.00m.	12.00 m.	12.00m.
PAVEMENT WIDTH	7.30m.	7.30m.	7.30m.
SHOULDER WIDTH	2.35m.	2.35 m.	2.35 m.
BRIDGE LANE WIDTH	7. 90m.	7.90m.	7.90m.
RIGHT OF WAY	30.00m.	30.00 m.	30.00 m.
HORIZONTAL CLEARANCE	10.00m.	10.00 m.	10.00 m.
DESIGN BRIDGE LOAD	H 20 - S 16	H 20 - S 16	H 20 - S 16
PAVEMENT TYPE	DOUBLE SURFACE OR ASPHALT CONCRETE	DOUBLE SURFACE OR ASPHALT CONCRETE	DOUBLE SURFACE OR ASPHALT CONCRETE
SHOULDER TYPE	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL.

FIGURE II. A. 3

DESIGN STANDARDS.

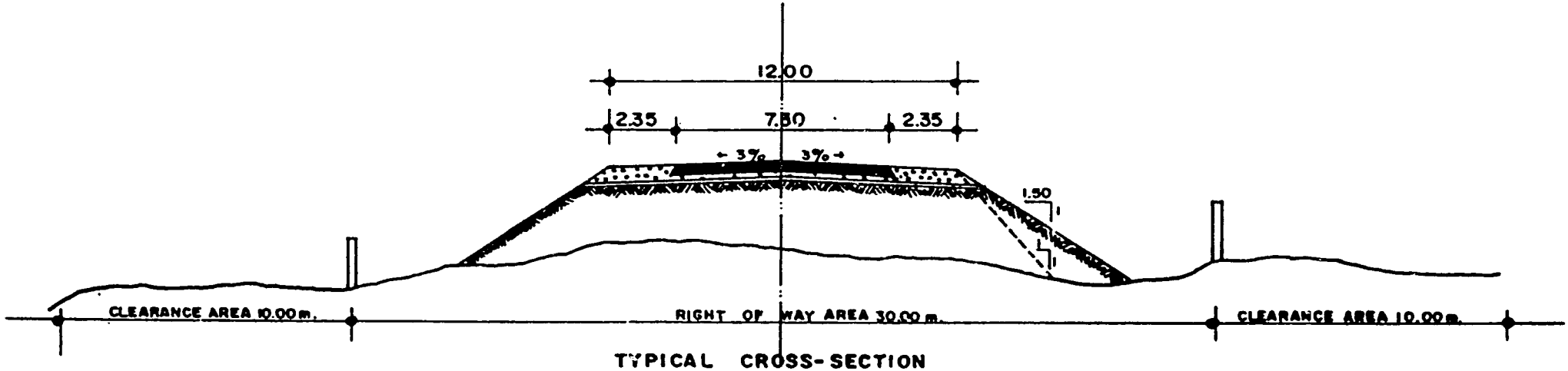
TYPICAL CROSS SECTIONS.

CLASSIFICATION: PRIMARY.



TYPICAL CROSS-SECTION
OF CUT

NOTE: - ANY TYPE OF CONSTRUCTION IS STRICTLY PROHIBITED IN THE RIGHT OF WAY AREA.
- PERMANENT CONSTRUCTION IS STRICTLY PROHIBITED IN THE CLEARANCE AREA. (DECREE No. 40.)



TYPICAL CROSS-SECTION
OF EMBANKMENT.

ALL DIMENSIONS IN METERS.
NOT TO SCALE.

- Obtain and analyze pavement condition history information (i.e., see how a road section's pavement condition history varies with time) in order to define pavement deterioration curves and establish the useful lives of different maintenance strategies.

- Optimize the use of maintenance funds, applying resources to the most critical highway sections based on their pavement condition index and other factors.

The Consultants asked the DGC Maintenance and Operations Division to estimate the road condition of all road categories in each of the 14 Salvadoran Departments. This subjective estimation was made by the departmental maintenance engineers who have intimate knowledge of the roadnet they control. The Consultants spot checked the survey results, to assure their correctness.

The project team provided the DGC M&O Division with appropriate guidelines to perform the requested road condition evaluation . Given the short time frame of this study, a three-category rating scheme was used. A description of each category follows:

- Good:
  Paved roads substantially free of defects, requiring only routine maintenance. Unpaved roads needing only routine grading and spot repairs.

- Fair:
  Paved roads having significant defects, requiring resurfacing or strengthening. Unpaved roads needing reshaping or resurfacing (regravelling) and spot repair of drainage.

- Poor:
  Paved roads with extensive defects, requiring immediate rehabilitation or reconstruction. Unpaved roads that need reconstruction and major drainage works.

(2) Network Condition

Table II.A.7 presents the results of the survey. Approximately 27 percent of the network is in good condition, 28 percent in fair condition, and 45 percent in poor condition. Paved roads are in better shape than unpaved roads. The inventory reveals that 36 percent of the paved-road length in the country is in good condition, 34 percent in fair condition, and 30 percent in poor condition. Unpaved roads have 17 percent of their length in good condition, 21 percent in fair condition and 62 percent in poor condition (see Appendix II.A.2).

TABLE II. A. 7

CURRENT CONDITION OF THE SALVADORAN

ROADWAY NETWORK BY DEPARTMENT

1/2

DEPARTMENT	GOOD (Km)	FAIR (Km)	POOR (Km)	TOTAL LENGTH (Km)
AHUACHAPAN	142.54	228.07	342.10	712.71
SANTA ANA	245.39	237.72	283.73	766.85
SONSONATE	123.77	182.96	231.39	538.12
LA LIBERTAD	137.02	193.07	292.72	622.80
SAN SALVADOR	124.55	181.17	260.43	566.15
CHALATENANGO	196.20	204.38	416.93	817.50
CUSCATLAN	242.79	165.81	183.58	592.18
CABANAS	191.08	172.59	252.72	616.38
LA PAZ	262.76	236.48	376.62	875.87
SAN VICENTE	222.02	127.66	205.37	555.05
USULUTAN	213.26	204.38	470.96	888.60
SAN MIGUEL	202.54	211.34	466.72	880.60
MORAZAN	67.72	117.38	266.36	451.45
LA UNION	162.17	162.17	351.36	675.70
GRAND TOTAL	2,533.81	2,625.17	4,400.98	9,559.96

TABLE II. A. 7

CURRENT CONDITION OF THE SALVADORAN ROADWAY NETWORK BY CLASS OF ROAD

2/2

CLASSIFICATION	CONDITION	LENGTH (Km)
SPECIAL	Good	81.74
	Fair	36.78
	Poor	17.71
PRIMARY	Good	160.57
	Fair	231.93
	Poor	202.20
SECONDARY	Good	343.74
	Fair	343.74
	Poor	323.52
TERTIARY	Good	479.48
	Fair	496.84
	Poor	760.84
RURAL "A"	Good	238.92
	Fair	290.12
	Poor	1,177.55
RURAL "B"	Good	350.02
	Fair	700.04
	Poor	3,325.21
TOTAL		9560.22

Overall roadway conditions become worse as highway categories lower. Road conditions vary across departmental boundaries. The Department of Morazan contains roadways which are in the worst condition.

(3) Condition of Selected Roads

In addition, a condition survey of a priority list of projects was requested. This survey was designed to perform an economic analysis and also to prioritize subsector projects. Basic characteristics of selected projects and their current condition are presented in Appendix II.A.3.

The list of analyzed projects was selected from priority lists of projects from the following organizations:

- o MOP, Project Coordination Unit
- o DGC, Planning Department
- o DGC, M & O Division
- o AID
- o The World Bank
- o IDB
- o CABEI

In addition, the consultants studied all highway projects currently underway or planned in Figures II.A.4 and II.A.5, as well as other projects considered appropriate or necessary by the ISA team.

(4) Bridges

Guerrilla attacks on the roadnet have concentrated on the bridges. Since the start of the conflict, direct damages of approximately 162 million colones have been caused, according to the DGC Planning Department. A bridge investment plan, including both temporary and permanent bridge repair and replacement, should be an important component of any transportation plan.

Some damaged bridges have so far been reconstructed and others have been temporarily replaced with Bailey bridges. Others are still waiting for maintenance or replacement. Table II.A.8 summarizes the current status of all bridges that have been damaged. A complete inventory of all Salvadoran bridges will be provided separately.

d. Road Construction and Major Maintenance History

Pavement structure histories are needed to develop locally-generated pavement deterioration curves. With these curves, future road conditions can be predicted if their current conditions are known. Table II.A.9 shows the age of several

TABLE II.A.8

BRIDGES DAMAGED BY THE INSURGENCY

BRIDGE NAME	LOCATION	DAMAGE DATE	CURRENT CONDITION	SPAN (M)	REPAIR/REPLACEMENT C O S T	NOTES	BAILEY BRIDGE LENGTH in Feet'
BATRES	CA-2 USULUTAN		RECONSTRUCTED	-	150,000.00	MAJOR DAMAGES	
JARDINES DE CANDELARIA	USULUTAN		RECONSTRUCTED	-	350,000.00	MAJOR DAMAGES	
CITALA	EL POY CHALATENANGO		TEMPORARY B.INSTD.	-	2,500,000.00	MAJOR DAMAGES	ACROW PANEL 430
TOMAYATE No.2	CA-4 SAN SALVADOR		RECONSTRUCTED	16.00	900,000.00	MAJOR DAMAGES	
MEANGUERA OVER TOROLA RIVER	CA-7 MORAZAN	11/04/82	DESTROYED	53.61	2,500,000.00	MAJOR DAMAGES	
CUSCATLAN OVER LEMPA RIVER	CA-1 SAN.VIC. USULUTAN	01/01/84	TEMPORARY B.INSTD.	-	30,000,000.00	DESTROYED	TDR190/TS700/TRS110
TOROLA	CA-7 MORAZAN	01/01/85	DESTROYED	31.00	750,000.00	MAJOR DAMAGES	
OVER CHACAHUACA RIVER	CA-3-CA-4 CHALATENANGO	02/03/81	REPAIRED	23.90	33,250.00	MINOR DAMAGES	
EL ENCALADO-VILLERIAS RIVER	CA-7 SAN MIGUEL	02/04/82	RECONSTRUCTED	-	55,000.00	MAJOR DAMAGES	
LOS MANGOS OVER GORGE DRY	SIRAMA,LA UNION	02/07/80	REPAIRED	30.00	22,400.00	MINOR DAMAGES	
OVER EL ZAPOTE RIVER	CA-4 CHALATENANGO	03/06/81	RECONSTRUCTED	21.70	145,000.00	MAJOR DAMAGES	
URBINA-GRANDE SAN MIGUEL RIVER	CA-7 SAN MIGUEL	04/09/83	RECONSTRUCTED	30.00	600,000.00	MAJOR DAMAGES	
DON LUIS DE MOSCOSO	CA-1 SAN MIGUEL	-----/84	TEMPORARY B.INSTD.	3*45m	5,000,000.00	DESTROYED	3*DT 150
OVER APANTA RIVER	LA PAZ	-----/89	DESTROYED	15.50	500,000.00	DESTROYED	
BOULEVARD DEL EJERCITO	SAN SALVADOR	05/05/81	RECONSTRUCTED	TUNNEL	7,000.00	MINOR DAMAGES	
MARIN FORD-GRANDE SAN MIGUEL R	CA-2 EL ESPINO	05/08/87	TEMPORARY B.INSTD.	57.40	2,500,000.00	MAJOR DAMAGES	DS 120
EL GRAMAL	CA-4 CHALATENANGO	05/08/87	TEMPORARY B.INSTD.	25.10	850,000.00	MAJOR DAMAGES	TS 110
TITIHUAPA	CABANAS	06/08/87	DESTROYED	-	1,200,000.00	MAJOR DAMAGES	
CHAPELTIQUE	SAN MIGUEL	06/11/80	RECONSTRUCTED	31.35	99,300.00	MAJOR DAMAGES	
EL DELIRIO-GRANDE SAN MIGUEL R	CA-2 SAN MIGUEL	14/10/88	RECONSTRUCTED	43.00	1,300,000.00	MAJOR DAMAGES	
OVER SUMPUL RIVER	CHALATENANGO ARCATAO	07/10/80	W/O REPAIR	20.40	545,000.00	MINOR DAMAGES	
OVER SAYULAPA RIVER	ILOBASCO,CABANAS	08/06/81	RECONSTRUCTED	12.20	150,000.00	MAJOR DAMAGES	
OVER DRY GORGE	CA-2 USULUTAN	25/07/87	TEMPORARY B.INSTD.	12.55	900,000.00	MAJOR DAMAGES	DS 60
SAN PEDRO OVER DRY RIVER	CA-7 SAN F. GOTERA	10/01/81	REPAIRED	53.61	165,350.00	MAJOR DAMAGES	
SANTA ANITA	CA-7 MORAZAN	10/07/80	REPAIRED	20.00	8,310.00	MINOR DAMAGES	
OVER LAS CANAS RIVER	CA-4 SAN SALVADOR	22/05/82	REPAIRED	43.00	33,500.00	MINOR DAMAGES	
LA JOYA OVER TAMULASCO RIVER	OJOS DE AGUA CHALAT.	11/02/81	RECONSTRUCTED	16.20	175,000.00	MAJOR DAMAGES	
TIERRA BLANCA	CA-2 USULUTAN	11/06/82	REPAIRED	-	10,000.00	MINOR DAMAGES	
OVER MOTOCHICO RIVER #1	CA-3 CHALATENANGO	11/11/86	RECONSTRUCTED	68.55	5,000.00	MINOR DAMAGES	
SANTO TOMAS	SAN MIGUEL	13/01/81	REPAIRED	25.00	4,300.00	MINOR DAMAGES	

TABLE II.A.8

BRIDGES DAMAGED BY THE INSURGENCY

BRIDGE NAME	LOCATION	DAMAGE DATE	CURRENT CONDITION	SPAN (M)	REPAIR/REPLACEMENT COST	NOTES	BAILEY BRIDGE LENGTH in Feet*
OVER LA TRINIDAD GORGE	CA-7 SAN MIGUEL	13/08/81	RECONSTRUCTED	31.35	20,(00.00	MINOR DAMAGES	
TONAYATE No.1	CA-2 SAN SALVADOR	14/02/82	REPAIRED	-	20,000.00	MINOR DAMAGES	
OVER JALPONGA RIVER	CA-2 LA PAZ	22/07/87	REPAIRED	31.00	20,000.00	MINOR DAMAGES	
OVER MOTOCHICO RIVER #2	CA-3 CHALATENANGO	15/03/81	REPAIRED	12.20	19,450.00	MINOR DAMAGES	
GOLDEN BRIDGE	CA-2 SAN VICENTE-USULAT	15/10/81	TEMPORARY B.INSTD.	776.3	60,000,000.00	DESTROYED	TS990/TRS220/TS110
OVER YOLOAIQUIN RIVER	CA-7 MORAZAN	16/08/81	RECONSTRUCTED	-	11,000.00	MINOR DAMAGES	
EL QUEBRADON	SIRAMA LA UNION	16/12/81	REPAIRED	13.30	2,300.00	MINOR DAMAGES	
SAN BUENAVENTURA	SAN MIGUEL	17/07/87	RECONSTRUCTED	-	900,000.00	MAJOR DAMAGES	
GUAYATIQUE	JIQUILISCO USULUTAN	18/11/82	RECONSTRUCTED	-	55,000.00	MAJOR DAMAGES	
OVER EREGUAYQUIN RIVER	CA-2 USULUTAN	30/03/82	RECONSTRUCTED	15.45	100,000.00	MAJOR DAMAGES	
EL COYOLITO	CA-2 USULUTAN	21/02/82	RECONSTRUCTED		230,000.00	MAJOR DAMAGES	
MOROLAPA- GRANDE SAN MIGUEL R	CA-2 EL ESPINO	21/03/81	DESTROYED	60.70	2,750,000.00	DESTROYED	
ZAPOTE OVER AZAMBIO RIVER	CA-4 CHALATENANGO	21/04/87	RECONSTRUCTED	21.70	9,500.00	MINOR DAMAGES	
MARIMBA OVER SUCIO RIVER	ISTAGUA CUSCATLAN	24/12/81	RECONSTRUCTED	7.00	16,000.00	MAJOR DAMAGES	
SAN ANTONIO	CA-2 LA PAZ	12/01/88	TEMPORARY B.INSTD.	4*13m	700,000.00	MAJOR DAMAGES	TS 90
OVER DRY GORGE	CA-1 SAN VICENTE	25/05/83	TEMPORARY B.INSTD.	30.00	700,000.00	MAJOR DAMAGES	DD 120
SAN JACINTO	METAPAN, STA.ANA	25/07/87	RECONSTRUCTED	16.00	700,000.00	MAJOR DAMAGES	
SANTA MARIA	CA-2 USULUTAN	26/03/82	RECONSTRUCTED	-	900,000.00	MAJOR DAMAGES	
LOMA DEL MACHO	CA-2 USULUTAN	26/05/85	RECONSTRUCTED	-	182,000.00	MAJOR DAMAGES	
LAS GUARAS	SUCHITOTO,CUSCATLAN	26/06/83	RECONSTRUCTED	25.93	200,000.00	MAJOR DAMAGES	
OVER GUAJOYO RIVER	CA-12 STA.ANA	27/12/31	RECONSTRUCTED	2*21.0	400,000.00	MAJOR DAMAGES	
LA SIERPE OVER TAMULASCO RIVER	CHALATENANGO	28/03/81	REPAIRED	15.00	500.00	MINOR DAMAGES	
GOASCORAN	CA-1 LA UNION	29/04/83	RECONSTRUCTED	-	1,100,000.00	MAJOR DAMAGES	
PASAQUINA	CA-1 LA UNION	29/04/83	RECONSTRUCTED	-	700,000.00	MAJOR DAMAGES	
AGUA SALADA	CA-1 LA UNION	29/04/83	RECONSTRUCTED	24.00	800,000.00	MAJOR DAMAGES	
SANTA ROSA	MILITAR ROUTE LA UNION	29/04/83	RECONSTRUCTED	-	270,000.00	MAJOR DAMAGES	
AGUA CALIENTE	MILITAR ROUTE LA UNION	29/04/83	RECONSTRUCTED	-	275,000.00	MAJOR DAMAGES	
PALO SECO	CA-2 JIQUILISCO	-----88	TEMPORARY B.INSTD.	18.00	900,000.00	MAJOR DAMAGES	DS 70
OVER LAS CANAS RIVER	SOYAPANGO-TONACATE	25/11/81	DESTROYED	55.00	3,500,000.00	DESTROYED	
JUTILLO	LA PAZ	-----89	DESTROYED	15.00	800,000.00	DESTROYED	

DS : DOUBLE SINGLE
TS : TRIPLE SINGLE
TRS: TRIPLE REINFORCED SINGLE
DD : DOUBLE DOUBLE
TDR: TRIPLE DOUBLE REINFORCED

TABLE II.A.9

AGE OF SOME PAVEMENT STRUCTURES IN THE ROAD NETWORK

HIGHWAY CODE	HIGHWAY SEGMENT	SEGMENT LENGTH (Km.)	PAVEMENT WIDTH	AGE YEARS	USEFUL LIFE YEARS	ANNUAL ROUTINE MAINTENANCE COST (COLONES / Km.)
CA-1	SAN SALVADOR-SANTA ANA-SAN CRISTOBAL	97.0	6.3	61	20	64,068.00
CA-1	SAN SALVADOR-SANTA TECLA	8.2	6.3	31	20	90,200.00
CA-1	SANTA TECLA-LA CUCHILLA	8.0	14.0	16	15	105,016.92
CA-1	LA CUCHILLA-Km. 35	13.0	8.5	16	25	25,000.00
CA-1	Km. 35-EL PORTEZUELO	16.5	14.0	12	25	89,105.88
CA-1	SAN SALVADOR-SAN MIGUEL-LA UNION	176.0	6.3	46	20	240,246.60
CA-1	SAN SALVADOR-ILOPANGO (Blvd)	7.4	14.0	33	20	(D.U.A.
CA-1	LA UNION-SIRAMA-GOASCORAN	41.0	7.3	16	20	30,971.52
CA-2	CARRETERA DEL LITORAL	313.0	7.3	26	20	54,809.28
CA-4	SANTA TECLA-LA LIBERTAD	24.0	7.3	16	20	14,318.88
	INTERAMERICANA-ILOBASCO	13.0	6.3	18	20	72,084.00
	ILOBASCO-SENSUNTEPEQUE	30.6	6.3	11	20	47,061.60
	INTERAMERICANA-SAN VICENTE	4.0	6.3	46	20	27,969.48
	INTERAMERICANA-MERCEDES UMANA-BERLIN	10.0	6.3	26	20	51,381.84
	INTERAMERICANA-JUCUAPA	4.0	6.3	42	20	39,587.04
	INTERAMERICANA-CHINAMECA	4.0	6.3	42	20	39,587.04
	INTERAMERICANA-LAS PLACITAS	10.0	6.3	42	20	51,277.44
	ZACATECOLUCA-SAN MARCOS LEMPA	20.675	7.3		20	132,147.48
CA-12	SANTA ANA-METAPAN-ANGUIATU	22.0	7.3	0	20	156,432.09
CA-4	APOPA-NEJAPA-QUEZALTEPEQUE	12.0	6.5	0	20	163,827.16
CA-2	SANTIAGO DE MARIA	22.0	6.5	0	20	228,054.77
	INTERCONNECTIONS					
CA-1-CA-8	EL PORTEZUELO-AHUACHAPAN	33.0	6.3	44	20	350,496.96
CA-1-CA-8	EL CONGO-SAN ISIDRO-EL ZUNZA	22.3	6.2	24	15	217,409.76
CA-1-CA-4	SITIO DEL NINO-QUEZALTEPEQUE-APOPA	24.0	6.5	23	15	52,652.64
CA-1-CA-2	SAN SALVADOR-COMALAPA	32.0	6.3	48	20	26,950.20
CA-1-CA-2	INTERAMERICANA-SANTIAGO DE MARIA-LITORAL	31.2	6.5	33	20	264,740.52
CA-7-CA-1	RUTA MILITAR (DESVIO GOTERA-AGUA SALADA)	34.0	7.3	22	20	350,114.28
	EL CONGO-LAGO DE COATEPEQUE	2.0	6.3	36	20	16,918.08
	TRONCAL DEL NORTE-CHALATENANGO	25.0	6.0	16	20	5,570.88
	INTERAMERICANA-LAGO DE ILOPANGO	4.5	6.3	40	20	52,822.56
	LITORAL-LA HERRADURA	19.0	6.3	35	20	35,079.72

pavement structures in El Salvador.

The average age of primary roads in El Salvador is approximately 27 years and 31 years for secondary roads. Table II.A.9 shows that many of these roads have reached the end of their service life. In the absence of major rehabilitation/reconstruction dates, no conclusions can be drawn in relation to the rates of deterioration which Salvadoran roads have undergone. However, the network's average age explains the highway design geometrics in Table II.A.6, Figure II.A.3 and Appendix II.A.1.

3. Projects Underway/Planned

The project team has reviewed all projects currently undertaken by the DGC for the next five years. In this process, the Consultants have interviewed transportation officers from the following organizations:

- DGC
- MOP
- AID
- The World Bank
- Inter-American Development Bank
- Central American Bank for Economic Integration

Table II.A.10 shows the highway projects that are currently underway and Table II.A.11 lists the presently planned highway projects. Project names, source of financing and yearly disbursements by project are presented. Figures II.A.4 and II.A.5 show the location of these projects.

A similar description is presented in Tables II.A.12 and II.A.13 for currently-underway and planned bridge projects.

There is one important new highway which, while currently not planned, can have an important impact on the development of northern El Salvador. This is the Northern Longitudinal highway (Carretera Longitudinal del Norte). It stretches from Chalatenango in the West to Osicala, Morazan in the East. This project has had approved financing from CABEI since 1980, but work has not yet started.

Parra-Meyer Asociados conducted the feasibility study for the proposed highway in 1980. Traffic demand estimates were calculated by means of previously developed models from a Central American Transportation Study. It was estimated that

TABLE II.A.10

H I G H W A Y P R O J E C T S U N D E R W A Y

PROGRAM	ROAD CATAGORY	PROJECT NAME	LENGTH	INT'NAL FIN.SOURCE	1990 (1)	1991 (1)	1992 (1)	1993 (1)	1994 (1)	TOTAL (1)
DGC-302 RDWY. IMPR/CONSTR.	TERTIARY	AHUACHAPAN-TACUBA	17.2	-	2,622.3	7,195.0	4,804.8	-	-	14,622.1
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	BERLIN-ALEGRIA-SANTIAGO DE MARIA	11.6	-	1,984.5	1,888.8	-	-	-	3,873.3
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	CA:2-SANTIAGO DE MARIA	17.0	-	4,886.2	-	-	-	-	4,886.2
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	CA:2-EL DELIRIO-SAN MIGUEL-LA UNION	32.0		-	2,608.3	1,738.9	-	-	4,347.2
DGC-302 RDWY. IMPR/CONSTR.		SUB TOTAL	77.8		9,493.0	11,692.1	6,543.7	0.0	0.0	27,728.8
DGC-303 N.DEV. ZONE ROADS		SUB TOTAL			26,523.8	45,560.0	45,866.1	-	-	117,949.9
DGC-304 REGIONAL WAYS	SPECIAL	SANTIAGO DE MARIA-SAN MIGUEL		CABEI-4	20,561.8	-	-	-	-	20,561.8
DGC-304 REGIONAL WAYS	SPECIAL	SAN SALVADOR-(KM 4°292)-SAN MARTIN	13.0	CABEZ-4	45,810.7	-	-	-	-	45,810.7
DGC-304 REGIONAL WAYS		SUB TOTAL	13.0		66,372.5	0.0	0.0	0.0	0.0	66,372.5
DGC-305 RURAL ROADS	RURAL	TEJUTEPEQUE-SAN ANTONIO BUENAVISTA-CORRAL VIEJO	9.8	IDBGG5SF-4	2,600.0	-	-	-	-	2,600.0
DGC-305 RURAL ROADS	RURAL	EL REFUGIO-EL CASTILLO-SN JOSE LA CUEVA-MONCAGUA-INTERCONEXION STA ANA-SN PABLO TACACHICO	19.3	IDBGG5SF-4	2,700.0	-	-	-	-	2,700.0
DGC-305 RURAL ROADS		SUB TOTAL	29.1		5,300.0	0.0	0.0	0.0	0.0	5,300.0
DGC-308 RESORT AREA	TERTIARY	(CA:8-EL CONGO)-CERRO VERDE	10.0		2,402.9	-	-	-	-	2,402.9
DGC-308 RESORT AREA		SUB TOTAL	10.0		2,402.9	0.0	0.0	0.0	0.0	2,402.9
A L L	A L L	T O T A L	129.9	A L L	110,092.2	57,252.1	52,409.8	0.0	0.0	219,754.1

(1) In Thousands of Colones

TABLE II.A.11

PLANNED HIGHWAY PROJECTS

1/2.

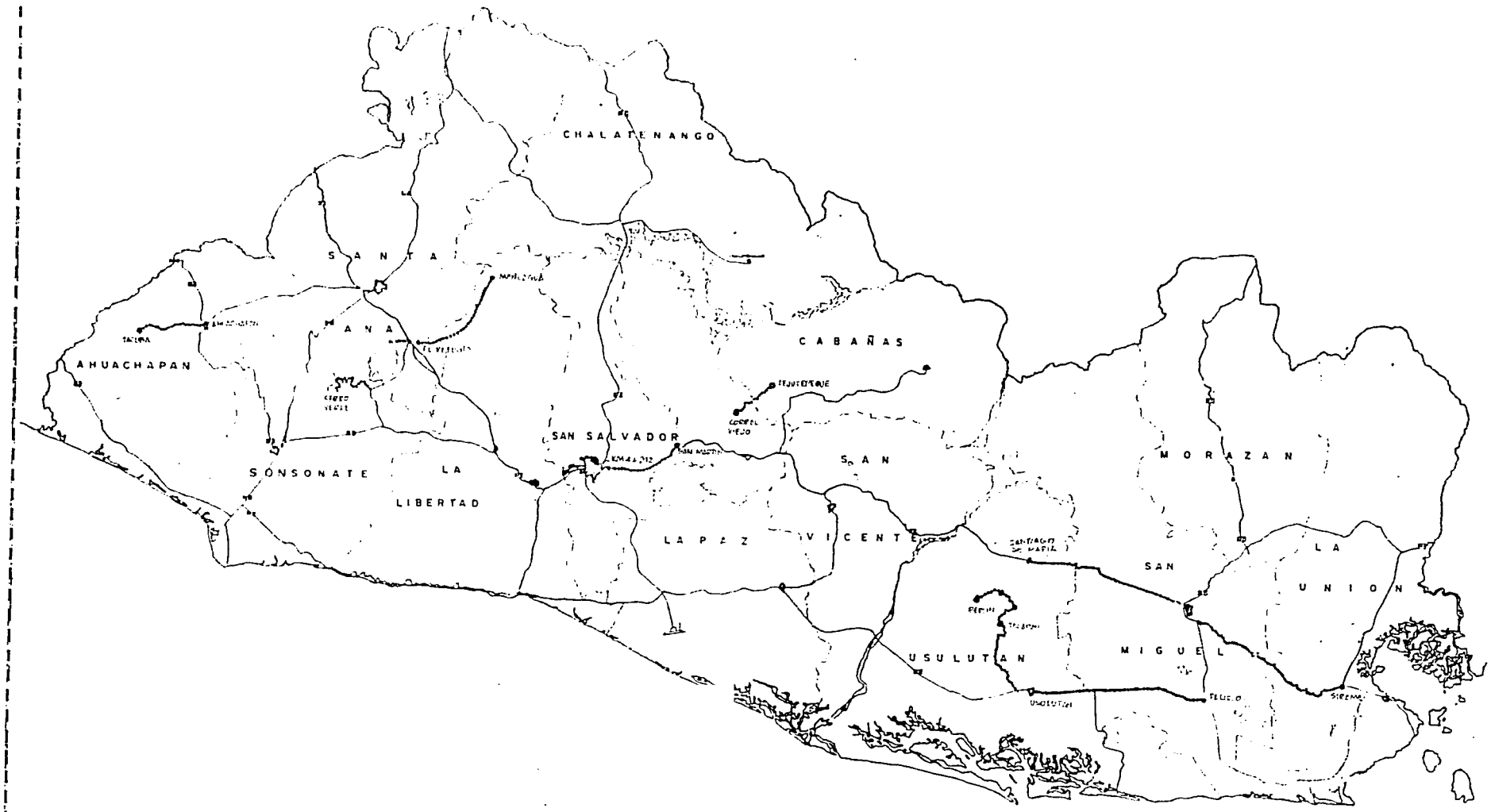
PROGRAM	ROAD CATEGORY	PROJECT NAME	LENGTH	INTERNATIONAL FINANCE SOURCE	1990 (1)	1991 (1)	1992 (1)	1993 (1)	1994 (1)	TOTAL (1)
DGC-302 RDWY. IMPR/CONSTR.	TERTIARY	CA:1-SAN ALEJO	10.1	-	2,480.6	2,987.5	-	-	-	5,468.1
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	REN APOPA-GUAZAPA-AGUILARES	20.0	-	3,712.7	-	-	-	-	3,712.7
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	SAN MIGUEL-LA UNION	45.0	-	5,251.5	-	-	-	-	5,251.5
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	CA:1-CA:2-CA:4	30.0	-	-	-	-	18,630.7	18,630.7	37,261.4
DGC-302 RDWY. IMPR/CONSTR.	RURAL	JUAYUA-SAN JOSE LA MAJADA-EL ARENAL	10.0	-	-	-	311.6	-	-	311.6
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	(CA:1-CA:2-EL DELIRIO)-SAN MIGUEL	15.3	-	-	1,404.1	1,404.1	-	-	2,808.2
DGC-302 RDWY. IMPR/CONSTR.	SECONDARY	CA:12-SANTA ANA-LOS NARANJOS	14.0	-	-	-	-	-	1,143.0	1,143.0
DGC-302 RDWY. IMPR/CONSTR.	PRIMARY	CA:2-LA LIBERTAD-CA:12	67.0	-	-	1,845.4	1,845.4	1,786.7	-	5,477.5
DGC-302 RDWY. IMPR/CONSTR.	PRIMARY	CERRO VERDE EXIT-CA:8	8.0	-	-	-	4,443.7	-	-	4,443.7
DGC-302 RDWY. IMPR/CONSTR.		SUB TOTAL	219.4		11,444.8	6,237.0	8,004.8	20,417.4	19,773.7	65,877.7
DGC-304 REGIONAL WAYS	SPECIAL	KM 0+000 TO KM 4+292		CABEI-2	27,700.0	3,976.0	-	-	-	31,676.0
DGC-304 REGIONAL WAYS	PRIMARY	LA HACHADURA-CA:12	42.0	CABEI-4	30,000.0	10,000.0	10,000.0	-	-	50,000.0
DGC-304 REGIONAL WAYS	PRIMARY	SANTA ANA-METAPAN-ANGUIATU	58.0	CABEI-4	30,000.0	11,250.0	11,250.0	-	-	52,500.0
DGC-304 REGIONAL WAYS	PRIMARY	LA LIBERTAD-COMALAPA	29.0	-	-	-	-	12,805.0	12,805.0	25,610.0
DGC-304 REGIONAL WAYS	PRIMARY	LA CUCHILLA-SONSONATE	44.0	-	-	-	-	-	-	0.0
DGC-304 REGIONAL WAYS	SPECIAL	CA:12-CA:1 (SANTA ANA)	4.2	CABEI-4	15,945.2	7,468.9	-	-	-	23,414.1
DGC-304 REGIONAL WAYS		SUB TOTAL	177.2		103,645.2	32,694.9	21,250.0	12,805.0	12,805.0	183,200.1
DGC-305 RURAL ROADS	RURAL	CA:1-QUEZALTEPEQUE-SN FCO-SN JUAN LOS PLANES	10.1	-	3,600.0	-	-	-	-	3,600.0
DGC-305 RURAL ROADS	RURAL	CA:3-EL CHAPERNO-CRIO SAN ISIDRO	8.3	-	1,100.0	-	-	-		1,100.0
DGC-305 RURAL ROADS	RURAL	L.CASITAS-SN ANTON.MASAHUAT-L.MORCONES-GUARNECIA	19.4	-	3,100.0	-	-	-	-	3,100.0
DGC-305 RURAL ROADS		CONSTRUCTION OF APROX. 400 KM OF RURAL ROADS	400.0	IDB ES0019-3	35,000.0	78,750.0	78,750.0	78,750.0	78,750.0	350,000.0
DGC-305 RURAL ROADS		SUB TOTAL	437.8		42,800.0	78,750.0	78,750.0	78,750.0	78,750.0	357,800.0
DGC-308 RESORT AREA	TERTIARY	KM 52 (CA:2-LA HERRADURA)-COSTA DEL SOL	18.0	CABEI-4	19,939.8	-	-	-	-	0.0
DGC-308 RESORT AREA		SUB TOTAL	18.0		19,939.8	0.0	0.0	0.0	0.0	0.0

TABLE II.A.11

PLANNED HIGHWAY PROJECTS

PROGRAM	ROAD CATEGORY	PROJECT NAME	LENGTH	INTERNATIONAL FINANCE SOURCE	1990 (1)	1991 (1)	1992 (1)	1993 (1)	1994 (1)	TOTAL (1)
OTHER INT'NALY. FINCD PRY	SECONDARY	SAN SALVADOR-LOS PLANES	9.0	ID8453OCES/AID(DPP)	5,200.0	5,200.0	-	-	-	10,400.0
OTHER INT'NALY. FINCD PRY	SECONDARY	SAN SALVADOR-SAN MARCOS	5.0	ID8453OCES/AID(DPP)	1,700.0	1,700.0	-	-	-	3,400.0
OTHER INT'NALY. FINCD PRY	PRIMARY	BLVD. DEL EJERCITO	5.0	ID8453OCES/AID(DPP)	2,300.0	2,300.0	-	-	-	4,600.0
OTHER INT'NALY. FINCD PRY	SPECIAL	COMALAPA FREEWAY REH/REC	4.0	AID	-	-	-	-	-	-
OTHER INT'NALY. FINCD PRY	SECONDARY	MEJICANOS - NARIONA - MEJAPA	16.0	AID	2,000.0	2,000.0	-	-	-	-
OTHER INT'NALY. FINCD PRY		SUB TOTAL	39.0		9,200.0	9,200.0	-	-	-	18,400.0
DGC-312 URB ROAD REHAB.		DIFFERENT PROJECTS	20.5	ID8-2	4,000.0	-	11,940.0	-	-	15,940.0
DGC-312 URB ROAD REHAB.		SUB-TOTAL	20.5		4,000.0	-	11,940.0	-	-	15,940.0
DGC-315 S.SAL-APOPA RECONS		SAN SALVADOR-APOPA	12.0	TWB/AID(DPP)-4	4,000.0	26,000.0	26,000.0	-	-	56,000.0
DGC-315 S.SAL-APOPA RECONS		APOPA-SAN JOSE LAS FLORES	-	TWB/AID(DPP)-4	-	-	-	-	-	-
DGC-315 S.SAL-APOPA RECONS		SUB-TOTAL	12.0		4,000.0	26,000.0	26,000.0	-	-	56,000.0
ALL	ALL	TOTAL	923.9	ALL	195,029.8	152,881.9	145,964.8	111,972.4	111,328.7	697,217.8

(1) In Thousands of Colones



FIGURE, II. A. 4

HIGHWAY PROJECTS UNDERWAY.

scale 1:500,000

30

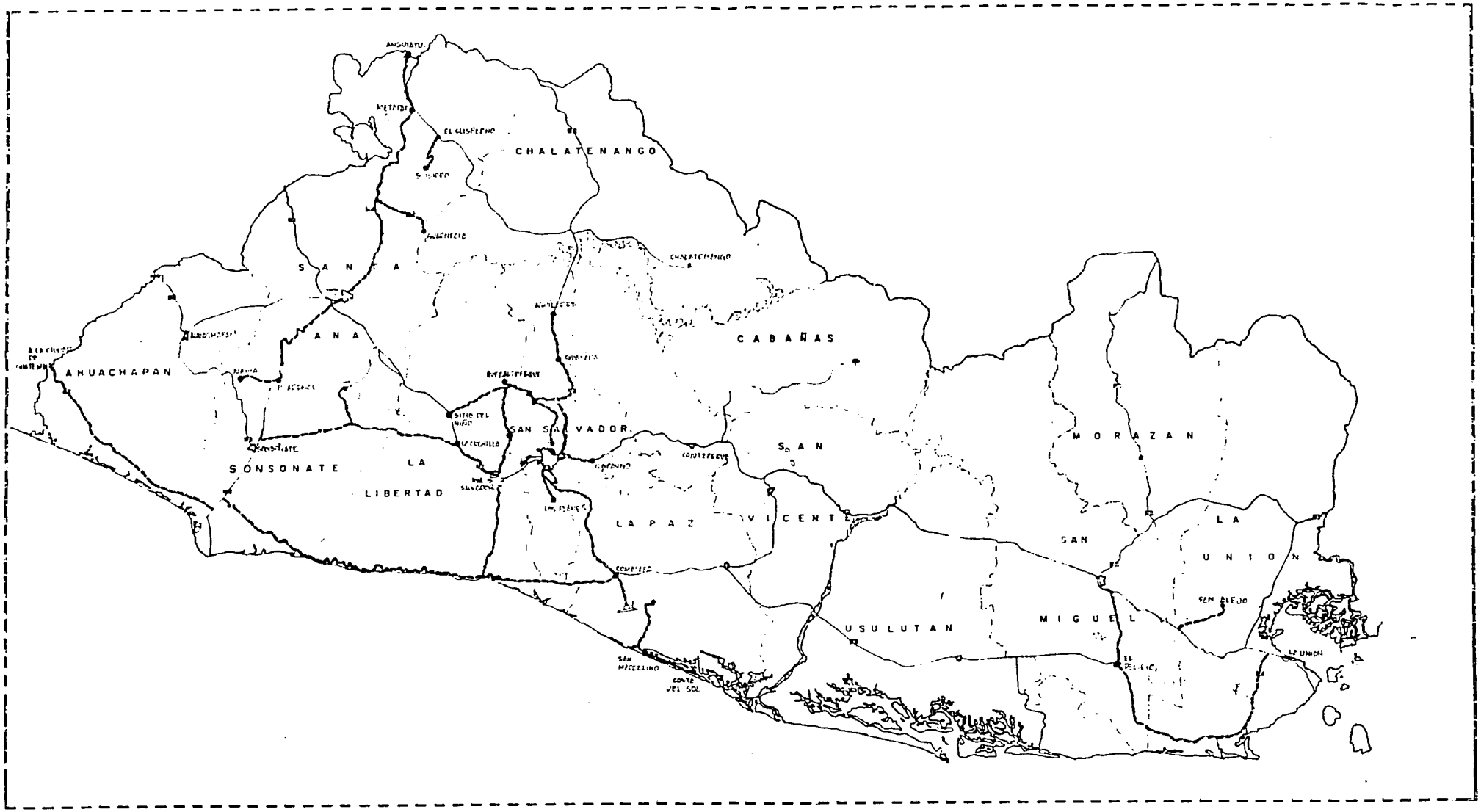


FIGURE II.A.5

PLANNED HIGHWAY PROJECTS.

scale 1:600,000

TABLE II.A.12

BRIDGE PROJECTS UNDERWAY

PROGRAM	PROJECT NAME	CHARACTERISTIC	INT'NAL FIN.SOURCE	1990 (1)	1991 (1)	1992 (1)	1993 (1)	1994 (1)	TOTAL (1)
DGC-309 OTHER IMPROVEMENTS	SAN LUIS DE MOSCOSO (SAN MIGUEL)	RECONSTRUCTION	-	3,500.0	-	-	-	-	3,500.0
DGC-309 OTHER IMPROVEMENTS	SAN ANTONIO (CA:2 KM 63 LA PAZ)	REPAIR	-	674.7	674.7	674.7	674.7	674.7	3,373.5
DGC-309 OTHER IMPROVEMENTS	TOTAL	-	-	4,174.7	674.7	674.7	674.7	674.7	6,873.5

(1) In Thousands of Colones

TABLE II.A.13

PLANNED BRIDGE PROJECTS

PROGRAM	PROJECT NAME	CHARACTERISTIC	INT'NAL FIN.SOURCE	1990 (1)	1991 (1)	1992 (1)	1993 (1)	1994 (1)	TOTAL (1)
DGC-309 OTHER IMPROVEMENTS	PALO SECO (JIQUILISCO)	REPAIR	-	864.3	864.3	864.3	864.3	864.3	4,321.5
DGC-309 OTHER IMPROVEMENTS	GORGE DRY (USULUTAN)	RECONSTRUCTION	-	508.2	508.2	508.2	508.2	508.2	2,541.0
DGC-309 OTHER IMPROVEMENTS	MANUEL J. ARCE (AHUACHAPAN)	REPAIR	-	366.3	366.3	366.3	366.3	366.3	1,831.5
DGC-309 OTHER IMPROVEMENTS	OVER LOS RANCHOS GORGE (SN VICENTE)	REPAIR	-	240.0	240.0	240.0	240.0	240.0	1,200.0
DGC-309 OTHER IMPROVEMENTS	EL GRAMAL (LA PALMA CHALATENANGO)	RECONSTRUCTION	-	842.8	842.8	842.8	842.8	842.8	4,214.0
DGC-309 OTHER IMPROVEMENTS	JUTILLO (LA PAZ)	RECONSTRUCTION	-	850.0	850.0	850.0	850.0	850.0	4,250.0
DGC-309 OTHER IMPROVEMENTS	LA MASCOTA (VERAPAZ SN VICENTE)	REPAIR	-	406.7	406.7	406.7	406.7	406.7	2,033.5
DGC-309 OTHER IMPROVEMENTS	OVER SHUTIA R(ATECO ZOL SONSONATE)	CONSTRUCTION	-	-	635.7	-	-	-	635.7
DGC-309 OTHER IMPROVEMENTS	EL LLANO (VERAPAZ SON VICENTE)	WIDENING	-	359.6	359.6	359.6	359.6	359.6	1,798.0
DGC-309 OTHER IMPROVEMENTS	CALABOZO	B.WIDEN'G	-	304.6	304.6	304.6	304.6	304.6	1,523.0
DGC-309 OTHER IMPROVEMENTS	LA HACIENDA(VERAPAZ, SON VICENTE)	B.WIDEN'G	-	319.2	319.2	319.2	319.2	319.2	1,596.0
DGC-309 OTHER IMPROVEMENTS	JIBUA (CA:2KM 41,LA PAZ)	PILLAR REPAIR	-	100.8	100.8	100.8	100.8	100.8	504.0
DGC-309 OTHER IMPROVEMENTS	T O T A L			5,162.5	5,798.2	5,162.5	5,162.5	5,162.5	26,449.2

(1) In Thousands of Colones

310,000 hectares could be opened to agricultural production. The area of influence included 11 percent of the Salvadoran population, mainly the rural poor. At that time, the forecasted financial rate of return was 15.5 percent and the economic rate of return was 16.7 percent.

There is a need to update this study and evaluate the present importance of this highway.

4. Traffic History and Forecasts

a. Traffic History

The project team has reviewed all available traffic data from the DGC. The DGC has both permanent and temporary traffic count stations throughout the country, and based on the results from these stations, estimates of present traffic volumes and traffic load distribution as well as historical trends can be established.

Table II.A.14 shows the location of the DGC's permanent traffic count locations and Table II.A.15 shows current and past average daily traffic volumes (ADTs) at those locations. Hourly, daily and monthly variations of traffic volumes are shown in Tables II.A.16 to II.A.18. Peak-hour traffic is about seven percent of ADT, representing a flat traffic distribution. Similar highways in the United States would have a peak hour traffic of ten percent of ADT. Traffic typically peaks on Fridays and Saturdays with the month of December having the highest traffic volumes.

Based on an analysis of these tables, design-hour volumes (30th and 50th highest hourly volumes in a year, used for highway geometric design purposes) have been calculated by the DGC for highways where permanent count stations are located. Table II.A.19 shows the calculated design-hour volumes as a percent of ADT. The thirtieth highest hourly volumes in a year are nine to ten percent of ADT. This shows a lack of traffic peaks throughout the year (15 percent is most common in USA).

To design a pavement structure, the expected number of equivalent 18,000-pound axles (ESAL) that a roadway will handle during its useful life is estimated. This number is obtained from estimates of current and expected traffic volumes, as well as from estimates of traffic load distribution. The traffic load categories defined by the DGC are the following:

- Passenger vehicles

TABLE II. A. 14

DGC PERMANENT TRAFFIC COUNT STATIONS

STATION	LOCATION	
	HIGHWAY	Km.
12B01	Frontera las Chinamas	116+600
12B02	Frontera la Hachadura	126+600
11C01	CA-1 Occte. Peaje Santa Ana	60+000
12C02	Frontera Anguiatu	58+800
13C03	Carretera Antigua a Santa Ana	66+000
13C04	Frontera San Cristobal	97+000
12D01	CA-8 Izalco	59+000
12D02	CA-12 Salida Sensenate-Acajutla	67+000
11E01	CA-1 Occidente Las Delicias	13+200
11F01	Autopista al Aeropuerto	18+000
13F02	Santo Tomás - Troncal del Norte	8+500
13F03	Troncal del Norte	10+000
12H01	CA-4 El Poy	97+000
13I01	CA-1 Oriente Cojutepeque	22+000
12P01	CA-1 Oriente El Amatillo	210+000

TABLE II. A. 15

CURRENT AND PAST AVERAGE DAILY TRAFFIC VOLUMES

STATION	1985	1986	INCREASE 85-86 %	1987	INCREASE 86-87 %	1988	INCREASE 87-88 %
12B01						185	
12B02						31	
11C01						5405	
12C02						88	
13C03						1154	
13C04						57	
12D01						3612	
12D02				4554		4605	+ 1.12
11E01	13516	13941	+3.14	13984	+0.31	14334	+2.50
11F01	4404	4518	+2.59	4536	+0.40	5553	+22.42
13F02	2450	1788	-27.02	1932	+8.05	1908	- 1.24
13F03	8448	8544	+ 1.14	8880	+3.93	10049	+13.16
12H01						49	
13I01	4718	4228	-10.38	4240	+0.28	5052	+19.15
12P01						61	

TABLE II. A. 16

HOURLY VARATIONS OF TRAFFIC VOLUMES AT
DGC PERMANENT TRAFFIC COUNT STATIONS

MONDAY - FRIDAY

STATION	A.M. PEAK HOUR		MIDDAY		P.M. PEAK HOUR	
	HOUR	% ADT	HOUR	% ADT	HOUR	% ADT
13C03	7-8	7.26	10-11	6.34	12-13	7.85
12D01	10-11	7.68	13-14	6.61	16-17	7.15
12D02	9-10	7.70	13-14	5.81	16-17	7.41
11E01	8-9	7.62	12-13	6.43	16-17	7.32
11F01	9-10	7.36	12-13	5.43	16-17	7.72
13F02	7-8	7.52	13-14	5.67	17-18	7.65
13F03	7-8	7.97	13-14	5.57	17-18	7.12
13I01	8-9	7.66	12-13	6.51	15-16	7.17

SATURDAY

STATION	A.M. PEAK HOUR		MIDDAY		P.M. PEAK HOUR	
	HOUR	% ADT	HOUR	% ADT	HOUR	% ADT
13C03	9-10	7.85	11-12	6.28	14-15	7.77
12D01	9-10	7.72	15-16	6.29	17-18	7.90
12D02	10-11	7.81	13-14	5.95	16-17	7.02
11E01	10-11	7.50	11-12	7.27	12-13	7.60
11F01	9-10	7.44	11-12	5.57	15-16	7.82
13F02	8-9	6.92	12-13	6.14	17-18	7.04
13F03	7-8	7.86	13-14	6.04	16-17	6.64
13I01	9-10	7.36	11-12	6.93	15-16	7.54

TABLE II. A. 17

DAILY VARIATIONS OF TRAFFIC VOLUMES (MAXIMUM DAY)

AT DGC PERMANENT TRAFFIC COUNT STATIONS

MONTH	PERMANENT STATION											
	12B01	12B02	12C02	12C03	12D01	12D02	11E01	11F01	13F02	13F03	13J01	12F01
JANUARY	V	-	D	-	-	-	V	D	S	L	V	-
FEBRUARY	S	-	S	-	-	-	V	S	S	V	V	-
MARCH	J	-	D	-	-	-	Ma	D	L	S	D	-
APRIL	L	-	D	-	-	-	L	S	D	Ma	V	-
MAY	S	-	L	-	-	-	L	D	S	V	V	-
JUNE	V	-	D	-	-	-	Ma	S	S	V	J	-
JULY	-	-	Mi	-	-	-	L	D	S	V	J	-
AUGUST	J	J	S	-	-	-	V	V	J	S	L	Mi
SEPTEMBER	V	-	S	-	-	V	Ma	S	S	J	S	D
OCTOBER	V	J	D	-	V	Ma	V	S	S	Ma	Ma	S
NOVEMBER	J	J	D	Mi	L	V	L	S	S	Mi	V	J
DECEMBER	V	J	Mi	L	Mi	Ma	V	V	S	V	V	Mi
TOTAL	J	J	S	Mi	J	Ma	L	S	S	V	V	Mi

TABLE II. A. 18

MONTHLY VARIATIONS OF TRAFFIC VOLUMES AT

FRONTERA LAS CHINAMAS (12B01)

MONTH	D A Y							
	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY	SUNDAY	AMDT
JANUARY	210	169	185	207	232	194	192	198
FEBRUARY	157	166	151	213	211	240	205	192
MARCH	176	194	239	274	216	155	251	215
APRIL	218	173	177	205	211	196	215	199
MAY	183	157	116	172	178	212	171	171
JUNE	153	189	224	229	246	177	199	202
JULY	-	-	--	-	-	-	-	--
AUGUST	194	223	243	279	153	159	265	277
SEPTEMBER	149	188	154	235	252	191	194	195
OCTOBER	108	112	109	117	145	130	98	116
NOVEMBER	126	110	92	133	128	118	90	113
DECEMBER	241	249	210	220	257	179	200	222
TOTAL	1915	1930	1900	2284	2229	1951	2080	2039
No. of Months	11	11	11	11	11	11	11	11
Average	174	175	173	208	203	177	189	185
% ADT	94.05	94.59	93.51	112.43	109.72	95.67	102.16	

A.A.D.T. = 185

TABLE II. A. 19

DESIGN HOUR VOLUME AS A PERCENTAGE OF ADT AT DGC PERMANENT TRAFFIC COUNT STATIONS

STATION	1 9 8 7	
	30º Hourly Volume	50º Hourly Volume
11 F01	9.50	8.70
13 F01	9.90	9.78
13 I01	9.98	9.60
11 E01	8.30	7.70
13 F02	9.08	8.30

- Light-weight trucks

- Buses

- Heavy-weight trucks, which include:

  - C2 double-axle trucks
  - C3 three-axle trucks
  - T2S1 double axle truck with single axle semi-trailer
  - C2R2 double axle truck with double axle trailer
  - T2S2 double axle truck with double axle semi-trailer
  - T3S1 three axle truck with single axle semi-trailer
  - T3S2 three axle truck with double axle semi-trailer
  - C3R2 three axle truck with double axle trailer

Table II.A.20 shows the characteristics of heavy-weight trucks. Salvadoran law allows up to 4,000 kg on single-tired axles, up to 8,000 kg on double-tired single-axles, and up to 14,900 kg on tandem axles. Two-axle vehicles should have a total weight of less than 12,000 kg, three-axle vehicles should be less than 20,000 kg, and truck/trailer combinations should weigh less than 33,800 kg.

Using the information on truck characteristics from Table II.A.20, the Consultants estimated the truck load factors that are used to convert the number of trucks into a number of equivalent 18,000-pound axle loads, typically used in pavement structural analysis. When calculating load factors, the Consultants assumed that each axle would carry the maximum legal weight. This is a conservative assumption considering that trucks are not always bearing cargo.

Available data on average daily traffic and traffic distribution is presented in Tables II.A.22 and II.A.23. Table II.A.22 shows ADTs and load distributions by highway and Table II.A.23 shows the same information summarized by highway category.

Three highway segments (San Salvador - Santa Tecla, Santa Tecla - La Cuchilla and San Salvador - San Martin) have ADTs higher than 10,000 vehicles per day. San Salvador - Santa Tecla is the most travelled segment in the country with an ADT of 38,000 vehicles per day.

Special highways receive an average of about 12,000 vehicles per day. Primary and secondary highways experience average ADTs of approximately 1,800 vehicles per day. Traffic volumes on unpaved roadways do not typically reach 500 vehicles per day. Tertiary roads receive about 400 and rural roads approximately 250.

There are several highway segments which should be considered for upgrading/improvement due to increased traffic demand. A list of roadway segments with traffic volumes higher than

TABLE II. A. 20

HEAVY TRUCK CHARACTERISTICS.

VEHICLE.	MAXIMUM LENGTH WITH HEIGHT IN METERS			MAXIMUM LOAD ON GROSS VEHICLE WEIGHT IN Kgs.	MAXIMUM LOAD FOR AXLES IN THOUSANDS OF Kgs.				
					AXLE 1	AXLE 2	AXLE 3	AXLE 4	AXLE 5
SIMPLE TRUCK WITH 2 AXLES. TYPE A. C_2	10	2.50	3.80	12,000	4	8	–	–	–
2 AXLE - TRUCK WITH 2 AXLE - TRAILER. TYPE A. WITH TRAILER. C_2R_2	18.3	2.50	3.80	20,000	4	8	b		–
SINGLE 3 AXLE TRUCK WITH TYPE B. C_3	12.1	2.50	3.80	16,900	4	14.9		–	–
						7.45	7.45		
3 AXLES TRUCK WITH 2-AXLE TRAILER. TYPE B. WITH TRAILER. C_3R_2	18.3	2.50	3.80	28,800	4	14.9		b	
						7.45	7.45		
2 AXLE TRUCK WITH 2 AXLE SEMI-TRAILER. TYPE C. T_2S_2	14	2.60	3.80	20,000	4	8	8	–	–
2-AXLE TRUCK WITH 2-AXLE SEMI-TRAILER. TYPE D. T_2S_2	14	2.50	3.80	26,900	4	8	14.9		–
							7.45	7.45	
3-AXLE TRUCK WITH 1-AXLE SEMI-TRAILER. TYPE E. T_3S_1	14	2.50	3.80	26,900	4	14.9		8	–
						7.45	7.45		
3-AXLE TRUCK WITH 2-AXLE SEMI-TRAILER. TYPE F. T_3S_2	14	2.50	3.80	33,900	4	14.9		14.9	
						7.45	7.45	7.45	7.45

NOTES: a) IN VEHICLES CROSSING THE ANY AXLE MAY BE LOADED WITH THE MAXIMUM AUTHORIZED WEIGHT BUT THE SUM OF THE WEIGHTS ON ALL AXLES MUST NOT EXCEED 33,000 Kg.
b) THE LOADS PER AXLE AND TRAILERS MUST NOT BE EXCEEDED; FOR ISOLATED AXLES WITH SIMPLE TIRES - 6,000 Kgs. AND FOR ISOLATED AXLES WITH DOUBLE TIRES - 8,000 Kgs.
c) THE DISTANCE BETWEEN "TANDEM" AXLES VARIES BETWEEN 1.00 m. (minimum) AND 2.40 (maximum).

TABLE II.A.21

H E A V Y T R U C K L O A D F A C T O R S

TRUCK CLASS	AXLE TYPE	AXLE 1_/ WEIGHT (W)	SINGLE AXLE LOAD FACTOR (W/18,000)EXP4	TANDEM AXLE LOAD FACTOR (W/33,700)EXP4	EQUIVALENT 18 KIP-AXLES PER TRUCK
C2	SINGLE	8,811	0.0574	-	0.9758
	SINGLE	17,621	0.9184	-	
C3	SINGLE	8,811	0.0574	-	0.9569
	TANDEM	32,819	-	0.8995	
T3-S2(& OTHERS)	SINGLE	8,811	0.0574	-	1.8564
	TANDEM	32,819	-	0.8995	
	TANDEM	32,819	-	0.8995	

1_/ USING MAXIMUM ALLOWABLE WEIGHT DESPITE OVERLOADED TRUCKS, THIS IS A CONSERVATIVE ASSUMPTION SINCE TRUCKS CIRCULATE BOTH (FULL AND EMPTY)

TABLE II. A. 22

1988 DAILY TRAFFIC VOLUMES AND LOAD DISTRIBUTION BY HIGHWAY

Station Number	HIGHWAY	Traffic Count Date	A D T Factor	A.A.D.T	LIGHT VEHICLES % Pass cars	Trucks	Buses %	HEAVY-TRUCKS LOAD DISTRIBUTION C2	C3	T2S1	C2R2	T2S2	T3S1	T3S2	C3R2	ESPEC	TOTAL
	INTERAMERICANA CA-1			8837	29	34	15	83	7					10			22
	INTERAMERICANA OCCIDENTE			11157	34	35	9	78	7					15			22
	San Salvador-Santa Tecla			37884	50	33	9	78	8					14			8
	Santa Tecla-La Cuchilla			13427	33	37	10	77	8					15			20
	La Cuchilla-Km 35			6067	32	37	9	76	7	.1	.1	.5		16	.1	.2	22
	Km 35-El Congo			4572	34	34	8	72	6	.2	.1	.5	.2	21			24
	El Congo-CA-12			4014	33	34	6	75	8					17			27
	CA-12-Las Chinam			979	23	35	9	88	4					8			33
	INTERAMERICANA ORIENTE			6517	24	34	21	87	8					5			21
	San Salvador-San Martín			12173	29	34	20	87	7					6			17
	San Martín-Cojutepeque			4895	22	34	24	90	6					4			20
	Cojutepeque-Desvio San Vicente			2483	21	35	20	84	12					4			24
	CARRETERA LITORAL			1134	16	39	17	71	5					24			28
	LITORAL OCCIDENTE			1066	14	35	16	54	4					42			35
	CA-12-La Hachadura			1066	14	35	16	54	4					42			35
	LITORAL ORIENTE			1202	19	42	17	88	7					5			22
	La libertad-Comalapa			1181	24	43	12	85	7					8			21

1988 DAILY TRAFFIC VOLUMES AND LOAD DISTRIBUTION BY HIGHWAY TABLE 11.A.22 (Cont.)

Station Number	HIGHWAY	Traffic Count Date	ADT	Factor	A.A.D.T.	LIGHT VEHICLES % Pass cars	% Trucks	% Buses	HEAVY-TRUCKS LOAD DISTRIBUTION C2	C3	T2S1	C2R2	T2S2	T3S1	T3S2	C3R2	ESPEC	TOTAL
	AUTOPISTA AL AEROPUERTO				4812	38	37	9	83	8			1		7		1	16
	AEROPUERTO-ZACATECOLUCA				1553	27	34	12	80	9				1	10			27
	CA-1-SAN VICENTE-TECOLUCA-CA-1				1111	24	44	13	93	5					2			19
	MEJICANOS-MARIONA-NEJAPA				1141	21	42	28	99						1			26
	SAN SALVADOR-LOS PLANES DE RENDEROS				2791	46	30	12	97	2					1			12
	LOS PLANES DE RENDEROS-PANCHIMALCO				890	34	40	9	100									17
	SITIO DEL NIÑO-SAN JUAN OPICO				1452	26	42	11	83	11				3	3			21
	CA-1-EL CONGO-CA-8				794	18	46	13	92	6					2			23
	CA-4-LA GARITA-SOYAPANGO				7362	27	40	18	92	6			1		1			15
	CA-8-SAN JULIAN				704	15	52	6	85	12					3			27
	CA-1-ILOBASCO				1316	15	44	17	97	3								24
	APOPA-SITIO DEL NIÑO, RAMAL A QUEZALTEPEQUE				1727	21	38	25	99						1			16
	CA-8-ARMENIA				1210	17	41	36	100									6
	CA-8-IZALCO				1198	16	39	29	99	1								16
	SONSONATE-SAN ANTONIO DEL MONTE				1104	24	42	20	100									14
	CA-8-NAHUIZALCO				2087	21	47	14	88	12								18
	SONSONATE-NAHUILINGO				997	16	44	15	98	2								25

(Cont.)

TABLE II.A.22 (CONT.) 1988 DAILY TRAFFIC VOLUMES AND LOAD DISTRIBUTION BY HIGHWAY

Station Number	H I G H W A Y	Traffic Count Date	A D T	Factor	A.A.D.T.	LIGHT VEHICLES %			HEAVY-TRUCKS LOAD DISTRIBUTION %									
						Pass cars	Trucks	Buses	C 2	C 3	T2S1	C2R2	T2S2	T3S1	T3S2	C3R2	Espec.	TOTAL
	Comalapa-Zacatecoluca				1224	14	41	22	92	6					2			23
	CA-4				5580	30	38	15	87	8					5			17
	CA-4 NORTE				7178	21	36	23	89	7					4			20
	San Salvador-Apopa				9654	23	35	24	86	8					6			18
	Apopa-Guazapa				4702	18	38	21	91	7					2			23
	CA-4 SUR				3982	38	40	7	85	9					6			15
	Santa Tecla-Pte La Libertad				3982	38	40	7	85	9					6			15
	CA-8				2138	25	37	13	81	6					13			25
	La Cuchilla-Sensonate				4316	24	35	10	74	6					20			31
	Sensonate-Ahuachapan				1520	21	47	12	92	7					1			20
	Ahuachapan-Las Chinamas				579	29	30	16	77	4					19			25
	CA-12				1701	19	34	11	64	6					30			35
	Acajutla-Sensonate				3110	18	33	8	63	7			.4	.4	29		.2	41
	Sensonate-SantaAna				1115	22	44	12	92	5					3			22
	Santa Ana-Metapán-Anguiatu				878	17	25	14	37	5			.5	.5	57			44
	SANTA ANA-AHUACHAPAN				3557	27	37	17	88	5					7			19
	APOPA-SITIO DEL NIÑO				2594	19	39	14	89	5					6			28

1988 DAILY TRAFFIC VOLUMES AND LOAD DISTRIBUTION BY HIGHWAY TABLE II.A.22 (Cont.)

Station Number	HIGHWAY	Traffic Count Date	ADT	Factor	A.A.D.T.	LIGHT VEHICLES & Pass cars	LIGHT VEHICLES & Trucks	Buses &	HEAVY TRUCKS LOAD DISTRIBUTION C2	C3	T2S1	C2R2	T2S2	T3S1	T3S2	C3R2	ESPEC	TOTAL
	CA-8-CALUCO				390	15	47	9	96						4			29
	CA-1-SAN SEBATIAN				380	12	47	22	100									19
	CA-2-LA HERRADURA				1035	16	38	15	96	3					1			31
	CA-2-SAN PEDRO NONUALCO				430	12	37	4	85	15								47
	SANTO TOMAS-SANTIAGO TEXACUANGOS				940	21	39	30	100									10
	CA-1-ESTANZUELAS				334	22	43	18	100									17
	CA-2-SANTA ELENA				413	12	34	34	100									20
	KM 35-SANTA ANA-CALLE ANTIGUA				1071	18	42	21	93	2					5			19
	SAN SALVADOR-SANTO TOMAS-COMALAPA				2599	23	40	22	92	5					3			15
	San Salvador-San Marcos				9130	39	36	16	96	3					1			9
	San Marcos-Santo Tomás				1908	25	38	26	96	3			0.1	0.1	.5	.1	.2	11
	Santo Tomás-Comalapa				653	17	42	22	89	7					4			19
	CA-1-APASTEPEQUE				587	33	41	13	97						3			13
	CA-1-SANTA CLARA				145	9	47	18	90	10								26
	SANTA ANA-AHUACHAPAN, RAMAL A ATIQUIZAYA				1555	22	29	32	99	1								17
	SANTO TOMAS-COMALAPA, RAMAL A OLOCUILTA				401	19	50	17	97	2					1			14
	(Cont.)																	

TABLE II. A. 23

1988 AVERAGE DAILY TRAFFIC VOLUMES AND
LOAD DISTRIBUTION BY HIGHWAY CATEGORY

Station Number	H I G H W A Y	Traffic Count Date	A D T	Factor	A.A.D.T.	LIGHT		HEAVY-TRUCK										
						Pass. Cars	Truck	Buses	LOAD DISTRIBUTION									
									C2	C3	T2S1	C2R2	T2S2	T3S1	T3S2	C3R2	ESPEC	TOTAL
	SPECIAL				12032	36	36	8	79	7	.2		.8		13			20
	PRIMARY				1828	22	40	13	77	7					16			23
	SECONDARY				1885	20	40	18	92	5					3			22
	TERTIARY				388	16	48	10	91	4					5			26
	RURAL				265	14	50	9	98	2								27

the desired levels for their functional class is presented in Appendix II.A.4.

b. Traffic Forecasts

To analyze the adequacy of a certain roadway, forecasts of ADTs, design-hour volumes, and ESALs over the analysis period are necessary. ADT estimates are used to obtain road user costs and carry out economic analysis. Design-hour volume estimates determine the geometric adequacy of a roadway. The expected ESAL, together with current pavement conditions and the existing pavement structure, indicate the need for pavement rehabilitation/reconstruction.

The Consultants determined future traffic volumes and load distribution for all projects in this study. Two different methods were considered. The first is based on the historical projections of available traffic data by road category and department. The second considers estimates of future demand based on macroeconomic parameters related to trip generation (i.e., population, auto availability, household income and rural production).

(1) Estimation of Annual Growth Factors by Department

Historical data on two-way traffic volumes along four highway segments are presented in Table II.A.24. The first three segments, Ahuachapan - Santa Ana, San Salvador - Santa Tecla and San Salvador - Los Planes, lie in areas not significantly affected by the conflict. San Martin - Cojutepeque, while not in a conflict zone, has experienced reduced traffic levels because of a reduction of trips to hostile areas in the East.

Traffic volumes along the three segments which have not been influenced by the war have evolved differently during the last decade. Ahuachapan - Santa Ana shows an annual growth factor of 1.4 percent. San Salvador - Santa Tecla's traffic volumes have grown at an annual rate of 5.7 percent, while traffic volumes on San Salvador - Los Planes have declined 53 percent.

Traffic growth in both the Ahuachapan - Santa Ana and San Salvador - Santa Tecla corridors is due to the population increase of these areas. The traffic growth rate in Ahuachapan - Santa Ana is similar to the nation's population growth rate and can be considered about average for El Salvador. The high traffic growth rate experienced in San Salvador - Santa Tecla is caused by mass immigration into this area away from conflict zones.

The decrease in traffic volumes in the San Salvador - Los

TABLE II.A.24

HISTORICAL TREND OF TRAFFIC VOLUMES AT

TYPICAL SALVADORAN HIGHWAY

Y E A R	HIGHWAY SEGMENTS			
	AHUACHAPAN--SANTA ANA (1)	CA1:S. SALVADOR-SANTA TECLA (2)	SAN SALVADOR--LOS PLANES (3)	CA1:SAN MARTIN--COJUTEPEQUE (4)
1966	902	-	-	-
1967	1,224	-	1,719	2,251
1968	1,204	-	1,652	2,824
1969	1,271	-	1,803	2,996
1970	na	-	3,445	2,826
1971	1,350	-	2,090	2,816
1972	1,357	-	2,178	3,101
1973	1,514	-	2,338	3,932
1974	1,840	-	2,131	3,421
1975	2,077	-	2,198	na
1976	1,987	-	4,601	5,063
1977	2,463	-	2,960	na
1978	2,922	19,539	5,846	5,648
(A) 1979	2,961	na	5,880	na
1980	2,975	16,704	5,790	6,111
(B) 1981	3,073	18,444	na	4,239
1982	3,192	21,275	2,422	4,299
1983	3,204	22,749	2,445	4,331
1984	3,256	24,151	na	4,375
1985	3,294	26,202	2,699	4,401
(C) 1986	3,304	29,501	2,718	4,444
1987	3,322	31,166	2,743	4,470
1988	na	34,298	2,791	5,624

(1) AHUACHAPAN,SANTA ANA
(2) SAN SALVADOR, LA LIBERTAD
(3) SAN SALVADOR
(4) CUSCATLAN

(A) CONFLICT BEGINNIG
(B) CONFLICT PEAK
(C) CONFLICT SECONDARY PEAK
na: NOT AVAILABLE

Planes corridor is due to traffic diversion to the Comalapa Airport Freeway, and is not related to population shifts.

Traffic volumes along the Pan American Highway west of San Martin have declined. The San Martin - Cojutepeque segment has experienced an eight percent decline in traffic volumes from 1980 to 1988. During a peak in the conflict in 1981 the drop in traffic volumes was 31 percent. A drop of this magnitude or even larger is typical of roads in conflict areas.

Thus, meaningful traffic projections based on historical data are difficult to obtain. These forecasts could be misleading in some areas, and the Consultants felt it was necessary to develop projections based on relevant macroeconomic indicators. In this manner, traffic was forecasted consistent with overall macroeconomic and population scenarios developed by the present study. The parameters considered and the factors obtained to estimate annual growth by department are described below.

(a) Population

Forecasts of urban and rural population were presented under Section I.D.2. A ratio [T1] of projected year-2000 over base year (1988) population was calculated (from Appendix I.B.1). Table II.A.25 shows the estimates of T1 which is one of the four factors with which traffic growth rate is computed.

(b) Vehicle Availability Ratios (VARs)

Vehicle availability directly influences trip generation. The higher vehicle availability ratio a country has, the more travelled its highways will be. Table II.A.26 analyzes the changes in the VAR over time. From 1980 to 1986, population increased six percent, gross national product first decreased 13 percent and then increased six percent, per capita gross national product first decreased 15 percent and then increased three percent; and according to available data, VAR was constant at approximately 30 vehicles per 1000 people.

For the purpose of this study, no changes in VAR has been forecasted for the future. A year-2000 VAR of 30.5 vehicles per 1,000 people is projected. T2 is the ratio of year-2000 VAR over the base-year VAR, and is equal to 1.0.

(c) Agricultural Production

El Salvador has a low VAR and its inter-urban highways contain a high percentage of trucks. This suggests that most inter-urban trips are related to the transport of goods. In addition, the economy is largely agricultural, and agricultural production significantly influences traffic volumes along the highways being studied.

TABLE II.A.25

ANNUAL TRAFFIC GROWTH RATE BY DEPARTAMENT

DEPARTMENT	POPULATION 1988	POPULATION 2000	T1 2000/1988	VARIATION 1988	VARIATION 2,000	T2 2000/1988	AGRICULTURAL PRODUCTION FACTOR T3	END OF CONFLICT FACTOR T4	2000 TRAFFIC / 1988 TRAFFIC	ESTIMATED ANNUAL GROWTH FACTOR
AHUACHAPAN	254,790	341,271	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
SANTA ANA	460,627	616,975	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
SONSONATE	341,147	456,941	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
CHALATENANGO	247,868	332,000	1.34	30.5	30.5	1.00	1.267	1.30	2.21	1.07
LA LIBERTAD	412,063	551,928	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
SAN SALVADOR	1,026,237	1,374,568	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
CUSCATLAN	209,238	280,259	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
LA PAZ	261,312	350,008	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
CABAÑAS	186,782	250,181	1.34	30.5	30.5	1.00	1.267	1.30	2.21	1.07
SAN VICENTE	207,830	278,373	1.34	30.5	30.5	1.00	1.267	1.00	1.70	1.05
USULUTAN	411,298	550,903	1.34	30.5	30.5	1.00	1.267	1.30	2.21	1.07
SAN MIGUEL	451,809	605,164	1.34	30.5	30.5	1.00	1.267	1.30	2.21	1.07
MORAZAN	202,658	271,446	1.34	30.5	30.5	1.00	1.267	1.30	2.21	1.07
LA UNION	324,992	435,303	1.34	30.5	30.5	1.00	1.267	1.30	2.21	1.07
TOTAL	4,998,653	6,695,320	1.34	30.5	30.5	1.00	1.267	1.13	1.92	1.06

(1) APPLICABLE ONLY TO CONFLICT AREAS

TABLE II.A.26

Y E A R L Y V A R I A T I O N O F T H E S A L V A D O R A N

V E H I C L E A V A I L A B I L I T Y R A T E

(C A R S / 1 , 0 0 0 P E O P L E)

YEAR	POPULATION	G.N.P.	GNP/Cap.	VEHICLES	V.A.R.	%
1980	4,525,402	3,289.3	727.0	145,680	31.1	
1981	4,582,638	3,016.8	658.0	148,177	30.9	- 0.643
1982	4,624,922	2,847.7	616.0	148,674	31.1	+ 0.647
1983	4,662,788	2,870.4	616.0	150,079	31.1	0.000
1984	4,687,962	2,935.6	626.0	151,664	30.9	- 0.643
1985	4,736,462	2,993.6	632.0	155,337	30.5	- 1.294
1986	4,813,971	3,013.0	626.0	161,436	29.8	- 2.295

GNP/Cap. in constant 1962 colones
G.N.P. in millions of constant 1962 colones

Coffee and cotton exports have diminished in the recent years. This, coupled with sluggish sugar cane production, prompted the Consultants to analyze overall agricultural production in a search for possible trends. Table II.A.27 depicts recent annual Salavdoran agricultural productions disaggregated by crop.

Total agricultural production (measured in quintals) has varied from about 21 million to 26.5 million during the last six years, and no particular trend is observed. Despite drops in exports, no significant reduction in overall coffee or sugar cane production has occurred. Cotton production has diminished to one third its previous levels. But (in terms of total volume) cotton is a relatively insignificant crop, even in cotton producing departments, such as Sonsonate, La Paz, Usulatan, and San Miguel.

These observations suggest that an agriculturally-based traffic recovery factor is not warranted. For consistency with this study's macroeconomic projections and given the preeminence of agriculture in the gross national product, the Consultants assume that agricultural production will follow the forecasted variations of the gross national product. No growth in agricultural production is expected until 1993 and a 4.5-percent annual increase is assumed for 1993-2000 (three percent in volume). Table II.A.25 shows T3, a ratio of expected year-2000 agricultural production over base-year production, as equal to 1.267.

(d) End-of-Conflict Traffic Adjustment Factor

As described above, traffic has significantly diminished in conflict areas and on roads which lead to conflict areas. Drops of twenty to seventy percent in traffic volumes have been observed, and it is probable that these drops will not totally recover when the conflict is over. Population emigration and production center shifts will not be reversed immediately. Because of this, the Consultants assume that traffic levels will recover only partially over a period of a few years.

Table II.A.25 shows T4, the end-of-conflict traffic adjustment factor. A thirty percent increase in traffic volumes is assumed during the period ending in the year 2000. This percentage is only applied to the six Salvadoran Departments most affected by the conflict. These include Cabanas Chalatenango, Usulatan, Morazan, San Miguel and La Union.

By multiplying the population growth factor T1, the vehicle availability ratio factor T2, the agricultural production factor T3, and the end-of-conflict traffic adjustment factor T4, overall traffic growth ratios (year-2000 traffic/1988

TABLE II.A.27

YEARLY VARIATION OF THE SALVADORAN

AGRICULTURAL PRODUCTION (BY CROP)

YEAR	COFFE		SUGAR CANE		COTTON		GRAINS		TOTAL	
	AREA 1,000 Ha	PRODUCTION 1,000 qq	AREA 1,000 Ha	PRODUCTION 1,000 qq	AREA 1,000 Ha	PRODUCTION 1,000 qq	AREA 1,000 Ha	PRODUCTION 1,000 qq	AREA 1,000 Ha	PRODUCTION 1,000 qq
83 - 84	248.2	2,929	53.0	5,326.1	52.5	3,284.6	443.5	11,491.3	797.2	23,031
84 - 85	243.9	3,562	57.9	5,817.3	53.3	3,297.0	452.1	13,894.4	806.3	26,571
85 - 86	234.2	2,580	59.0	5,873.1	39.3	2,014.6	470.1	13,018.0	802.6	23,486
86 - 87	234.2	2,700	58.7	5,375.4	19.6	1,162.7	472.4	11,614.3	784.9	20,852
87 - 88	234.2	3,300	56.6	4,103.7	19.4	1,114.6	504.5	14,021.4	814.7	22,540
88 - 89	234.2	2,500	NA	NA	18.5	1,084.8	NA	NA	NA	NA

traffic) are obtained. An annual growth factor has been calculated for each department from these ratios (see Table II.A.25).

(2) Traffic Volume Estimates for the Analyzed Projects

Figures II.A.6 and II.A.7 show the location of highway segments which are being analyzed for rehabilitation/reconstruction and improvement. Table II.A.28 shows current traffic volumes for each of these segments and lists the project name, road category, ADT and load distribution. When no traffic information is available, the average ADT and load distribution for each roadway category is assumed.

Table II.A.29 presents expected ADTs, design-hour volumes (DHVs), and ESALs for the highway projects under study. Year-2000 ADTs have been estimated based on current ADTs and calculated annual growth factors. DHVs are computed by multiplying the expected ADTs by 0.10 (highest value in Table II.A.19). ESALs have been obtained by projecting the total number of vehicles over a twelve-year period (1989-2000) and also by taking into account the load factors from Table II.A.21.

5. Design Standards

There is continual activity in design and construction of highways in El Salvador. The Consultants have found that there is no ordered compilation of norms, be it for geometric design, structural pavement design, or for the different study phases of soils and construction materials.

The DGC has norms for geometric and structural pavement design, using methods such as CBR and Group Indices. In some projects, the old AASHO design procedure is still being used, but recently the new AASHTO design method was selected. 1983 AASHTO norms are kept in mind for the design of bridges.

The use of the term "norm" implies obligatory use, and uniformity. Serious problems can arise, especially in the use of local materials, when these norms are extrapolated indiscriminately. In this regard, it is important that the MOP adopt and distribute norms and recommendations for the design of highways and bridges that are consistent with Salvadoran conditions. Each section of the network has a function which should be associated with a norm and design recommendation, a level of service, and a construction, maintenance and rehabilitation cost.

Road construction is governed by the MOP's "Specifications for Road and Bridge Construction", Document EG-78. This

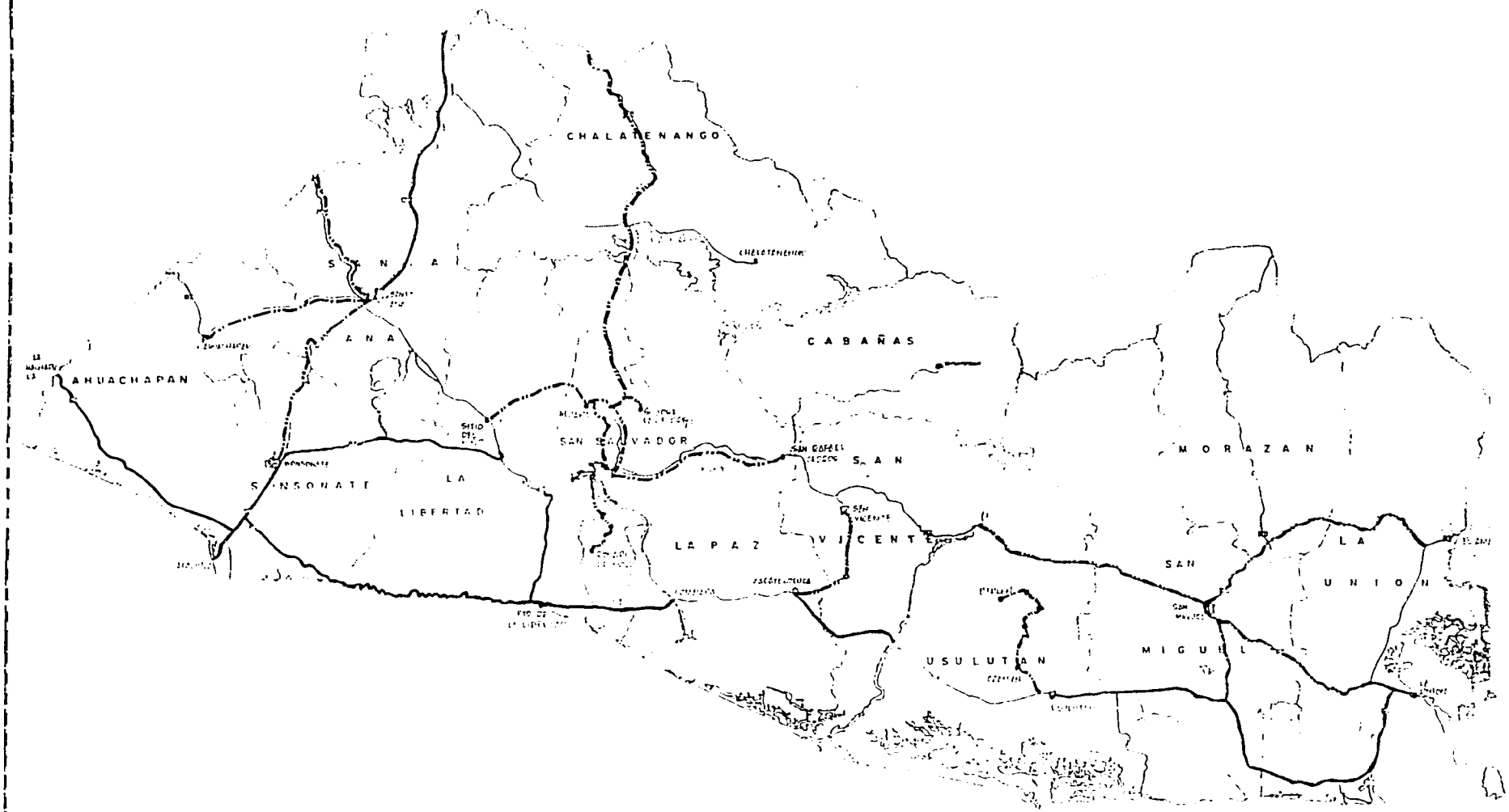


FIGURE II. A.6

HIGHWAY PROJECTS INCLUDED IN PROPOSED FIRST FIVE-YEAR PLAN. - SPECIAL, PRIMARY AND SECONDARY.

SCALE 1 500,000

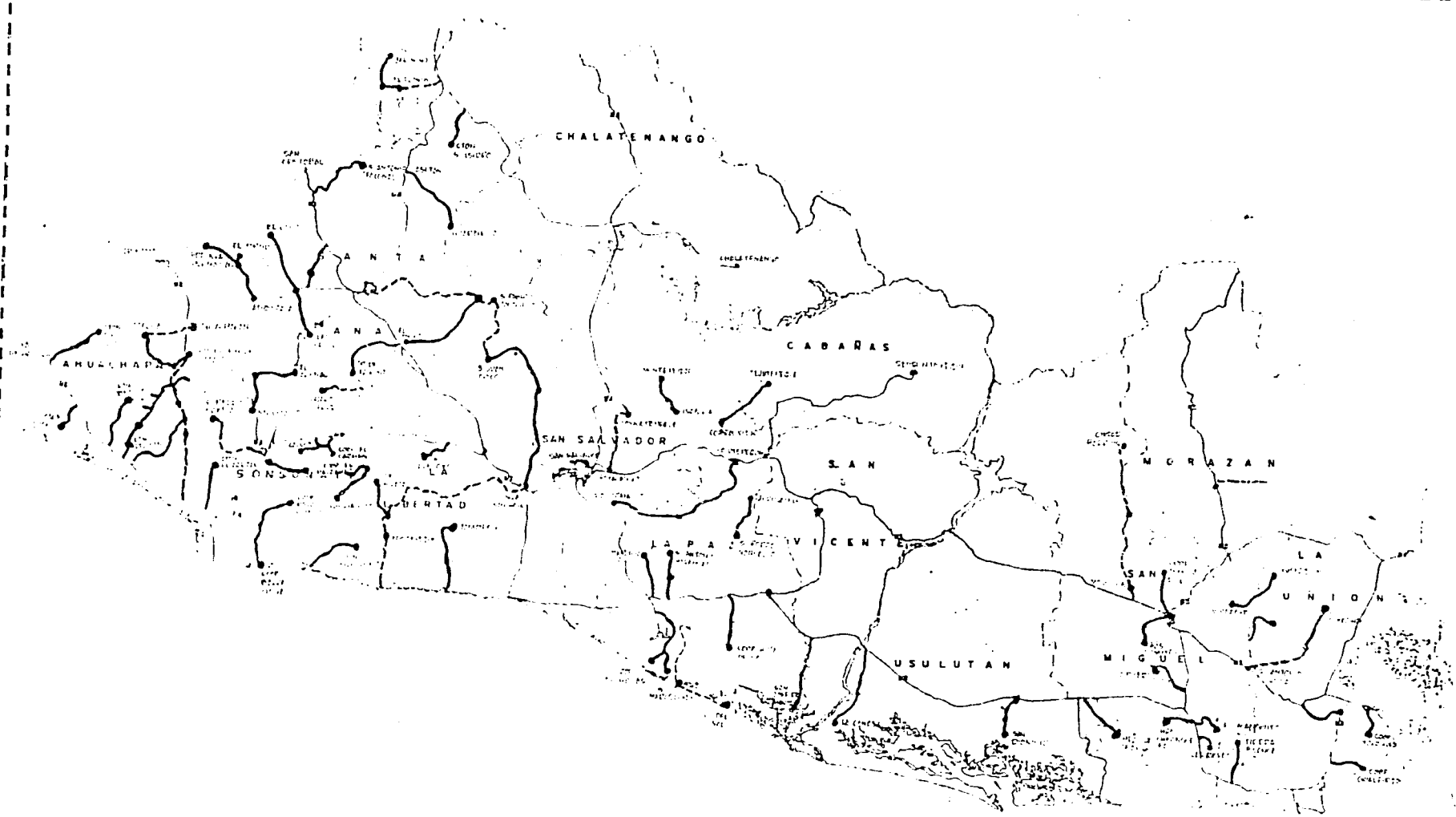


FIGURE II.A.7
HIGHWAY PROJECTS INCLUDED IN PROPOSED FIRST FIVE-YEAR PLAN. -TERTIARY, RURAL "A" AND RURAL "B."

TABLE II.A.28

1988 TRAFFIC VOLUME ESTIMATES FOR THE ANALYZED PROJECTS

ROAD CATEGORY	PROJECT NAME	LENGTH (km)	ADT	PASSENGER CARS %	LIGHT TRUCKS %	BUSES %	HEAVY TRUCKS % C2 %	C3 %	T3-S2 OTHER %	TOTAL %
SPECIAL	SAN SALVADOR - SANTA TECLA (LIBERTAD EXIT)	4.5	37884	50	33	9	78	8	14	8
SPECIAL	SAN SALVADOR - COMALAPA FREEWAY	42.0	4812	38	37	9	83	8	9	16
SECONDARY	CA:1 SANTA ANA-EL PORTEZUELO	4.0	4001	27	38	18	94	3	3	17
SECONDARY	CA:1 EL PORTEZUELO-KM 73	3.0	815	20	40	1	93	3	4	39
SECONDARY	CA:1 KM73-EL PORVENIR	3.0	1035	18	36	17	91	5	4	29
SECONDARY	CA:1 EL PORVENIR-SAN CRISTOBAL	17.0	1000	18	37	16	92	4	4	29
SPECIAL	CA:1 SITIO DEL NINO-SANTA TECLA	15.0	13427	33	37	10	77	8	15	20
SECONDARY	CA:1 SAN SALVADOR-SAN MARTIN (KM 18)	18.0	12173	29	34	20	87	7	6	17
SECONDARY	CA:1 SAN MARTIN (KM 18)-COJUTEPEQUE (KM 33)	15.0	4895	22	34	24	90	6	4	20
SECONDARY	CA:1 COJUTEPEQUE-SAN RAFAEL CEDROS	7.0	2483	21	35	20	84	12	4	24
SECONDARY	CA:1 EAST OF LEMPA RIVER- S.RAFAEL ORIENTE EXIT	40.0	2483	21	35	20	84	12	4	24
SECONDARY	CA:1 SAN RAFAEL ORIENTE EXIT -SAN MIGUEL	6.0	5626	32	41	12	90	5	5	15
SECONDARY	CA:1 SAN MIGUEL-LA UNION EXIT	38.0	3414	16	44	10	92	3	5	30
PRIMARY	CA:2 LA HACHADURA-CA:12	42.0	1066	64	35	16	54	4	42	35
PRIMARY	CA:2 LA LIBERTAD-CA:12	67.0	1319	45	39	7	76	11	13	9
PRIMARY	CA:2 LA LIBERTAD (KM 32)-SAN DIEGO (KM 37)	5.0	1779	48	34	11	90	3	7	7
PRIMARY	CA:2 SAN DIEGO (KM 37)-COMALAPA (KM 61)	24.0	1181	24	43	12	85	7	8	21
PRIMARY	CA:2 ZACATECOLUCA (KM 56)-LEMPA RIVER (KM 83)	27.0	1177	22	40	1	75	9	16	37
PRIMARY	CA:2 USULUTAN-SANTA ELENA (KM 114)	3.0	2517	19	46	16	85	7	8	19
PRIMARY	CA:2 SANTA ELENA (KM 114)-LA UNION	86.0	1869	15	46	14	82	8	10	25
SECONDARY	CA:4 SAN SALVADOR-APOPA	13.0	10049	26	35	23	86	7	7	16
SECONDARY	CA:4 APOPA (KM 13)-KM 15	2.0	4702	18	38	21	91	7	2	23
SECONDARY	CA:4 KM 15-KM 17	2.0	3874	15	36	22	85	10	5	27
SECONDARY	CA:4 KM 17-KM 20	3.0	3042	15	38	17	87	8	5	30
SECONDARY	CA:4 KM 20-AGUILARES	14.0	2417	15	39	18	92	6	2	28
SECONDARY	CA:4 AGUILARES-SAN IGNACIO	56.0	1885	20	40	18	92	5	3	22
PRIMARY	CA:4 SAN IGNACIO-EL POY	6.0	48	12	18	1	81	-	19	69
PRIMARY	CA:12 SONSONATE KM-80	14.0	4605	17	40	9	67	7	26	34
PRIMARY	CA:12 KM 80-ACAJUTLA	6.0	3145	18	32	8	66	6	28	42

TABLE II.A.28 (Contd.)

1988 TRAFFIC VOLUME ESTIMATES FOR THE ANALYZED PROJECTS

ROAD CATEGORY	PROJECT NAME	LENGTH (km)	ADT	PASSENGER CARS %	LIGHT TRUCKS %	BUSES %	HEAVY TRUCKS % C2 %	C3 %	T3-S2 OTHER %	TOTAL %
SECONDARY	CA:12 SONSONATE-SANTA ANA	34.0	1308	24	45	11	91	5	4	20
PRIMARY	CA:12 SANTA ANA-TEXISTEPEQUE	16.0	2025	17	33	15	71	8	21	35
PRIMARY	CA:12 TEXISTEPEQUE-METAPAN	30.0	878	17	25	14	37	5	58	44
PRIMARY	CA:12 METAPAN-ANGUIATU	12.0	521	11	22	20	28	7	64	47
PRIMARY	CA:8 SONSONATE-IZALCO EXIT	6.0	3612	22	36	10	68	6	26	32
PRIMARY	CA:8 IZALCO EXIT-CALUCO EXIT	1.0	4224	23	31	9	74	5	21	37
PRIMARY	CA:8 CALUCO EXIT-SAN JULIAN EXIT	9.0	4189	21	33	9	73	4	23	37
PRIMARY	CA:8 SAN JULIAN EXIT-EL CONGO EXIT	4.0	4109	23	34	11	67	7	26	32
PRIMARY	CA:8 EL CONGO EXIT-ARMENIA EXIT	6.0	4320	23	34	11	68	6	26	32
PRIMARY	CA:8 ARMENIA EXIT-SACACOYO EXIT	6.0	4170	25	32	9	75	7	18	34
PRIMARY	CA:8 SACACOYO EXIT-TEPECOYO EXIT	2.0	4627	22	31	8	72	10	18	39
PRIMARY	CA:8 TEPECOYO EXIT-CA:1	10.0	4869	20	36	8	71	10	19	36
TERTIARY	AHUACHAPAN-TACUBA	17.2	388	16	48	10	91	4	5	26
SECONDARY	SANTA ANA-AHUACHAPAN	34.0	3557	27	37	17	88	5	7	19
RURAL	JUAYUA-SAN JOSE LA MAJADA-EL ARENAL	10.0	265	14	50	9	98	2	-	27
TERTIARY	CERRE VERDE-(EL CONGO-CA:8)	10.0	388	16	48	10	91	4	5	26
SECONDARY	EL CONGO-CA:8 FROM CERRO VERDE TO CA:8	3.0	388	20	35	18	82	12	6	27
RURAL	EL CONGO-FLOR AMARILLA	12.0	265	14	50	9	98	2	-	27
RURAL	FLOR AMARILLA-PLANES DE LA LAGUNA	12.0	265	14	50	9	98	2	-	27
TERTIARY	SANTA ANA-SAN PABLO TACACHICO	26.0	388	16	48	10	91	4	5	26
SECONDARY	APOPA-KM 20	7.0	3408	18	40	12	87	7	6	30
SECONDARY	KM 20-NEJAPA	3.0	2562	18	36	14	92	3	5	30
SECONDARY	NEJAPA-KM 27	4.0	2474	18	38	14	91	4	5	30
SECONDARY	KM 27-QUEZALTEPEQUE EXIT	3.0	2485	19	41	21	91	4	5	19
SECONDARY	QUEZALTEPEQUE EXIT-SITIO DEL NINO	13.0	1856	21	39	16	88	5	7	24
PRIMARY	CA:1-NUEVO CUSCATLAN EXIT	1.0	7487	53	34	2	87	6	7	11
PRIMARY	NUEVO CUSCATLAN EXIT-SN. JOSE VILLANUEVA EXIT	9.0	2723	27	42	10	89	8	3	21
PRIMARY	SN JOSE VILLANUEVA EXIT-EL CIMARRON	8.0	2570	27	43	10	88	9	3	20
PRIMARY	EL CIMARRON-LA LIBERTAD	5.0	3148	50	35	9	84	10	6	6

TABLE II.A.28 (Contd.)

1988 TRAFFIC VOLUME ESTIMATES FOR THE ANALYZED PROJECTS

ROAD CATEGORY	PROJECT NAME	LENGTH (km)	ADT	PASSENGER CARS %	LIGHT TRUCKS %	BUSES %	HEAVY TRUCKS % C2 %	C3 %	T3-S2 OTHER %	TOTAL %
TERTIARY	SANTA TECLA-SN.JUAN LOS PLANES-QUEZALTEPEQUE	17.0	388	16	48	10	91	4	5	26
RURAL	EL REFUGIO-EL CASTILLO-SAN JOSE LA CUEVA-MONCAGUA	9.0	265	14	50	9	98	2	-	27
RURAL	EL COCO-CHALCHUAPA	14.0	719	13	51	16	98	2	-	20
RURAL	CA:1-EL PORVENIR-(SANTA ANA-AHUACHAPAN)	9.0	265	14	50	9	98	2	-	27
RURAL	CA:1-SAN ANTONIO PAJONAL	14.0	189	16	42	22	100	-	-	20
RURAL	EL RONCO-OSTUA	8.0	880	12	38	4	62	6	32	46
RURAL	OSTUA-SAN JERONIMO	8.0	225	10	56	4	100	-	-	30
SECONDARY	MEJICANOS-MARIONA-NEJAPA	16.0	1141	21	42	28	99	-	1	26
SECONDARY	SAN SALVADOR-SAN MARCOS	5.0	9130	39	36	16	96	3	1	9
SECONDARY	APOPA-SAN JOSE LAS FLORES	9.0	1013	17	37	32	72	22	1	14
SECONDARY	SAN SALVADOR-LOS PLANES	9.0	2791	46	30	12	97	2	1	12
TERTIARY	CA:8 JAYAQUE DETOUR	2.0	1184	12	42	5	83	11	6	41
TERTIARY	JAYAQUE DETOUR-TEPECOYO	5.0	370	15	57	4	98	2	-	24
RURAL	QUEZALTEPEQUE-SAN MATIAS	19.0	294	15	57	9	100	-	-	19
RURAL	SAN MATIAS-SAN JUAN OPICO	5.0	147	5	52	9	100	-	-	34
TERTIARY	CA:2-LA HERRADURA (VIA SAN MARCELINO)	18.0	921	21	39	13	94	6	-	27
SECONDARY	LOS PLANES-PANCHIMALCO	7.0	890	34	40	9	100	-	-	17
SECONDARY	PANCHIMALCO-ROSARIO DE MORA	4.0	495	13	34	19	100	-	-	34
TERTIARY	TONACATEPEQUE-SOYAPANGO	12.0	882	16	42	20	99	1	-	22
SECONDARY	BERLIN-ALEGRIA-SANTIAGO DE MARIA	11.6	1885	20	40	18	92	5	3	22
SECONDARY	SANTIAGO DE MARIA-TECAPAN-OZATLAN-CA:2	17.0	649	15	45	16	94	6	-	24
RURAL	TEJUTEPEQUE-SAN ANTONIO BUENA VISTA-CORRAL VIEJO	9.8	265	14	50	9	98	2	-	27
RURAL	CA:12-LAS CASITAS-S ANTONIO MAS-L HORCONES-GUARNECIA	19.4	265	14	50	9	98	2	-	27
RURAL	TAPALHUACA-CA:2(ANTIGUA COMALAPA)	8.0	170	16	60	-	100	-	-	24
RURAL	CA:2-SAN PEDRO MASAHUAT	6.0	265	14	50	9	98	2	-	27
RURAL	SAN PEDRO MASAHUAT-SAN ANTONIO MASAHUAT	3.0	137	15	55	13	100	-	-	17
TERTIARY	CIUDAD BARRIOS-MONCAGUA	28.0	388	16	48	10	91	4	5	26
SECONDARY	SAN MIGUEL-EL DELIRIO	15.3	2478	23	41	14	91	4	5	22

TABLE II.A.28 (Contd.)

1988 TRAFFIC VOLUME ESTIMATES FOR THE ANALYZED PROJECTS

ROAD CATEGORY	PROJECT NAME	LENGTH (km)	ADT	PASSENGER CARS %	LIGHT TRUCKS %	BUSES %	HEAVY TRUCKS %			
							C2 %	C3 %	T3-S2 OTHER %	TOTAL %
SECONDARY	SAN MIGUEL-MILITAR ROUTE EXIT	16.0	2825	21	69	12	90	6	4	19
SECONDARY	MILITAR ROUTE EXIT-PASAQUINA	30.0	1885	20	40	18	92	5	3	22
TERTIARY	CA:1-SAN ANTONIO SILVA-SAN ALEJO	10.1	388	16	48	10	91	4	5	26
PRIMARY	CA:1 JUNCTION-LA UNION	7.0	3414	16	44	10	92	3	5	30
SECONDARY	ZACATECOLUCA-TECOLUCA-SAN VICENTE	21.0	1111	24	44	13	93	5	2	19
RURAL	TACUBA-CONCEPCION DE ATACO	13.0	265	14	50	9	98	2	-	27
RURAL	ISTAGUA-ORATORIO DE CONCEPCION-MONTEPEQUE	9.0	265	14	50	9	98	2	-	27
RURAL	CHALCHUAPA-LAS CRUCES	8.0	83	18	48	4	100	-	-	30
RURAL	SAN JOSE EL NARANJO-LAS DELICIAS-CA:2	7.8	265	14	50	9	98	2	-	27
RURAL	NAHUIZALCO-JUAYUA	8.5	265	14	50	9	98	2	-	27
RURAL	CA:3-EL CHAPERNO-CASERIO SAN ISIDRO	8.3	265	14	50	9	98	2	-	27
TERTIARY	SAN PEDRO NONUALCO-JERUZALEN	12.8	388	16	48	10	91	4	5	26
TERTIARY	S ANTONIO MONTE-STO DOMINGO GUZMAN-S PEDRO PUXTLA	13.0	388	16	48	10	91	4	5	26
RURAL	ATIQUIZAYA-SAN LORENZO-EL PORTILLO	9.3	358	24	48	9	100	-	-	19
TERTIARY	SAN JUAN OPICO-SAN PABLO TACACHICO	14.0	388	16	48	10	91	4	5	26
TERTIARY	CA:2-TEOTEPEQUE-SANTA TECLA	44.0	388	16	48	10	91	4	5	26
RURAL	SAN JULIAN-CUISNAHUAT	10.0	228	10	58	-	100	-	-	32
TERTIARY	CA:2-GUAYMANGO-JUJUTLA-ATACO-AHUACHAPAN	34.0	388	16	48	10	91	4	5	26
TERTIARY	CA:12-EL RONCO	7.3	880	12	38	4	62	6	32	46
RURAL	SANTO TOMAS-SAN MIGUEL TEPEZONTES-COJUTEPEQUE	23.7	137	15	62	-	100	-	-	23
RURAL	CA:2-CANTON LA CANOA	18.3	265	14	50	9	98	2	-	27
RURAL	SAN LORENZO-HACIENDA SAN MARTIAS	6.4	265	14	50	9	98	2	-	27
RURAL	HACIENDA SAN MARTIN-CA:2	15.5	265	14	50	9	98	2	-	27
RURAL	NAHULINGO-LA CHAPINA COOP.	7.5	265	14	50	9	98	2	-	27
RURAL	SAN JOSE EL NARANJO-(JUJUTLA-ATACO)	24.9	265	14	50	9	98	2	-	27
RURAL	COMALAPA FREEWAY-LAS HOJAS COOP.	19.2	265	14	50	9	98	2	-	27
RURAL	CALUCO - EL CARMEN COOPERATIVE.	9.8	265	14	50	9	98	2	-	27
RURAL	ULUAZAPA-COOPERATIVE 21 DE MARZO	11.1	265	14	50	9	98	2	-	27
RURAL	HAC. SANTA ELENA-I.(YAYANTIQUE)	10.0	265	14	50	9	98	2	-	27

TABLE II.A.28 (Contd.)

1988 TRAFFIC VOLUME ESTIMATES FOR THE ANALYZED PROJECTS

ROAD CATEGORY	PROJECT NAME	LENGTH (km)	ADT	PASSENGER CARS %	LIGHT TRUCKS %	BUSES %	HEAVY TRUCKS % C2 %	C3 %	T3-S2 OTHER %	TOTAL %
RURAL	CA:2 - HAC.CHILANGUERA	6.2	265	14	50	9	98	2	-	27
RURAL	LA CHILATA-SAN MARCOS	16.0	265	14	50	9	98	2	-	27
RURAL	CA:2 -TAMANIQUE	14.5	61	3	46	20	100	-	31	27
RURAL	SAN JULIAN-EL BALSAMAR COOPERATIVE	12.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - CARA SUCIA	8.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - SAN BENITO	11.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - AGUA FRIA	11.0	265	14	50	9	98	2	-	27
RURAL	TACUBA-CONCEPCION DE ATACO	13.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - PALO COMBO COOPERATIVE	8.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - BARRA CIEGA COOPERATIVE	8.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - EL ZARZAL	12.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - SIHUAPILAPA	12.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - HACIENDA LA CABANA	12.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - SAN DIONISIO	8.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - SAN JOSE DE LA MONTANA	16.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - HOJA DE SAL COOPERATIVE	11.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - EL MANGUITO COOPERATIVE	7.0	265	14	50	9	98	2	-	27
RURAL	MILITAR ROUTE-MAYUCAQUIN COOPERATIVE	9.0	265	14	50	9	98	2	-	27
RURAL	SAN MIGUEL-LA PUERTA	9.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - TIERRA BLANCA	9.0	265	14	50	9	98	2	-	27
RURAL	CA:2 - LLANO DE LAS ROSAS	7.0	265	14	50	9	98	2	-	27
RURAL	PANAMERICANA-CA:2-LA UNION	12.0	265	14	50	9	98	2	-	27
RURAL	SAN ALEJO-EL TAMARINDO	11.0	265	14	50	9	98	2	-	27
RURAL	CA:2 GUALPIRQUE COOP.	8.0	265	14	50	9	98	2	-	27
RURAL	LA UNION-YOLOGUAL COOP.-EL FARO	9.0	265	14	50	9	98	2	-	27

TABLE II.A.29

ESTIMATED HIGHWAY PARAMETERS FOR HIGHWAY PROJECTS UNDER STUDY

ROAD CATEGORY	PROJECT NAME	1,988 ADT	ESTIMATED ANNUAL GROUTH FACTOR	2,000 ADT	2,000 DHV	ESAL 1989-2000
SPECIAL	SAN SALVADOR - SANTA TECLA (LIBERTAD EXIT)	37884	1.05	64,403	6,440	49,275,454
SPECIAL	SAN SALVADOR - COMALAPA FREEWAY	4812	1.05	8,180	818	11,989,559
SECONDARY	CA:1 SANTA ANA-EL PORTEZUELO	4,001	1.05	6,802	680	9,732,455
SECONDARY	CA:1 EL PORTEZUELO-KM 73	815	1.05	1,386	139	2,026,151
SECONDARY	CA:1 KM73-EL PORVENIR	1,035	1.05	1,760	176	3,175,834
SECONDARY	CA:1 EL PORVENIR-SAN CRISTOBAL	1,000	1.05	1,700	170	2,995,832
SPECIAL	CA:1 SITIO DEL NINO-SANTA TECLA	13,427	1.05	22,826	2,283	28,821,206
SECONDARY	CA:1 SAN SALVADOR-SAN MARTIN (KM 18)	12,173	1.05	20,694	2,069	31,700,480
SECONDARY	CA:1 SAN MARTIN (KM 18)-COJUTEPEQUE (KM 33)	4,895	1.05	8,322	832	14,946,578
SECONDARY	CA:1 COJUTEPEQUE-SAN RAFAEL CEDROS	2,483	1.05	4,221	422	7,432,920
SECONDARY	CA:1 EAST OF LEMPA RIVER- S.RAFAEL ORIENTE EXIT	2,483	1.07	5,487	549	8,836,916
SECONDARY	CA:1 SAN RAFAEL ORIENTE EXIT -SAN MIGUEL	5,626	1.07	12,433	1,243	12,671,524
SECONDARY	CA:1 SAN MIGUEL-LA UNION EXIT	3,414	1.07	7,545	754	10,685,289
PRIMARY	CA:2 LA HACHADURA-CA:12	1,066	1.05	1,812	181	4,377,661
PRIMARY	CA:2 LA LIBERTAD-CA:12	1,319	1.05	2,242	224	1,600,452
PRIMARY	CA:2 LA LIBERTAD (KM 32)-SAN DIEGO (KM 37)	1,779	1.05	3,024	302	2,415,691
PRIMARY	CA:2 SAN DIEGO (KM 37)-COMALAPA (KM 61)	1,181	1.05	2,008	201	2,692,828
PRIMARY	CA:2 ZACATECOLUCA (KM 56)-LEMPA RIVER (KM 83)	1,177	1.05	2,001	200	3,057,855
PRIMARY	CA:2 USULUTAN-SANTA ELENA (KM 114)	2,517	1.07	5,563	556	7,334,443
PRIMARY	CA:2 SANTA ELENA (KM 114)-LA UNION	1,869	1.07	4,130	413	5,984,932
SECONDARY	CA:4 SAN SALVADOR-APOPA	10,049	1.05	17,083	1,708	27,854,846
SECONDARY	CA:4 APOPA (KM 13)-KM 15	4,702	1.05	7,993	799	14,037,822
SECONDARY	CA:4 KM 15-KM 17	3,874	1.05	6,586	659	12,896,203
SECONDARY	CA:4 KM 17-KM 20	3,042	1.05	5,171	517	9,556,198
SECONDARY	CA:4 KM 20-AGUILARES	2,417	1.05	4,109	411	7,380,385
SECONDARY	CA:4 AGUILARES-SAN IGNACIO	1,885	1.07	4,166	417	6,098,701
PRIMARY	CA:4 SAN IGNACIO-EL POY	48	1.07	106	11	272,719
PRIMARY	CA:12 SONSONATE KM-80	4,605	1.05	7,829	783	14,577,328
PRIMARY	CA:12 KM 80-ACAJUTLA	3,145	1.05	5,347	535	11,621,444

ESTIMATED HIGHWAY PARAMETERS FOR HIGHWAY PROJECTS UNDER STUDY

ROAD CATEGORY	PROJECT NAME	1,988 ADT	ESTIMATED ANNUAL GROWTH FACTOR	2,000 ADT	2,000 DHV	ESAL 1989-2000
SECONDARY	CA:12 SONSONATE-SANTA ANA	1,308	1.05	2,224	222	2,754,071
PRIMARY	CA:12 SANTA ANA-TEXISTEPEQUE	2,025	1.05	3,443	344	7,252,365
PRIMARY	CA:12 TEXISTEPEQUE-METAPAN	878	1.05	1,493	149	4,356,913
PRIMARY	CA:12 METAPAN-ANGUIATU	521	1.05	886	89	3,010,349
PRIMARY	CA:8 SONSONATE-IZALCO EXIT	3,612	1.05	6,140	614	11,194,434
PRIMARY	CA:8 IZALCO EXIT-CALUCO EXIT	4,224	1.05	7,181	718	13,852,347
PRIMARY	CA:8 CALUCO EXIT-SAN JULIAN EXIT	4,189	1.05	7,121	712	13,900,709
PRIMARY	CA:8 SAN JULIAN EXIT-EL CONGO EXIT	4,109	1.05	6,985	699	13,032,957
PRIMARY	CA:8 EL CONGO EXIT-ARMENIA EXIT	4,320	1.05	7,344	734	13,703,753
PRIMARY	CA:8 ARMENIA EXIT-SACACOYO EXIT	4,170	1.05	7,089	709	12,609,719
PRIMARY	CA:8 SACACOYO EXIT-TEPECOYO EXIT	4,627	1.05	7,866	787	15,166,575
PRIMARY	CA:8 TEPECOYO EXIT-CA:1	4,869	1.05	8,277	828	15,092,866
TERTIARY	AMUACHAPAN-TACUBA	388	1.05	660	66	929,901
SECONDARY	SANTA ANA-AMUACHAPAN	3,557	1.05	6,047	605	8,943,929
RURAL	JUAYUA-SAN JOSE LA MAJADA-EL ARENAL	265	1.05	451	45	612,926
TERTIARY	CERRE VERDE-(EL CONGO-CA:8)	388	1.05	660	66	929,901
SECONDARY	EL CONGO-CA:8 FROM CERRO VERDE TO CA:8	388	1.05	660	66	1,183,649
RURAL	EL CONGO-FLOR AMARILLA	265	1.05	451	45	612,926
RURAL	FLOR AMARILLA-PLANES DE LA LAGUNA	265	1.05	451	45	612,926
TERTIARY	SANTA ANA-SAN PABLO TACACHICO	388	1.05	660	66	929,901
SECONDARY	APOPA-KM 20	3,408	1.05	5,794	579	9,517,594
SECONDARY	KM 20-NEJAPA	2,562	1.05	4,355	436	7,492,065
SECONDARY	NEJAPA-KM 27	2,474	1.05	4,206	421	7,233,896
SECONDARY	KM 27-QUEZALTEPEQUE EXIT	2,485	1.05	4,225	422	6,924,721
SECONDARY	QUEZALTEPEQUE EXIT-SITIO DEL NINO	1,856	1.05	3,155	316	5,087,608
PRIMARY	CA:1-OLD HIGHWAY TO SANTA TECLA	7,487	1.05	12,728	1,273	7,044,869
PRIMARY	OLD HIGWAY TO SANTA TECLA-SN. JOSE VILLANUEVA EXIT	2,723	1.05	4,629	463	5,662,084
PRIMARY	SN JOSE VILLANUEVA EXIT-EL CIMARRON	2,570	1.05	4,369	437	5,194,792
PRIMARY	EL CIMARRON-LA LIBERTAD	3,148	1.05	5,352	535	3,615,435

TABLE II.A.29

ESTIMATED HIGHWAY PARAMETERS FOR HIGHWAY PROJECTS UNDER STUDY

ROAD CATEGORY	PROJECT NAME	1,988 ADT	ESTIMATED ANNUAL GROWTH FACTOR	2,000 ADT	2,000 DHV	ESAL 1989-2000
TERTIARY	SANTA TECLA-SN.JUAN LOS PLANES-QUEZALTEPEQUE	388	1.05	660	66	929,901
RURAL	EL REFUGIO-EL CASTILLO-SAN JOSE LA CUEVA-NONCAGUA	265	1.05	451	45	612,926
RURAL	EL COCO-CHALCHUAPA	719	1.05	1,222	122	1,746,615
RURAL	CA:1-EL PORVENIR-(SANTA ANA-AHUACHAPAN)	265	1.05	451	45	612,926
RURAL	CA:1-SAN ANTONIO PAJONAL	189	1.05	321	32	541,912
RURAL	EL RONCO-OSTUA	880	1.05	1,496	150	3,328,779
RURAL	OSTUA-SAN JERONIMO	225	1.05	383	38	476,526
SECONDARY	MEJICANOS-MARIONA-NEJAPA	1,141	1.05	1,940	194	4,198,354
SECONDARY	SAN SALVADOR-SAN MARCOS	9,130	1.05	15,521	1,552	16,564,835
SECONDARY	APOPA-SAN JOSE LAS FLORES	1,013	1.05	1,722	172	3,263,880
SECONDARY	SAN SALVADOR-LOS PLANES	2,791	1.05	4,745	474	4,725,775
TERTIARY	CA:8 JAYAQUE DETOUR	1,184	1.05	2,013	201	3,473,391
TERTIARY	JAYAQUE DETOUR-TEPECOYO	370	1.05	629	63	658,350
RURAL	QUEZALTEPEQUE-SAN MATIAS	294	1.05	500	50	547,669
RURAL	SAN MATIAS-SAN JUAN OPICO	147	1.05	250	25	398,062
TERTIARY	CA:2-LA HERRADURA (VIA SAN MARCELINO)	921	1.05	1,566	157	2,397,773
SECONDARY	LOS PLANES-PANCHIMALCO	890	1.05	1,513	151	1,5[illegible]7,626
SECONDARY	PANCHIMALCO-ROSARIO DE MORA	495	1.05	842	84	1,701,421
TERTIARY	TONACATEPEQUE-SOYAPANGO	882	1.05	1,499	150	2,499,439
SECONDARY	BERLIN-ALEGRIA-SANTIAGO DE MARIA	1,885	1.07	4,166	417	6,098,701
SECONDARY	SANTIAGO DE MARIA-TECAPAN-OZATLAN-CA:2	649	1.07	1,434	143	2,047,351
RURAL	TEJUTEPEQUE-SAN ANTONIO BUENA VISTA-CORRAL VIEJO	265	1.07	586	59	728,701
RURAL	CA:12-LAS CASITAS-S ANTONIO MAS-L MORCONES-GUARNECIA	265	1.05	451	45	612,926
RURAL	TAPALHUACA-CA:2(ANTIGUA COMALAPA)	170	1.05	289	29	252,983
RURAL	CA:2-SAN PEDRO MASAHUAT	265	1.05	451	45	612,926
RURAL	SAN PEDRO MASAHUAT-SAN ANTONIO MASAHUAT	137	1.05	233	23	279,736
TERTIARY	CIUDAD BARRIOS-NONCAGUA	388	1.07	857	86	1,105,549
SECONDARY	SAN MIGUEL-EL DELIRIO	2,478	1.07	5,476	548	7,226,068

TABLE II.A.29

ESTIMATED HIGHWAY PARAMETERS FOR HIGHWAY PROJECTS UNDER STUDY

ROAD CATEGORY	PROJECT NAME	1,988 ADT	ESTIMATED ANNUAL GROWTH FACTOR	2,000 ADT	2,000 DHV	ESAL 1989-2000
SECONDARY	SAN MIGUEL-MILITAR ROUTE EXIT	2,825	1.07	6,243	624	7,215,880
SECONDARY	MILITAR ROUTE EXIT-PASAQUINA	1,885	1.07	4,166	417	6,098,701
TERTIARY	CA:1-SAN ANTONIO SILVA-SAN ALEJO	388	1.07	857	86	1,105,549
PRIMARY	CA:1 JUNCTION-LA UNION	3,414	1.07	7,545	754	10,685,289
SECONDARY	ZACATECOLUCA-TECOLUCA-SAN VICENTE	1,111	1.05	1,889	189	2,414,501
RURAL	TACUBA-CONCEPCION DE ATACO	265	1.05	451	45	612,926
RURAL	ISTAGUA-ORATORIO DE CONCEPCION-MONTEPEQUE	265	1.05	451	45	612,926
RURAL	CHALCHUAPA-LAS CRUCES	83	1.05	141	14	175,765
RURAL	SAN JOSE EL NARANJO-LAS DELICIAS-CA:2	265	1.05	451	45	612,926
RURAL	NAHUIZALCO-JUATUA	265	1.05	451	45	612,926
RURAL	CA:3-EL CHAPERNO-CASERIO SAN ISIDRO	265	1.05	451	45	612,926
TERTIARY	SAN PEDRO NONUALCO-JERUZALEN	388	1.05	660	66	929,901
TERTIARY	S ANTONIO MONTE-STO DOMINGO GUZMAN-S PEDRO PUXTLA	388	1.05	660	66	929,901
RURAL	ATIQUIZAYA-SAN LORENZO-EL PORTILLO	358	1.05	609	61	666,889
TERTIARY	SAN JUAN OPICO-SAN PABLO TACACHICO	388	1.05	660	66	929,901
TERTIARY	CA:2-TEOTEPEQUE-SANTA YECLA	388	1.05	660	66	929,901
RURAL	SAN JULIAN-CUISNAHUAT	228	1.05	388	39	442,058
TERTIARY	CA:2-GUAYMANGO-JUJUTLA-ATACO-AHUACHAPAN	388	1.05	660	66	929,901
TERTIARY	CA:12-EL RONCO	880	1.05	1,496	150	3,328,779
RURAL	SANTO TOMAS-SAN MIGUEL TEPEZONTES-COJUTEPEQUE	137	1.05	233	23	196,156
RURAL	CA:2-CANTON LA CANOA	265	1.07	586	59	728,701
RURAL	SAN LORENZO-HACIENDA SAN MARTIAS	265	1.05	451	45	612,926
RURAL	HACIENDA SAN MARTIN-CA:2	265	1.05	451	45	612,926
RURAL	NAMULINGO-LA CHAPINA COOP.	265	1.05	451	45	612,926
RURAL	SAN JOSE EL NARANJO-(JUJUTLA-ATACO)	265	1.05	451	45	612,926
RURAL	COMALAPA FREEWAY-LAS HOJAS COOP.	265	1.05	451	45	612,926
RURAL	CALUCO - EL CARMEN COOPERATIVE.	265	1.05	451	45	612,926
RURAL	ULUAZAPA-COOPERATIVE 21 DE MARZO	265	1.07	586	59	728,701
RURAL	HAC. SANTA ELENA-I.(YAYANTIQUE)	265	1.07	586	59	728,701

ESTIMATED HIGHWAY PARAMETERS FOR HIGHWAY PROJECTS UNDER STUDY

ROAD CATEGORY	PROJECT NAME	1,988 ADT	ESTIMATED ANNUAL GROWTH FACTOR	2,000 ADT	2,000 DHV	ESAL 1989-2000
RURAL	CA:2 - HAC.CHILANGUERA	265	1.07	586	59	728,701
RURAL	LA CHILATA-SAN MARCOS	265	1.05	451	45	612,926
RURAL	CA:2 -TAMANIQUE	61	1.05	104	10	203,809
RURAL	SAN JULIAN-EL BALSAMAR COOPERATIVE	265	1.05	451	45	612,926
RURAL	CA:2 - CARA SUCIA	265	1.05	451	45	612,926
RURAL	CA:2 - SAN BENITO	265	1.05	451	45	612,926
RURAL	CA:2 - AGUA FRIA	265	1.05	451	45	612,926
RURAL	TACUBA-CONCEPCION DE ATACO	265	1.05	451	45	612,926
RURAL	CA:2 - PALO COMBO COOPERATIVE	265	1.05	451	45	612,926
RURAL	CA:2 - BARRA CIEGA COOPERATIVE	265	1.05	451	45	612,926
RURAL	CA:2 - EL ZARZAL	265	1.05	451	45	612,926
RURAL	CA:2 - SIHUAPILAPA	265	1.05	451	45	612,926
RURAL	CA:2 HACIENDA LA CABANA	265	1.07	586	59	728,701
RURAL	CA:2 - SAN DIONISIO	265	1.07	586	59	728,701
RURAL	CA:2 - SAN JOSE DE LA MONTANA	265	1.05	451	45	612,926
RURAL	CA:2 - HOJA DE SAL COOPERATIVE	265	1.05	451	45	612,926
RURAL	CA:2 - EL MANGUITO COOPERATIVE	265	1.07	586	59	728,701
RURAL	MILITAR ROUTE-MAYUCAQUIN COOPERATIVE	265	1.07	586	59	728,701
RURAL	SAN MIGUEL-LA PUERTA	265	1.07	586	59	728,701
RURAL	CA:2 - TIERRA BLANCA	265	1.07	586	59	728,701
RURAL	CA:2 - LLANO DE LAS ROSAS	265	1.07	586	59	728,701
RURAL	PANAMERICANA-CA:2-LA UNION	265	1.07	586	59	728,701
RURAL	SAN ALEJO-EL TAMARINDO	265	1.07	586	59	728,701
RURAL	CA:2 GUALPIRQUE COOP.	265	1.07	586	59	728,701
RURAL	LA UNION-YOLOGUAL COOP.-EL FARO	265	1.07	586	59	728,701

takes into consideration the following:

- work contracting
- earth works
- bases and pavements
- miscellaneous work
- bridge construction.

These specifications are normally complemented by the FHWA specifications FP-74. Soil test and construction materials follow AASHTO norms, or their ASTM equivalents.

These specifications are adequate but need to be updated, especially for local access and rural roads since they are oriented towards primary-road work. Considering that most of the Salvadoran network is in the rural or local categories, with low traffic volumes, appropriate specifications and quality requirements are needed for these roads.

Furthermore, the materials necessary for primary roads should have different physical and mechanical properties than those used for tertiary or rural roads, and should be defined in the technical specifications for road construction.

Clear quantitative criteria should also be adopted for the acceptance of construction activities. In recent versions of the FHWA General Specifications, the concept of "payment adjustment factors" has been introduced. These factors allow the owner to pay a lower price for work, which while not meeting all specifications does not badly affect durability and soundness, without having to replace or remove the work done.

Many states have adopted the concept of payment adjustment factors with encouraging results. Despite possible implementation problems, the Consultants recommend further study of this issue, since this system would allow for the usage of local materials currently not accepted by specifications.

MOP should study the use of non-destructive tests for work acceptance and pavement evaluation. This is vital to define the need for maintenance and rehabilitation.

There is a lack of precise definitions for improvement, reconstruction and rehabilitation. MOP should pay attention to rehabilitation project design standards, given present network needs. Such aspects as engineering design, construction procedures, special specifications, work measurement and payment require definition.

In the field of roadway maintenance, the Consultants have observed an absence of performance standards for the

different maintenance activities. There is also a lack of pavement distress inventory procedures and guidelines for selecting maintenance alternatives according to distress types.

The Consultants have analyzed the Central American Road Maintenance Manual. Despite some appropriate guidelines provided in the manual, it should be updated to account for new technological improvements.

6. Costs of Construction/Maintenance

A detailed analysis of unit costs of road construction and maintenance activities has been completed. Construction activities have been taken from the current General Specifications for Road and Bridge Construction of the MOP (DGC). DGC and Consultant experiences have been taken into account in the case of road maintenance. Unit price analysis includes the following principal components:

Direct Costs:

- equipment
- labor
- performance
- materials
- transportation

Indirect Costs:

- overhead and unforeseen expenses
- benefits
- field supervision.

The following paragraphs present the assumptions and criteria followed to estimate unit costs. Prices refer to December, 1988 when the colon/US dollar exchange rate was 5 to 1.

a. Mechanical Equipment

Rental costs of mechanical equipment were defined on the basis of local quotes. These costs were correlated with others that had been defined in the past (DUA-1980) and more recently (DGC-1989), by way of the implicit price index of the Gross Domestic Product - Public and Private Construction. Table II.A.30 shows rental prices for basic mechanical equipment adopted in the current project, not including operators or assistants. In our opinion, these prices adequately represent the costs of renting mechanical equipment in El Salvador.

TABLE.II.A.30

HOURLY RENT OF MECHANICAL EQUIPMENT
(DECEMBER, 1988)

MECHANICAL EQUIPMENT	HOURLY RENTAL (C)
Truck, 4m3	80
Dump Truck, 6m3	120
Tractor with Ripper, 140HP	250
Motor Grader, 125Hp	200
Loader, 2.3m3	225
Water Tanker, 2000gal	150
Asphalt Tanker, 2000gal	180
Tandem Roller, 8-12 Ton	120
Vibratory Roller, 8-12 Ton	200
Pneumatic Wheel Compactor, 10-16 Ton	120
Manual Compactor	20
Jack-Hammer	10
Air Compressor	125
Mechanical Sweeper	80
Aggregate Spreader	100
Pavement Marking Equip., 50gal	50
Petrol Tanker, 50gal	50
Concrete Mixer	30
Concrete Vibrators	15
Hot Asphalt Mix Plant	1300
Finisher	200
Water Pump	20
Primary Crushing Plant	400
Secondary Crushing Plant	500

NOTES: 1. Operators not included
2. Rent was adjusted by means of Price Indices Implicit in GDP, Private & Public Construction

SOURCES: Rental Investigation in the local market.
Rents adjusted from studies by DUA (1980) & Comalapa Highway (1989)

b. Labor

Two salary and social benefit regimes are followed in the Salvadoran construction industry:

- Labor Department mediation regulations define payment of personnel in the private sector. Investigations into some private companies show better payment for road-construction personnel.

- The MOP (DGC) defines its own basic hourly salaries for workers, according to their occupation and specialization.

For the purposes of this study it is appropriate to use first-category worker basic salaries established by the MOP (DGC), for both the government and the private sectors. (see Table II.A.31). The effect of social benefits on salary unit costs has also been analyzed (Table II.A.32), aiming at defining an effective hourly worker salary (Table II.A.31). Fringe benefits amount to 80 percent and 120 of the basic hourly salaries for the private sector and government respectively.

c. Performance

For each construction and maintenance activity considered, a combination of equipment and labor was selected, and was assigned a daily performance standard. Selected equipment, labor, and performance standards represent reasonable levels for field achievement.

d. Materials

Table II.A.33 shows unit prices for basic construction materials. They include transportation to the work site. Distances were estimated on the basis of the location of material sources and production plants. An analysis of material unit prices shows that 10 percent corresponds to labor and 90 percent corresponds to equipment.

e. Indirect Costs

Total direct cost has been used as a basis for determining indirect costs. Indirect costs have been calculated as follows:

TABLE II.A.31

HOURLY SALARIES OF LABOR FORCE
(in Colones)

OCCUPATION	BASIC HOURLY SALARY PER 1st CATEGORY	FRINGE BENEFITS		HOURLY SALARY	
		GOVT.	PRIVATE	GOVT.	PRIVATE
Assistant Engineer & Architect	6.56	7.87	5.25	14.43	11.81
Field Supervisor/Gen Foreman	4.81	5.77	3.85	10.58	8.66
Technican	4.95	5.94	3.96	10.89	8.91
Foreman	3.48	4.18	2.78	7.66	6.26
Dump Truck Driver	4.62	5.54	3.70	10.16	8.32
Pick Up Driver	3.83	4.60	3.06	8.43	6.89
Heavy Vehicle Equipment Operator	5.22	6.26	4.18	11.48	9.40
Crushing Equipment Operator	4.67	5.60	3.74	10.27	8.41
Concrete-Mixer Operator	3.51	4.21	2.81	7.72	6.32
Asphalt Spreader	4.59	5.51	3.67	10.10	8.26
Finisher Operator	5.22	6.26	4.18	11.48	9.40
Assistant Operator	3.55	4.26	2.84	7.81	-
Painter	3.56	4.27	2.85	7.83	6.41
Bricklayer	3.56	4.27	2.85	7.83	6.41
Carpenter	3.56	4.27	2.85	7.83	6.41
Worker	3.16	3.79	2.53	6.95	-

SOURCE: Code Table for Occupations & Hourly Salaries, DGC, 1988

TABLE.II.A.32

FRINGE BENEFIT IMPACT ON SALARY PAYMENT

Construction Worker-December, 1988

	GOVERNMENT	PRIVATE ENTERPRISE
A. NON-WORKING DAYS IN THE YEAR	DAYS	DAYS
1. Saturdays	52	26
2. Sundays	52	52
3. Vacations	25	15
4. Permitted Days	10	5
5. Sick Leave (ISSS)	20	10
TOTAL	159	108
B. WORKING DAYS IN THE YEAR	206	257
C. PAY	COLONES	COLONES
1. Basic Annual Salary		
365 * 3.16(colones) * 7hr	8,073.80	-
365 * 2.60(colones) * 7hr	-	6,643.00
2. Holidays		
6.5 % Basic Annual Salary	524.80	431.80
3. SUB TOTAL (1+2)	8,598.60	7,074.80
4. Social Security		
5.57 % (3)	478.94	-
8.25 % (3)	-	583.67
5. INPEP 4.5 % (3)	386.94	-
6. FSV 5% (3)	-	353.74
7. Christmas Bonus		
500 colones	500.00	-
3.5 % (3)	-	247.62
8. Severance Pay		
30 days * 18.18 colones/12	-	45.45
9. Life Insurance Premium		
5 colones * 12	-	60.00
10.Annual Pay	9,964.48	8,365.28
D. ANNUAL PAY/WORKING DAY - 10/B	48.37	32.55
G. IMPACT OF FRINGE BENEFITS		
D/22.12 colones	2.19	-
D/18.18 colones	-	1.79
ADOPTED	2.20	1.80

TABLE.II.A.33

CONSTRUCTION MATERIAL UNIT PRICES
(DECEMBER 1988)

M A T E R I A L	UNIT	TRANSPORT DISTANCE (KM)	PRICE (Colones)
Crushed Stone-Gravel No.1	m3	20	60
Fine C'shed Stone-Gravel No.2	m3	20	65
Sieved Sand	m3	20	50
Hot Asphalt Mix	m3	20	380
Granular Base Material	m3	20	55
Sub-Base Material	m3	10	30
Fill Material	m3	5	20
Ballast Material	m3	10	30
Portland Cement (42.5kg/bag)	bag	80	16
Liquid Asphalt RC-2	gal.	150	5.64
Asphalt Concrete	gal.	150	4.14
Industrial Kerosene	gal.	150	5.70
Iron	qq	60	155
Water	m3	10	55
Paint	gal.	80	60

All figures include Transportation costs.

SECTOR	GOVERNMENT	PRIVATE
OVERHEAD	25	10
UNFORESEEN EXPENSES	10	10
PROFITS	0	15
FIELD SUPERVISION	5	5
TOTAL	40	40

Indirect costs are defined as 40 percent of direct costs, when the work is carried out by either the private sector (contracted work) or the government (force account work). The indirect cost figure for government work is normative. It relates to efficiently-run force-account work rather than to current operations (which show much higher overhead ratios due to excess personnel). Overhead includes: office rent, equipment mobilization, administrative personnel salaries, communications, transport, furniture, office and laboratory equipment and stationary, plants and workshops, warehouses, financial and legal costs, etc.

Field supervision includes: engineers' salaries, survey teams, camps, communications, expenses, transportation equipment, accommodation costs, etc. Unforeseen expenses are taken into account to cover uncertainties.

f. Total Costs

Unit price analyses for each of the basic activities relevant to this project will be presented separately. A sample worksheet is given in Appendix II.A.5. Summaries of calculated unit prices appear in Table II.A.34. Tables II.A.35 and II.A.36 show quantities and financial costs of necessary maintenance activities, according to the condition of the different types of road. Work quantities adopted by the Consultants are based on their local and international experience.

Table II.A.37 presents rehabilitation work quantities and financial costs, according to the condition of the different types of road. For primary and secondary roads in good condition, it is assumed that a seal coat will be applied, although this may be viewed as optional. When they are in fair or poor condition, it is assumed that a re-enforcing hot-mix layer will be applied, four and eight centimeters thick, respectively.

Reconstruction has also been considered as an alternative for roads in poor condition. It is assumed that 15 centimeters of the base are excavated and replaced, and a resurfacing course is applied, consisting of five centimeters

TABLE II.A.34

DECEMBER, 1988 - UNIT PRICES
(in Colones)

ACTIVITY	UNIT	FINANCIAL		ECONOMIC	
		CONTRACTED	FORCE ACC.	CONTRACTED	FORCE ACC.
		(in Colones)		(in Colones)	
Platform-Widening Fill	m3	56.43	56.00	62.50	62.94
Platform-Widening Cut	m3	55.55	63.17	59.09	62.00
Ditch Construction	km	6,360.90	6,531.00	7,001.89	7,106.93
Existing Granular Surface Conformation	m2	1.90	1.95	2.10	2.13
Material Excavation & Removal	m3	26.57	28.00	29.91	30.12
Existing Asphalt Mix.Scarification & Removal	m3	38.92	39.20	37.97	38.45
Ballast or Sub-Base	m3	74.22	77.00	83.56	83.87
Granular Base or Sub-Base	m3	116.22	116.20	129.98	130.29
Prime Coat	m2	4.27	4.32	4.77	4.79
Tack Coat	m2	2.44	2.50	2.83	2.85
Double Surface Treatment	m2	11.18	11.34	12.42	12.52
Seal Coat	m2	6.88	7.00	7.69	7.73
Hot Asphalt Mix	m3	579.28	580.91	649.09	650.21
Pavement Marking	l/km	4,397.90	4,410.00	4,930.89	4,936.95
Crack Sealing	m	9.80	10.08	10.75	10.94
Localized Seal Coating	m2	9.82	10.08	10.89	11.01
Layer Patching (Mutiple Surface Treatment)	m2	22.45	24.50	26.04	26.49
Premix Leveling	m2	84.88	91.00	94.23	95.72
Hot Mix Patching	m2	101.95	105.00	111.67	113.66
Ditch Cleaning	m2	1.93	2.31	1.84	2.07
Culvert Cleaning	m2	9.05	10.73	8.70	9.72
Granular Surface Grading	m2	0.10	0.10	0.11	0.11
Ballast Patching	m2	23.07	24.09	25.08	25.68

TABLE II.A.35

ROUTINE MAINTENANCE WORK QUANTITIES AND FINANCIAL COSTS
PRIMARY AND SECONDARY HIGHWAYS
(DECEMBER, 1988)

CONDITION	CLASSIFICATION	WORK QUANTITIES PER KM									COST KM/YR (In Colones)	
		CRACK SEALING	LOCAL'ZD SEAL COATING	HOT MIX PATCHING	PREMIX LEVELING	LAYER PATCHING (1)	DITCH CLEANING	CULVERT CLEANING	PAVEMENT MARKING	SHOULDER PATCHING		
		M	M2	M2 (2)	M2 (1)	M2	M	M	KM	M2 (3)	CONTRACTED	FORCE ACC.
GOOD	Primary	50	130	10	--	--	300	20	0.3	5	6,295	6,540
	Secondary	60	155	--	5	12	300	15	0.3	6	6,290	6,560
FAIR	Primary	380	260	300	50	--	600	40	0.6	40	48,820	50,575
	Secondery	450	310	--	60	360	600	30	0.6	45	28,370	30,025
POOR	Primary	20	540	800	70	--	900	80	0.9	80	105,210	108,810
	Secondary	25	650	--	85	960	900	60	0.9	95	47,770	51,000

NB: (1) Multiple Localized Surface Treatment
(2) Average Depth 5cm
(3) Average Depth 15cm

TABLE II.A.36

ROUTINE MAINTENANCE WORK QUANTITIES AND FINANCIAL COSTS
TERTIARY AND RURAL HIGHWAYS
DECEMBER 1988

CONDITION	CLASSIFICATION	WORK QUANTITIES PER KM							COST KM/YR (In Colones)	
		BALLAST PATCHING	GRANULAR SURFACE CONFORM.	GRANULAR SURFACE GRADING	BALLAST LEVELING	EARTH LEVELING	DITCH CLEANING	CULVERT CLEANING		
		m2 (1)	m2	m2	m2 (2)	m2 (2)	m	m	CONTRACTED	FORCE ACC.
GOOD	Tertiary	30	300	600	15	--	500	14	2,690	2,965
	Rural	--	--	1,100	--	100	500	13	2,600	2,810
FAIR	Tertiary	60	600	1,500	60	--	750	28	5,490	5,960
	Rural	--	--	1,750	--	250	750	26	5,385	5,695
POOR	Tertiary	120	1,200	3,000	120	--	1,000	42	9,885	10,615
	Rural	--	--	3,500	--	500	1,000	39	9,685	10,095

NB: (1) Average Depth 0.15m
(2) Average Depth 0.25m

TABLE II.A.37

REHABLILITATION WORK QUANTITIES AND FINANCIAL COSTS

CLASSIFICATION	CONDITION	WORK QUANTITIES PER KM									COST KM/YR (In Colones)	
		GRANULAR SURFACE CONFORM.	ASPHALT SURFACE S'CATION	MATERIAL EXCAVT. REMOVAL	BALLAST SUB-BASE or BASE	PRIME COAT or BASE	TACK COAT	ASPHALT HOT MIX	PAVEMENT MARKING	CULVERT CLEANING		
		m2	m3	m3	m3	m2	m2	m3	l/KM	M	CONTRACTED	FORCE ACC.
PRIMARY	Good	-	-	-	-	-	-	7,300(1)	2	20	59,200	60,135
	Fair	4,700		-	188(2)	-	7,300	292	2	40	219,000	220,760
	Poor	4,700		-	376(2)	-	7,300	584	2	80	402,470	405,315
	Poor (R)	4,700	365	1,095	1,095(3)	7,300	-	365	2	80	431,620	434,620
SECONDARY	Good	-		-	-	-	-	6,500(1)	2	15	53,650	54,485
	Fair	3,000		-	100(2)	-	6,500	260	2	30	188,660	189,975
	Poor	3,000		-	200(2)	-	6,500	520	2	60	346,970	349,055
	Poor (R)	3,000	163	975	975(3)	6,500	-	6,500(4)	2	60	261,030	264,065
TERTIARY	Fair	6,000	-	-	900(5)	-	-	-	-	28	78,450	81,290
	Poor	6,000	-	-	1,200(5)	-	-	-	-	42	100,845	104,540
RURAL	Fair	5,000	-	-	750(5)	-	-	-	-	26	65,400	67,765
	Poor	5,000	-	-	1,000(5)	-	-	-	-	39	84,075	87,160

NB: (1) Seal Coat (Optional)
(2) Sub-Base 5cm thick
(3) Base
(4) Double Surface Treatment
(5) Ballast
(R) Reconstruction

of hot-asphalt mixture for primary roads or of a double surface treatment for secondary roads. For tertiary and rural roads in fair or poor condition, it is assumed that a ballast layer will be added, 15 and 20 centimeters thick, respectively.

Tables II.A.38 to II.A.40 show the criteria adopted to define work quantities for road improvement. Five possible combinations were analyzed. For earth-moving work calculations, a half cut/half fill section was assumed. Consistent with Salvadoran topography, hilly terrain was assumed. In the same way, average pavement structure thicknesses were defined for each type of road. Tables II.A.41 and II.A.42 show improvement costs for each roadway type.

Summaries of financial and economic costs of rehabilitation, improvement and maintenance work are presented in Tables II.A.43 to II.A.45.

7. Financial Position

a. Expenditures

As a government ministry, MOP receives a yearly budget from the central government. This comprises of an ordinary budget administered by the Ministry of Finance and an extraordinary or development budget administered by SETEFE (Ministry of Planning). The extraordinary budget consists mostly of development assistance funds.

The following table represents the 1988 preliminary budget allocations for MOP's two main directorates, DUA and DGC.

1988 MOP BUDGET ALLOCATION
(Thousands Colones)

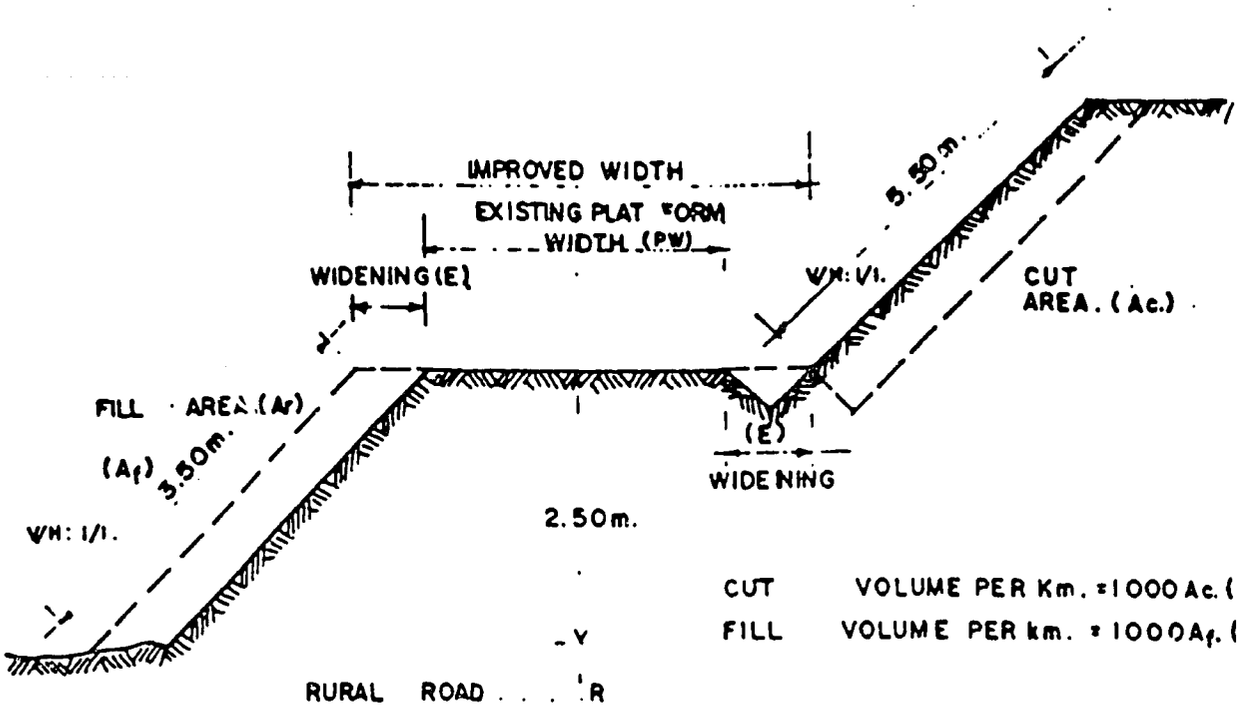
	DUA	DGC
Permanent salaries	2,466	2,207
Other Wages	8.190	61,514
Supplies and materials	757	4,579
Machinery and equipment	22	0
Current transfers	21	157
TOTAL	11,456	68,457

Source: 1988, Infrastructure Damage Assessment

Table II.A.46 presents DGC's ordinary and extraordinary budget actual expenses from 1985 to 1987, as well as the

TABLE II. A. 38

ROAD IMPROVEMENT
PLATFORM - WIDENING



COMBINATION	PW (m)	IW (m)	E (m)	Ac (m2)	Af (m2)	VC (m3)	Vf (m3)
R to T	5.0	6.0	0.50	2.75	1.75	2750	1750
R to S	5.0	9.50	2.25	12.38	7.88	12380	7880
T to S	6.0	9.50	1.75	9.63	6.13	9630	6130
T to P	6.0	12.0	3.00	16.50	10.50	16500	10500
S to P	9.5	12.0	1.25	6.88	4.38	6880	4380

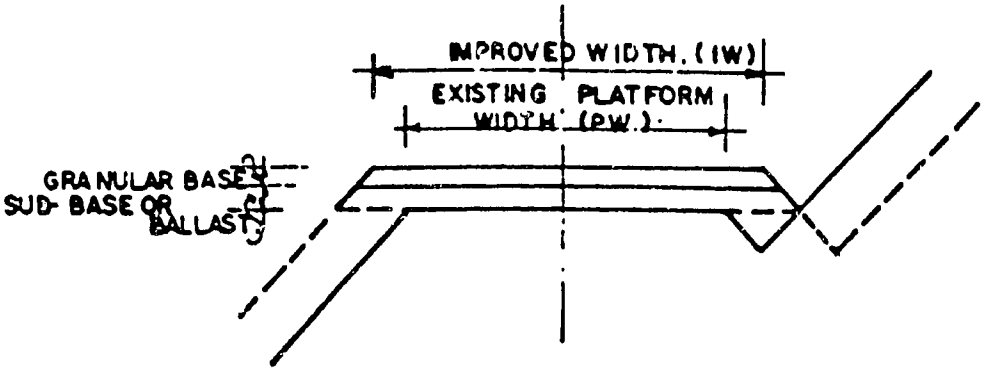
Vf = PLATAFORM - WIDENING FILL

Ve = PLATAFORM - WIDENING CUT

TABLE II. A. 39

ROAD IMPROVEMENT

PAVEMENT STRUCTURE



RURAL CLASS . . . . . .R
TERTIARY CLASS . . . . .T
SECONDARY CLASS . . . . .S
PRIMARY CLASS . . . . .P

TYPE OF IMPROVEMENT.	THICKNESS (cm)				IW (m)	VOLUME (M^3/Km)			AREA(1)
	BALLAST	SUB-BASE	BASE	SURFACE		BALLAST	SUB-BASE	BASE	SURFACE
R to T	30	-	-	-	6.0	1800	--	—	-
R to S	-	35	15	DST	9.5	-	3325	1425	6500
T to S	-	25	15	DST	9.5	-	2375	1425	6500
T to P	-	20	25	5 (2)	12.0	-	2400	3000	7300
S to P	-	-	15	5 (2)	12.0	-	750 (3)	1800	7300

(1) m2/Km.
(2) ASPHALT HOT MIX.

DST: DOUBLE SURFACE TREATMENT.

TABLE II.A.40

ROAD IMPROVEMENT - WORK QUANTITIES

CONSTRUCTION ACTIVITY	UNIT	TYPE OF IMPROVEMENT				
		RURAL to TERTIARY	RURAL to SECONDARY	TERTIARY to SECONDARY	TERTIARY to PRIMARY	SECONDARY to PRIMARY
Platform-Widening Fill	m3	1,750	7,880	6,130	10,500	4,380
Platform Widening Cut	m3	2,750	12,380	9,630	16,500	6,880
Ditch Construction	km	1	1	1	1	1
Exist.Granular Surface Conform	m2	5,000	5,000	6,000	6,000	9,500
Exist.Asphalt Mixture -						
Scarification and Removal	m3					165
Ballast	m3	1,800				
Sub-Base	m3		3,375	2,375	2,400	750
Base	m3		1,425	2,375	3,000	1,800
Prime Coat	m2		6,500	6,500	7,300	7,300
Double Surface Treatment	m2		6,500	6,500		
Hot Asphalt Mix	m3				365	365
Pavement Marking	l/km		2	2	2	2
Culverts		2036"(13m)	2036"(15m)	2036"(15m)	3036"(20m)	1036"(20m)

TABLE II.A.41

FINANCIAL UNIT COSTS OF CONTRACTED ROAD IMPROVEMENT
DECEMBER, 1988
(Colones/km)

CONSTRUCTION ACTIVITY	TYPE OF IMPROVEMENT				
	RURAL to TERTIARY	RURAL to SECONDARY	TERTIARY to SECONDARY	TERTIARY to PRIMARY	SECONDARY to PRIMARY
Platform-Widening Fill	98,750	444,670	345,920	592,515	247,165
Platform Widening Cut	152,765	687,710	534,945	916,575	382,185
Ditch Construction	6,360	6,360	6,360	6,360	6,360
Exist.Granular Surface Conform	9,500	9,500	11,400	11,400	18,050
Exist.Asphalt Mixture -					
Scarification and Removal	-	-	-	-	6,420
Ballast	133,595	-	-	-	-
Sub-Base	-	246,780	176,270	178,130	55,665
Base	-	165,615	165,615	348,660	209,195
Prime Coat	-	27,755	27,755	31,170	31,170
Double Surface Treatment	-	72,670	72,670	-	-
Hot Asphalt Mix	-	-	-	211,435	211,435
Pavement Marking	-	8,795	8,795	8,795	8,795
Culverts	13,000	22,500	22,500	30,000	10,000
TOTAL (in Colones)	413,970	1,692,355	1,372,230	2,365,040	1,186,440

TABLE II.A.42

FINANCIAL UNIT COST OF FORCE ACCOUNT ROAD IMPROVMENT
DECEMBER, 1988
(Colones/km)

CONSTRUCTION ACTIVITY	TYPE OF IMPROVEMENT				
	RURAL to TERTIARY	RURAL to SECONDARY	TERTIARY to SECONDARY	TERTIARY to PRIMARY	SECONDARY to PRIMARY
Platform-Widening Fill	98,000	441,280	343,280	588,000	245,280
Platform Widening Cut	173,250	779,940	606,690	1,039,500	433,440
Ditch Construction	6,535	6,535	6,535	6,535	6,535
Exist.Granular Surface Conform	9,740	9,740	11,690	11,690	18,510
Exist.Asphalt Mixture - Scarification and Removal	-	-	-	-	6,470
Ballast	138,600	-	-	-	-
Sub-Base	-	256,025	182,875	184,800	57,750
Base	-	165,585	165,585	348,600	209,160
Prime Coat	-	28,060	28,060	31,510	31,510
Double Surface Treatment	-	73,710	73,710	-	-
Hot Asphalt Mix	-	-	-	212,065	212,065
Pavement Marking	-	8,820	8,820	8,820	8,820
Culverts	13,065	22,635	22,635	30,170	10,055
TOTAL (in Colones)	439,190	1,792,330	1,449,880	2,461,690	1,239,595

TABLE II.A.43

FINANCIAL & ECONOMIC REHABILITATION UNIT COSTS
DECEMBER, 1988
(Colones/km)

CLASSIFICATION	CONDITION	FINANCIAL		ECONOMIC	
		CONTRACTED	FORCE ACC.	CONTRACTED	FORCE ACC.
PRIMARY	Good	59,200	60,135	66,170	66,495
	Fair	219,000	220,760	245,980	246,710
	Poor	402,470	405,315	451,575	452,725
	Poor (R)	431,620	434,620	481,105	482,640
SECONDARY	Good	53,650	54,485	59,975	60,265
	Fair	188,660	189,975	211,940	212,520
	Poor	346,970	349,055	389,320	390,255
	Poor (R)	261,030	264,065	290,500	292,030
TERTIARY	Fair	78,450	81,290	88,050	88,315
	Poor	100,845	104,540	113,240	113,830
RURAL	Fair	65,400	67,765	73,395	73,805
	Poor	84,075	87,160	94,400	94,900

NB: (R) Reconstruction

TABLE II.A.44

FINANCIAL & ECONOMIC ROAD IMPROVEMENT UNIT COSTS
DECEMBER, 1988
(Colones/km)

IMPROVEMENT TYPE	ECONOMIC		FINANCIAL	
	CONTRACTED	FORCE ACC.	CONTRACTED	FORCE ACC.
Rural to Tertiary	452,785	455,865	413,970	439,190
Rural to Secondary	1,848,685	1,875,705	1,692,355	1,792,330
Tertiary to Secondary	1,499,530	1,517,510	1,372,230	1,449,880
Tertiary to Primary	2,552,920	2,588,080	2,365,040	2,461,690
Secondary to Primary	1,314,690	1,325,510	1,186,440	1,239,595

TABLE II.A.45

FINANCIAL & ECONOMIC ROUTINE MAINTENANCE UNIT COSTS
DECEMBER, 1988
(Colones/km/year)

		FINANCIAL		ECONOMIC	
CLASSIFICATION	CONDITION	CONTRACTED	FORCE ACC.	CONTRACTED	FORCE ACC.
PRIMARY	Good	6,295	6,540	5,400	5,540
	Fair	48,820	50,575	50,545	50,745
	Poor	105,210	108,810	110,825	112,930
SECONDARY	Good	6,290	6,560	5,430	5,565
	Fair	28,370	30,025	28,690	29,265
	Poor	47,770	51,000	63,985	50,330
TERTIARY	Good	2,690	2,965	2,805	2,960
	Fair	5,490	5,960	5,805	6,065
	Poor	9,805	10,615	10,570	10,960
RURAL	Good	2,600	2,810	2,715	2,855
	Fair	5,385	5,695	5,705	5,935
	Poor	9,685	10,095	10,380	10,705

D. G. C. EXPENDITURES DURING 1985 - 1988

(IN MILLION COLONES)

	1985 SPENT	1986 SPENT	1987 SPENT	1988 PLANNED
INCOME				
CENTRAL GOVERMENT				
FOR CURRENT EXPENDITURES	63.08	71.97	82.35	88.01
FOR CAPITAL EXPENDITURES				
CABEI, NORTHERN LONGITUDINAL HIGHWAY	0.49	0.67	0.00	0.00
CABEI, REGIONAL ROADWAY	6.95	24.78	0.62	0.63
CABEI, LA HERRADURA-COSTA DEL SOL	1.04	1.98	0.00	0.00
IDB, RURAL ROADS 665/SF	0.38	1.05	0.85	0.50
IDB, RURAL ROADS 472/SF	0.00	0.00	0.00	0.00
IDB, S. MARCOS BRIDGE OVER LEMPA R.	0.03	0.25	0.02	0.00
ROAD CONSTRUCTION+IMPROVEMENT	13.24	18.10	19.15	26.32
TURIST HIGHWAY IMPROVEMENTS	0.11	2.84	2.53	3.28
SECONDARY ROAD PAVING	2.42	6.42	0.57	7.96
SUB-TOTAL	24.66	56.09	23.74	38.69
EXTRAORDINARY FUNDS				
IDB, RURAL ROADS 665/SF	9.54	7.30	9.41	0.00
CABEI	0.00	0.00	0.00	25.00
SUB-TOTAL	9.54	7.30	9.41	25.00
EXTERNAL LOANS				
CABEI, NORTHERN LONGITUDINAL HIGHWAY	0.00	0.00	0.00	9.71
CABEI, REGIONAL ROADWAY	10.77	13.51	27.74	20.68
CABEI, LA HERRADURA-COSTA DEL SOL	6.83	0.08	0.00	0.00
IDB, RURAL ROADS 665/SF	13.79	18.50	19.37	30.10
IDB, RURAL ROADS 472/SF	0.00	0.00	0.00	0.00
IDB, S. MARCOS BRIDGE OVER LEMPA R.	0.00	0.00	0.00	0.00
SUB-TOTAL	31.39	32.09	47.11	60.49
TOTAL INCOMES	128.67	167.45	162.61	212.19

CONTINUING

TABLE II. A. 46.

D. G. C. EXPENDITURES DURING 1985 - 1988

(IN MILLION COLONES)

	1985 SPENT	1986 SPENT	1987 SPENT	1988 PLANNED
EXPENDITURES				
CURRENT				
MANAGEMENT + CO-ORDINATION	0.08	0.09	0.10	0.10
ADMINISTRATION	8.16	9.24	10.35	11.57
PROJECTS	2.03	2.61	3.13	2.87
ROAD MAINTENANCE	50.55	58.31	66.81	71.41
SUPERVISION, EVALUATION + CONTROL	2.26	1.72	1.96	2.06
SUB-TOTAL	63.08	71.97	82.35	88.01
CAPITAL				
CABEI, NORTHERN LONGITUDINAL HIGHWAY	0.50	0.67	0.00	9.73
CABEI, REGIONAL ROADWAY	17.72	38.28	26.07	21.30
CABEI, LA HERRADURA-COSTA DEL SOL	7.87	2.06	0.00	0.00
IDB, RURAL ROADS 665/SF	22.55	26.46	9.11	30.60
IDB, RURAL ROADS 472/SF	0.00	0.00	0.00	0.00
IDB, S. MARCOS BRIDGE OVER LEMPA R.	0.03	0.25	0.00	0.00
ROAD CONSTRUCTION+IMPROVEMENT	13.24	18.10	19.45	26.32
TURIST HIGHWAY IMPROVEMENTS	0.11	2.84	2.53	3.28
SECONDARY ROAD PAVING	2.42	6.42	0.58	7.95
SUB-TOTAL	64.44	95.08	57.74	99.18
TOTAL EXPENDITURES	127.52	167.05	140.09	187.19

projected expenses for 1988. Table II.A.47 presents DGC's expenditures since 1980 and Table II.A.48 shows projected expenditures until 1994. Although the figures in Tables II.A.46 and II.A.47 do not match exactly they help to identify the characteristics of DGC's financial position.

- Permanent salaries and other wages represent an overwhelming component (up to 90 percent) of DGC's current expenditures.

- DGC systematically overruns its current-expenditure budget, while not being able to execute budgeted capital investments.

- Close to half of DGC's budget depends on foreign assistance, before taking into account Economic Support and PL-480 fundings.

Table II.A.47 shows that DGC's maintenance expenditures reached 66 million colones in 1988, but this amount does not mean that 66 million colones were spent in highway maintenance. Given the excess-personnel burden, most of this money went to salaries.

In any event the above figures are very low. According to the Consultants' estimates, routine and periodic maintenance requirements for the Salvadoran network are in the order of C 138,000,000 (for efficient operations). Thus, current maintenance activities would have been minimal even if resources had been effectively applied. Roads will keep steadily deteriorating until their condition justifies an investment project which can be financed from outside sources.

Since foreign assistance is mostly available for new investment projects, this could well be the only possible alternative for MOP. It is, however, very costly to the users, the central government, and development assistance agencies.

b. Highway Sector Revenues

Proper cost allocation procedures require road users to pay for maintenance in proportion to their use. The two most straight forward methods used are tolls and gasoline taxes.

Tolls are not widespread in El Salvador, and although it is more accurate than gas taxes because it permits vehicle fee assessment according to size, tolls are expensive to manage and feasible only on highly-travelled roads.

Table II.A.49 presents general-fund revenues linked to

TABLE II.A.47

SUMMARY OF DGC EXPENDITURES

	CAPITAL EXPENDITURES		OPERATIONAL EXPENDITURES		
	Force-Account	Contracted Work (External Finance)	Maintenance	Administration	TOTAL
1980	29.4	46.2	39.1	9.3	124.0
1981	32.9	48.5	37.6	10.1	129.1
1984	23.4	40.3	37.1	2.7	103.5
1983	22.7	60.7	38.5	10.8	132.8
1984	19.8	39.6	42.7	11.5	113.7
1985	25.6	49.1	45.8	13.0	133.6
1986	33.7	55.9	55.3	18.1	163.1
1987	35.7	49.6	64.6	19.2	169.2
1988	33.4	90.7	65.7	21.9	211.8

TABLE II. A. 48

DGC BUDGETED EXPENDITURES

(Thousands of Colons)

ROADWAY CLASS	Y E A R					TOTAL
	1990	1991	1992	1993	1994	
SPECIAL	4,611	4,841	5,083	5,337	5,603	25,475
PRIMARY	18,486	19,410	20,380	21,399	22,469	102,144
SECONDARY	25,221	26,482	27,806	2 9,196	30,659	139,364
TERTIARY	19,544	20,521	21,547	22,624	23,755	107,991
RURAL "A"	12,777	13,416	14,088	14,792	16,029	71,102
RURAL "B"	6,590	6,870	7,213	7,574	7,953	36,200
SUBTOTAL	87,229	91,540	96,117	100,922	106,468	482,276
Applied Indirect Costs	21,497	22,622	23,753	24,941	25,688	118,501
TOTAL	108,726	114,162	119,870	125,863	132,156	600,777

TABLE II.A.49

1988 HIGHWAY SECTOR REVENUES

Incoming Taxes	Estimated Income	Actual Income	Difference
- Import Tax-Transport Materials	29,975,000	39,985,733.95	(+)10,010,733.95
- Consumer Tax-Petroleum Products	36,848,000	34,375,810.85	(-) 2,472,189.15
- Vehicle Registration Tax	22,799,900	18.813.122.27	(-) 3.986.777.73
Taxable Items			
- License Plates	7,500,000	13,104,646.20	(+) 5,604,646.20
- Toll fees	5,200,000	4,814,756.11	(-) 385,243.89
- License fees	750,000	1,273,861.00	(+) 523,861.00
- Learning fees and other	61,000	238,578.20	(+) 177,578.20
- Traffic fines	2,633,700	1,681,841.93	(-) 951,858.07
TOTAL	105,767,600	114,288,350.5	(+) 8,002,128.20

Source: Central Accounting Division, Ministry of Finance

highway transportation. Gas, registration, license and toll revenues amounted to 114 million colones, 25 million short of DGC's required maintenance expenditures. However, the 1988 road revenues of 114 million Colones is roughly equivalent to the 121 million spent by DGC.

8. Private Engineering/Construction Industry

a. Registries

CASALCO, the Salvador Chamber of Construction, is a private association of persons and companies working in the construction field. It classifies them as general contractors, housing contractors, consultants and suppliers.

CASALCO does not rank either consultant or contractor members, and is only recently trying to gather information on member volume of business. This makes it difficult to assess firm strength in this field. At present, CASALCO's division of General Contractors has hired a marketing firm to study the situation of the construction industry in the country.

Table II.A.50 shows a registry of Salvadoran companies which have worked with the DGC. Consultants, supervisors and contractors are included in the list. The most experienced high-quality contractors include D.L. Harrison G.; Agroman Siman, S.A.; Terra-Pax S.A. and Dreo S.A. These firms are involved mostly with highway construction.

Other companies include MOM-CBL (embankments); Raul Mazzona (rural highways) and Terracon, which is associated with D.L. Harrison. COPRESA specializes in bridge repair/reconstruction. The most important consultants and supervisors, are: Planeamiento y Arquitectura, Consultores de Ingenieria, NHA Compania de Ingenieros, Luis Renato Murcia, Suelos y Materiales, and Rodriguez Melendez.

The Ministry of Public Works proposes that a single registry of contracting firms be developed to avoid the present diversification of registries.

b. Business Environment

In large consulting or construction projects open to international bidding, national firms complain of insufficient participation. Salvadoran legislation does not require foreign firms to joint venture with local firms when bidding. Salvadoran firms are too small to pre-qualify for

TABLE II. A. 50

DGC - CERTIFIED HIGHWAY FIRMS

Consultants

Consultora Técnica, S.A.
Mauricio A. Lara y Asociados, S.A. de C.V.
Rodriguez Melendez
Consultores de Ingeniería
Rivera Harrouch
Luis Renato Murcia
TECONSSA
Hidrodesarrollo
Suelos y Materiales
HCSD
CSYD, Ingenieros Arquitectos
Planeamiento y Arquitectura
Ingeniería y Transportes, S.A. de C.V.
Ing. Francisco López Quezada
Ing. Sergio Fernández
N.H.A. Compañía de Ingenieros, S.A.
Ing. Oscar Armando Herrera Pinto
A.G.P., Ingenieros Consultores de Ingeniería
Estrada y Compañía
Hector Hermógenes Pineda.

Contractors

MUM-CBL
Ing. Oscar Raúl Mazorra
Ing. Vega Gómez
Constructora DELTA, S.A. de C.V.
SIMAN, S.A.
TERRACON, S.A. de C.V.
Ing. José Rodolfo Machuca
D.L. Harrison Company
TERRA-PAV, S.A.
AGROMAN, S.A.
ARCO, S.A.
Molina Cuenca, S.A. de C.V.
COPRESA, S.A. de C.V. Ing. Emilio Puente
TERRATRACTO, S.A.
Ing. Sergio Fernández
TEPAVINSA.

these services, and their participation is limited to that of sub-contractors. Should large projects develop in the future, both local consultants and contractors can rapidly improve their capabilities by participating in joint ventures with experienced foreign firms.

Local firms have proposed a "Regulatory Law for the Contracting and Consulting Industry" by which foreign firms would be bound to enter into joint ventures with local firms in order to participate in Salvadoran projects. The ratio of participation still has not been established but a 60/40 foreign/national ratio is often mentioned.

In recent years, contractor and supplier work levels have been rising due to the construction that have been carried out in the country. But there has also been a decline in consulting and supervisory activities, which has brought greater unemployment in this sector. This unemployment, although minor, is important because it applies to specialists.

During the past ten years, some contractors have kept working in conflictive areas after reaching special agreements with the insurgent forces. Because equipment and contractor installations away from urban centers are

prone to be destroyed, contracting costs have risen appreciably.

Contractors can insure 50 percent of their equipment at a job site against damages by guerrilla warfare. The importation of construction equipment carries low tariffs and is duty free for government projects.

Although mechanical equipment has suffered from the consequences of the guerrilla attacks, the majority of damages have been repaired, and capacity has even increased by 20 percent. With the exception of suppliers, there is little or no participation by the construction industry in the maintenance of transportation infrastructure. The MOP should study ways to achieve greater private sector participation in these activities since the Consultants believe greater efficiency could be achieved in this manner, as private sector unit costs are less expensive than force account unit costs.

House construction is the only construction industry sector considered "strategic" (deserving priority because of defense/security reasons) by the GOES. This has not fostered the development of a stronger transportation construction industry.

9. Problem Areas

The following paragraphs summarize significant problem areas in the Consultants' diagnosis of the transportation sector.

a. Road Network in Bad Shape

The Salvadoran roadway network is in bad shape. Almost half of the network is in poor condition, needing immediate rehabilitation/reconstruction. An estimated total of C938,000,000 is currently required to bring the network to acceptable standards. Of this amount, C379,000,000 corresponds to paved highways and C559,000,000 to unpaved highways (see Tables II.A.51 and 52).

The present condition has been caused by years of deferred routine and major road maintenance due to scarcity of resources, deviation of resources to emergency maintenance and lack of access to conflict areas.

b. Insufficient Funds

There is a severe scarcity of resources for routine and major maintenance of highways. DGC applies 53 percent of the funds it receives from the government, to routine maintenance activities. The Consultants estimate that twice as much (a total of C135,000,000 per year, efficiently used) is needed to maintain the network.

Road rehabilitation, reconstruction and improvements receive 23 percent of DGC's government funds. This represents a small portion of the resources which have been used in this area (and an even smaller portion of the resources which are needed). International financing has been and will continue to be the basis for funding road rehabilitation, reconstruction and improvements.

c. Congestion

There are several roadway segments which experience undue delays because of increased traffic levels. In those cases, available roadway capacities do not meet current demands and the possibility of upgrading/improvement should be considered.

TABLE II. A. 51.

SALVADORAN ROADWAY NETWORK
NEEDED REHABILITATION AND ANNUAL
ROUTINE MAINTENANCE COST

PAVED ROADS

CLASSIFICATION	CONDITION	LENGTH km	REHAB. COST PER km (colones)	ROAD MAINTENANCE COST km/Year (colones)	TOTAL REHABILIATION COST (colones)	TOTAL ANNUAL MAINTENANCE COST (colones)
SPECIAL	Good	81.74	118,400	12,590	9,678,016	1,029,107
	Fair	36.79	438,000	97,640	16,114,020	3,592,176
	Poor	17.71	804,940	210,420	14,255,487	3,726,538
PRIMARY	Good	115.61	59,200	6,295	6,844,112	727,765
	Fair	248.28	219,000	48,820	54,373,320	12,121,030
	Poor	106.55	402,470	105,210	42,883,179	11,210,126
	Poor (R)	124.26	431,620	105,210	53,633,015	13,073,374
SECONDARY	Good	343.74	53,650	6,290	18,441,651	2,162,125
	Fair	343.74	188,660	28,370	64,849,988	9,751,904
	Poor	161.76	346,970	47,770	56,125,867	7,727,275
	Poor (R)	161.76	261,030	47,770	42,224,213	7,727,275
SUB-TOTAL		1,741.94			379,422,868	72,848,693

(R) : RECONSTRUCTION

TABLE II. A. 52.

SALVADORAN ROADWAY NETWORK
NEEDED REHABILITATION AND ANNUAL
ROUTINE MAINTENANCE COST

UNPAVED ROADS

CLASSIFICATION	CONDITION	LENGTH km	REHAB. COST PER km (colones)	ROAD MAINTENANCE COST km/Year (colones)	TOTAL REHABILITATION COST (colones)	TOTAL ANNUAL MAINTENANCE COST (colones)
TERTIARY	Good	479.48	0	2,690	0	1,289,801
	Fair	496.17	78,450	5,490	38,924,537	2,723,973
	Poor	760.84	100,845	9,885	76,726,910	7,520,903
RURAL	Good	588.95	0	2,600	0	1,531,257
	Fair	990.17	65,400	5,385	64,756,798	5,332,039
	Poor	4,502.76	84,075	9,685	378,569,539	43,609,230
SUB-TOTAL		7,818.36			558,977,784	62,007,203
TOTAL		9,560.30			938,400,652	134,855,896

(R) : RECONSTRUCTION

d. Bridges

Bridges constitute an important element of a road network. Without bridges, where necessary, traffic cannot circulate. Many bridges in El Salvador are in poor condition. Because of attacks, lack of inspection and repair, and need for widening, 69 of the 289 bridges in the network require major work.

Given the current state of affairs, it may not be wise to invest in permanent reconstruction or widening of bridges. Furthermore, these improvements may not be the most cost-effective until other more urgent works have been completed after the conflict ends. In the short term, investment should focus on temporary Bailey repairs of destroyed bridges and, perhaps, on doubling one-lane bridges where traffic warrants. A bridge inventory and management system should help to prioritize investments in this area.

e. DGC Organization

The project team questions DGC's ability to carry out an ambitious reconstruction program. Labor-management conflicts occur often, and there is no professional team in charge of pavement evaluation and management. There are no job descriptions, no job requirements, and no procedure manuals. Improvements are needed in the areas of material and mechanical equipment supply, laboratories, and traffic load control.

f. Lack of Maintenance and Rehabilitation Planning

DGC lacks an adequate system for road maintenance and rehabilitation planning (an integrated maintenance and pavement management system). There is a need for improving the technical capacity of DGC's maintenance personnel and staff concerned with pavement evaluation, maintenance planning, execution of maintenance activities and the administration of contracts.

g. Lack of Norms and Specifications

Current norms and specifications represent a constraint to project implementation. There are no guidelines for engineering, construction procedures, work measurement and payment of rehabilitation/reconstruction work. Prevailing

norms for new roadway construction need to be compiled and updated.

10. Economic Evaluation

a. Method

This section identifies the economic benefits generated by a proposed highway improvement/rehabilitation plan (five-year highway plan-1990/1994) comprised of road segments on DGC and international agency priority lists. Highway segments are evaluated in relation to their costs to determine expected economic returns. The economic methodologies are based on the consumer surplus method presented in the introduction to this study (Volume I). This theory, when applied to highway improvement/rehabilitation economic analysis, estimates benefits by means of determining different vehicles operating costs and annual road maintenance costs with and without a project.

Three types of benefits can be associated to a highway improvement/rehabilitation project:

- vehicle operating cost savings
- reduced user travel times, with their associated value (not included in this analysis)
- annual road maintenance cost savings

In the case of new road projects, an increase in economic activity in lands surrounding those roads is associated with the new roads. This type of economic benefit is considered to be minimal in the case of highway improvement/rehabilitation work.

Vehicle operating cost savings are a function of traffic volumes. In general, the following traffic flows should be considered:

- Normal traffic, related to current traffic volumes and non-project related growth

- Generated or induced traffic, c.g., traffic which only takes place because of reduced operating costs (assumed insignificant for rehabilitation/improvement work)

- Attracted traffic, e.g., traffic which deviates from alternate routes of modes to the analyzed project (assumed insignificant for rehabilitation/improvement work, given the existing distance among alternate routes)

Current and expected traffic volumes and load distribution

for each segment included in the five-year highway plan appear in Tables II.A.28 and II.A.29.

The following parameters have been used to perform this economic analysis:

- 1988 Colones are used when estimating all cost flows.

- Twelve-percent discount rate.

- Economic or shadow prices, reflecting the real cost to society of manpower, equipment and materials, net of taxes and foreign exchange bias.

- Ten and 15 percent discount rates for sensitivity analysis.

- Twenty-year analysis period.

Based on these assumptions, internal rates of return and net-benefit-over investment rations have been calculated for each highway segment, each highway program, and the overall five-year improvement/rehabilitation plan. A detailed explanation of the methodology, as well as comments on the results, are presented below.

b. Needed work in Highway Sections under Study

Table II.A.28 shows all highway sections that were analyzed for possible inclusion in our five-year improvement/ rehabilitation plan. Some of these segments are presently designated for improvement (upgrading) by the DGC, and have been analyzed as such. Remaining segments were analyzed as rehabilitation/reconstruction projects unless their traffic levels warranted improvement.

Table II.A.53 shows estimated service volumes for each of the road classes considered. Service volumes represent the highest traffic volumes which a road can handle at a specific service level. Service levels measure a road's man coverability as well as the average delay per vehicle from a user's standpoint.

Level of service "A" represents free-flow condition where vehicle density is low enough to allow motorists to drive at their desired speed. As traffic increases, users perceive lower service levels. Level of service "E" represents the highest volume which a road can handle (capacity), approaching unstable flow. Level of service "F" corresponds to a stop-and-go situation. Special roads have a capacity of 2,000 vehicles per lane per hour. Two-way capacity for primary roads is 1,600 vehicles per hour, for secondary is roads 1,200, 300 for tertiary roads and 100 for rural roads.

TABLE II. A. 53.

SERVICE VOLUMES FOR THE DIFFERENT ROAD CATEGORIES (1)

LEVEL OF SERVICE	ROAD CATEGORY					
	SPECIAL GL	SPECIAL HL	PRIMARY	SECONDARY	TERTIARY	RURAL
A	3600	2400	160	120	21	7
B	4800	3200	320	240	57	19
C	7200	4800	640	480	105	35
D	9600	6400	960	720	156	52
E	12000	8000	1600	1200	300	100
F	(2)	(2)	(2)	(2)	(2)	(2)
ACCEPTABLE LEVEL OF SERVICE FOR DESIGN PURPOSE	B	B	C/D(3)	C/D(3)	D	D

(1) BASED ON SERVICE LEVEL V/Cs FROM THE 1985 HIGHWAY CAPACITY MANUAL

(2) UNSTABLE FLOW

(3) B/C IN THE US.

To decide whether a road segment warrants improvement, the Consultants have compared its expected year-2000 design hour volume (DHV) from Table II.A.29 with the service volumes for its category from Table II.A.53. When a segment's year-2000 DMV is higher than the acceptable design service volume for its road category, the segment has been analyzed as an improvement project.

(1) Roughness

A key factor in determining vehicle operating costs is road roughness. Estimates of road roughness with and without the project over the analysis period are required to estimate cost savings. The Consultants have projected roughness variation by means of appropriate pavement deterioration curves.

Pavement deterioration curves estimate future values of an index related to pavement condition, such as a pavement condition index or roughness, as a function of current values of values of that index and time or accumulated axle loads. The Consultants have used different deterioration curves for paved and unpaved roads, as well as correlated current and expected road conditions to specific roughness levels. Appendix II.A.6 show the pavement deterioration curves used in this study.

Expected roughness levels with and without project were calculated for each of the analysis years. Table II.A.55 shows expected roughness levels for year 1 (end of 1990) and the associated roughness levels for each pavement.

(2) Speed

Speed is one of the determinants of vehicle operating costs. It is necessary that a segment's average running speed (with and or without the investment) be known for each of the analysis years. Speed is a function of both volume-over-capacity (V/C) ratios and roughness. The higher V/C a road has, the slower vehicles would operate (lower service levels). The rougher a road is, the less average speed it would have.

The Consultants estimated yearly speeds on each of the analyzed highway segments by mean of curves or formulas which relate speed to roughness and V/C. Table II.A.55 shows expected speeds for year 1 (end of 1990). The formulas are shown in Appendix II.A.6.

c. Calculations

(1) Unit Vehicle Operating Costs

As mentioned before, the major benefits are the reduction of vehicle operating costs. A World Bank Study demonstrated that vehicle operating costs are a function of type of vehicle, road roughness and average running speed. To obtain estimates of pre-project and post-project vehicle operating costs on a roadway segment, an analyst should multiply pre-project and post-project unit vehicle operating costs by the segment length and traffic volumes.

The Consultants obtained unit vehicle operating cost for three types of vehicles (a medium-size car, a typical Salvadoran bus, and a medium-size truck) and for an exhaustive list of roadway roughness and speeds. These results are presented in Table II.A.54.

Unit vehicle operating costs were calculated using the HDM-III software model, developed by the World Bank. Appendix II.A.6 presents a brief description of the HDM-III model and the assumed inputs for running HDM-III.

(2) Vehicle Operating Costs

The Consultants selected appropriate yearly unit vehicle operating costs for the do and do-nothing scenarios based on estimated speeds and roughnesses. Multiplying unit vehicle operating cost by expected traffic and by segment length, yearly vehicle operating costs (and differentials) were obtained (see Table II.A.55).

(3) Yearly Maintenance Costs

In Section II.A.6 annual routine maintenance costs by road class and condition were presented (see Table II.A.45). Road condition is determined from the estimate of roughness which has been calculated for each of the analysis years. Based on the assumed condition/roughness relationships, the Consultants estimated yearly maintenance costs with and without the analyzed investments (see Table II.A.55).

(4) Capital Costs

Table II.A.43 and II.A.44 present roadway rehabilitation and improvement costs for each road class and condition. Based on the roadway's current condition and required work (see code in Appendix II.A.6), the Consultants have estimated required investment costs (see Table II.A.55).

TABLE II. A. 54

VEHICLE OPERATING COSTS - HDM-III RESULTS - W/ TIME VALUE OF USER COST

Speed(km/h)	ROUGHNESS (m/km)																			
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
10	3.158	3.206	3.253	3.301	3.348	3.438	3.528	3.618	3.708	3.816	3.923	4.031	4.138	4.246	4.353	4.461	4.568	4.676	4.783	Cars
20	2.288	2.336	2.383	2.431	2.478	2.568	2.658	2.748	2.838	2.948	3.058	3.168	3.278	3.388	3.498	3.608	3.718	3.828	3.938	Cars
30	1.418	1.466	1.513	1.561	1.608	1.698	1.788	1.878	1.968	2.081	2.193	2.306	2.418	2.531	2.643	2.756	2.868	2.981	3.093	Cars
40	1.261	1.309	1.357	1.405	1.453	1.545	1.637	1.729	1.821	1.938	2.056	2.173	2.291	2.408	2.526	2.643	2.761	2.878	2.996	Cars
50	1.103	1.152	1.201	1.249	1.298	1.392	1.486	1.579	1.673	1.796	1.918	2.040	2.163	2.286	2.408	2.530	2.653	2.776	2.898	Cars
60	1.056	1.105	1.154	1.202	1.251	1.347	1.444	1.540	1.636	1.763	1.890	2.017	2.144	2.270	2.397	2.524	2.651	2.778	2.905	Cars
70	1.009	1.058	1.107	1.155	1.204	1.303	1.402	1.500	1.599	1.730	1.862	1.993	2.124	2.255	2.387	2.518	2.649	2.780	2.912	Cars
80	0.962	1.011	1.060	1.108	1.157	1.258	1.360	1.461	1.562	1.698	1.833	1.969	2.105	2.240	2.376	2.511	2.647	2.783	2.918	Cars
90	0.868	0.917	0.966	1.014	1.063	1.169	1.276	1.382	1.488	1.632	1.777	1.921	2.066	2.210	2.354	2.499	2.643	2.787	2.932	Cars
100	0.657	0.705	0.754	0.803	0.852	0.969	1.087	1.204	1.322	1.486	1.650	1.814	1.978	2.142	2.306	2.470	2.634	2.798	2.962	Cars
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
10	6.108	6.148	6.189	6.229	6.269	6.322	6.374	6.427	6.479	6.547	6.614	6.682	6.749	6.817	6.884	6.952	7.019	7.087	7.154	Buses
20	4.557	4.599	4.641	4.683	4.725	4.783	4.841	4.899	4.958	5.038	5.118	5.198	5.278	5.358	5.438	5.518	5.598	5.678	5.758	Buses
30	3.006	3.050	3.094	3.137	3.181	3.245	3.309	3.372	3.436	3.529	3.621	3.714	3.806	3.899	3.991	4.084	4.176	4.269	4.361	Buses
40	2.830	2.876	2.921	2.967	3.013	3.084	3.156	3.228	3.300	3.410	3.520	3.630	3.740	3.850	3.960	4.070	4.180	4.290	4.400	Buses
50	2.654	2.702	2.749	2.797	2.844	2.924	3.004	3.084	3.164	3.292	3.419	3.547	3.674	3.802	3.929	4.057	4.184	4.312	4.439	Buses
60	2.649	2.698	2.747	2.797	2.846	2.932	3.019	3.105	3.191	3.329	3.466	3.604	3.741	3.879	4.016	4.154	4.291	4.429	4.566	Buses
70	2.643	2.694	2.746	2.797	2.848	2.941	3.033	3.126	3.218	3.366	3.513	3.661	3.808	3.956	4.103	4.251	4.398	4.546	4.693	Buses
80	2.638	2.691	2.744	2.797	2.850	2.949	3.048	3.146	3.245	3.403	3.560	3.718	3.875	4.033	4.190	4.348	4.505	4.663	4.820	Buses
90	2.627	2.683	2.740	2.797	2.854	2.965	3.077	3.188	3.299	3.477	3.654	3.832	4.009	4.187	4.364	4.542	4.719	4.897	5.074	Buses
100	2.602	2.667	2.732	2.798	2.863	3.002	3.142	3.281	3.421	3.643	3.866	4.088	4.311	4.533	4.756	4.978	5.201	5.423	5.646	Buses
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
10	4.770	4.930	5.090	5.250	5.410	5.568	5.725	5.883	6.040	6.198	6.355	6.513	6.670	6.828	6.985	7.143	7.300	7.458	7.615	Trucks
20	3.733	3.894	4.055	4.216	4.378	4.539	4.700	4.861	5.023	5.189	5.355	5.521	5.688	5.854	6.020	6.186	6.353	6.519	6.685	Trucks
30	2.695	2.858	3.020	3.183	3.345	3.510	3.675	3.840	4.005	4.180	4.355	4.530	4.705	4.880	5.055	5.230	5.405	5.580	5.755	Trucks
40	2.545	2.709	2.874	3.038	3.203	3.371	3.540	3.709	3.878	4.057	4.236	4.416	4.595	4.774	4.954	5.133	5.313	5.492	5.671	Trucks
50	2.395	2.561	2.728	2.894	3.060	3.233	3.405	3.578	3.750	3.934	4.118	4.301	4.485	4.669	4.853	5.036	5.220	5.404	5.588	Trucks
60	2.353	2.519	2.685	2.851	3.018	3.192	3.366	3.541	3.715	3.902	4.089	4.276	4.463	4.649	4.836	5.023	5.210	5.397	5.584	Trucks
70	2.310	2.476	2.643	2.809	2.975	3.151	3.328	3.504	3.680	3.870	4.060	4.250	4.440	4.630	4.820	5.010	5.200	5.390	5.580	Trucks
80	2.268	2.434	2.600	2.766	2.933	3.111	3.289	3.467	3.645	3.838	4.031	4.224	4.418	4.611	4.804	4.997	5.190	5.383	5.576	Trucks
90	2.183	2.349	2.515	2.681	2.848	3.029	3.211	3.393	3.575	3.774	3.974	4.173	4.373	4.572	4.771	4.971	5.170	5.369	5.569	Trucks
100	1.991	2.158	2.324	2.490	2.656	2.847	3.037	3.227	3.418	3.631	3.844	4.058	4.271	4.485	4.698	4.912	5.125	5.338	5.552	Trucks

TABLE II. A. 55

ESTIMATION OF PROJECT ECONOMIC BENEFITS - FIRST YEAR ANALYSIS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF CONDITION MORE	RR (m/km)	VD (km)	IDEAL CAPAC W/O P	IDEAL CAPAC W/ PR	ROUGHNESS (m/km) W/O PROJ	ROUGHNESS (m/km) W/ PROJ	SPEED (km/h)(1) W/O PROJ	SPEED (km/h)(1) W/ PROJ	UNIT MAINT. COST W/O PROJ	UNIT MAINT. COST W/ PROJ	AVG UNIT USR CST W/O PROJ	AVG UNIT USR CST W/ PROJ	1988 ADT	AN. TRAF. GR. RATE	1a YR TRAF VOL	TOTAL MAINT. COST W/O PROJ	TOTAL MAINT. COST W/ PROJ	TOTAL USER COST W/O PROJ	TOTAL USER COST W/ PROJ	FIRST YEAR BENEFITS
SAN SALVADOR - SANTA TECLA (LIBERTAD EXIT)	0	4.5	12 P	6	100	8000	12000	6.00	2.25	63	82	101090	14200	1.7	1.4	37804	1.045	39589	454985	72900	1125045538	804888037	263985505
SAN SALVADOR - COMALAPA FREEWAY	0	42	0 P	6	100	8000	8000	6.00	2.25	82	96	101090	90800	1.8	1.4	4812	1.045	5029	4245780	453600	1397715682	107822826	356884957
CA:1 SANTA ANA-EL PORTEZUELO	2	6	10 P	6	75	1600	8000	6.00	2.25	55	96	28690	10800	2.1	1.6	6001	1.045	6181	116760	43200	12813020	9611251	3273330
CA:1 EL PORTEZUELO-KM 73	2	3	2 P	6	75	1600	1600	6.00	2.25	62	72	28693	5430	2.2	1.7	815	1.045	852	86070	14290	2963682	1991172	522290
CA:1 KM73-EL PORVENIR	2	3	2 P	6	75	1600	1600	6.00	2.25	61	72	28690	5430	2.2	1.8	1035	1.045	1082	86070	14290	2660485	2155806	571569
CA:1 EL PORVENIR-SAN CRISTOBAL	2	17	2 P	6	75	1600	1600	6.00	2.25	61	72	28690	5430	2.2	1.8	1000	1.045	1045	487730	92310	14501018	11724689	3171710
CA:1 SITIO DEL NIÑO-SANTA TECLA	0	15	0 P	6	100	8000	8000	6.00	2.25	77	90	101090	90800	1.9	1.6	13427	1.045	14031	1514350	162000	149111164	119288849	31265464
CA:1 SAN SALVADOR-SAN MARTIN (KM 18)	2	18	10 P	6	75	1600	8000	6.00	2.25	57	91	28690	10800	2.4	1.6	12173	1.045	12721	5164320	194400	2018146877	1530664127	490719790
CA:1 SAN MARTIN (KM 18)-CUSCATANCINGO (KM 33)	2	15	10 P	6	75	1600	8000	6.00	2.25	53	96	28690	10800	2.2	1.7	6895	1.045	5175	4383350	162000	622955350	476664100	146899680
CA:1 CUSCATANCINGO-SAN RAFAEL CEDROS	2	7	10 P	6	75	1600	8000	6.00	2.25	58	97	28690	10800	2.2	1.7	2483	1.045	2595	2000830	75600	14821327	11194246	3752511
CA:1 MOUTH OF LEMPA RIVER- S.RAFAEL ORIENTE EXIT	2	40	10 P	10	75	1600	8000	10.00	2.25	49	97	63985	10800	2.9	1.7	2483	1.045	2632	2539480	432000	1180345681	853750088	470908873
CA:1 SAN RAFAEL ORIENTE EXIT -SAN MIGUEL	2	6	10 P	10	75	1600	8000	10.00	2.25	63	95	63985	10800	2.6	1.5	5626	1.045	6049	3839910	64800	34051109	19157099	15213120
CA:1 SAN MIGUEL-LA UNION EXIT	2	38	9 P	6	75	1600	7900	6.00	2.25	56	71	28690	5400	2.2	1.8	3414	1.045	3644	1098220	291200	1133262687	88678981	25466886
CA:2 LA HACIENDIRA-CA:12	1	42	1 P	10	80	2000	2000	10.00	2.25	56	77	110825	5400	2.9	1.9	1046	1.045	1114	4434650	226800	49196330	32963620	21560560
CA:2 LA LIBERTAD-CA:12	1	67	1 P	10	80	2000	2000	10.00	2.25	56	76	110825	5400	2.2	1.4	1319	1.045	1378	7425275	361800	75313380	47514334	34862529
CA:2 LA LIBERTAD (KM 32)-SAN DIEGO (KM 37)	1	5	1 P	10	80	2000	2000	10.00	2.25	55	75	110825	5400	2.2	1.6	1779	1.045	1859	554125	27000	7524475	4842561	3209238
CA:2 SAN DIEGO (KM 37)-COMALAPA (KM 61)	1	24	1 P	10	80	2000	2000	10.00	2.25	56	77	110825	5400	2.6	1.7	1181	1.045	1234	2658800	129600	27955297	17997978	12487521
CA:2 ZACATECOLUCA (KM 56)-LEMPA RIVER (KM 65)	1	27	0 P	6	80	2000	2000	6.00	2.25	66	77	50545	5400	2.2	1.7	1177	1.045	1230	1364715	145800	26134604	20345934	6987586
CA:2 VENCEDOR-SANTA ELENA (KM 114)	1	3	1 P	10	80	2000	2000	10.00	2.25	54	76	110825	5400	2.6	1.7	2517	1.060	2688	332475	14200	7725777	5054386	2987667
CA:2 SANTA ELENA (KM 114)-LA UNION	1	86	1 P	10	80	2000	2000	10.00	2.25	55	75	110825	5400	2.7	1.8	1869	1.060	1996	9530950	666400	178394306	118433332	69877526
CA:6 SAN SALVADOR-APOPA	2	13	10 P	10	75	1600	8000	10.00	2.25	36	92	63985	10800	2.9	1.6	10849	1.045	10501	831885	140400	142967671	81525408	42133618
CA:6 APOPA (KM 13)-KM 15	2	2	9 P	10	75	1600	2000	10.00	2.25	45	69	63985	5400	2.9	1.9	4782	1.045	4916	127970	18000	18276020	6446002	3767188
CA:6 KM 15-KM 17	2	2	9 P	10	75	1600	2000	10.00	2.25	47	71	63985	5400	2.9	1.9	3674	1.045	4048	127970	18000	8712818	5543723	3206268
CA:6 KM 17-KM 20	2	3	2 P	10	75	1600	1600	10.00	2.25	48	66	63985	5430	2.9	1.9	3042	1.045	3179	191955	14290	10267455	6543709	3809411
CA:6 KM 20-ABRYLANES	2	14	2 P	10	75	1600	1600	10.00	2.25	50	68	63985	5430	2.9	1.9	2417	1.045	2526	895790	76820	37818835	24188854	14448750
CA:6 ABRYLANES-SAN TOMACHO	2	56	2 P	10	75	1600	1600	10.00	2.25	51	69	63985	5430	2.7	1.8	1885	1.060	2013	3583140	304000	110085067	76099643	39264504
CA:6 SAN TOMACHO-EL POY	1	6	1 P	10	80	2000	2000	10.00	2.25	58	79	110825	5400	3.2	2.0	48	1.060	51	664950	32400	364584	226459	772276
CA:1 SUBURBAN KM-80	1	14	1 P	6	80	2000	2000	6.00	2.25	59	69	50545	5400	2.3	1.8	4605	1.045	4812	707630	75600	55848727	44582543	11000195
CA:1 KM 80-ACAJUTLA	1	6	1 P	6	80	2000	2000	6.00	2.25	62	72	50545	5400	2.3	1.8	3141	1.045	3287	303270	32400	16618697	13134795	3754767
CA:12 SUBURBAN-SANTA ANA	2	34	2 P	6	75	1600	1600	6.00	2.25	61	71	28690	5430	2.0	1.6	1308	1.045	1367	975460	104620	34484123	27888259	7586786
CA:12SANTA ANA-TEXISTEPEQUE	1	16	1 P	10	80	2000	2000	10.00	2.25	55	75	110825	5400	2.9	1.9	2025	1.045	2116	1773200	86400	35244346	22894251	14458914
CA:12TEXISTEPEQUE-METAPAN	1	30	1 P	10	80	2000	2000	10.00	2.25	57	77	110825	5400	3.0	1.9	878	1.045	918	3324750	162000	29825774	19275832	13712692
CA:12METAPAN-ASCUNTATU	1	12	1 P	10	80	2000	2000	10.00	2.25	57	78	110825	5400	3.1	2.0	521	1.045	544	1329900	64800	7391767	4871100	3785790

TABLE II. A. 55

ESTIMATION OF PROJECT ECONOMIC BENEFITS - FIRST YEAR ANALYSIS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF CONDITION WORK	DD (m/km)	VO (km)	IDEAL CAPAC V/C P	V/ PR	BOUNDARIES (m/km) V/O PROJ	V/ PROJ	SPEED (km/h)(1) V/O PROJ	V/ PROJ	UNIT MAINT. COST V/O PROJ	V/ PROJ	AVG UNIT USR CST V/O PROJ	V/ PROJ	YEAR ADT	Ad. TRAF. GR. RATE	TRAF	to YR VOL	TOTAL MAINT. COST V/O PROJ	V/ PROJ	TOTAL USER COST V/O PROJ	V/ PROJ	FIRST YEAR BENEFITS
CA:[illegible]-IZALCO EXIT	1	6	11 F	6	80	2000	8000	6.80	2.25	61	97	50545	10800	2.2	1.6	3612	1.045		3775	385270	64800	18886595	13409747	4913278
CA:IZALCO EXIT-CALUCO EXIT	1	1	11 F	6	80	2000	8000	6.80	2.25	60	96	50545	10800	2.3	1.6	4224	1.045		4414	50545	10800	3459144	2459901	904988
CA:IZALCO EXIT-SAN JULIAN EXIT	1	9	11 F	6	80	2000	8000	6.80	2.25	60	96	50545	10800	2.3	1.7	4189	1.045		4378	454905	97200	32828339	23831868	9754977
CA:SAN JULIAN EXIT-EL CORRO EXIT	1	4	11 F	6	80	2000	8000	6.80	2.25	60	96	50545	10800	2.2	1.6	4189	1.045		4294	202160	43260	13741452	10225228	3475204
CA:EL CORRO EXIT-ARMENIA EXIT	1	6	11 F	6	80	2000	8000	6.80	2.25	60	96	50545	10800	2.2	1.6	4329	1.045		4514	303270	64800	22062728	16125451	6175747
CA:ARMENIA EXIT-TACACOYO EXIT	1	6	11 F	6	80	2000	8000	6.80	2.25	60	96	50545	10800	2.2	1.6	4178	1.045		4358	303270	64800	21225786	15397165	6067992
CA:TACACOYO EXIT-TEPECOYO EXIT	1	2	11 F	6	80	2000	8000	6.80	2.25	59	96	50545	10800	2.3	1.7	4627	1.045		4835	101090	21600	8806325	6849513	2316501
CA:TEPECOYO EXIT-CA:1	1	10	11 F	6	80	2000	8000	6.80	2.25	59	96	50545	10800	2.3	1.6	4869	1.045		5088	505450	108000	42109951	30450711	12056690
AHUACHAPAN-TACUBA	3	17.2	3 F	10	60	500	500	12.80	4.89	48	53	10570	2805	3.1	2.0	200	1.045		209	101804	48246	4090957	2819861	1604454
SANTA ANA-AHUACHAPAN	2	34	9 F	6	75	1600	2000	6.80	2.25	56	71	28690	5400	2.1	1.7	3557	1.045		3717	975460	183600	97466187	78161829	20096138
JUAYUA-SAN JOSE LA MAMBA-EL ARENAL	4	10	4 P	10	50	300	300	12.00	4.89	34	45	10380	2715	3.3	2.2	50	1.045		52	105000	27150	622789	411935	287505
CERRO VERDE-(EL CORRO-CA:8)	3	10	3 F	10	60	500	500	12.00	4.89	48	53	10570	2805	3.1	2.0	200	1.045		209	105700	28050	2378443	1523175	932938
EL CORRO-CA:8 FROM CERRO VERDE TO CA:8	2	3	2 F	6	75	1600	1600	6.80	2.25	63	71	28690	5430	2.2	1.8	200	1.045		209	86070	16290	508321	415352	166749
EL CORRO-PLOR AMARILLA	4	12	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045		52	124560	32580	1092514	696322	698173
PLOR AMARILLA-PLANES DE LA LABORA	4	12	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045		52	124560	32580	1092514	696322	698173
SANTA ANA-SAN PABLO TACACHICO	3	26	3 F	10	60	500	500	12.00	4.89	48	53	10570	2805	3.1	2.0	200	1.045		209	274820	72930	4184005	3066253	2425648
APOPA-KM 20	2	7	2 P	10	75	1600	1600	10.00	2.25	48	65	63985	5430	2.9	1.8	3408	1.045		3561	447695	98010	26291505	16459830	10241568
KM 20-HEJAPA	2	3	2 P	10	75	1600	1600	10.00	2.25	49	68	63985	5430	2.9	1.8	2562	1.045		2677	191955	16290	8517223	5371112	3321776
HEJAPA-KM 27	2	4	2 P	10	75	1600	1600	10.00	2.25	50	68	63985	5430	2.9	1.8	2674	1.045		2585	255960	21720	10984230	6915499	4284950
KM 27-GUAZALTEPEQUE EXIT	2	3	2 P	10	75	1600	1600	10.00	2.25	50	68	63985	5430	2.8	1.8	2485	1.045		2597	191955	16290	7978818	5158004	2980478
GUAZALTEPEQUE EXIT-SITIO DEL NIÑO	2	13	2 P	10	75	1600	1600	10.00	2.25	51	69	63985	5430	2.7	1.8	1856	1.045		1948	831805	79590	24464560	16478058	8047718
CA:1-NUEVO CUSCATLAN EXIT	1	1	11 F	6	80	2000	8000	6.80	2.25	54	96	50545	10800	1.7	1.2	7687	1.045		7824	50545	10800	4918885	3417570	1540972
NUEVO CUSCATLAN EXIT-BL. JOSE VILLANUEVA EXIT	1	9	1 F	6	80	2000	2000	6.80	2.25	63	73	50545	5400	2.0	1.6	2723	1.045		2846	454905	68680	18964142	15215527	4154919
Bl. JOSE VILLANUEVA EXIT-EL CUSCATLAN	1	8	1 F	6	80	2000	2000	6.80	2.25	63	74	50545	5400	2.0	1.6	2570	1.045		2686	404360	43200	15017599	12809858	3481781
EL CUSCATLAN-LA LIBERTAD	1	5	1 F	6	80	2000	2000	6.80	2.25	62	72	50543	5400	1.7	1.4	3148	1.045		3290	252725	27000	10245986	8520650	2151250
SANTA TECLA-BL. JARD LOS PLANES-GUAZALTEPEQUE	3	17	4 P	14	60	500	500	16.00	4.89	33	53	10570	2715	3.8	2.0	200	1.045		209	179600	66155	4916132	2589397	2440269
EL REFUGIO-EL CASTILLO-SAN JOSE LA CUEVA-HERCADIA	4	9	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045		52	95420	24435	819386	378761	517629
EL CHOCO-CHALCHUAPA	4	14	5 F	10	50	309	500	13.33	5.92	28	60	10380	5805	4.4	2.3	719	1.045		751	143320	81270	16753829	8673633	8143446
LCA:1-EL PORVENIR-(SANTA ANA-AHUACHAPAN)	4	9	4 F	18	50	300	250	12.00	4.89	34	45	10380	2715	3.3	2.2	50	1.045		52	95420	24435	568511	378761	258754
CA:1-SAN ANTONIO PAJONAL	4	14	4 P	14	50	300	300	16.00	4.89	27	44	10380	2715	4.8	2.2	189	1.045		198	143320	38010	4826448	2237226	2806492
EL CHOCO-SITIA	4	8	5 F	10	50	300	500	13.33	5.92	27	47	10380	5805	4.4	2.6	888	1.045		929	83060	44440	12431962	6513106	5955456
SITIA-SAN JERONIMO	4	8	4 F	10	50	300	300	12.00	4.89	33	44	10380	2715	3.3	2.2	225	1.045		235	83060	21720	2267259	1401335	847224
MEJICANOS-PANCHIMA-HEJAPA	2	16	2 P	10	75	1600	1600	10.00	2.25	52	71	63985	5430	2.9	2.0	1161	1.045		1192	1023760	86880	29341734	13635510	7443104

TABLE II. A. 55

ESTIMATION OF PROJECT ECONOMIC BENEFITS - FIRST YEAR ANALYSIS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF CONDITION MODE	RD (m/km)	VD (km)	IDEAL CAPAC U/D P	IDEAL CAPAC W/ PR	ROUGHNESS (m/km) U/D PROJ	ROUGHNESS (m/km) W/ PROJ	SPEED (km/h)(1) U/D PROJ	SPEED (km/h)(1) W/ PROJ	UNIT MAINT. COST U/D PROJ	UNIT MAINT. COST W/ PROJ	AVG UNIT USR CST U/D PROJ	AVG UNIT USR CST W/ PROJ	1985 ADT	AN. TRAF. GR. RATE	1a YR TRAF VOL	TOTAL MAINT. COST U/D PROJ	TOTAL MAINT. COST W/ PROJ	TOTAL USER COS. U/D PROJ	TOTAL USER COS. W/ PROJ	FIRST YEAR BENEFITS
SAN SALVADOR-SAN MARCOS	2	5	90 P	10	75	1600	8000	10.80	2.25	37	93	63985	10600	2.6	1.4	9130	1.045	9541	319925	54000	45895013	24819225	21751713
APOPA-SAN JOSE LAS FLORES	2	9	2 P	6	75	1600	1600	6.80	2.25	61	72	28690	5430	2.2	1.9	1013	1.045	1059	258210	48870	7742919	6510482	1433757
SAN SALVADOR-LOS PLANES	2	9	2 P	6	75	1600	1600	6.80	2.25	57	67	28690	5430	1.9	1.5	2791	1.045	2917	258210	48870	17927611	14481276	3455675

TABLE II. A. 55

ESTIMATION OF PROJECT ECONOMIC BENEFITS - FIRST YEAR ANALYSIS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	RO (m/km)	VD (km)	IDEAL CAPAC U/O P	IDEAL CAPAC W/ PR	ROUGHNESS (m/km) U/O PROJ	ROUGHNESS (m/km) W/ PROJ	SPEED (km/h)(1) U/O PROJ	SPEED (km/h)(1) W/ PROJ	UNIT MAINT. COST U/O PROJ	UNIT MAINT. COST W/ PROJ	AVG UNIT USR CST U/O PROJ	AVG UNIT USR CST W/ PROJ	1988 ADT	ANN. TRAF. GR. RATE	1o YR TRAF VOL	TOTAL MAINT. COST U/O PROJ	TOTAL MAINT. COST W/ PROJ	FIRST YEAR BENEFITS
CA:8 JAYAMAK BETOUR	3	2	7 P	14	69	500	1600	17.33	5.92	27	63	10570	28690	5.1	2.2	1184	1.045	1237	21140	57380	2612521
JAYAMAK BETOUR-TEPECOYO	3	5	3 P	14	60	500	500	17.33	5.92	30	50	10570	5805	4.8	2.0	370	1.045	387	52850	29025	1981791
GUEZALTEPEQUE-SAN MATIAS	4	19	4 P	14	50	300	300	17.33	5.92	25	41	10380	5705	4.8	2.2	294	1.045	307	197220	108395	5614648
SAN MATIAS-SAN JUAN OPICO	4	5	4 P	14	50	300	300	16.00	4.89	27	44	10380	2715	5.0	2.3	147	1.045	154	51908	13575	792712
CA:2-LA HERRADURA (VIA SAN MARCELINO)	3	18	7 F	10	60	500	1600	13.33	5.92	35	64	10570	28690	3.4	2.1	921	1.045	962	190260	516420	7952391
LOS PLANES-PANCHIMALCO	2	7	2 F	6	75	1600	1600	6.80	2.25	62	72	28690	5430	1.9	1.6	890	1.045	930	208830	38010	1065873
PANCHIMALCO-ROSARIO DE MORA	2	6	2 F	6	75	1600	1600	6.80	2.25	63	73	28690	5430	2.4	1.9	495	1.045	517	116760	21720	429579
PANCHIMALCO-SISTAPANGO	3	12	3 F	10	60	500	500	13.33	5.92	35	67	10570	5805	3.4	2.3	882	1.045	922	126840	69660	4427961
BERLIN-ALEGRIA-SANTIAGO DE MARIA	2	11.6	2 P	6	75	1600	1600	6.80	2.25	59	69	28690	5430	2.2	1.8	1885	1.045	2013	332804	62988	3663197
SANTIAGO DE MARIA-TECAPAN-GEATLAN-CA:2	2	17	2 P	10	75	1600	1600	10.80	2.25	53	73	63985	5430	2.7	1.8	649	1.045	693	1087745	92310	5054437
TEJUTEPEQUE-SAN ANTONIO BUENA VISTA-CORRAL VIEJO	4	9.8	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045	53	101724	26607	574395
CA:12-LAS CASITAS-S ANTONIO MAS-L NORCONES-GUARNECIA	4	19.4	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045	52	201372	52671	1115779
TAPALHUACA-CA:2(ANTIGUA COMALAPA)	4	8	4 P	14	50	300	300	16.00	4.89	27	44	10380	2715	4.6	2.0	170	1.045	178	83040	21720	1481454
CA:2-SAN PEDRO MASAHUAT	4	6	4 P	10	50	300	300	12.00	4.89	34	45	10380	2715	3.3	2.2	50	1.045	52	42288	16290	172583
SAN PEDRO MASAHUAT-SAN ANTONIO MASAHUAT	4	3	4 F	10	50	300	300	12.00	4.89	33	44	10380	2715	3.1	2.1	137	1.045	143	31140	8145	187535
CIUDAD BARRIOS-RONCAGUA	3	28	3 P	14	60	500	500	16.00	4.89	33	53	10570	2805	3.8	2.0	200	1.068	214	295960	78540	4134835
SAN MIGUEL-EL DELIRIO	2	15.3	2 P	6	75	1600	1600	6.80	2.25	58	68	28690	5430	2.1	1.7	2478	1.068	2647	438957	83079	4290879
SAN MIGUEL-MILITAR ROUTE EXIT	2	16	9 F	6	75	1600	2000	6.80	2.25	57	73	28690	5400	2.2	1.8	2825	1.068	3017	439040	86400	8690273
MILITAR ROUTE EXIT-PASAQUINA	2	30	2 P	6	75	1600	1600	6.80	2.25	59	69	28690	5430	2.2	1.8	1885	1.068	2013	868788	162900	9473791
CA:1-SAN ANTONIO SILVA-SAN ALEJO	3	10.1	3 P	14	60	900	500	16.00	4.89	33	53	10570	2805	3.8	2.0	200	1.068	214	106757	28331	1491286
CA:1 JUNCTION-LA UNION	1	7	1 F	6	80	2000	2000	6.80	2.25	61	71	50545	5400	2.2	1.8	3414	1.068	3646	353815	37800	4471132
ZACATECOLUCA-TECOLUCA-SAN VICENTE	2	21	2 F	6	75	1600	1600	6.80	2.25	61	71	28690	5430	2.1	1.7	1111	1.045	1161	602490	114030	3991547
TACUBA-CONCEPCION DE ATACO	4	13	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.9	2.2	50	1.045	52	134940	35295	747887
ISTAHUA-ORATORIO DE CONCEPCION-MONTEPEQUE	4	9	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045	52	93420	24435	517829
CHALCHUAPA-LAS CRUCES	4	8	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.7	2.1	83	1.045	87	83040	21720	724510
SAN JOSE EL BARRAJO-LAS DELICIAS-CA:2	4	7.8	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045	52	80964	21177	448612
NAHUIZALCO-JUAYUA	4	8.5	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045	52	88230	23078	488872
CA:3-EL CHAPERNO-CASERIO SAN ISIDRO	4	8.3	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.045	52	86154	22535	477369
SAN PEDRO NORNALCO-JERUSALEN	3	12.8	3 P	14	60	500	500	16.00	4.89	33	53	10570	2805	3.8	2.0	200	1.045	209	133296	35904	1851286
S ANTONIO NORTE-STO DOMINGO GUZMAN-S PEDRO PANTLA	3	13	3 P	14	60	500	500	16.00	4.89	33	53	10570	2805	3.8	2.0	200	1.045	209	137696	36465	1888213
ATIQUIZAYA-SAN LORENZO-EL PORTILLO	4	9.3	4 P	14	50	300	300	17.33	5.92	24	41	10380	5705	4.7	2.1	358	1.045	374	96534	53057	3301804
SAN JUAN OPICO-SAN PABLO TACACHICO	3	14	3 F	10	60	500	500	12.00	4.89	40	53	10570	2805	3.1	2.0	200	1.045	209	147980	39270	1306114
CA:2-TEOTEPEQUE-SANTA TECLA	3	44	3 P	14	60	500	500	16.00	4.89	33	53	10570	2805	3.8	2.0	200	1.045	209	465080	123420	6363796

TABLE II. A. 55

ESTIMATION OF PROJECT ECONOMIC BENEFITS - FIRST YEAR ANALYSIS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	RD (m/km)	VD (km)	IDEAL CAPAC W/O P	IDEAL CAPAC W/ PR	ROUGHNESS (m/km) W/O PROJ	ROUGHNESS (m/km) W/ PROJ	SPEED (km/h)(1) W/O PROJ	SPEED (km/h)(1) W/ PROJ	UNIT MAINT. COST W/O PROJ	UNIT MAINT. COST W/ PROJ	AVE UNIT USR CST W/O PROJ	AVE UNIT USR CST W/ PROJ	1988 ADT	AN. TRAF. GR. RATE	1st YR TRAF VOL	TOTAL MAT W/O PROJ	COST PROJ	TOTAL USER COST W/O PROJ	TOTAL USER COST W/ PROJ	FIRST YEAR BENEFITS
SAN JULIAN-CUISNAHUAT	4	10	4	P	14	50	300	300	16.00	4.09	27	43	10380	2715	4.8	2.1	220	1.045	230	103800	27150	4167903	1857115	2387438
CA-2-GUAYMANGO-JUJUTLA-ATACO-AHUACHAPAN	3	34	3	P	16	60	500	500	16.00	4.09	33	53	10570	2805	3.8	2.0	200	1.045	209	359380	95370	9832264	5178795	4917679
CA:12-EL ROMCO	3	7.3	3	P	14	60	500	500	17.33	5.92	28	47	10570	5805	5.2	2.4	880	1.045	920	77161	42377	12733961	5943209	6825536
SANTO TOMAS-SAN MIGUEL TEPEZONTES-COJUTEPEQUE	4	23.7	4	P	14	50	300	300	16.00	4.09	27	44	10380	2715	4.6	2.0	137	1.045	143	246006	64344	5495965	2500443	3376002
CA:2-CANTON LA CANOA	4	18.3	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	189954	49605	1702754	770433	1072591
SAN LORENZO-HACIENDA SAN MATIAS	4	6.4	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	66432	17376	582674	263438	368092
HACIENDA SAN MARTIN-CA:2	4	15.5	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.9	2.2	50	1.045	52	160090	42083	1411165	638699	891473
HAMULINGO-LA CHAPINA COOP.	4	7.5	4	P	14	50	300	300	16.00	4.09	20	45	10380	2715	4.8	2.2	50	1.045	52	77850	20343	682822	308951	431358
SAN JOSE EL NARANJO-(JUJUTLA-ATACO)	4	24.9	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	258442	67604	2266068	1025718	1432108
COMALAPA FREEWAY-LAS HOJAS COOP.	4	19.2	4	P	14	58	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	199296	52128	1748025	790915	1104276
CAL..CO - EL CARMEN COOPERATIVE.	4	9.8	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	101724	26607	892220	403696	565441
HUIZAPA-COOPERATIVE 21 DE MARZO	4	11.1	4	P	15	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	115218	30137	1032818	467312	650588
HAC. SANTA ELENA-I.(TATANUSIQUE)	4	10	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	103800	27150	930467	421001	586116
CA:2 - HAC.CHILANGUERA	4	6.2	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	64356	16833	576889	261021	363392
LA CHILATA-SAN MARCOS	4	16	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	166080	43440	1456/46	659096	920230
CA:2 -TAMANIQUE	4	14.5	4	P	14	50	300	300	16.00	4.09	28	45	10382	2715	5.0	2.3	61	1.045	64	150310	39348	1671120	779049	1002376
SAN JULIAN-EL BALSAMAR COOPERATIVE	4	12	4	P	14	50	300	300	16.00	4.09	28	45	10330	2715	4.8	2.2	50	1.045	52	125560	32500	1092514	494322	690173
CA:2 - CARA SUCIA	4	8	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	83040	21720	728343	329548	460115
CA:2 - SAN BENITO	4	11	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	114180	29865	1001672	453120	632650
CA:2 - AGUA FRIA	4	11	4	P	14	58	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	114180	29865	1001672	453120	632658
TACUBA-CONCEPCION DE ATACO	4	13	4	P	14	50	300	300	16.00	4.09	28	45	16380	2715	4.0	2.2	50	1.045	52	134940	35295	1183557	535515	747687
CA:2 - PALO GORDO COOPERATIVE	4	8	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	83040	21720	728343	329548	460115
CA:2 - BARRA CIEGA COOPERATIVE	4	8	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	83040	21720	728343	329548	460115
CA:2 - EL ZARZAL	4	12	4	P	16	50	300	300	16.00	4.09	28	45	10380	2715	4.8	[illegible]	58	1.045	52	125560	32500	1092516	494322	690173
CA:2 - SIHUAPILAPA	4	12	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	125560	32500	1092516	494322	690172
CA:2 - HACIENDA LA CABANA	4	12	4	P	14	50	300	300	16.00	4.09	28	45	10360	2715	4.8	2.2	50	1.068	53	125560	32500	1116560	505202	703339
CA:2 - SAN DIONISIO	4	8	4	P	10	50	300	300	12.00	4.09	34	45	10380	2715	3.3	2.2	50	1.068	53	83040	21720	509197	336001	233716
CA:2 - SAN JOSE DE LA MONTANA	4	16	4	P	16	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	166080	43440	1456486	659096	920230
CA:2 - HOJA DE SAL COOPERATIVE	4	11	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.045	52	114180	29865	1001672	453120	632650
CA:2 - EL MAMONCITO COOPERATIVE	4	7	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	72660	19005	651327	294701	410281
MILITAR MONTE-MAYUCAQUIN COOPERATIVE	4	9	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	93420	24435	837420	370001	527504
SAN MIGUEL-LA PUERTA	4	9	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	93420	24435	837420	370001	527504
CA:2 - TIERRA BLANCA	4	9	4	P	14	50	300	300	16.00	4.09	28	45	10380	2715	4.8	2.2	50	1.068	53	93420	24435	837420	370001	527504

TABLE II. A. 55

ESTIMATION OF PROJECT ECONOMIC BENEFITS - FIRST YEAR ANALYSIS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF CONDITION	RD (m/km)	VD (km)	IDEAL CAPAC W/O P	IDEAL CAPAC W/ PR	ROUGHNESS (m/km) W/O PROJ	ROUGHNESS (m/km) W/ PROJ	SPEED (km/h)(1) W/O PROJ	SPEED (km/h)(1) W/ PROJ	UNIT MAINT. COST W/O PROJ	UNIT MAINT. COST W/ PROJ	AVG UNIT USR CST W/O PROJ	AVG UNIT USR CST W/ PROJ	1988 ADT	AN. TRAF. GR. RATE	1a YR TRAF VOL	TOTAL MAINT. W/O PROJ	MT. COST W/ PROJ	TOTAL USER COST W/O PROJ	TOTAL USER COST W/ PROJ	FIRST YEAR BENEFITS
CA:2 - LLANO DE LAS ROSAS	4	7	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.060	53	72660	19005	651527	294701	410291
PANAMERICANA-CA:2-LA UNION	4	12	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.060	53	124560	32580	1116560	505262	703339
SAN ALEJO-EL TAMARINDO	4	11	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.060	53	114180	29865	1023516	463102	644727
CA:2 GUALPIRENE COOP.	4	8	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.060	53	83040	21720	744376	336801	468992
LA UNION-VOLCANAL COOP.-EL PASO	4	9	4 P	14	50	300	300	16.00	4.89	28	45	10380	2715	4.8	2.2	50	1.060	53	93420	24435	837420	378901	527506

(1) Weighted average between peak and off-peak periods.

d. Highway Results

Estimated cash flow allows for the calculation of economic indicators for project evaluation. Table II.A.56 presents the resulting net present values, internal rates of return and net benefit-over-investment (NB/I) ratios. A 12 percent discount rate was used as a basis. To analyze the sensitivity of these results, the Consultants also calculated NB/Is for 10 and 15 percent discount rates.

Table II.A.56 shows projects that have been grouped into six components or programs. Each component has been divided into improvement and rehabilitation work subcomponents. The recommended five-year plan programs are listed below in descending NB/I order:

- Secondary Highways (improvement and rehabilitation; NB/I = 13.5)

- CA:2, Coastal Highway (rehabilitation; NB/I = 11.0)

- CA:1, Pan-American Highway (improvement and rehabilitation; NB/I = 8.6)

- Special and Primary Highways (improvement and rehabilitation; NB/I = 8.2)

- Tertiary Roadways (improvement and rehabilitation; NB/I = 4.4)

- Rural Roadways (rehabilitation; NB/I = 3.0)

Economic indicators are highest when traffic volumes are high and original roadway condition is poor. The roadway segments which present the highest returns for their investment (highest NB/Is and IRR - where 1.0 equals 100 percent) are presented below in descending NB/I order.

- Rehabilitation of CA:1 from Sitio del Nino to Santa Tecla (15km), NB/I = 47.9, IRR = 4.53

- Widening to six lanes of the five-kilometer segment of CA:1 from San Salvador to Santa Tecla (La Libertad Exit), NB/I = 37.0, IRR = 2.72

- Rehabilitation of CA:12 from Sonsonate to km 80, NB/I = 34.7, IRR = 3.69

- Rehabilitation of Apopa - Sitio del Nino, from Apopa to km 20, NB/I = 31.7, IRR = 4.44

- Rehabilitation of CA:4 from 17 km to Km 20, NB/I = 28.2, IRR = 3.95

TABLE II.A.56

ESTIMATION OF FIRST FIVE YEAR HIGHWAY PLAN ECONOMIC BENEFITS FINANCIAL RATIOS (1)

SECONDARY HIGHWAYS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS (UNIT	TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	V. P. V. (12%)	I. R. R. (%)	N.B./I. (12%)	N.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																		
CA:4 KM 17-KM 20	2	3	2	P	339910	1019730	3899411	6007446	3517995	0	0	54372008	28707356	27687624	3.954	28.152	30.887	24.708
CA:4 KM 20-AGUILARES	2	14	2	P	339910	4758740	14448750	22798195	10857615	0	0	193001827	104125471	99366731	3.173	21.881	23.937	19.279
CA:4 AGUILARES-SAN IGNACIO	2	56	2	P	339910	19034960	39264504	77382001	41066074	0	0	651710635	340773322	321738362	2.279	17.902	19.680	15.664
CA:12 SONSONATE-SANTA ANA	2	34	2	F	211940	7205960	7586704	16132982	17458215	0	0	178856252	84537968	77332008	1.277	11.732	13.089	10.054
EL CONGO-CA:8 FROM CERRO VERDE TO CA:8	2	3	2	F	211940	635820	166749	349961	237389	0	0	3263641	1650958	1015138	0.380	2.597	2.869	2.256
APOPA-KM 20	2	7	2	P	339910	2379370	10241560	15764525	9278882	0	0	142938675	75428360	73048990	4.435	31.701	34.784	27.820
KM 20-MEJAPA	2	3	2	P	339910	1019730	3321776	5233081	2489610	0	0	44300352	23906664	22886934	3.395	23.444	25.646	20.658
MEJAPA-KM 27	2	4	2	P	339910	1359640	4284950	6745824	3205204	0	0	57094603	30817010	29457370	3.288	22.666	24.794	19.973
KM 27-QUEZALTEPEQUE EXIT	2	3	2	P	339910	1019730	2988478	4784721	2301130	0	0	40508091	21802036	20782306	3.073	21.380	23.398	18.828
QUEZALTEPEQUE EXIT-SITIO DEL NIÑO	2	13	2	P	339910	4418830	8947718	16125132	9505693	0	0	142460853	74113134	69694304	2.206	16.772	18.447	14.667
MEJICANOS-MARIONA-MEJAPA	2	16	2	P	339910	5438560	7443104	12610527	7211397	0	0	111612118	58485849	53047289	1.518	10.754	11.811	9.423
APOPA-SAN JOSE LAS FLORES	2	9	2	F	211940	1907460	1633757	3140671	1432098	0	0	34877003	16425978	14518516	0.968	8.611	9.614	7.373
SAN SALVADOR-LOS PLANES	2	9	2	F	211940	1907460	3455675	9312091	9071505	0	0	95901124	45283295	43375835	2.163	23.740	26.503	20.322
LOS PLANES-PANCHIMALCO	2	7	2	F	211940	1483580	1065073	2324713	2411129	0	0	25179531	11952536	10468956	0.930	8.057	8.984	6.910
PANCHIMALCO-ROSARIO DE MORA	2	4	2	F	211940	847760	429579	907224	799940	0	0	9156153	4459549	3611789	0.681	5.260	5.863	4.537
BERLIN-ALEGRIA-SANTIAGO DE MARIA	2	12	2	F	211940	2458504	3663199	8372675	8506544	0	0	89367757	42408780	39950276	1.758	17.250	19.237	14.791
SANTIAGO DE MARIA-TECAPAN-OZATLAN-CA:2	2	17	2	P	339910	5778470	5054437	8915320	5439256	0	0	79951313	41494738	35716268	1.021	7.181	7.900	6.277
SAN MIGUEL-EL DELIRIO	2	15	2	F	211940	3242682	6290079	17017575	17813275	0	0	181370661	84744002	81501320	2.297	26.134	29.222	22.321
MILITAR ROUTE EXIT-PACAMUERA	2	30	2	F	211940	6358200	9473791	21653471	21999683	0	0	231123510	109677879	103319679	1.758	17.250	19.237	14.791
ZACATECOLUCA-TECOLUCA-SAN VICENTE	2	21	2	F	211940	4450740	3991567	8569926	9107876	0	0	93992916	44505307	40054567	1.116	10.000	11.154	8.573
IMPROVEMENT																		
SAN MIGUEL-MILITAR ROUTE EXIT	2	16	9	F	1186440	18983040	8690273	20977805	25396384	-749440	-749440	237089707	111032153	92049113	(2)	5.849	6.542	4.992
CA:4 APOPA (KM 13)-KM 15	2	2	9	P	1186440	2372880	3767188	6493826	3476150	-93680	8450215	80603180	32471416	30098536	(2)	13.686	15.396	11.671
CA:4 KM 15-KM 17	2	2	9	P	1186440	2372880	3286265	5652427	3438604	-93680	93680	49194168	25831292	23459412	(2)	10.886	11.961	9.532
SANTA ANA-ARUACHAPAN	2	34	9	F	1186440	40338960	20096138	46672424	52788858	7937925	-1592560	559122489	251479696	211140736	(2)	6.234	7.200	5.298
SAN SALVADOR-SAN MARCOS	2	5	10	P	3500000	17500000	21251713	51167896	45356229	38279026	47896703	845151196	299291635	281791635	1.492	17.102	19.698	14.099
CA:4 SAN SALVADOR-APOPA	2	13	10	P	3500000	45500000	55254453	133036528	117874196	99529468	124531627	2197393110	778158252	732658252	1.492	17.102	19.698	14.099
TOTAL	2	352	-	-	-	203,793,686	249,774,872	527,963,967	433,970,531	144,805,620	178,442,664	8,429,393,775	2,743,564,630	2,539,770,944	1.452	13.462	15.151	11.432

(1) In colones. (2) Multiple IRRs (3) IRR = 1.0 (100 Percent)

TABLE II.A.56

ESTIMATION OF FIRST FIVE-YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

COASTAL HIGHWAY (CA:2)

	PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (%)	B.B./I. (12%)	B.B./I. (10%)	B.B./I. (15%)
CA:2	LA HACHADURA-CA:12	1	42	1	P	466340	19586280	21560568	35225856	18196907	0	0	303402304	161699224	142112944	1.231	8.256	9.048	7.256
CA:2	LA LIBERTAD-CA:12	1	67	1	P	466340	31244780	36862529	59197509	33293934	0	0	520014782	273471716	242226936	1.259	8.753	9.611	7.672
CA:2	LA LIBERTAD (KM 32)-SAN DIEGO (KM 37)	1	5	1	P	466340	2331700	3209238	5636547	3300703	0	0	49891072	26033685	23701785	1.538	11.165	12.274	9.771
CA:2	SAN DIEGO (KM 37)-COMALAPA (KM 61)	1	24	1	P	466340	11192160	12487521	20487019	11152419	0	0	179072485	94845832	83653672	1.248	8.474	9.295	7.440
CA:2	ZACATECOLUCA (KM 56)-LEMPA RIVER (KM 83)	1	27	1	F	245980	6641460	6987586	14309786	13178493	0	0	147755466	71692305	65050845	1.261	10.705	11.996	9.304
CA:2	USULUTAN-SANTA ELENA (KM 114)	1	3	1	P	466340	1399020	2987667	5598508	3666141	0	0	50993157	26097225	24698205	2.333	18.654	20.566	16.258
CA:2	SANTA ELENA (KM 114)-LA UNION	1	86	1	P	466340	40105240	69027524	125522573	79679270	0	0	1135816739	585054375	544949135	1.902	14.588	16.068	12.732
TOTAL		1	254	1	-	-	112,500,640	151,122,632	265,977,798	162,447,867	0	0	2,386,946,005	1,238,894,162	1,126,393,522	1.505	11.012	12.115	9.627

TABLE II.A.56

ESTIMATION OF FIRST FIVE YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

PAN AMERICAN HIGHWAY (CA:1)

	PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (3)	N.B./I. (12%)	N.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																			
CA:1	EL PORTEZUELO-KM 73	2	3	2	F	211940	635820	522290	1069758	1020227	0	0	11220773	5417721	4781401	1.019	8.520	9.475	7.336
CA:1	KM73-EL PORVENIR	2	3	2	F	211940	635820	574569	1200575	1238561	0	0	13031811	6210977	5575157	1.114	9.768	10.885	8.387
CA:1	EL PORVENIR-SAN CRISTOBAL	2	17	2	F	211940	3602980	3171749	6628862	6792476	0	0	71721630	34215797	30612817	1.089	9.497	10.580	8.155
CA:1	SITIO DEL NIÑO-SANTA TECLA	0	15	0	F	491960	7379400	31245464	70742793	68631473	0	0	739663590	353597046	346217646	4.532	47.917	53.377	41.153
CA:1	JUNCTION - LA UNION	1	7	1	F	245980	1721860	4471132	6212605	8632369	0	0	82296401	38815918	37094058	2.691	22.543	25.139	19.345
IMPROVEMENT																			
CA:1	SAN SALVADOR - SANTA TECLA (LIBERTAD EXIT)	0	5	12	F	2200000	9900000	24398505	51790414	74452508	137788145	140311243	1156190115	366075606	356175606	2.718	36.977	43.170	29.960
CA:1	SANTA ANA-EL PORTEZUELO	2	4	10	F	3500000	14000000	3273330	6599598	6976186	1884411	2503576	89695231	37330491	23330491	0.346	2.666	3.013	2.251
CA:1	SAN SALVADOR-SAN MARTIN (KM 18)	2	18	10	F	3500000	63000000	69071970	205073744	223772349	188697685	235850304	3865412855	1285815672	1222815672	1.458	20.410	23.748	16.580
CA:1	SAN MARTIN (KM 18)-COJUTEPEQUE (KM 35)	2	15	10	F	3500000	52500000	14809600	29977349	32100638	8760933	79051973	613385844	195052813	142552813	0.612	3.715	4.325	3.026
CA:1	COJUTEPEQUE-SAN RAFAEL CEDROS	2	7	10	F	3500000	24500000	3752511	6429778	6160475	1611977	2230485	83868492	36162526	11662526	0.198	1.476	1.659	1.256
CA:1	EAST OF LEMPA RIVER- S.RAFAEL ORIENTE EXIT	2	40	10	P	3500000	140000000	47098073	75495834	52924904	14886223	23160673	865954087	393746649	253746649	0.408	2.812	3.135	2.421
CA:1	SAN RAFAEL ORIENTE EXIT -SAN MIGUEL	2	6	10	P	3500000	21000000	15213120	26631416	18597843	38674911	54106962	606558827	184081787	163081787	0.863	8.766	10.284	7.069
CA:1	SAN MIGUEL-LA UNION EXIT	2	38	9	F	1186440	45084720	25468806	60803861	61400560	-1779920	17046807	1146798409	365716708	320631988	(2)	8.112	9.430	6.622
TOTAL		-	178	-	-	-	383,960,600	243,090,919	548,656,585	562,700,569	266,524,365	707,663,821	9,345,798,065	3,302,237,211	2,918,276,611	0.848	8.600	9.901	7.096

(1) In colones.

(2) Multiple IRRs.

TABLE II.A.56

ESTIMATION OF FIRST FIVE YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

SPECIAL AND PRIMARY ROADWAYS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (2)	B/I. (12%)	B/I. (10%)	B/I. (15%)
REHABILITATION/RECONSTRUCTION																		
SAN SALVADOR - COMALAPA FREEWAY	0	42	0	F	491960	20662320	35684957	71989222	71320473	0	0	769766255	370029781	349367461	1.949	17.908	19.928	15.40
CA:4 SAN IGNACIO-EL POY	1	6	1	P	466340	2798040	772276	889400	159869	0	0	6732333	4044938	3246898	0.234	1.446	1.558	1.30
CA:12 SONSONATE KM-80	1	14	1	F	245980	3443720	11898195	24010604	21358011	0	0	244583260	119395830	115952110	3.693	34.671	38.493	29.92
CA:12 KM 80-ACAJUTLA	1	6	1	F	245980	1475880	3754767	7486846	7850942	0	0	82332432	39786487	37810607	2.771	26.619	29.654	22.86
CA:12 SANTA ANA-TEXISTEPEQUE	1	16	1	P	466340	7461440	14038914	23364591	13148261	0	0	205979249	108508303	101046863	2.032	14.543	15.964	12.75
CA:12 TEXISTEPEQUE-METAPAN	1	30	1	P	466340	13990200	13712692	21848808	10910367	0	0	187153204	100353796	86363596	1.098	7.173	7.854	6.31
CA:12 METAPAN-ANGUIATU	1	12	1	P	466340	5596080	3785759	5711754	2596959	0	0	48152085	26216123	20620043	0.763	4.685	5.118	4.13
NUEVO CUSCATLAN EXIT-SN. JOSE VILLANUEVA EXIT	1	9	1	F	245980	2213820	4154919	8753513	9626391	0	0	97910062	46200783	43986463	2.120	20.869	23.290	17.87
SN JOSE VILLANUEVA EXIT-EL CIMARRON	1	8	1	F	245980	1967840	3481701	7357087	8058527	0	0	82102777	38755723	36787883	2.011	19.695	21.978	16.87
EL CIMARRON-LA LIBERTAD	1	5	1	F	245980	1229900	2151259	4870214	5834578	0	0	56467003	26173504	24943604	2.020	21.281	23.817	18.15
IMPROVEMENT																		
CA:8 SONSONATE-IZALCO EXIT	1	6	11	F	2300000	13800000	4913278	8786314	8829558	1074875	3671328	112348759	48831480	35031480	0.468	3.539	3.974	3.01
CA:8 IZALCO EXIT-CALUCO EXIT	1	1	11	F	2300000	2300000	1042988	1733239	1761606	567568	734576	24256648	10151454	7851454	0.562	4.414	4.978	3.73
CA:8 CALUCO EXIT-SAN JULIAN EXIT	1	9	11	F	2300000	20700000	9354977	15538692	15746663	5051310	6540400	216922620	90890203	70190203	0.560	4.391	4.951	3.72
CA:8 SAN JULIAN EXIT-EL CONGO EXIT	1	4	11	F	2300000	9200000	3675204	6565767	6727642	2184089	2830904	91785326	38041526	28841526	0.520	4.135	4.671	3.49
CA:8 EL CONGO EXIT-ARMENIA EXIT	1	6	11	F	2300000	13800000	6175747	10323567	10643812	3478110	4498555	146007696	60777817	46977817	0.558	4.404	4.971	3.72
CA:8 ARMENIA EXIT-SACACOYO EXIT	1	6	11	F	2300000	13800000	6067092	10111343	10341487	3369869	4363169	142315062	59376674	45576674	0.548	4.303	4.855	3.64
CA:8 SACACOYO EXIT-TEPECOYO EXIT	1	2	11	F	2300000	4600000	2316501	3831419	3912838	1268048	1634785	53841420	22509714	17909714	0.616	4.893	5.520	4.14
CA:8 TEPECOYO EXIT-CA:1	1	10	11	F	2300000	23000000	12056690	19948302	23714416	6745861	8679401	298248672	122904752	99904752	0.643	5.344	6.044	4.50
CA:1-NUEVO CUSCATLAN EXIT	1	1	11	F	2300000	2300000	1540978	3070504	3390861	1183432	7430902	62833883	20221581	17921581	0.851	8.792	10.226	7.16
TOTAL	0/1	193	-	-	-	164,339,240	160,578,892	256,189,184	235,933,062	24,923,563	40,384,021	2,929,733,744	1,352,669,969	1,188,330,729	1.016	8.231	9.185	7.06

(1) In colones. (2) IRR = 1.0 (100 Percent)

TABLE II A.56

ESTIMATION OF FIRST FIVE YEAR HIGHWAY PLAN ECONOMIC BENEFITS FINANCIAL RATIOS (1)

TERTIARY ROADWAYS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (%)	N.B./I. (12%)	N.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																		
AMUACHAPAN-TACUBA	3	17	3	F	88050	1514460	1604656	2962145	0	0	0	17341287	10452098	9137638	1.222	7.034	7.571	6.331
CERRE VERDE-(EL CONGO-CA:8)	3	10	3	F	88050	880500	932938	1722177	0	0	0	10082144	6193080	5312580	1.222	7.034	7.571	6.331
SANTA ANA-SAN PABLO TACACHICO	3	26	3	F	88050	2289300	2425640	4477661	0	0	0	26213574	16102008	13812708	1.222	7.034	7.571	6.331
SANTA TECLA-SN.JUAN LOS PLANES-GUEZALTEPEQUE	3	17	4	P	94400	1604800	2460269	2930931	3230	3230	3230	19381855	12299261	10694461	1.573	7.664	8.205	6.953
JAYAQUE DETOUR-TEPECOYO	3	5	3	P	113240	566200	1981791	0	0	0	0	4954477	3974526	3408326	3.230	7.020	7.264	6.680
TONACATEPEQUE-SOYAPANGO	3	12	3	F	88050	1056600	4427941	0	0	0	0	11069853	8880335	7823735	3.924	8.405	8.697	7.997
CIUDAD BARRIOS-MONCAGUA	3	28	3	P	113240	3170720	4134035	0	0	0	0	10335088	8290899	5120179	0.998	2.615	2.706	2.488
CA:1-SAN ANTONIO SILVA-SAN ALEJO	3	10	3	P	113240	1132400	1491206	0	0	0	0	3728014	2990646	1846922	0.998	2.615	2.706	2.488
SAN PEDRO NONUALCO-JERUZALEN	3	13	3	P	113240	1472120	1851286	2204387	0	0	0	14547957	9245021	7795549	1.314	6.378	6.827	5.787
S ANTONIO MONTE-STO DOMINGO GUZMAN-S PEDRO PUXTLA	3	13	3	P	113240	1472120	1880213	2238811	0	0	0	14775269	9389475	7917355	1.314	6.378	6.827	5.787
SAN JUAN OPICO-SAN PABLO TACACHICO	3	14	3	F	88050	1232700	1306114	2411048	0	0	0	14115001	8670312	7437612	1.222	7.034	7.571	6.331
CA:2-TEOTEPEQUE-SANTA TECLA	3	44	3	P	113240	4982560	6363796	7577580	0	0	0	50008602	31779761	26797201	1.314	6.378	6.827	5.787
CA:2-GUAYMANGO-JUJUTLA-ATACO-AMUACHAPAN	3	34	3	P	113240	3850160	4917679	5855403	0	0	0	38643010	24557088	20706928	1.314	6.378	6.827	5.787
CA:12-EL ROMCO	3	7	3	P	113240	826652	6825536	0	0	0	0	17063839	13688763	12862111	7.999	16.559	17.136	15.757
IMPROVEMENT																		
CA:8 JAYAQUE DETOUR	3	2	7	P	1372230	2744460	2612521	883375	1127146	1430928	-106830	22976367	10620059	7875599	(2)	3.870	4.281	3.378
CA:2-LA HERRADURA (VIA SAN MARCELINO)	3	18	7	F	1372210	24700140	7952391	6207350	7972184	10171488	12912221	177269073	58965505	34245365	0.299	2.386	2.760	1.963
TOTAL	3	270	-	-	-	53,484,568	51,167,810	39,470,888	9,102,559	11,605,646	12,808,621	452,505,411	236,278,838	182,794,270	0.921	4.418	4.811	3.934

(1) In colones.

(2) Multiple IRRs.

TABLE II.A.56

ESTIMATION OF FIRST FIVE YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

RURAL ROADWAYS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. B. R. (%)	N.B./I. (12%)	N.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																		
JUAYUA-SAN JOSE LA MAJADA-EL ARENAL	4	10	4	F	73395	733950	287585	431589	0	0	0	2660912	1659731	925781	0.423	2.261	2.428	2.043
EL CONGO-FLOR AMARILLA	4	12	4	P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
FLOR AMARILLA-PLANES DE LA LAGUNA	4	12	4	P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
EL REFUGIO-EL CASTILLO-SAN JOSE LA CUEVA-MONCAGUA	4	9	4	P	94400	849600	517629	388430	0	0	0	3042009	2012939	1163339	0.521	2.369	2.520	2.170
CA:1-EL PORVENIR-(SANTA ANA-AMUACHAPAN)	4	9	4	F	73395	660555	258754	388430	0	0	0	2394821	1493758	833703	0.423	2.261	2.428	2.043
CA:1-SAN ANTONIO PAJONAL	4	14	4	P	94400	1321600	2696492	1032255	0	0	0	11386376	7998466	6676866	1.874	6.052	6.379	5.614
OSTUA-SAN JERONIMO	4	8	4	F	73395	587160	847224	0	0	0	-717143	-33369	1637041	849881	(2)	2.447	2.372	2.480
QUEZALTEPEQUE-SAN MATIAS	4	19	4	P	94400	1793600	5616640	0	0	0	0	14036600	11260285	9466685	2.858	6.278	6.497	5.974
SAN MATIAS-SAN JUAN OPICO	4	5	4	P	94400	472000	792712	647828	0	0	0	4897006	3215619	2743619	1.630	6.813	7.255	6.228
TEJUTEPEQUE-SAN ANTONIO BUENA VISTA-CORRAL VIEJO	4	10	4	P	94400	925120	576393	471597	0	0	0	3558170	2335499	1410379	0.551	2.525	2.689	2.308
CA:12-LAS CASITAS-S ANTONIO MAS-L MORCONES GUARNECIA	4	19	4	P	94400	1831360	1115779	837283	0	0	0	6557220	4339001	2507641	0.521	2.369	2.520	2.170
TAPALHUACA-CA:2(ANTIGUA COMALAPA)	4	8	4	P	94400	755200	1401454	1152089	0	0	0	8688037	5701980	4946780	1.808	7.550	8.041	6.902
CA:2-SAN PEDRO NASAHUAT	4	6	4	F	73395	440370	172503	258953	0	0	0	1596547	995839	555469	0.423	2.261	2.428	2.043
SAN PEDRO NASAHUAT-SAN ANTONIO NASAHUAT	4	3	4	F	73395	220185	187035	349703	0	0	0	2041253	1252734	1032549	1.003	5.689	6.125	5.120
TACUBA CONCEPCION DE ATACO	4	13	4	P	94400	1227200	747687	561066	0	0	0	4394013	2907578	1680378	0.521	2.369	2.520	2.170
ISTAGUA-ORATORIO DE CONCEPCION-MONTEPEQUE	4	9	4	P	94400	849600	517629	388430	0	0	0	3042009	2012939	1163339	0.521	2.369	2.520	2.170
CHALCHUAPA LAS CRUCES	4	8	4	P	94400	755200	724510	570618	0	0	0	4379057	2885070	2129870	0.894	3.820	4.066	3.495
SAN JOSE EL NARANJO-LAS DELICIAS-CA:2	4	8	4	P	94400	736320	448612	336639	0	0	0	2636408	1744547	1008227	0.521	2.369	2.520	2.170
NAHUIZALCO-JUAYUA	4	9	4	P	94400	802400	488872	366851	0	0	0	2873009	1901109	1098709	0.521	2.369	2.520	2.170
CA:3 EL CHAPERNO-CASERIO SAN ISIDRO	4	8	4	P	94400	783520	477369	358219	0	0	0	2805408	1856377	1072857	0.521	2.369	2.520	2.170
ATIQUIZAYA-SAN LORENZO-EL PORTILLO	4	9	4	P	94400	877920	3301004	0	0	0	0	8252509	6620236	5742316	3.491	7.541	7.803	7.176
SAN JULIAN-CUISNAHUAT	4	10	4	P	94400	944000	2187438	0	0	0	0	5968595	4788060	3844060	2.251	5.072	5.249	4.826
SANTO TOMAS-SAN MIGUEL TEPEZONTES-COJUTEPEQUE	4	24	4	P	94400	2237280	3376982	2747957	0	0	0	20808260	13669005	11431725	1.458	6.110	6.506	5.586
CA:2-CANTON LA CANOA	4	18	4	P	94400	1727520	1072591	880636	0	0	0	6644339	4361187	2633667	0.551	2.525	2.689	2.308
SAN LORENZO-HACIENDA SAN MARTIAS	4	6	4	P	94400	604160	368092	276217	0	0	0	2163206	1431423	827263	0.521	2.369	2.520	2.170
HACIENDA SAN MARTIN-CA:2	4	16	4	P	94400	1663200	891473	668961	0	0	0	5239016	3466727	2003527	0.521	2.369	2.520	2.170
NAHULINGO-LA CHAPINA COOP.	4	8	4	P	94400	708000	431358	323692	0	0	0	2535008	1677449	969449	0.521	2.369	2.520	2.170
SAN JOSE EL NARANJO-(JUJUTLA-ATACO)	4	25	4	P	94400	2350560	1432108	1074657	0	0	0	8416225	5569130	3218570	0.521	2.369	2.520	2.170
COMALAPA FREEWAY-LAS ROJAS COOP.	4	19	4	P	94400	1812480	1104276	828651	0	0	0	6489619	4294269	2481789	0.521	2.369	2.520	2.170
CALUCO - EL CARMEN COOPERATIVE.	4	10	4	P	94400	925120	563641	422957	0	0	0	3312410	2191866	1266746	0.521	2.369	2.520	2.170

URUAZAPA-COOPERATIVE 21 DE MARZO	4	11	4	P	94400	1047840	650588	534156	0	0	0	4030173	2665310	1597470	0.551	2.525	2.689	2.308
NAC. SANTA ELENA-I.(YAYANTIQUE)	4	10	4	P	94400	944000	586116	481222	0	0	0	3630786	2385163	1439163	0.551	2.525	2.689	2.308
CA:2 - NAC.CHILANGUERA	4	6	4	P	94400	585280	363392	298357	0	0	0	2251087	1477561	892781	0.551	2.525	2.689	2.308
LA CHILATA-SAN MARCOS	4	16	4	P	94400	1510400	920230	690542	0	0	0	5408016	3578557	2068157	0.521	2.369	2.520	2.170
CA:2 -TAMANIQUE	4	15	4	P	94400	1468800	1002574	778889	0	0	0	6010936	3965017	2596217	0.657	2.897	3.083	2.651
SAN JULIAN-EL BALSAMAR COOPERATIVE	4	12	4	P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
CA:2 - CARA SUCIA	4	8	4	P	94400	755200	460115	345271	0	0	0	2704008	1789279	1034079	0.521	2.369	2.520	2.170
CA:2 - SAN BENITO	4	11	4	P	94400	1038400	632658	474748	0	0	0	3718011	2460258	1421858	0.521	2.369	2.520	2.170
CA:2 - AGUA FRIA	4	11	4	P	94400	1038400	632658	474748	0	0	0	3718011	2460258	1421858	0.521	2.369	2.520	2.170
IACUBA-CONCEPCION DE ATACO	4	13	4	P	94400	1227200	747687	561066	0	0	0	4394013	2907578	1680378	0.521	2.369	2.520	2.170
CA:2 - PALO COMBO COOPERATIVE	4	8	4	P	94400	755200	460115	345271	0	0	0	2704008	1789279	1034079	0.521	2.369	2.520	2.170
CA:2 - BARRA CIEGA COOPERATIVE	4	8	4	P	94400	755200	460115	345271	0	0	0	2704008	1789279	1034079	0.521	2.369	2.520	2.170
CA:2 - EL ZARZAL	4	12	4	P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
CA:2 - SIHUAPILAPA	4	12	4	P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
CA:2 - HACIENDA LA CABANA	4	12	4	P	94400	1132800	703339	577466	0	0	0	4356943	2859795	1726995	0.551	2.525	2.689	2.308
CA:2 - SAN DIONISIO	4	8	4	F	73395	587160	233716	184977	0	0	0	2316689	1434879	847719	0.453	2.444	2.627	2.204
CA:2 - SAN JOSE DE LA MONTANA	4	16	4	P	94400	1510400	920230	690542	0	0	0	5408016	3578557	2068157	0.521	2.369	2.520	2.170
CA:2 - ROJA DE SAL COOPERATIVE	4	11	4	P	94400	1038400	632658	474748	0	0	0	3718011	2460258	1421858	0.521	2.369	2.520	2.170
CA:2 - EL MANGUITO COOPERATIVE	4	7	4	P	94400	660800	410281	336855	0	0	0	2541550	1668214	1007614	0.551	2.525	2.689	2.308
MILITAR ROUTE-MAYUCAQUIN COOPERATIVE	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
SAN MIGUEL-LA PUERTA	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
CA:2 - TIERRA BLANCA	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
CA:2 - LLANO DE LAS ROSAS	4	7	4	P	94400	660800	410281	336855	0	0	0	2541550	1668214	1007614	0.551	2.525	2.689	2.308
PANAMERICANA-CA:2-LA UNION	4	12	4	P	94400	1132800	703339	577466	0	0	0	4356943	2859795	1726995	0.551	2.525	2.689	2.308
SAN ALEJO-EL TAMARINDO	4	11	4	P	94400	1038400	644727	529344	0	0	0	3993865	2621479	1583079	0.551	2.525	2.689	2.308
CA:2 GUALPIRQUE COOP.	4	8	4	P	94400	755200	468892	384977	0	0	0	2904629	1906530	1151330	0.551	2.525	2.689	2.308
LA UNION-YOLOGUAL COOP.-EL FARO	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
IMPROVEMENT																		
EL ROMCO-OSTUA	4	8	5	F	413970	3311760	5955456	-1520	-1520	1520	1520	14862039	11935493	8623733	(2)	3.604	3.729	3.430
EL COCO-CHALCHUAPA	4	14	5	F	413970	5795580	8143446	-2660	-2660	-2660	2660	20312065	16317328	10521748	(2)	2.815	2.913	2.679
TOTAL	4	644	-	-		67,107,600	64,503,056	29,704,234	(4,180)	(4,180)	(721,323)	292,729,924	203,634,920	136,527,320	(2)	3.034	3.205	2.807

(1) In colones. (2) Multiple IRRs (3) IRR = 1.0 (100 Percent)

- Rehabilitation of CA:12 from km 80 to Acajutla, NB/I = 26.6, IRR = 2.77

A projects ranking based on NB/I is typically similar to its IRR-based ranking, though there are exceptions. IRRs are biased towards early capital recovery, and at high-IRR levels (e.g. Higher than 0.50), private cash flows occurring after two or three years do not have significant weight. The project with the highest IRR is the improvement of CA:12-El Ronco (IRR = 8.00).

The following projects present the highest total return (highest NPV):

- Widening of CA:1 from San Salvador to San Martin (NPV = C 1,222,815,672)

- Rehabilitation of CA:2 from San Salvador to Apopa (NPV = C 732,658,252)

- Rehabilitation of CA:2 from Santa Elena (km 114) to La Union (NPV = C 544,949,135)

- Widening of CA:1 from San Salvador to Santa Tecla (La Libertad Exit) (NPV = C 356,175,606)

- Rehabilitation of the Comalapa Freeway (NPV = C 349,367,461)

The Consultants recommend the implementation of listed projects within the proposed five-year highway plan (see Section II.E for proposed implementation schedule). It is proposed that programs be implemented following a descending NB/I order. Within each program, priority projects should also be selected based on NB/I ratios (see Appendix II.A.7).

Final feasibility studies and more detailed design are required to implement the five-year plan. Economic indicators are preliminary, and should be used for project and program conceptual definition and prioritization only. Final feasibility studies will show more accurate results. However, it may not be worthwhile to analyze indicators which already present extremely high results.

e. Bridges

This section reviews the economic benefits of replacing temporary Bailey bridges with permanent concrete bridges. Bailey bridges are temporary by nature and should be replaced with permanent structures at some point in the future. The purpose of this section is to evaluate whether the early

TABLE II.A.57

ANNUAL CONCRETE BRIDGE MAINTENANCE COST - 60m STRUCTURE
DECEMBER, 1988
(In Colones)

Adpoted span : 20 m		COST
1. INSPECTION (Annual)		
Pick-Up Truck		480
Wages		490
Tools and Scaffold (50% of Wage:		245
Sub-Total		1,215
2. VARIOUS REPAIRS (Annual)		
4-m3 Truck		895
Paint		165
Asphalt		40
Concrete		112
Wages		670
Tools and Scaffold (70% of Wages)		470
Sub-Total		2,350
3. CONFORMATION OF FILL AND RIVER BED (every 4 years)		
140-HP Tractor		2,800
Wages		670
Sub-Total	3,470 * .25 % =	870
Total		4,435
TOTAL PER METER		220
TOTAL FOR A 60-METER BRIDGE (1)		13,200

(1) includes overhead

TABLE II.A.58

ANNUAL BAILEY BRIDGE MAINTENANCE COSTS - 60m STRUCTURE
DECEMBER, 1988
(in Colones)

For One lane:	**Cost**
1. WOODEN FLOOR REPLACEMENT	
Material : 90 parts @40 each, 3 times/yr	10,800
Equipment: 2 trucks for 2 days, 3 times/yr	11,500
Labor : 10 workers for 2 days, 3 times/yr	4,700
2. ADJUSTMENT AND LUBRICATION OF PARTS	
Equipment: 1 truck for 1 day, 6 times/yr	5,800
Labor : 10 workers for 1 day, 6 times/yr	4,200
Sub-Total	37,000
Overhead 40 %	14,800
Total Cost, One Lane	51,800
Total Cost, Two Lanes	103,000

TABLE II.A.59

BRIDGE REHABILITATION/RECONSTRUCTION PLAN
1995-2000

BRIDGE NAME	L O C A T I O N	C O S T
CUSCATLAN OVER LEMPA RIVER	CA-1 SAN VIC.USULUTAN	30,000,000
DON LUIS DE MOSCOSO	CA-1 SAN MIGUEL	5,000,000
OVER APANTA RIVER	LA PAZ CA-1 and CA-2	500,000
EL GRAMAL	CA-4 CHALATENANGO	4,210,000
OVER DRY GORGE	CA-2 USULUTAN	2,540,000
GOLDEN BRIDGE	CA-2 SAN VIC.USULUTAN	60,000,000
SAN ANTONIO	CA-2 LA PAZ	700,000
PALO SECO	CA-2 JIQUILISCO	4,320,000
MANUEL J.ARCE	AHUACHAPAN	1,830,000
TOTAL (in Colones)		109,100,000

TABLE II.A.60

CONSTRUCTION WORKERS REQUIREMENT

ROAD IMPROVEMENT

IMPROVEMENT TYPE	KM	NUMBER OF CONSTRUCTION WORKER/KM	TOTAL OF WORKERS	EXECUTION TIME (MONTH)	NUMBER OF WORKERS-MTH
Rural to Tertiary	22	21	462	2.0	924
Tertiary to Secondary	20	21	420	6.7	2,814
Secondary to Primary	92	21	1,932	5.0	9,660
Secondary to Special	108	63	6,804	5.3	36,061
Primary to Special	45	42	1,890	5.7	10,773
Special (4) to Special (6)	5	42	210	5.7	1,197

ROAD REHABILITATION

CLASSIFICATION	CONDITION	KM	NUMBER OF CONSTRUCTION WORKER/KM	TOTAL OF WORKERS	EXECUTION TIME (MONTH)	NUMBER OF WORKERS-MTH
SPECIAL	Fair	57	40	2,280	0.3	684
PRIMARY	Fair	76	20	1,520	0.3	456
	Poor	146	24	3,504	0.4	1,402
	Poor (R)	145	16	2,320	0.6	1,392
SECONDARY	Fair	167	20	3,340	0.2	668
	Poor	68	25	1,700	0.4	680
	Poor (R)	68	10	680	0.6	408
TERTIARY	Fair	79	11	869	0.2	174
	Poor	171	11	1,881	0.2	376
RURAL	Fair	44	10	440	0.2	88
	Poor	580	10	5,800	0.2	1,160
TOTAL FOR ALL ROAD WORKS		1,904				68,917

AVERAGE = 36 w-m/km

replacement of Bailey bridges after the conflict is over would offer attractive economic returns.

Table II.A.57 and II.A.58 show expected annual maintenance costs for a permanent concrete bridge and a temporary Bailey bridge, in the case of a typical 60-meter structure. It is more expensive to maintain a Bailey structure than a concrete one: the former costs C 103,600 per year, and the latter C 13,200 per year.

For the purpose of this analysis, vehicle operating costs are assumed to be the same in both cases. Additional costs caused by speed reductions at Bailey bridges are generally negligible when considering the overall cost of an interurban trip. The only cases where additional costs due to increased delay may be significant occur when there is a one-lane Bailey bridge and roadway traffic exceed 3,000 vehicles per day.

The useful life of a Bailey bridge is assumed to be 30 years, after which replacement is necessary. Since temporary bridges are already in service, their costs are considered "sunk" and not included in the analysis.

Therefore, the cost saving of C 90,400 per year (for up to 15 years) could be expected out of replacing temporary bridges with permanent ones. This annual saving does not justify the required investment of C 3,000,000 for a new permanent structure at a twelve percent discount rate (it could justify an investment of about C 620,000). More urgent needs, such as road reconstruction, should be met before replacement of Bailey bridges is warranted.

Bridges in roadways with ADTs higher than 3,000 warrant more immediate action. Table II.A.59 show a list of bridge projects to be implemented during 1995-2000. The proposed program includes major repairs and replacement of one-lane Bailey bridges.

11. Social Impact

A direct social benefit of transportation system improvement program is new employment opportunities. This effect is especially beneficial to lower-income levels of society, providing new jobs to unskilled labor.

Table II.A.60 summarizes the manpower requirements needed to implement the proposed five-year road rehabilitation and improvement plan. Improvement work will generate most of the expected new employment. A total of 1914 field jobs over three years will be created by the proposed five-year plan.

Table II.A.61 summarizes the required manpower for conducting an effective in-house routine maintenance program. Rural roads generate the greatest quantity of employment, and direct total employment generated from routine maintenance work is expected to be 1,560 jobs.

Employment will also be generated by implementing the recommended improvement works in bridges and other modes of transport, but levels of generated employment will be lower than those generated by road work.

Transportation improvements are also beneficial to the health, education and production of the population. These indirect benefits are based on the reduction of travel times between homes, and health, education and production centers. Regarding health and education, tertiary and rural roads should be given special mention, because they are in very poor condition. This makes transportation between communities and health/education centers very difficult, costing many man-hours, and in some cases lives.

12. Project Needs

The project team has analyzed and prioritized a set of roadway rehabilitation, reconstruction and improvement projects. In defining these projects, the Consultants used tentative priority lists provided by different divisions within the DGC and by transportation officers of other local and international organizations. Current pavement conditions and traffic levels were considered.

a. 1990-1994

Table II.A.56 lists the segments included in the five-year highway rehabilitation/improvement plan project in decreasing order of their respective net-benefit-over-investment ratio. Traffic levels, current condition; and appropriate curves were taken into account during project selection. This plan has been organized in six components. A summary of these components is presented below:

ROADWAY PROGRAM	KM	AMOUNT (in millions of Colones)
Pan American Highway (CA:1)	178	383
Costal Highway (CA:2)	254	113
Special and Primary Highways	193	165
Secondary Highways	352	204
Tertiary Roadways	270	53
Rural Roadways	646	67
TOTAL	1,893 km	985

TABLE II.A.61

ROAD MAINTENANCE -WORKERS REQUIREMENT

CLASSIFICATION	CONDITION	KM	NUMBER OF CONSTRUCTION WORKER/KM	TOTAL OF WORKERS	EXECUTION TIME (MONTH)	NUMBER OF WORKERS-MTH
SPECIAL	Good	81.74	12	981	0.12	118
	Fair	36.79	16	589	0.56	330
	Poor	17.71	18	319	1.08	345
PRIMARY	Good	115.61	6	694	0.12	83
	Fair	248.28	8	1,986	0.56	1,112
	Poor	230.81	9	2,077	1.08	2,243
SECONDARY	Good	343.74	6	2,062	0.12	247
	Fair	343.74	7	2,406	0.36	866
	Poor	323.52	8	2,588	0.56	1,449
TERTIARY	Good	479.48	6	2,877	0.12	345
	Fair	496.17	6	2,977	0.24	714
	Poor	760.84	6	4,565	0.32	1,461
RURAL	Good	588.95	4	2,356	0.16	377
	Fair	990.17	4	3,961	0.28	1,109
	Poor	4,502.76	4	18,011	0.44	7,925
TOTAL FOR ALL ROAD WORKS		9,560.31				18,724

AVERAGE = 2w-m/km

The proposed program upgrades 291 km of roadways (C 639,000,000) and rehabilitates 1,602 km of roadways (C 346,000,000). This will cover all expected road improvement needs to the year 2000.

b. 1995 - 2000

The Consultants propose a second five year road rehabilitation program for 1995 - 2000. This program should address rehabilitation needs not included in the first five-year plan. Total expenditures should amount to 850 million 1988 colones (a yearly increase of five percent in rehabilitation work need is expected).

c. Pavement and Maintenance Management

There is a need to develop and implement an integrated pavement and maintenance management system. The pavement management component should aid rehabilitation work planning and decision making. The maintenance management sub-system should address all phases of routine highway maintenance work, such as planning, programming, execution, and control.

d. Bridge Management

The Consultants recommend the development of a bridge management system. Due to damages and repairs that bridges have suffered during these last years, the safety of the bridges is unknown. The load capacity and remaining life of the bridges should be defined, and bridge locations, spans, costs and water sheds should be recorded as well as inspection and maintenance activities should be specified and executed.

e. MOP Management Study

A management study of the MOP is necessary. It should address or define the following issues:

- Reasonableness of current personnel levels at the different departments of MOP and DGC; recommendations to their possible reduction.
- Job descriptions and requirements.
- Procedure manuals.

f. Specifications and Norms

A study should be performed to review and update current road construction specifications. As part of this study, norms for rehabilitation/reconstruction work should be proposed.

g. Technical Assistance

Finally, the Consultants believe in the need for technical assistance in the areas of pavement management, contract administration, and performance of routine and major maintenance activities.

B. OTHER MODES

1. The Autonomous Executive Commission for Ports "CEPA"

a. Organization

CEPA is an autonomous public service institution that falls under the Ministry of the Economy. It is responsible for the operation, administration and maintenance of the Port of Acajutla, the International Airport of El Salvador(AIES) and the National Railway of El Salvador (FENADESAL) - maritime, air and rail transportation. The port of Cutuco is considered an extension of the railway system, and is managed in close coordination with FENADESAL under CEPA.

CEPA is headed by a Board of Directors that consists of a President and six Directors who are appointed as follows:

- The President of the Board of Directors is appointed by the President of the nation.
- Four Directors are named by the ministries of Economy, Finance, Defense and Public Works.
- Two Directors are named by the Ministry of the Economy from nominations: one by agricultural and industrial associations, and the other by commercial associations.

There are also six substitute Directors, appointed in the same way as Directors.

CEPA has the following functions and attributes:

- Planning, construction, maintenance, improvement and expansion of port, airport and railway structures, and other complementary installations.

- Maritime navigational aids, and meteorological and oceanographic installations.

- Acquisition, maintenance and improvement of port, airport and railway equipment.

- Direction of anchorage, provision of pilot services for docking and undocking, and direction of auxiliary boats, tugs and barges used to serve ships.

- Loading and unloading ship cargo and rail cargo.

- Receiving, handling, warehousing and controlling export, import, and local products in port and railway installations.

- Tariff policy and labor policy in the port, airport and rail systems of the country.

- Custody of goods deposited at the ports and railway stations.

The organization of CEPA is summarized in the Figure II.B.1. Administration and maintenance of the International Airport of El Salvador (AIES) is CEPA's responsibility. Close connections are maintained with the General Directorate for Civil Aeronautics (Ministry of Economy) regarding legislation that controls commercial airline operations.

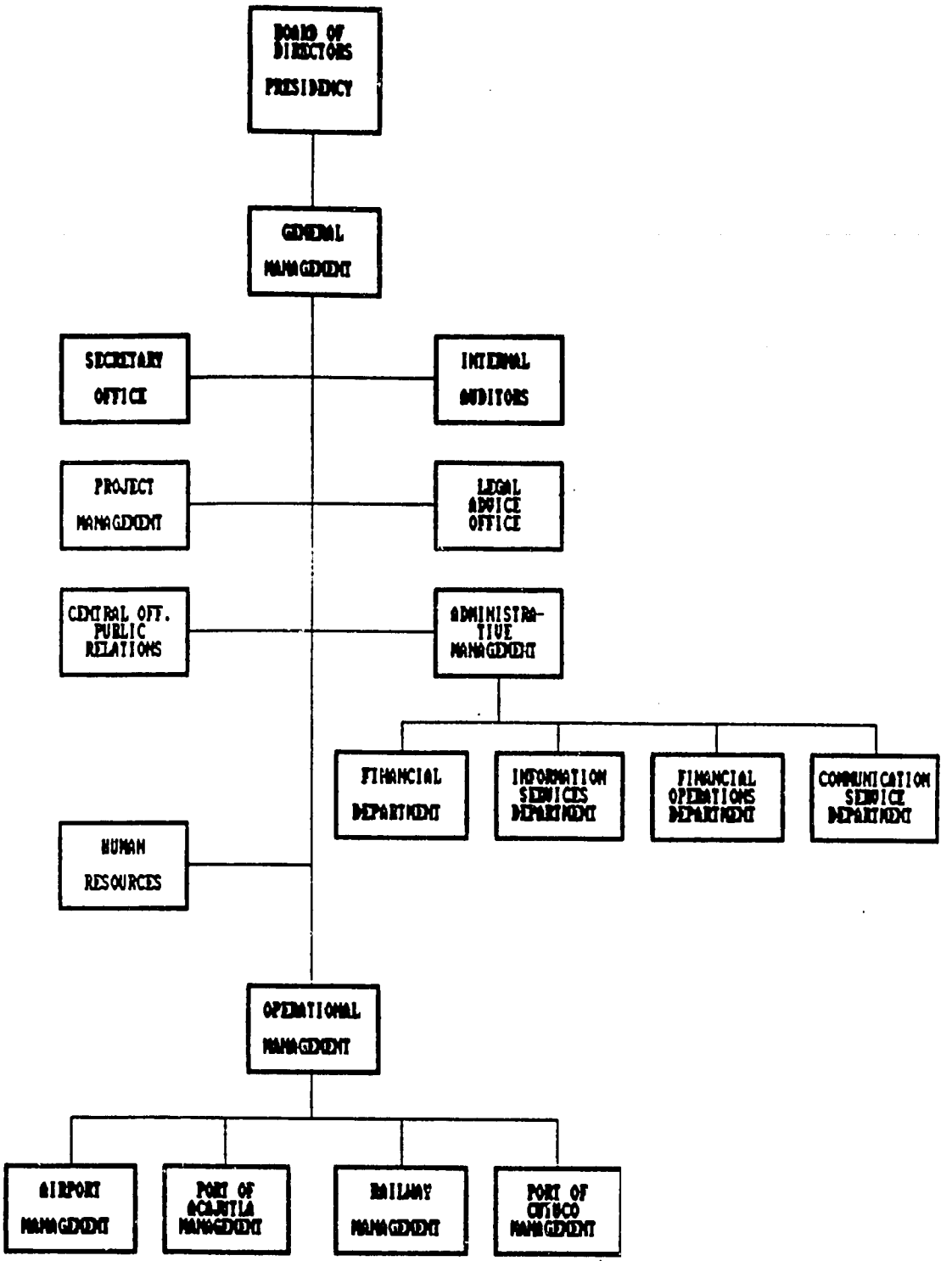
FENADESAL is in charge of the national rail system, and its administration is the responsibility of CEPA. For administration purposes, CEPA considers the Port of Cutuco to be a rail terminal.

On the other hand the port of Acajutla carries out functions necessary for embarking, warehousing and disembarking goods CEPA, is responsible for its administration and operation.

A Technical Assistance and Project Management Division performs planning functions in coordination with the operating divisions.

FIGURE II.B.1

ORGANIZATIONAL CHART-CEPA



b. Human Resources

Except for the International Airport of El Salvador, CEPA has reduced its number of employees during the last five years. This is largely due to a personnel austerity policy. Specialized staff needed to maintain public service functions were not affected by these measures. Staffing figures are presented in the following table:

Area and Company	1984	1985	1986	1987	1988
Central Office	160	157	157	147	154
Port of Acajutla	1,570	1,515	1,418	1,414	1,441
AIES	313	290	316	312	354
FENADESAL & Cutuco	1,333	1,301	1,216	1,152	1,100
TOTAL	3,376	3,263	3,107	3,025	3,049

CEPA maintains a training program for several levels of personnel. It relies on internal training programs, with the collaboration of external institutions and trainers. The airport sector has the collaboration of the International Civil Aviation Organization (OACI), and the Federal Aviation Authority of the United States. The port sector has received programs and grants from the International Maritime Organization (OMI), the Central American Maritime Transport Commission (COCATRAN) and the Latin American Maritime Transport Commission. FENADESAL has received help from the Central American Economic Integration Secretariat (SIECA) and from the Latin American Railway Association (ALAF).

In spite of the above, CEPA lacks professional personnel. Only 83 professionals work for CEPA, 2.7 percent of total employees. The relative number of professionals amounts to: 20.8 percent in the Central Office, 1.7 percent in Acajutla, 5.9 percent in AIES, and 0.5 percent in FENADESAL. There are also frequent labor conflicts and strikes at Acajutla.

c. Financial Situation

CEPA divides its accounting into two groups:

- the Port of Acajutla and the International Airport (AIES)
- the railway (FENADESAL) and the Port of Cutuco, which CEPA manages for the GOES.

(1) Acajutla Port-International Airport

Table II.B.1 shows the balance sheets for Acajutla and AIES from 1985 to 1988.

CEPA's assets have not been revalued after the 1986 devaluation. Instead, CEPA accounted for the change in debt value as an "exchange loss", and considered it as an asset. This accounting procedure avoided writing the loss in the 1986 financial statement or partially compensating the loss through an asset revaluation, to be depreciated in following years. As a result, CEPA's income statement show smaller losses than those actually incurred.

Most of CEPA's losses are related to airport operations, which has heavy financial expenses. This is partially explained by the fact that the airport was designed before the conflict a higher-than-current traffic levels.

Acajutla's operating margin decreased from 17 in 1985 to 10 in 1988. This is due to lack of tariff adjustments. As all public autonomous organizations, CEPA has little control over its budget. Tariff adjustments are requested by CEPA, but usually involve a long political process resulting in a lower adjustment many years later. For instance, the last adjustment presented in 1984 was authorized in October 1987, but with lower rates.

Also CEPA is sometimes obliged to provide services free of charge to other governmental institutions such as the National Commission for displaced people-CONADES.

In conclusion, CEPA should increase its revenue base by:

- readjusting tariffs and/or costs in the port section; and

- negotiating some transfer from the government, to compensate CEPA for conflict-related traffic losses.

(2) FENADESAL

The Consultants have summarized the financial activities of the railway, including Cutuco Port in Table II.B.2. During this period FENADESAL have increased from C12.5 millions, in 1985, to C19.2 millions in 1988, approximately 85 of these losses attributed to the railroad. Revenues have been constant, but do not even cover 50 of operating expenses. This situation, along with an inadequate tariff system, has created a financial crisis for Fenadesal. The state has subsidized the railroad a cumulative total of about C134 million over this period.

TABLE II.B.1

1985 - 88 SUMMARIZED ACAJUTLA-AIES BALANCE SHEETS
(in thousands of Colones)

Item	1985	1986	1987	1988
Assets				
Current	35,363	46,610	57,275	60,481
Long Term	201,974	193,458	178,674	170,965
Others	2,370	150,424	149,431	152,498
Total Assets	239,707	390,492	385,380	383,944
Liabilities				
Current	85,239	109,970	126,761	135,997
Long Term	129,245	257,441	254,863	246,065
Subtotal Liabilities	214,484	367,411	381,624	382,062
Equity	25,223	23,081	3,756	1,882
Total Equity and Liabilities	239,707	390,492	385,380	383,944
	STATEMENT OF PROFIT AND LOSS			
Profit/Loss				
Acajutla	4,368	(195)	(194)	3,690
Airport	(8,250)	(6,647)	(17,467)	(9,967)
Others	(229)	390	(393)	(246)

SOURCE: CEPA

Note: Excluding Government Subsidies

4,368 Profit
(8,250) Loss

TABLE II. B.2

FENADESAL BALANCE SHEET EVOLUTION
(Including Port of Cutuco)
(Thousand Colones)

Item	1985	1986	1987	1988
Assets				
Current	6,091	7,246	15,923	10,843
Long Term	55,113	59,323	58,876	60,263
Others	1,680	1,356	1,358	2,893
Total Assets	62,884	67,925	76,157	73,999
Liabilities				
Current	1,957	2,269	3,139	2,714
Subtotal Liabilities	1,957	2,269	3,139	2,714
Equity	60,927	65,656	73,018	71,285
Total Equity and Liabilities	62,884	67,925	76,157	73,999

STATEMENT OF PROFIT AND LOSS

Income	8,194	8,067	9,716	8,850
Expenditures	20,707	24,217	27,958	28,168
Profit(Loss)				
Railways	(10,978)	(13,742)	(15,905)	(16,773)
Cutuco Port	(1,535)	(2,408)	(2,337)	(2,545)
Total	(12,513)	(16,150)	(18,242)	(19,318)

SOURCE: FENADESAL

2. Railways

The Salvadoran Railway System (Ferrocarriles Nacionales de El Salvador - FENADESAL) began operations in 1975, as two railway companies, the Salvador Railways Company and the International Railways of Central America (IRCA), were merged by the Salvadoran Government. A brief history of these companies is presented below.

In 1882, two railway lines were established, one between Acajutla and Sonsonate, and the other between Sonsonate and Santa Ana. Construction of the railway segment between Santa Ana and San Salvador began in 1894. In December of that year, the Salvador Railways Company Limited took over the railway lines, and operated those lines until October 22, 1962 when it was nationalized by the Salvadoran Government.

From 1965 to 1975, this railway (called Ferrocarril de El Salvador - FES) was administered by CEPA.

IRCA was established in 1908. It built and operated the following railway segments:

Cutuco	- San Miguel		(1912)
San Miguel	- San Salvador		(1920)
San Salvador	- Texis Junction	- Santa Lucia	(1927)
Santa Lucia	- Ahuachapan		(1927)
Texis Junction	- Guatemalan Border		(1929)

This firm's operations were taken over by the Government after IRCA declared bankruptcy in 1971.

a. Inventory of Facilities

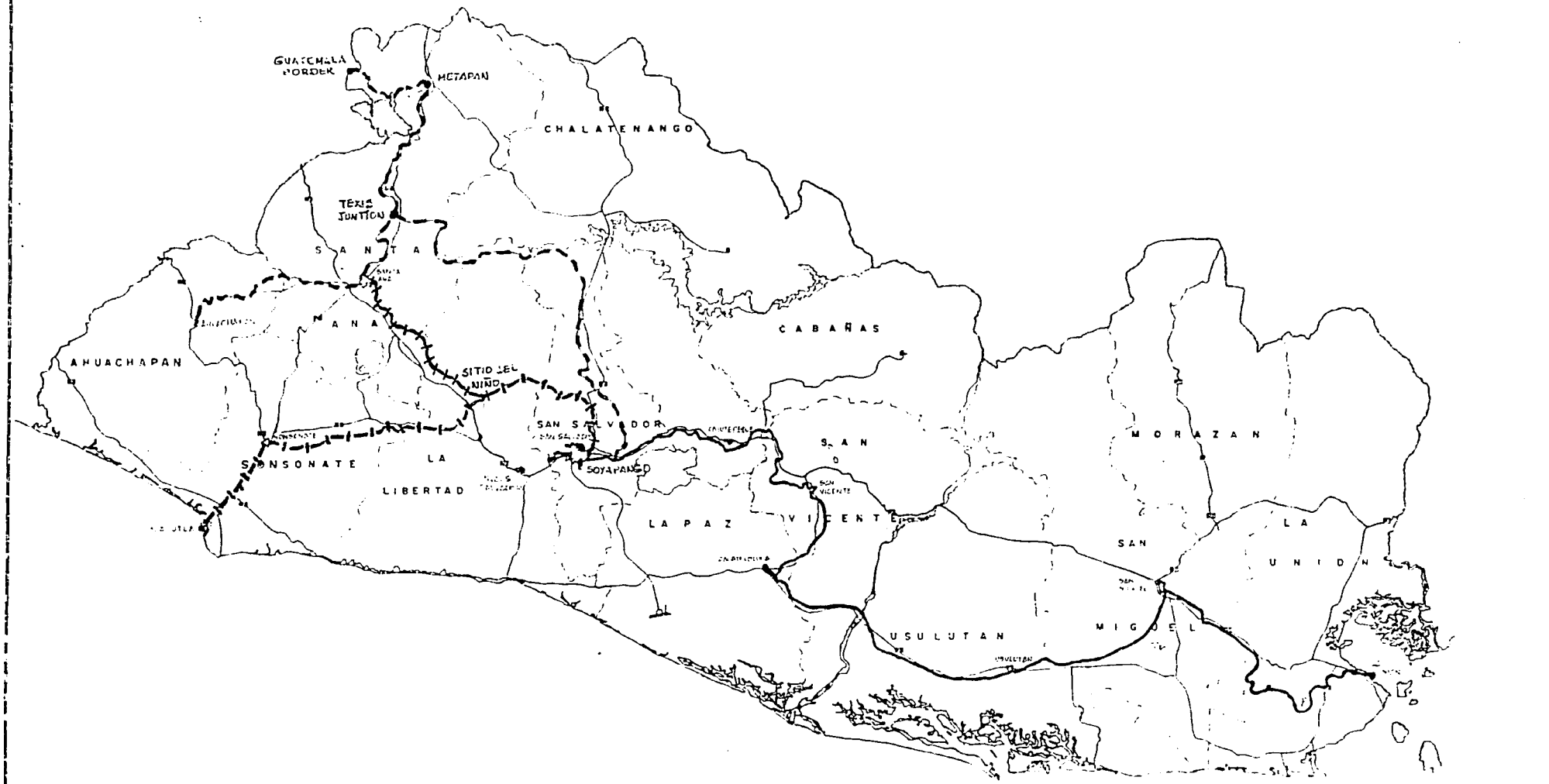
(1) Physical Inventory

The total length of the railway is 602 km of single-track rail. The system is divided into three districts which comprise the three main lines (see Figure II.B.2):

- District 1: San Salvador - La Union (Cutuco docks), with 253 km of track.

- District 2: San Salvador - La Virgen (Guatemalan Border via Metapan), with 206 km of track (including the Texis Junction-Santa Lucia(Santa Ana) - Ahuachapan branch)

- District 3: San Salvador - Acajutla (port warehouses), with 143 km of track (including the Sitio del Nino-Santa Ana branch)



SYMBOLS.

- DISTRICT 1
- DISTRICT 2
- DISTRICT 3
- PRINCIPAL CITIES
- PORTS

FIGURE II - B. 2

SALVADORAN RAILWAY SYSTEM.

scale 1:500,000

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Geometric and physical-track standards are similar in the three districts. Standards presently used by FENADESAL are shown in Table II.B.3.

The total numbers of locomotives, coaches and other components of the rolling stock available for work and in need of repair are summarized in Table II.B.4.

(2) Current Condition

The railway system has been the transportation mode most affected by the conflict. The total amount of damages caused by guerrillas to FENADESAL between 1979 and 1988 has been estimated at 179 million Colones. The frequency of these attacks has increased in recent years (although their cost has diminished due to safety measures).

This conflict, coupled with years of deferred preventive maintenance, has caused the present condition of the tracks and rolling stock to deteriorate. Operating budgets only provide for corrective maintenance to damaged segments of track due to derailments or attacks.

Prevailing track condition limits speed 35 km per hour, and FENADESAL estimates that approximately 50 percent of the network track is in satisfactory condition. At temporarily-repaired bridges, trains travel at walking speed, and derailments occur often due to the poor track condition.

Bridges, including the costly bridge over the Lempa river, have undergone several attacks. A summary of damages to track, stations and bridges is presented in Table II.B.5. Table II.B.6 details the current status of attacked bridges. Rolling stock, particularly locomotives, has been a common target. Table II.B.7 describes the current condition of wagons and coaches, and a summary of the repair needs of other elements of the rolling stock is presented in Table II.B.8.

b. Projects Underway/Planned

The only project currently being conducted by FENADESAL is the repair of a container-handling crane in the Acajutla Port.

FENADESAL has both short-and long-term plans. To keep the railway functional while the conflict continues, repairs of direct damages caused by the insurgency will continue to have first priority. Availability of rolling stock and current track conditions, probably meet the reduced requirements of present railway traffic. A series of spares and maintenance

TABLE II.B.3

PHYSICAL AND GEOMETRIC DESIGN TRACK STANDARDS

1. The gauge is 3' (914 mm)
2. Fifty percent of the track is in poor condition.
3. Rails of 54, 60 and 75 pounds/yard are used.
4. The route has no ballast.
5. Untreated hardwood crossties are used, of 6"x8"x7'
6. Track switches used for lines and yards are numbers 7 and 8.
7. Wheel guides 10', 12' and 15 are used.
8. The track is fastened with nails.
9. The maximum degree of curvature is 18 degrees.
10. The maximum grade is 3.5 percent.
11. Bridge structural capacity allows locomotives 15-60 COOPER to circulate.
12. Maximum train speed is from 30 to 40 km/hr.

TABLE II. B. 4.

1988 ROLLING STOCK INVENTORY

UNIT	DESCRIPTION	MISSING	DISTRICTS		
			1	2	3
5	Steam Locomotives	-	2	0	3
14	Diesel (train) locomotives	-	10	2	2
4	Diesel (yard) locomotives	-	4	0	0
422	Wagons	-	215	141	66
10	Cabooses	-	8	2	0
120	Platforms	-	92	2	26
19	Gondolas	-	9	0	10
1	Platforms	-	0	1	0
7	Mixed wagons	-	5	0	2
15	Tank wagons	-	6	0	9
1	Refrigerated wagon	-	0	0	1
12	Livestock wagons	-	10	2	0
9	Equipment and mail coaches	-	7	0	2
6	Passenger coaches	-	4	1	1
5	Passenger coaches	-	2	0	3
31	Passenger coaches	1	23	0	7
8	Floating equipment	-	13	0	0
2	Garbage wagons	-	2	0	0
25	Dormatory cars	-	16	9	0
7	Cranes	-	4	0	3
2	Turning cars (turntables)	-	2	0	0
30	Motor cars to inspect the line (1)	-	21	5	4
8	Motor cars to serve passengers	-	0	0	8
15	Work equipment	-	13	0	2
1	Right of way burning equipment	-	1	0	0
1	Tank car for oil and water	-	1	0	0
20	Fork lift	-	16	0	4
28	Office administration equipment	-	25	0	3
5	Miscellaneous equipment	1	4	0	0
7	Various equipment (equipment that will be written off)	5	2	0	0
845		7	517	165	156

(1) 21 Vehicles in a regular state of service

TABLE II. B. 5

DAMAGES TO BRIDGES, TRACKS AND STATIONS
(IN THOUSANDS COLONES)

YEAR	BRIDGES	TRACK	STATIONS	TOTAL
1979	-	-	-	0
1980	650	-	25	675
1981	-	-	154	154
1982	299	-	10	309
1983	1023	18	15	1056
1984	44	138	-	182
1985	-	41	-	41
1986	-	39	-	39
1987	50	73	-	123
TOTAL	2066	309	204	2579
		GRAND TOTAL		2579

TABLE II. B. 6

BRIDGES DAMAGED BY THE CONFLICT

BRIDGE NAME	BRIDGE SPAN (M)	ATTACK DATE	COST (COLONES)	CURRENT STATUS
RIO SUCIO. Dist.2	3 x 18	05/12/80	650,000	Substituted
CHILCUYO. Dist.2	24	04/04/82	56,000	Repaired
Km. 71. Dist.1	10	13/11/82	47,115	Reconstructed
Km. 118 Dist.1	13	06/08/82	15,298	Repaired
Km. 350 Dist.2	36	26/08/82	25,886	Repaired
Km. 134 Dist.1		25/01/83	10,420	Repaired
Km. 122 Dist.1	16	25/12/84	39,196	Repaired
EL BURRO Dist.1	3*19,15,21	19/08/83	386,757	Replaced
Km. 93 Dist.1	45	26/05/83	177,084	Repaired
Km. 61 Dist.1	3*12,62,19	03/09/83	100,048	Repaired
Km.302	46	26/07/87	50,000	Repaired
T O T A L			1,557,804	

TABLE II. B. 7

AVAILABILITY OF CARS AND WAGONS

TYPE OF CAR/WAGON	NUMBER OF UNITS	CAPACITY		AVAILABLE	NOT AVAILABLE
CLOSED WAGON	3	30,000	Lbs		X
CLOSED WAGON	26	40,000	Lbs		X
CLOSED WAGON	104	40,000	Lbs	X	
CLOSED WAGON	241	50,000	Lbs	X	
CLOSED WAGON	35	50,000	Lbs		X
CLOSED WAGON	13	60,000	Lbs	X	
PLATFORMS	1	16,000	Lbs		X
PLATFORMS	3	40,000	Lbs		X
PLATFORMS	93	40,000	Lbs	X	
PLATFORMS	18	50,000	Lbs	X	
PLATFORMS	1	50,000	Lbs		X
PLATFORMS	23	80,000	Lbs	X	
MIXED WAGON	5	40,000	Lbs	X	
MIXED WAGON	2	40,000	Lbs		X
TANKS	4	7,585	Lbs	X	
TANKS	1	7,563	Lbs	X	
TANKS	1	5,393	Lbs	X	
TANKS	1	4,073	Lbs	X	
TANKS	1	4,243	Lbs	X	
TANKS	1	4,281	Lbs	X	
TANKS	1	4,539	Lbs	X	
TANKS	3	4,539	Lbs	X	
TANKS	1	4,539	Lbs		X
TANKS	1	4,726	Lbs	X	
LVSTCK.WAGON	3	40,000	Lbs	X	
LVSTCK.WAGON	5	40,000	Lbs		X
LVSTCK.WAGON	1	50,000	Lbs	X	
LVSTCK.WAGON	3	50,000	Lbs		X
SPCL. WAGON	1	50,000	Lbs	X	
COACHES	25	60	Pass	X	
COACHES	17	60	Pass		X
MOTOR CARS	3	42	Pass	X	
MOTOR CARS	5	42	Pass		X

SOURCE : FENADESAL 1988

TABLE II. B. 8

1988 ROLLING STOCK CONDITION

EQUIPMENT	DISTRICT NO. 1				DISTRICT NO. 2				DISTRICT NO. 3				TOTAL
	10	20	30	50	10	20	30	50	10	20	30	50	
Steam locomotives	2	0	0	0	0	0	0	0	0	0	0	0	2
Diesel locomotives	3	3	3	0	0	0	0	0	0	0	0	0	9
Cargo vans	35	7	14	3	1	0	0	0	2	1	1	0	64
Turntables	1	0	1	1	0	0	0	0	0	0	1	1	5
Coaches	3	1	3	7	0	0	0	0	3	0	0	0	17
Fork lifts	2	1	0	3	0	0	0	0	2	0	0	1	9
Others	21	13	7	15	1	4	0	0	3	0	0	3	67
TOTAL	67	25	28	29	2	4	0	0	10	1	2	5	173

AVAILABILITY OF EQUIPMENT

	DISTRICT NO. 1	DISTRICT NO. 2	DISTRICT NO. 3	TOTAL
Total equipment located in each district	517	165	156	838
Unavailable equipment (1)	149	6	18	173
EQUIPMENT IN OPERATION	368	159	138	665

KEY TO THE CODE OF PHYSICAL STATE

10 - Minor repairs
20 - Major repairs - lack of wheels, plugs, etc.
30 - Major repairs - partially dismantled
50 - Unserviceable

activities are needed in the short term. The amounts of aid in local and foreign currency to cover the costs of these elements are presented in Tables II.B.9 and II.B.10.

When the conflict is over and as traffic begins to increase improvements and repairs to both track and rolling stock will be necessary. FENADESAL has two long-term projects. One is the construction of a 4.50-km track segment at Santa Ana which would connect the District 2 and 3 lines. This new segment, coupled with track improvements and cargo transfer capabilities at the Guatemalan border, would allow FENADESAL to run trains to the Atlantic. The name of this project is Sitio del Nino-Texis Junction-Guatemalan Border (or Santa Ana-Santa Lucia-Guatemalan border). Its financing is being sought from CABEI and the EEC. Table II.B.11 shows the principal characteristics of the project.

A second project is the extension of the District-1 line from Cutuco to Pueblo Viejo. This extension starts at the FENADESAL yards at Cutuco, passes through an area reserved for an industrial park, a fishing complex and ends at the Salvador - Alaska sawmill. It will link the public port of Cutuco to the private port of Punta Gorda. A description

of the project characteristics and costs is presented in Table II.B.12.

c. Traffic History

Table II.B.13 shows yearly and monthly variations of cargo and passenger traffic. During the period from 1975 - 1979, FENADESAL carried an increasing amount of cargo and passengers. Traffic increased from 50,000 ton-kilometers and 22,000 passenger-kilometers in 1975, to 80,000 ton-kilometers and 30,000 passenger-kilometers in 1979. Its share of the transport market for important Salvadoran exports and imports also rose steadily during this period.
In 1979, due to the conflict, the railway system experienced a sharp decline in operations. In 1988, FENADESAL provided 45 percent of the ton-kilometers and served only 19 percent of the passengers it serviced in 1979.

Table II.B.14 breaks cargo traffic into three categories : export, import,and local traffic. Approximately 50 percent of the cargo conveyed by FENADESAL is local (cement, grains, fertilizer, cotton, and others). Imports account for 30 percent of cargo traffic (oil products, steel, chemical products, processed food, machinery, and others). Exports comprise the remaining 20 percent (mainly coffee, cotton and honey).

Goods transported in 1988 are presented in Tables II.B.15

TABLE II.B.9

AID PROGRAM IN LOCAL CURRENCY

DETAILS	YEARS				
	1	2	3	4	5
1. PURCHASE OR PRODUCTION OF CONCRETE CROSS-TIES (50,000 UNT.)	600,000	600,000	600,000	600,000	600,000
2. CUTUCO PIER CONCRETE STRUCTURE REPAIR (300 M2)	250,000	250,000	250,000	-	-
3. RAILWAY MAINTENANCE (500 KM.)	330,000	330,000	330,000	400,000	400,000
4. STEEL BRIDGE STRUCTURE MAINTENANCE (100 M.)	-	-	-	180,000	180,000
T O T A L = 5,900,000	1,180,000	1,180,000	1,180,000	1,180,000	1,180,000

SOURCE : RAIL AND STRUCTURES DEPARTMENT-APRIL/89

TABLE II. 8. 10

AID PROGRAM IN FOREIGN CURRENCY

QUANTITY	DESCRIPTION	COST (US $)		YEARS				
		UNITARY	TOTAL	1	2	3	4	5
3	PORTABLE WELDING EQUIPMENT	4,000	12,000	4,000		8,000		
6	MANUAL WATER PUMPS	1,000	6,000	4,000		2,000		
60	TAMPER-MOTOR CAR WHEELS	600	36,000	18,000	18,000			
80	CAR WHEELS	500	40,000		20,000	20,000		
20	HYDRAULIC RAIL BENDERS	2,000	40,000	12,000	18,000	10,000		
1,000	RAIL NAILS	105	105,000			25,200	25,200	54,600
16	PLASTIC FORK-LIFT TIRES	800	12,800	6,400	6,400			
2	FORK-LIFT RIMS	1,000	2,000	2,000				
50	10 TONS RAIL JACKS	700	35,000	14,000			14,000	7,000
6	18,000 POUNDS CHAIN PULLEY	1,500	9,000	4,500	4,500			
	RAIL PADLOCKS AND TAMPER MOTOR CAR SPARES		32,200				26,800	5,400
	T O T A L		330,000	64,900	66,900	65,200	66,000	67,000

SOURCE : RAIL AND STRUCTURES DEPARTMENT-APRIL/89

TABLE II. B. 11

PRINCIPAL CHARACTERISTICS OF THE SITIO DEL NINO-TEXIS JUNCTION GUATEMALAN BORDER PROJECT

1. CORREDOR SITIO DEL NINO-TEXIS JUNCTION

1.1 Distance: 60 km
1.2 Gauge: 914 mm
1.3 Costs of rehabilitation

Materials		C5,970,000
Labor for embankment work		C4,600,000
Labor for drainage work		C 900,000
Labor for laying and leveling of track		C1,300,000
Unforeseen expenses		C1,277,000
	TOTAL	C14,047,000

2. Stretch between Texis Junction and the Guatemalan Border

2.2 Distance: 53 kms
2.2 Gauge: 91 mm.
2.3 Conditioning costs

Material		C2,200,000
Labor for embankment work		C 30,000
Labor for drainage work		C 120,000
Labor for laying and leveling of track		C 600,000
	SUB-TOTAL	C2,950,000
	TOTAL	C16,997,000

NOTE:
FENADESAL will obtain the land required for the route, and its cost has not been taken into consideration.

TABLE II. 6. 12

PRINCIPAL CHARACTERISTICS OF THE
CUTUCO-PUEBLO VIEJO EXTENSION PROJECT

NUMBER		UNIT	QUANTITY	C UNIT PRICE	C TOTAL PRICE
1	Right-of-way	m2	30,000	5.00	150,000.00
2	Earth excavation-stone	m3	37,500	80.00	3,000,000.00
3	Earth excavation-ditches	m3	1,000	25.00	25,000.00
4	Rock excavation	m3	800	100.00	80,000.00
5	Compacted fill	m3	21,600	20.00	432,000.00
6	Rock piling	m3	3,600	50.00	180,000.00
7	Material tranportation	m3	21,600	10.00	216,000.00
8	Rails	Tn	248	4,000.00	992,000.00
9	Crossties	Un	5,232	20.00	104,640.00
10	Other track materials	S.G.	0	0.00	142,860.00
11	Ballast	m3	1,500	60.00	90,000.00
12	Laying the line	km	3	35,000.00	105,000.00
13	Concrete structures	S.G.	0	0.00	200,000.00
					C5,717.500.00
			Unforeseen expenses		572,500.00
				TOTAL	C6,290.000.00

NOTES: - The project covers a distance of 3 km.
- The estimated right-of-way is 10 meters

TABLE II. B. 13

YEARLY AND MONTHLY VARIATIONS OF CARGO AND PASSENGER TRAFFIC TRANSPORTED BY FENADESAL

YEAR/ MONTH	CARGO (1,000 TON.) (1)					PASSENGER (1,000)		
	TON-KILOMETERS	TOTAL CARGO	SOLID CARGO	LIVESTOCK	OIL PRODUCTS	PASSENGER-KILOMETERS	PASSENGERS	TRAIN-KILOMETERS
1967	72,426.7	496.3	433.3	10.3	52.7	31,936	1,744.0	1,727.0
1968	60,505.5	423.0	396.9	9.2	16.9	27,136	1,500.0	1,480.0
1969	57,825.8	395.6	359.0	10.3	26.3	26,391	1,472.0	1,548.0
1970	63,840.6	494.5	446.4	9.3	38.8	32,932	1,572.0	1,596.0
1971	52,368.7	502.8	472.9	10.7	19.2	30,208	1,555.0	1,480.0
1972	52,049.8	524.5	504.6	9.2	10.7	30,540	1,661.0	1,473.0
1973	53,801.7	508.9	498.6	3.1	7.2	31,742	1,747.0	1,418.0
1974	51,075.5	490.5	485.2	2.1	3.2	33,458	1,928.0	1,351.0
1975	52,424.7	402.2	399.0	1.7	1.5	22,654	1,510.0	1,103.0
1976	45,872.2	460.9	456.6	2.3	2.0	26,182	1,794.0	1,229.0
1977	56,041.7	518.6	515.7	1.5	1.4	30,137	1,980.0	1,215.0
1978	75,734.9	586.9	571.2	5.3	10.4	30,872	1,986.0	1,348.0
1979	80,209.0	589.5	573.1	7.3	9.1	30,008	2,011.0	1,332.0
1980	55,143.3	450.4	436.7	5.0	8.7	26,985	1,696.0	1,122.0
1981	30,861.4	341.5	332.6	2.0	6.9	14,050	905.0	730.0
1982	31,491.1	311.0	310.2	0.4	0.4	5,868	381.0	598.0
1983	32,438.8	364.5	362.6	0.5	1.4	3,825	247.0	350.0
1984	25,428.3	314.4	313.9	0.1	0.4	4,671	290.0	447.0
1985	25,442.0	324.1	324.1	0.0	0.0	4,749	308.0	432.0
1986	24,454.2	321.4	NA	NA	NA	4,996	322.0	485.0
1987	39,536.2	353.3	NA	NA	NA	NA	364.0	NA
1988	36,151.5	319.9	NA	NA	NA	6,030	390.0	NA
JANUARY	3,987.7	36.4	NA	NA	NA	603	38.9	NA
FEBRUARY	3,831.8	30.7	-	-	-	552	35.6	-
MARCH	3,359.2	29.6	-	-	-	476	30.7	-
APRIL	3,560.8	46.2	-	-	-	551	35.6	-
MAY	2,771.9	39.2	-	-	-	385	24.9	-
JUNE	2,784.9	23.5	-	-	-	445	28.7	-
JULY	1,988.2	16.3	-	-	-	461	30.3	-
AUGUST	2,180.6	16.9	-	-	-	517	33.4	-
SEPTEMBER	1,886.9	14.9	-	-	-	454	29.3	-
OCTOBER	2,770.3	21.8	-	-	-	544	35.1	-
NOVEMBER	2,613.4	19.2	-	-	-	525	33.9	-
DECEMBER	4,415.7	25.1	-	-	-	517	33.4	-
								-

(1) EXCLUDING CRUDE OIL

TABLE II. B. 14

YEARLY VARIATIONS OF CARGO TRAFFIC (TONS)

YEAR	IMPORTS	EXPORTS	LOCAL	TOTAL
1976	150,252	136,272	174,373	460,897
1977	164,523	137,841	216,257	518,621
1978	150,042	157,698	279,208	586,948
1979	143,050	126,208	320,239	589,497
1980	93,589	114,683	242,132	450,404
1981	96,486	88,173	156,859	341,518
1982	64,702	80,620	181,813	327,135
1983	94,826	102,662	165,865	363,353
1984	93,558	60,087	160,805	314,450
1985	120,170	67,221	136,781	324,172
1986	114,685	47,462	159,849	321,996
1987	102,293	60,078	190,973	353,344

TABLE II. B. 15

1988 EXPORT AND IMPORT GOODS

TRANSPORTED BY FENADESAL

PRODUCT	PORT OF ORIGIN/DESTINATION	I T E M	TONNAGE
COFFEE	CUTUCO	EXPORT	17,300
BORRA	CUTUCO	EXPORT	523
TOTAL			17,823
CEREALS	CUTUCO	IMPORT	6,901
POWDER MILK	CUTUCO	IMPORT	746
FERTILIZER	CUTUCO	IMPORT	39,297
COTTON SEED OIL	CUTUCO	IMPORT	409
SOY OIL	CUTUCO	IMPORT	394
FOOD	CUTUCO	IMPORT	591
TOTAL			48,338
COFFEE	ACAJUTLA	EXPORT	28,802
HONEY	ACAJUTLA	EXPORT	61
AJONJOLI	ACAJUTLA	EXPORT	476
COTTON	ACAJUTLA	EXPORT	450
TOTAL			29,789
FOOD	ACAJUTLA	IMPORT	221
CEREALS	ACAJUTLA	IMPORT	6,448
IRON AND DERIVED	ACAJUTLA	IMPORT	34,555
POWDER MILK	ACAJUTLA	IMPORT	1,631
INDUSTRIAL SODA	ACAJUTLA	IMPORT	1,146
PAPER	ACAJUTLA	IMPORT	223
COOKING OIL	ACAJUTLA	IMPORT	410
CHEMICAL PRUDUCTS	ACAJUTLA	IMPORT	355
IRONWORKS	ACAJUTLA	IMPORT	438
ELECTRONIC	ACAJUTLA	IMPORT	441
RESINS (RAW MAT.)	ACAJUTLA	IMPORT	207
MACHINERY	ACAJUTLA	IMPORT	194
MISCELLANEOUS	ACAJUTLA	IMPORT	1,270
TOTAL			47,539
GRAND TOTAL			143,489

and II.B.16. Exports and imports are shown in Table II.B.15, classified by type of cargo and port of origin/destination. Table II.B.16 lists the amount, type, of local cargo traffic, for each of the three railway districts.

FENADESAL expects to transport 407,218 tons of cargo this year, which represents a 28 percent increase over the 1988 level. This estimate is based on an assumed increase in cement traffic. Passenger traffic should increase 3 percent to 401,300 passengers.

Local cargo traffic generates 56 percent of income. Exports account for 12 percent of the revenues, coffee the only significant commodity. Imports total 18 percent of the income, passenger fares 3 percent, and miscellaneous sources 11 percent.

There is no train schedule. FENADESAL currently runs two trains per day, Mondays through Saturdays, and one train on Sundays from San Salvador to Cutuco (District 1). Three trains per day, Mondays through Saturdays and one or two on Sundays operate from Metapan to San Salvador (District 2). In District 3, two trains per day run from Acajutla to San Salvador.

d. Costs of Operations/Maintenance

Railway operations, maintenance and rehabilitation costs are defined below. Table II.B.17 and Figure II.B.3 allow the calculation of ideal annual railway maintenance costs, as a function of cargo. Table II.B.18 shows maintenance costs for a railway section in poor condition. The real maintenance unit cost - C55,660 per kilometer - is thus 2.5 times the ideal value. Table II.B.19 shows rehabilitation costs for a railway section, of C234,115 per kilometer.

Tables II.B.20 and II.B.21 show transportation costs for typical cargoes in Districts 2 and 3, assuming maximum-load trips for existing locomotives. FENADESAL lacks a proper costing system. The establishment of a costing system should improve planning and decision-making. Table II.B.22 shows the historical fluctuation of transportation costs, indicating an increase of over 100 percent in the last nine years.

e. Problem Areas

(1) Low Traffic Volumes

FENADESAL's major problem is its low traffic volumes. In

TABLE II.B.16

1988 LOCAL TRAFFIC BY DISTRICT

ITEM	DISTRICT 1	DISTRICT 2	DISTRICT 3	T O T A L
CEMENT	25,754	123,802	236	149,792
FERTILIZER	24,285		14,721	39,006
FLOUR	1,446			1,446
IRONWORKS	305			305
IRON	583		383	966
MISCELLANEOUS	3,279	113	1,433	4,825
AJONJOLI			902	902
GRAND TOTAL	55,652	123,915	17,675	197,242

TABLE II.B.17

IDEAL TRACK MAINTENANCE COST PER KM
(All Costs in Colones)
DECEMBER 1988

	COST/KM/YR	
Net Tons per Year	300,000	0
Ties - 15yr life, 1750 ties/km., C60./tie	7,000	9,330(1)
Rail repair/replacement C1,500/rail 3 rails/km/yr	4,500	
Switch repair 30 yr life, C96,000/switch or C3,200 switch/year(2)	320	
Grade crossing 15 yr life C25,600/crossing or C1,700/crossing/yr 0.6 crossing/km	1,020	
Weed Control 3 times/year	130	130
Surfacing and Maintenance 1 man/2 km @ C1,280/month	7,680	1,535(3)
Telegraph Maintenance 12 man/C1,535/month * 1.2 (materials)-600km	445	445
Bridges C130/meter/yr average 8m long, 0.3 bidges/km	345	
Ballast 5 cubic meters/km/, Material cost C25, Transportation C15/cubic meter to load, total C41/cubic m.	200	
TOTAL COST C(Colones)/KM/year	21,640	11,440

1. Includes Cost of Installation
2. 1 switch/10 Km of track
3. Minimal Maintenance

FIGURE II.B.3

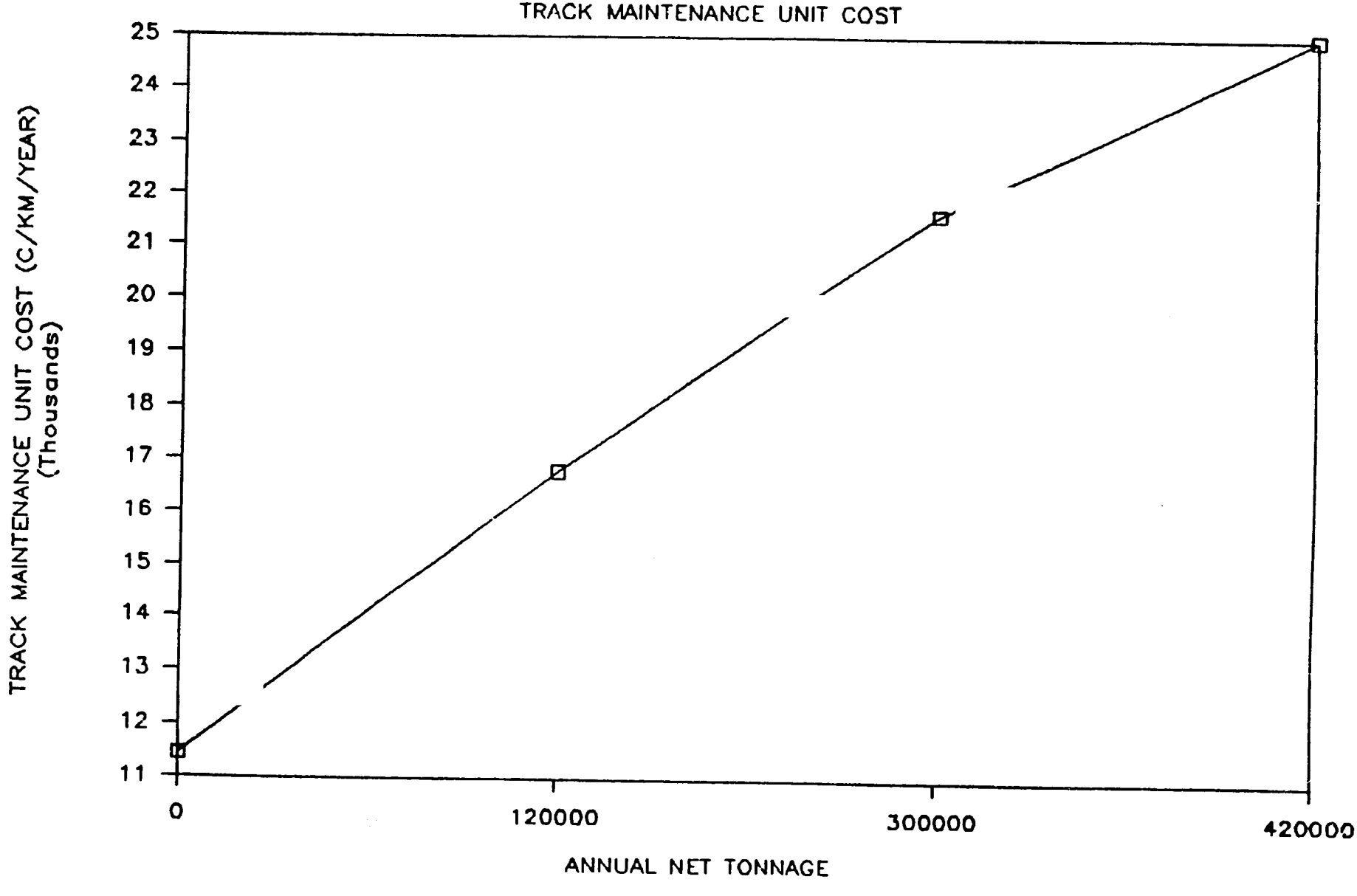

TRACK MAINTENANCE UNIT COST
TRACK MAINTENANCE UNIT COST (C/KM/YEAR)
(Thousands)
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
0
120000
300000
420000
ANNUAL NET TONNAGE

TABLE II.B.18

1988 TRACK MAINTENANCE UNIT COST

SECTION: TEXIS JUNCTION - GUATEMALAN BORDER

Distance	53 km
Gauge	914 mm

MATERIALS

Quantity	Unit	Unit Cost (C)	Total Cost (C)
30,000	Crossties	60	1,800,000
400	Rail nails	875	350,000
50	Rail bolts	1,000	50,000
SUB-TOTAL			2,200,000

LABOR

Embankment works	30,000
Drainage works	120,000
Track alignment and leveling	600,000
SUB-TOTAL	750,000
TOTAL	2,950,000

TOTAL COST PER KM: C55,660

TABLE II.B.19

1988 TRACK REHABILITATION UNIT COST

SECTION: SITIO DEL NIÑO - TEXIS JUNCTION SECTION

Distance: 60 Km
Gauge: 914 mm

MATERIALS

Quantity	Unit	Unit Cost (C)	Total Cost (C)
63,750	Crossties	60	3,825,000
900	75 rails	1,500	1,350,000
680	rail nails	875	595,000
200	rail bolts	1,000	200,000
SUB-TOTAL			5,970,000

LABOR

Embankment works	4,600,000
Drainage works	900,000
Track laying and leveling	1,300,000
SUB TOTAL	6,800,000
Unforeseen expenses	1,277,000
TOTAL	14,047,000

TOTAL COST PER KM: C234,115

TABLE II.B.20

IDEAL CARGO TRANSPORTATION COSTS
December, 1988
(in colones)

MOVEMENT OF CEMENT BETWEEN METAPAN & SAN SALVADOR	1 TRIP/ DAY	2 TRIPS/ DAY	3 TRIPS/ DAY
Locomotive (1)	2,000	2,100	2,200
Wagons (2) 11 wagons/set , 3 sets @C.175,000 Col - C.50/day	1,650	1,650	1,650
Fuel-6 hrs & 800hp at .75 full load, @ C.5. US /gallon	1,000	2,000	3,000
Crew 4 man/month	300	600	900
SUB TOTAL	4,950	6,350	7,750
Track Cost (135 Km * Graph I cost)	7,550	8,825	10,350
Operating & Track Cost	12,500	15,175	18,100
Overhead 35%, 30% and 25%	4,375	4,550	4,525
SUB TOTAL	16,875	19,725	22,625
Total Net Tons/year (3)	120,000	240,000	360,000
Cost/Ton	42.19	24.65	18.85
Cost/ton Km	0.313	0.183	0.140
Present Truck Cost - 8 ton trucks	C 0.30/ton-Km (incl. Delivery)		
Present Railway Charge	C 0.14/ton-Km		
Present Railway Cost approx.	C 0.40/ton-Km		

(1) Based on new C.5 mill. locomotive, 20yr life, 300 days/yr, amortization and maintenance
(2) Each train 10,40 ton wagon & 1 spare for maintenance & repair, 20yr life amortization and maintenance
(3) 300 tons one way, empty return

TABLE II.B.21
IDEAL CONTAINERIZED TRANSPORTATION COSTS
December, 1988
(in colones)

MOVEMENT OF CONTAINERS BETWEEN SAN SALVADOR & ACAJUTLA	1 TRIP/ DAY	2 TRIPS/ DAY	3 TRIPS/ DAY
Locomotive (1)	2,000	2,100	2,200
Wagons (2) 16 @ C 200,000 or C 60/day/wagon	960	960	2,880
Fuel- 800hp @ 4hrs/round trip at .75 full load @ C 5. US /gallon	665	1,330	1,995
Crew 4 man/month	300	600	900
SUB TOTAL TRIP	3,925	4,990	7,975
Track Cost (103 Km * Graph I cost)	5,775	6,725	7,900
Operating & Track Cost	9,700	11,715	15,875
Overhead 35%, 30% and 25%	3,395	3,515	3,970
TOTAL COST PER DAY	13,095	15,230	19,845
Total Net Tons/year (3)	135,000	270,000	405,000
Cost/Ton	29.10	16.90	14.70
Cost/ton Km	0.283	0.164	0.143
Cost/22 Ton Container	645.81	373.89	328.57
Delivery Cost	160.00	160.00	160.00
T'fer Cost-C1,750,000 Cont. Cranes	83.94	41.97	27.98
TOTAL TRANSPORTATION/DELIVERY COST	889.75	575.86	516.55
Truck Charge		628.11	

(1) Based on new C.5 mill. locomative, 20yr life, 300 days/yr, amortization and maintenance
(2) Each train would require 15 wagons, 1 as a spare, 20yr life 300 days/yr amortization and maintenance
(3) Assumed 300 tons of freight import & 150 tons export on return trip

TABLE II.B.22

HISTORICAL FLUCTUATION OF CARGO TRANSPORTATION COSTS

Year	Expenses (millions of colones)	Ton-km (millions of colones)	Transportation costs (C/ton-Km)
1980	17.1	55.1	0.31
1981	16.2	30.9	0.52
1982	15.2	31.5	0.50
1983	15.4	32.4	0.48
1984	15.1	25.4	0.59
1985	17.4	25.4	0.69
1986	20.6	24.5	0.84
1987	24.2	39.5	0.61
1988	24.2	36.2	0.67

1988, it transported 320,000 tons of cargo and 390,000 passengers in 1988, or approximately 55 and 19 percent of pre-conflict traffic levels. Several factors have contributed to this decrease and subsequent loss of market share:

- Reduced production of traditional railway cargoes.

- Reduced safety due to guerrilla attacks.

- Reduced reliability due to poor condition of equipment and track.

- Indirect government subsidy to the highway alternative via gas subsidies and low registration and title fees.

Though District 1 (San Salvador-La Union) handled roughly the same traffic as the other lines in 1988, its economic prospects are worse. A 1986 study estimated that 350,000 tons per year would be needed to recover operating costs. This amounts to three and a half times the present traffic.

(2) Financial Problems

The railway's income has diminished, due to reduced traffic levels and constant tariffs. However, operating costs have risen in the last years. Due to increases in salaries and administration costs, higher operating costs for deferred track maintenance, aggravated by extensive active and passive security measures. As a result, operating losses have reached to roughly half of operating costs, requiring an increase in the amounts of subsidy.

(3) Long-Term Planning

There is a lack of a strategic long-term plan for the railroad. In addition to the two investment projects in the pipeline Santa Ana-Santa Lucia-Guatemalan Border and Cutuco-Pueblo Viejo, the strengthening the container-handling capabilities is under consideration. The Consultants believe no investment should take place until a multimodal national transportation plan gives perspective to these projects.

(4) Maintenance

Track infrastructure is still functional for current traffic levels, though it needs to be improved as it has past its service life. Prevailing maintenance is only corrective, causing a series of derailments and low operating speeds. Rolling stock is also in poor shape.

Maintenance costs are very high in District 2 (San Salvador -Metapan). This is due principally to serious slope stability problems. The Santa Ana-Santa Lucia project would

allow District-2 traffic (including cement cargo) to be run via the existing District-3 branch to Santa Ana, avoiding the slope stability problem areas.

(5) Traffic to the Atlantic

There is a need for an agreement with the Guatemalan Railways to allow traffic to reach the Atlantic Ocean. Since the nationalization of their respective railways, Guatemala and El Salvador have not allowed traffic between the two countries. Traffic to San Pedro de Castilla would begin only after an agreement is reached.

(6) Organization

There is a need for more professional staff and technical assistance in different areas, as well as for the establishment of a planning department, a central dispatching office and a marketing department. FENADESAL also lacks a costing system.

f. Economic Evaluation

This section presents an economic analysis of FENADESAL's most significant planned project: the linkage of District-2 and District-3 lines at Santa Ana, coupled with track rehabilitation from Sitio del Nino to the Guatemalan Border (see Table II.B.11).

The principal advantages of this project are summarized below:

- It would foster trade with Guatemala and facilitate trade with Europe and East U.S. via Santo Tomas de Castilla on the Atlantic. Providing a reliable and less expensive alternative to highway traffic, it is expected to capture a significant market share of the San Salvador-Castilla traffic as well as the Acajutla-Castilla traffic. The overall track distance between these two ports will be reduced by the proposed connection, reducing railway, and transportation costs for inter-oceanic traffic (dry channel concept).

- Track rehabilitation along Districts 2 and 3 should also benefit local traffic. A more reliable service would be offered to the cement plants. However, the proposed new route via Santa Ana - District 3 - Sition del Nino will be longer and more circuitous for cement traffic than the current route.

- With the new route, existing severe slope stability problem will be avoided along current District-2 track (by the Las

Canas river. Over the last few years, the 15 kilometer track segment parallel to the Las Canas River has been eroded, forcing FENADESAL to constantly realign the track and modify the approach to the existing bridge over the Las Canas River.

- The proposed connection would allow FENADESAL to close a 93-kilometer segment of District 2's track from Texis Junction to Soyapango (See Figure II.B.2). In this manner, FENADESAL will significantly save on track maintenance cost. In addition, maintenance personnel could be concentrated along District 3's track to offer better service levels in the future.

- FENADESAL could sell District 2's right-of-way along the 93-kilometer segment to be closed, obtaining about C20,000,000 . The proposed project could be self-financed in this way.

- Rail service's reliability should increase as trains begin to run along a safer corridor. Cement traffic is currently directed along District 2's track from Soyapango to Texis Junction, through conflictive areas; this segment suffered 44 guerrilla attacks from 1980 to 1988. With the planned interconnection, trains would be run along District 3's track on safer lands, enabling FENADESAL to cut down on expensive security measures.

- This new route could help FENADESAL obtain new clients since it is located within a coffee-growing area, as opposed to the current alignment which has virtually no crops or other products.

There is, however, one main draw-back to the proposed connection: because of increased grades and degrees of curvature (longer equivalent track mileage), it will be more expensive to operate trains along the Castilla-Metapan-San Salvador corridor. The Acajutla-Castilla corridor will be less expensive to operate, since track mileage between the two ports is significantly reduced, though equivalent track milage, for this corridor is reduced by a less significant amount. Since traffic along the former corridor is expected to be much higher than along the latter one, overall train operations would be more expensive.

Table II.B.23 presents a preliminary comparison of the proposed and existing routes for San Salvador-Mepatan (and Atlantic Ocean) traffic. It would cost C8.48 per ton more to transport freight via Santa Ana than along the existing route. Considering track maintenance and investment savings, it would be less expensive to operate trains along the new route if traffic were less than 200,000 tons per years. This threshold is unlikely to be achieved within the next few years (but could be achieved within our planning horizon).

TABLE II.B.23

COST COMPARISON OF EXISTING AND PROPOSED ROUTES
FROM SAN SALVADOR TO METAPAN (AND THE ATLANTIC)

	Proposed Route (via Santa Ana, District 3)	Existing Route (via Las Canas River, Dist.2)
1) Length (km) (1)	141.75	136.3
2) Length (miles)	88.1	84.7
3) Total gradient (ft)	2111	1024
4) Equivalent track length for gradient (2)	133.6	64.8
5) Degrees of central-angle curvature	3283	2040
6) Equivalent track length of curvature (3)	6.2	3.9
7) Total equivalent track miles (2+4+6)	227.9	153.4
8) Difference in track miles	3.4 (5.4)	-
9) Difference in equivalent miles	74.5 (119.2 km)	
10) Maximum gradient	3%	2%
11) Maximum load for 800-HP locomotive (tons)	300	400
12) Additional fuel cost (0.11/ton Km)	C 8.48/ton (4)	
13) Track-km that can be closed		92.9
14) Track maintenance cost savings (3,000C/km (5)		1,208,000 C/year
15) Traffic that will negate maintenance savings (tons/year)(14/12)		142,400
16) Construction cost in Colones (6)	17.0 million	20.9 million
17) Salvage value/R-O-W sale cost (7)	-	-
18) Net cost difference (17-20.9)	3.9 million	
19) Equivalent annual cost at 12%	468,000/year	
20) Traffic that will negate investment (tons/year)		55,200
21) Total traffic that will make river-line less expensive (tons/year) (15+20)		197,600

(1) Includes 4.75 Km for connection
(2) Assuming 25 MPH operation, 6 lb/ton resistance on tangent level track or 15.8 ft. rise equals one mile.
(3) 528 degrees of central-angle curvature equals one mile of tangent track.
(4) The equivalent miles difference is assumed to be primarily in fuel cost; there is additional track maintenance cost because curves and gradients are more expensive to maintain, but since tonnage is relatively low this has been ignored.
(5) Maintenance cost savings from maintaining only one route as opposed to two routes.
(6) Santa Ana connection would cost C17.0 million which would be offset by a C20.9 million investment required to overcome an erosion problem in the Las Canas River line.
(7) R.O.W sale prices and salvage costs are not included in the analysis since the two alternate alignments are similar in length and assumed to be similar in land value. If we built the proposed connection, we could sell the river's segment; and if we kept the present route, we could sell the Santa Ana segment.

Source: 1986 Damage Assessment Report and Consultants' Estimates.

In summary, this project presents several interesting advantages and opportunities to help FENADESAL. But, since unit cargo costs for the Castilla-Metapan-San Salvador corridor should be higher than present costs in the long-run, it could be inappropriate to operate the proposed route (especially after the war is over).

Before recommending any investments, the Consultants suggest further analysis of this issue with more precisely estimated future cargo levels (e.g., a national transportation study).

g. Project Needs

(1) National Transport Study

There is a need for a national transportation study, and only within the frame of such a study, can the feasibility of (and geo-political need for) the railway system be assessed. This plan should address the following issues related to railways:

- economic feasibility of the railway system
- value of the railway system as an alternative mode to highways
- importance of the railway system as an integrating and developing Sector for Eastern El Salvador
- definition of the need for an efficient port alternative to Acajutla at Cutuco or Punta Gorda or neither. (This will influence the future role of District 1 and its tentative extension to Pueblo Viejo)
- types of cargo by corridor in which the railway should concentrate. (This should help to evaluate the need for increased container-handling equipment and a possible extension to the proposed container yard at Acajutla.
- level of acceptable subsidy, if any (typically not more than 30 percent of operating expenses).

(2) Management Study

The Consultants recommend a management study of FENADESAL. The structure of a proposed marketing department should be defined. A variable costing system should be developed. The proposed study should analyze whether it is appropriate to establish a planning department and central train dispatching. After this study, it is recommended that technical assistance be provided in the areas of marketing, manpower planning, operations and forecasting.

The proposed linkage of Districts 2 and 3, coupled with cargo transfer capabilities at the Guatemalan border, could benefit the economic performance of the railway system. Running trains to the Atlantic will benefit the railways whether FENADESAL runs trains via Santa Ana or not. This could be achieved whether Salvadoran or Guatemalan trains are used. No capital investment should take place until the proposed national transportation plan defines, the future role of the railway system.

3. Marine Ports

The analysis will concentrate on the current economic performance and capabilities of Acajutla and Cutuco, with special emphasis placed on the benefits to be derived from the rehabilitation/replacement of their assets.

a. Inventory of Facilities

The infrastructure of the port of Acajutla presents a series of damaged areas principally caused by strong winds, wave action and water salinity. The electrical system has been already affected by the continuous voltage changes, and the port lacks sufficient cranes to move containers. This is further complicated by the fact that the railway line does not enter the dock areas.

A description of the ports of Acajutla and Cutuco is presented in the following paragraphs.

(1) Port of Acajutla

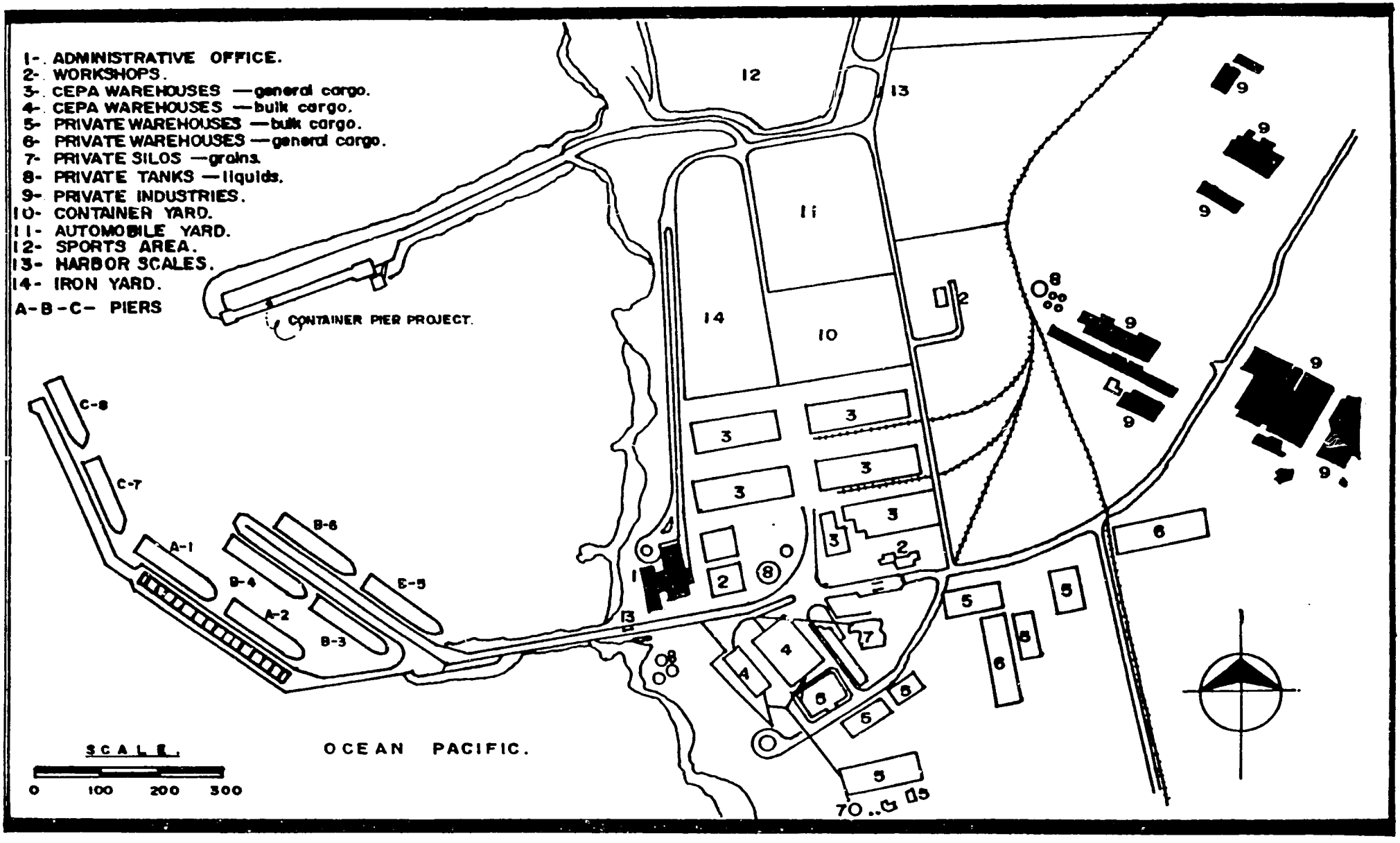
The port of Acajutla is located on the Pacific coast in the Western zone of the country, to the southwest of the capital, San Salvador, at a distance of 85 km by highway, and 103 km by railway.

It fulfills vital functions for the loading, storage and unloading of goods. It has the following facilities:

(a) Piers

Acajutla is a direct docking port and has three piers and space for eight ships, distributed in the following way (see Figure II.B.4):

PORT OF ACAJUTLA..



PIER	FUNCTION	CAPACITY	NAMES
"A"	Pier and Jetty	2	A-1
			A-2
"B"	Pier	4	B-3
			B-4
			B-5
			B-6
"C"	Pier and Jetty	2	C-7
			C-8

Pier "A" has two berths, and handle: general cargo, solid and liquid bulk. The jetty has a length of 310 meters and a width of 37 meters.

Pier "B" has 4 berths and handles mostly solid bulk and some general cargo. The jetty is 370 meters long and 28 meters wide. Pier coverage is 4.8m above sea-level. 152-meter-long and nine-meter draft ships can berth at platform "B". Depths at low tide are 10 meters in berths B-3, B-5, and B-6 and 12m in B-4.

Pier "C" is designed to better existing installations, improve operational efficiency and provide the port with a berth for tankers up to 40,000 tons. It extends out in the same direction as pier "A" to a distance of 35 meters in the first section, deflecting 30 degrees in the second section for 270 meters. It has a length, measured at the axle, of 307 meters. It is approximately 21.5 meters wide.

It has two berths which can mobilize general cargo, bulk and containers. It can handle two 12 meter-draft and 128 meter-long ships in berths C-7 and C-8, or one 205 meter-long and 12 meter-draft ship.

(b) Storage Areas

Storage facilities consists of warehouses, yards for general cargo and vehicles, and one container yard which includes an area with 24 outlets for refrigerated containers. Characteristics of these installations are listed in Table II.B.24.

(c) Equipment

The port's cargo movement equipment, are described below:

To assist ship movements:

1 1,800-HP tug
1 1,200-HP tug
1 800-HP tug

TABLE II.B.24

STORAGE AREAS AT THE PORT OF ACAJUTLA

INSTALLATION	a) Dimensions (m) b) Area (m2) c) Volume (tons of cargo)	CARGO
Warehouse #1	a) 150 * 40 * 6.5 b) 6.000	EXPORTS
Warehouse #2	a) 135 * 40 * 6.5 b) 5.400	IMPORTS
Warehouse #3	a) 150 * 40 * 6.5 b) 6.000	IMPORTS
Warehouse #4	a) 120 * 40 * 6.5 b) 4,800	IMPORTS
Transit Warehouse	a) 250 * 18 * 4.6 b) 4.500	IMPORTS AND EXPORTS
Yard for general cargo	b) 24.500	IMPORTS AND EXPORTS
Yard for vehicles	b) 36.000	IMPORTS AND EXPORTS
General warehouse	a) 30 * 78 * 21 b) 2,840 c) 12,000	EXPORTS
Modules	b) 10.372	IMPORTS AND EXPORTS
Warehouse for bulk	b) 5.200 c) 18.000	IMPORTS
Container yard	b) 29.700	IMPORTS AND EXPORTS

To handle solid bulk:

One crane with a 240 ton-per-hour capacity handles exports and a 150 ton-per-hour crane imports. These products are transported via conveyor belts to CEPA or private warehouses. Productivity varies according to product density.

To handle containers in the yards:

Two container-handling cranes with a maximum capacity of 35 tons, are able to elevate and lower containers to three different levels.

Miscellaneous Equipment:

Clamp-type loaders for container handling
6,000-,11,000-, and 20,000-pounds fork lifts
Tractors
Front-end loaders
Caterpillar tractors
Pulleys
Two cranes, of 60- and 30-ton capacities

(d) Current Condition

The steel cells which constitute the structure of Pier "A" are badly deteriorated and in need of urgent repair. Berth fenders at Pier "B" are also in poor condition.

The warehouse roofs are very deteriorated, causing leaks during the rainy season which in turn affects the merchandise stored therein. Other storage places are in good condition. In general terms, this port's equipment is obsolete and in bad disrepair, resulting in high maintenance expense.

(2) Port of Cutuco

The Port of Cutuco is located in the Gulf of Fonseca, in Eastern El Salvador. Its distance from San Salvador is 252 km by rail and 185 km by road. Its functions include the loading, storage and unloading of goods. Its facilities are described below.

(a) Piers

Cutuco has one pier with two berths. The northern berth is 152 meters long and has a 7.6 meter-wide unloading bay with two railway tracks. The southern berth is 174 meters long and 6.1 meters wide, with only one railway track.

(b) Storage Areas

A transit warehouse 15.24m wide and 146.3m long, provides

2,230 m2 of storage space. Apart from this, Cutuco has open storage space of 482,824m2 and covered spaces with 23,940 m2, distributed among five warehouses for exports and one for imports. In addition, Cutuco has a yard for 256 railway wagons or coaches. There are two oil tanks with an approximate capacity of 20,000 barrels each.

c) Equipment

Cutuco has eight fork-lifts with a capacity ranging from 4,000 to 6,000 pounds. There is also a 120-HP tug.

(d) Current Condition

The port of Cutuco was built at the beginning of this century with a few repairs having been made during its operation. The state of its pier and other installations is poor.

b. Projects Underway/Planned

(1) Port of Acajutla

(a) Projects Underway.

There are no projects currently underway as such. Only infrastructure maintenance work, such as anticorrosive painting of metal structures, is being done.

The replacement of wooden defenses for the berthing of boats is also being undertaken. This is done with local wood, which only lasts for a short time. In addition, roofs have been waterproofed, and there has been some replacement of railway lines.

(b) Planned projects.

The principal planned projects are described below:

((1)) Repair Pier "A"

This is being studied by the German firm Reynolds, with technical assistance and finance from KfW of Germany. The study is about to begin and will last approximately one year. Construction work will also be financed by KfW.

A preliminary report prepared by a German consulting firm, recommends KfW finance for this project. The approximate cost of this project is US$15.million.

((2)) Enlargement of container areas

This project has been planned for future storage demands.

It includes a pier for the unloading of containers, which will notably reduce the current transport of 1.8 km from Pier "C". An extension to the railway line from the warehouse area would couple with new container facilities. Preliminary design and cost estimates of US$56 million were obtained in 1982.

((3)) Replacement/Acquisition of Operational Equipment

The port needs to replace between 80 and 90 of its operating equipment. US$3.16 million is the cost of this project. At present, steps are being taken to obtain finance from the governments of Japan and Germany.

CEPA is in the process of changing the port's radio communication system at a cost of US$1200.

To facilitate unloading, improvements are planned for the crane systems on Piers "C" and "B". In the case of Pier "C", acquisition of a multipurpose crane for moving containers, bulk cargo and other cargo is being considered. There are also plans for the acquisition of containers, and other works, the cost of which exceeds US$11 million. German government financing could be available for this project.

((4)) Warehouse roof improvements

The German government has apparently developed a study for improving the warehouse roofs, with an estimated cost of US$600,000.

(2) Port of Cutuco

As previously explained, the pier on this port is in very bad condition. If a decision is made to improve operations, a total remodelling of the pier is necessary.

c. Traffic History

(1) Port of Acajutla

Acajutla is the most important port in El Salvador, as most exports and imports are transported from here. Over 55 percent of all exports were shipped from Acajutla in 1985. It mobilizes approximately 14 times as much cargo and seven times as many ships as the second most important port - Cutuco.

Table II.B.25 shows a summary of 1988 port activities at Acajutla. A total of 1,055,280 tons were handled. Bulk cargo was the most significant with 554,000 tons. Other cargo categories comprise 370,000 tons of general cargo, 109,000

TABLE II.B.25

SUMMARY OF 1988 PORT ACTIVITIES AT ACAJUTLA

	SHIP CLASS				
	GENERAL	BULKSHIP	TANK	MIXED	TOTAL
I. PRODUCTION					
CARGO IN TONS.	370547	554521	109443	20769	1055280
IMPORTS IN TONS	266662	482820	109443	16464	875389
EXPORTS IN TONS	103885	71701	---	4305	179891
GRT	2431503	604215	171553	320037	3527308
NRT	1431794	393181	112530	180604	2118109
II. TRAFFIC					
NUMBER OF SHIPS BERTHED	265	47	23	28	363
HOURS IN PORT (ANCHOR-SAIL)	12324	10663	2686	677	26350
HOURS IN PIER (DOCKING-UNDOCKING)	10243	8661	2167	550	21621
HOURS EFFECTIVELY WORKED	6471	5366	1891	358	14086
HOURS NOT WORKED (INACTIVITY + DELAYS*)	3772	3295	276	192	7535
HOURS BETWEEN ANCHORING AND DOCKING	1703	1779	396	122	4000
HOURS BETWEEN UNDOCKING AND RE-DOCKING	188	182	118	-	488
HOURS BETWEEN UNDOCKING AND SAIL	190	41	5	5	241
III. INDICATORS					
AVERAGE TONS / SHIP	1398	11758	4758	742	2907
AVERAGE GRT / SHIP	9175	12856	7459	11430	9717
AVERAGE NRT / SHIP	5403	8366	4893	6450	5835
AVERAGE DAILY ARRIVALS	0.7	0.1	0.1	0.1	1.0
AVERAGE HOURS-SHIP IN PORT	46.5	226.9	116.8	24.2	72.6
AVERAGE HOURS-SHIP IN PIER	38.7	184.3	94.2	19.7	59.6
AVERAGE HOURS-SHIP EFFECTIVELY WORKED	24.4	114.2	82.2	12.8	38.8
AVERAGE HOURS-SHIP NOT WORKED	14.3	70.1	12.0	6.9	20.8
AVERAGE HOURS-SHIP ANCHORING-DOCKING	6.4	37.8	17.2	4.3	11.0
AVERAGE HOURS SHIP UNDOCKING-RE-DOCKING	0.7	3.9	5.2	-	1.3
AVERAGE HOURS SHIP UNDOCKING-SAIL	0.7	0.9	0.2	0.2	0.7
IV. PERFORMANCE					
TONS-HOUR SHIP IN PORT	30.1	52.0	40.7	30.7	40.0
TONS-HOUR SHIP IN PIER	36.2	64.0	50.5	37.8	48.8
TONS-HOUR PER-SHIP EFFECTIVELY WORKED	57.3	103.3	59.9	58.0	74.9
V. RATIOS					
HOURS DOCKED AS % PORT STAY	83	81	81	81	82
HOURS ANCHORING-DOCKING AS % PORT STAY	14	17	15	18	15
HOURS UNDOCKING-REDOCKING AS % PORT STAY	1	2	4	-	2
HOURS UNDOCKING-SAIL AS % PORT STAY	2	-	-	1	1
HOURS EFFECTIVELY WORKED AS % PIER STAY	63	62	87	65	65
HOURS NOT WORKED AS % PIER STAY	37	38	13	35	35

* DELAYS APPEARED DURING OPERATIONS

tons of liquid bulk and 21,000 tons of mixed cargo. Exports amounted to 180,000 tons and imports to 875,000 tons.

Acajutla harbored 363 ships with a total registered gross tonnage of 3,527,308 tons in 1988. Ships stayed an average of 72.6 hours within the port and 59.6 hours at the piers. An average of 48.8 tons per berthed ship-hour and of 40.0 tons per harbored ship-hour were handled.

The following paragraphs present more detailed information on cargo and ships handled by Acajutla.

(a) Cargo Traffic

Table II.B.26 shows the yearly imports and exports through Acajutla, by cargo type. Figure II.B.5 depicts the yearly fluctuation of exports and imports. Imports have remained stable during the last ten years at an average level of 850,000 tons (with the exception of 1982 in which imports were 500,000 tons). On the other hand, exports have decreased significantly to approximately 39 percent of their 1979 (pre-conflict) level.

A list of exported and imported goods is presented in Table II.B.27. Prominent imports (by order of weight) are fertilizers, grains, soy flour and iron. Coffee is the only significant export (76 percent of all exports by weight).

Countries which trade with El Salvador via Acajutla are recorded in Table II.B.28. The US is the most important trading partner, receiving 32 percent of exports and shipping 61 percent of imports. Germany and the Soviet Union are meaningful importers of Salvadoran products, accounting for 29 and 23 percent of export tonnage.

Table II.B.29 shows container movements at Acajutla during 1986-1988.

(b) Ship Movement

Table II.B.30 presents a monthly total of incoming ships as well as the number of ships simultaneously berthed during the year. The first half of the year receives more ships than the second half (56 and 44 percent respectively). Port activities peak during March-June, during which all berths are occupied simultaneously for several days. Sixty-one percent of the time, two to four berths are operating simultaneously; 20 percent of the time, five or more berths; and 19 percent of the time, one or less.

Table II.B.31 shows pier activities during 1988. Pier "B" presents the highest performance, having handled 578,857 tons of cargo. This is explained by the presence of a large crane and conveyor belts on that pier.

TABLE II.B.26

COMPARATIVE CARGO MOVEMENTS FOR 1979/1988

CLASSIFIED BY MOVEMENT AND CLASS OF CARGO

CONCEPT (TONS)	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
IMPORTS										
GENERAL CARGO	252,008	219,962	195,313	158,626	203,874	224,378	207,233	232,270	240,361	227,900
BULK CARGO	569,522	577,200	526,590	333,646	567,695	522,567	611,337	616,118	605,908	571,262
LIQUID BULK CARGO	32,367	22,289	32,271	25,411	44,069	48,145	54,284	74,835	64,295	76,227
SUB-TOTAL	853,897	819,451	754,174	517,683	815,638	795,090	872,854	923,223	910,564	875,389
EXPORTS										
GENERAL CARGO	161,564	179,035	144,418	126,687	235,393	154,181	130,830	93,374	115,227	101,786
BULK CARGO	269,423	106,373	104,974	83,966	99,203	85,380	130,519	99,240	37,787	78,105
LIQUID BULK CARGO	30,452		14,758	19,999	23,824	757	12,842	14,928	6,082	-
SUB-TOTAL	461,439	285,408	264,150	230,652	348,620	240,318	274,191	207,542	159,096	179,891
TOTAL	1,315,336	1,104,859	1,018,324	748,335	1,164,258	1,035,408	1,147,045	1,130,765	1,069,660	1,055,280

FIGURE II.B.5

YEARLY CARGO MOVEMENTS AT ACAJUTLA

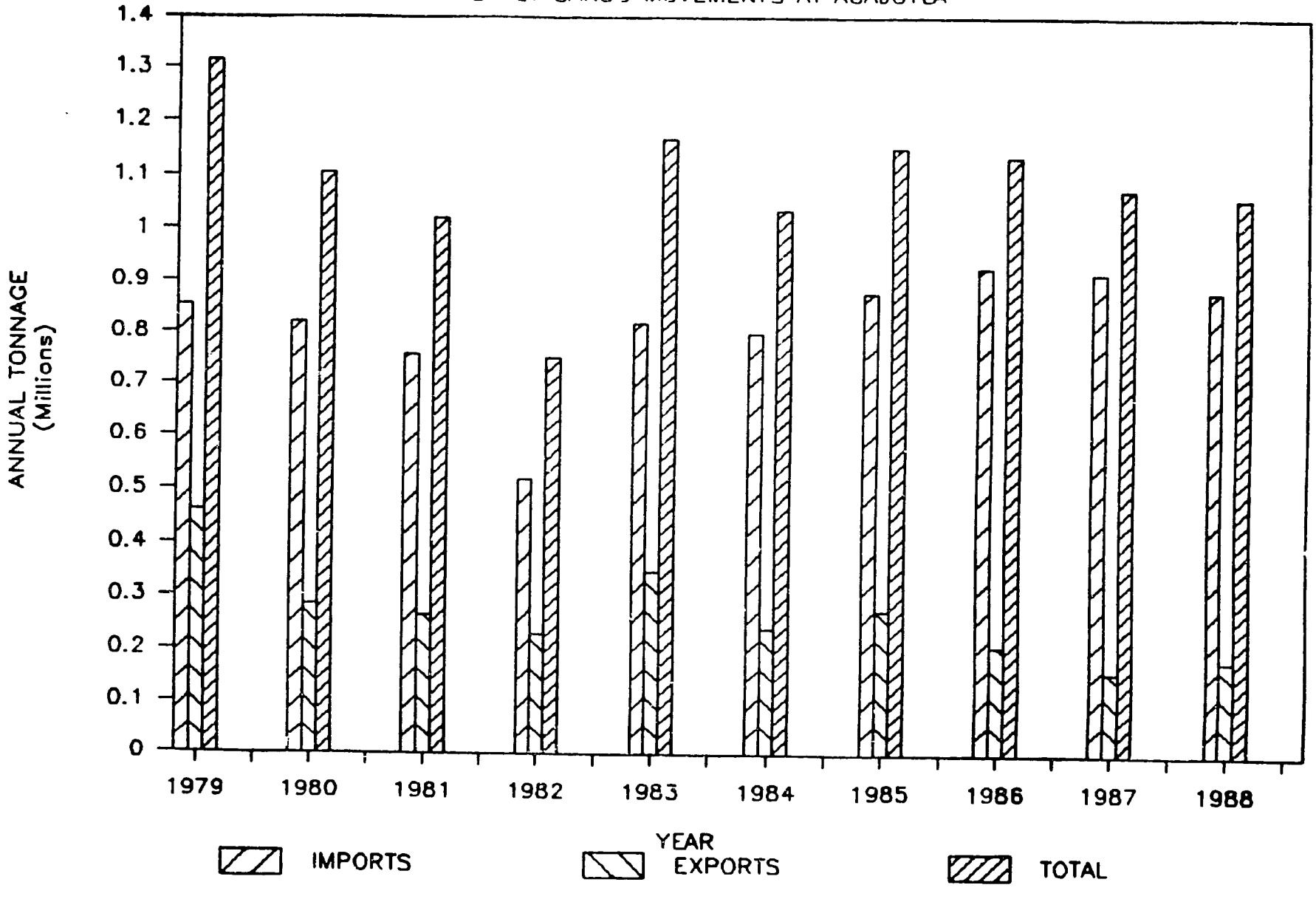


TABLE II.B.27

1988 EXPORT AND IMPORTS FROM/TO ACAJUTLA BY CARGO

C O N C E P T	I M P O R T S		E X P O R T		T O T A L	
	T O N S	%	T O N S	%	T O N S	%
G E N E R A L C A R G O						
GROCERIES	12,947	1.48	529	0.29	13,476	1.28
AJONJOLI			5,746	3.19	5,746	0.54
COTTON			583	0.32	583	0.06
BALSAM			53	0.03	53	0.01
EMPTY REELS			24	0.01	24	0.0023
COFFEE			76,956	42.78	76,956	7.29
COTTON FIBER			1,016	0.56	1,016	0.10
HONEY			705	0.39	705	0.07
OTHER FOODS			44	0.02	44	0.0042
FERTILIZER IN GENERAL	288	0.03			288	0.03
OILS, VEG. & AN. FAT	1,369	0.16			1,369	0.13
ANIMAL FOOD	14	0.0016			14	0.0013
CLAY ARTICLES & SIMILARS	5,036	0.58			5,036	0.48
PAPER & PRINTED MAT.	1,653	0.19			1,653	0.16
CEMENT	627	0.07			627	0.06
CEREALS IN BAGS	29,737	3.40			29,737	2.82
LOADED CONTAINER *	11,531	1.32	4,750	2.64	16,281	1.54
EMPTY CONTAINER *	2,027	0.23	8,994	5.00	11,021	1.04
PERSONAL EFFECTS	186	0.02	128	0.07	314	0.03
EQUIPMENT IN GENERAL	851	0.10			851	0.08
HARDWARE	4,003	0.46	70	0.04	4,073	0.39
FLOUR IN BAGS	956	0.11			956	0.09
LUBRICANTS	295	0.03			295	0.03
TIRES	1,468	0.17			1,468	0.14
WOOD	285	0.03			285	0.03
MACHINERY	4,728	0.54	35	0.02	4,763	0.45
CONSTRUCTION MATERIALS	3	0.00			3	0.0003
PLASTIC MAT. & ARTIFICIAL FIBER	999	0.11			999	0.09
MINERALS	3,026	0.35			3,026	0.29
PAPER REELS	18,400	2.10			18,400	1.74
INSECTICIDE	407	0.05			407	0.04
IRON PRODUCTS	69,779	7.97			69,779	6.61
INDUSTRIAL SUPPLIES	1,107	0.13			1,107	0.10
PRODUCTS FOR THE INDUSTRY	20,653	2.36	201	0.11	20,854	1.98
CHEMICAL PRUDUCTS	10,661	1.22	74	0.04	10,735	1.02
SPARES	3,754	0.43			3,754	0.36
RESINES	1,376	0.16			1,376	0.13

TABLE II.B.27

1988 EXPORT AND IMPORTS FROM/TO ACAJUTLA BY CARGO

CONCEPT	IMPORTS		EXPORT		TOTAL	
	TONS	%	TONS	%	TONS	%
GENERAL CARGO						
TEXTILES, LEATHER ARTICLES	1,029	0.12	258	0.14	1,287	0.12
ELECTRIC MATERIALS	2,078	0.24			2,078	0.20
VEHICLES	5,546	0.63			5,546	0.53
GLASS	2,170	0.25			2,170	0.21
OTHER PRODUCTS	8,911	1.02	1,620	0.90	10,531	1.00
BULK CARGO						
FERT. & RAW MATERIAL FOR FERT.	235,102	26.86			235,102	22.28
SODIUM CARBONATE	16,377	1.87			16,377	1.55
CEREALS	210,144	24.01			210,144	19.91
CORN FLOUR	2,610	0.30			2,610	0.25
SOY FLOUR	101,262	11.57			101,262	9.60
SUGAR			78,105	43.42	78,105	7.40
OTHERS	5,767	0.66			5,767	0.55
LIQUID CARGO						
OIL	7,354	0.84			7,354	0.70
COTTON SEED OIL	19,368	2.21			19,368	1.84
FAT	32,655	3.73			32,655	3.09
BUTANE	12,481	1.43			12,481	1.18
OTHERS	4,369	0.50			4,369	0.41
TOTAL	875,389	100	179,891	100	1,055,280	100

* REFERS ONLY TO WEIGHT OF THE CONTAINER

TABLE II.B.28

1988 EXPORTS AND IMPORTS FROM/TO ACAJUTLA BY COUNTRY

COUNTRY	EXPORT		IMPORTS	
	TONS	%	TONS	%
UNITED STATES OF AMERICA	57,171	31.78	537,309	61.38
GERMANY	52,461	29.16	18,555	2.12
SOVIET UNION	40,613	22.58	4,059	0.46
JAPAN	13,212	7.34	12,100	1.38
CANADA	4,855	2.70	35,710	4.08
NETHERLANDS	3,000	1.67	25,890	2.96
UNITED KINGDOM	1,348	0.75	4,060	0.46
BELGIUM	(1)		63,182	7.22
VENEZUELA	(1)		37,939	4.33
NORWAY	(1)		15,074	1.72
RUMANIA	(1)		13,775	1.57
PHILLIPINES	(1)		13,005	1.49
ECUADOR	(1)		12,076	1.38
MEXICO	(1)		10,970	1.25
TAIWAN	(1)		8,089	0.92
CHILE	(1)		8,026	0.92
SOUTH KOREA	(1)		7,136	0.82
COSTA RICA	(1)		5,407	0.62
PUERTO RICO	(1)		4,576	0.52
BRAZIL	(1)		4,420	0.50
FRANCE	(1)		4,046	0.46
DUTCH WEST INDIES	(1)		3,261	0.37
LIBYA	(1)		3,012	0.34
PERU	(1)		2,509	0.29
OTHERS	7,231	4.02	21,203	2.42
TOTAL	179,891	100	875,389	100

(1) INCLUDED UNDER "OTHERS"

TABLE II. B. 29

ACAJUTLA CONTAINER MOVEMENTS

	40-FOOT CONTAINERS			20-FOOT CONTAINERS		
	LOADED	EMPTY	TOTAL	LOADED	EMPTY	TOTAL
1986 IMPORTS	1,035	170	1,205	2,145	1,344	3,489
1986 EXPORTS	402	624	1,026	1,726	1,482	3,208
1986 TOTAL			2,231			6,697
1987 IMPORTS	1,409	138	1,547	2,454	1,312	3,766
1987 EXPORTS	432	851	1,283	2,015	1,709	3,724
1987 TOTAL			2,830			7,490
1988 IMPORTS	1,673	132	1,805	2,616	643	3,259
1988 EXPORTS	341	1,554	1,895	1,599	1,583	3,182
1988 TOTAL			3,700			6,441

TABLE II.B.30

1988 SHIP MOVEMENTS AT ACAJUTLA PORT

MONTH	TOTAL DAYS	NUMBER OF SHIPS AT PIER (DAYS IN MONTH)								No. OF INCOMING SHIPS
		0	1	2	3	4	5	6	7	
JANUARY	31	2	5	8	9	6	1			35
FEBRUARY	29	2	4	7	7	7	2			33
MARCH	31	1	4	5	4	11	4	1	1	36
APRIL	30	2	3	2	3	3	8	5	4	35
MAY	31	1	2	6	6	5	4	5	2	32
JUNE	30		1	7	1	4	8	5	4	33
JULY	31	1	6	7	10	4	3			28
AUGUST	31		2	6	16	3	4			25
SEPTEMBER	30	4	7	3	9	4	3			29
OCTOBER	31			4	13	7	1	4	2	29
NOVEMBER	30		5	9	7	5	3	1		25
DECEMBER	31	6	10	10	4	1				23
TOTAL	366	19	49	74	89	60	41	21	13	363

TABLE II.B.31

1988 ACTIVITIES AT ACAJUTLA

MONTH	PIER "A"				PIER "B"				PIER "C"			
	No S	WEIGHT T	H.E.W.	H.S.P.	No S	WEIGHT T	H.E.W.	H.S.P.	No S	WEIGHT T	H.E.W.	H.S.P.
TOTAL	167.9	278,111	5,020	7,124	100.8	578,857	5,798	9,626	94.3	198,312	3,268	4,871
JANUARY	12	25,133	488	610	10	26,189	351	520	13	6,561	144	232
FEBRUARY	16	28,246	395	537	10	50,436	339	590	7	4,987	135	364
MARCH	16.4	14,988	338	500	7.4	98,846	624	989	12.2	11,111	256	334
APRIL	15	42,650	622	764	10	80,913	802	1,234	10	19,564	350	422
MAY	13	23,798	528	781	12.9	39,599	484	943	6.1	13,971	261	407
JUNE	21	34,068	604	880	7.5	58,433	713	1,193	4.5	27,296	376	638
JULY	11	17,212	360	555	11	20,997	379	625	6	26,762	277	445
AUGUST	13	12,875	323	577	5	33,844	386	861	7	12,771	165	326
SEPTEMBER	12	17,599	336	527	7	39,299	154	344	10	16,131	223	326
OCTOBER	16	25,155	414	538	11.4	64,700	792	1,205	1.6	33,530	330	660
NOVEMBER	12.5	15,428	311	449	5.6	58,875	710	987	6.9	16,412	346	436
DECEMBER	10	20,959	301	406	3	6,726	64	133	10	9,216	205	281

No S = NUMBER OF SHIPS; WEIGHT T = METRIC TONS ; H.E.W. = HOURS EFECTIVELY WORKED ; H.S.P. = HOURS STAY AT PIER

Ships experienced 9,761 hours of delay at Acajutla last year. Most of the delay (52 percent) took place during the March-June peak period. Equipment failures and operating problems were the cause for 42 percent of the total delay.

(2) Port of Cutuco

Cutuco is the second most important port in El Salvador. It serves as an alternate port for Acajutla.

Table II.B.32 shows Cutuco's activities for 1983-1988. Berthed ships and the total cargo handled have been decreasing with time. Last year, there were 76,700 tons of cargo, of which 64,600 tons were imports and 12,100 tons were exports.

d. Problem Areas

(1) Pier A

The Consultants' visit to the Port of Acajutla confirmed that the most important immediate problem is the poor condition of Pier A's infrastructure. The steel cells at this pier show a high degree of corrosion. In the mid term, this could seriously affect Pier A's structural stability, precluding port operations.

(2) Cargo handling

Acajutla has a cargo-handling capability problem. Though this can be partially traced to lack of adequate equipment, the port's general configuration is more important.

Acajutla's piers are laid out in "fingers" not adapted to modern shipping requirements. Containerized cargo is becoming prominent in general cargo traffic, and this phenomenon will continue to grow. Given the existing configuration, the handling of containers on pier "C" will prove very costly.

The proposed new pier does not seem, at first glance, an adequate solution either. The resulting configuration would still not be adapted to modern port technology. A deep back-up area is required directly behind the berth, to allow for optimal use of expensive heavy equipment. In addition, there is some question as to the waves and swells that would be created by the new pier.

CEPA should urgently look at a number of alternatives. The Consultants propose some preliminary ideas in the following section.

TABLE II.B.32

CUTUCO PORT ACTIVITIES FOR 1983 - 1988

ACTIVITY	1983	1984	1985	1986	1987	1988
SHIP ARRIVALS TOTAL	73	57	80	55	n.a	36
LINER SHIPS	73	57	80	55	n.a	27
TANK BOATS						9
MERCHANT SHIPS DOCKED						
NUMBER OF SHIPS DOCKED	73	57	80	55	n.a	36
G. R. T. (IN THOUSANDS)	506.0	377.3	646.2	412.9	-	271.2
N. R. T. (IN THOUSANDS)	305.5	299.1	389.7	258.6	-	179.2
TOTAL WEIGHT MOBILIZED (IN THOUSANDS OF TONS)	135.4	87.5	112.3	83.8	77.6	76.7
IMPORTS (IN THOUSANDS OF TONS)	81.8	60.1	76.8	70.6	61.1	64.6
GENERAL CARGO	1.1	7.4	3.3	3.9	7.1	4.7
BULK CARGO	69.4	42.9	64.0	53.7	34.3	39.3
LIQUID BULK CARGO	11.3	9.8	9.5	13.0	19.7	20.6
EXPORT (IN THOUSANDS OF TONS)	53.6	27.4	36.1	16.2	16.5	12.1
GENERAL CARGO	53.6	27.4	36.1	16.2	16.5	12.1

TABLE II.8.32

CUTUCO PORT ACTIVITIES FOR 1983 - 1988

ACTIVITY	1983	1984	1985	1986	1987	1988
INDICATORS						
AVERAGE TONS MOBILIZED/SHIP (IN THOUSANDS)	1.90	1.50	1.40	1.60	na	2.10
AVERAGE GRT / SHIP (IN THOUSANDS)	6.90	6.60	8.10	7.50	-	7.50
AVERAGE NRT / SHIP (IN THOUSANDS)	4.20	4.00	4.90	4.70	-	5 [illegible]
AVERAGE DAILY ARRIVALS	0.20	0.20	0.20	0.20	-	0.10
AVERAGE HOURS-SHIP IN PORT	75.14	53.32	44.53	46.50	-	63.01
AVERAGE HOURS-SHIP IN PIER	60.17	48.19	40.31	43.40	-	58.61
AVERAGE HOURS-SHIP EFFECTIVELY WORKED	30.02	30.26	25.45	27.50	-	39.14
AVERAGE HOURS-SHIP NOT WORKED	30.14	17.53	14.47	15.50	-	19.17
AVERAGE HOURS SHIP-ANCHORING-DOCKING	6.47	4.59	4.04	2.50	-	4.14
AVERAGE HOURS SHIP UNDOCKING-RE-DOCKING	0.41	0.02	0.04	0.01	-	0.03
AVERAGE HOURS SHIP UNDOCKING-SAIL	8.09	0.11	0.14	0.10	-	0.19
PERFOMANCE						
TONS-HOUR SHIP IN PORT	24.7	28.7	41.4	33.6	n.a	33.80
TONS-HOUR SHIP IN PIER	30.8	31.8	34.8	36.2	-	36.30
TONS-HOUR PER-SHIP EFFECTIVELY WORKED	48.8	50.5	54.8	56.8	-	54.40
RATIOS						
HOURS DOCKED AS % PORT STAY	81	90	90	93	n.a	93
HOURS EFFECTIVELY WORKED AS % PORT STAY	51	57	57	59	-	62
HOURS EFFECTIVELY WORKED AS % PIER STAY	63	63	64	64	-	67
HOURS NOT WORKED AS % PIER STAY	37	37	36	36	-	33
HOURS ANCHORING-DOCKING AS % PORT STAY	1	9	1	0	-	7
HOURS UNDOCKING-REDOCKING AS % PORT STAY	NA	0	-	-	-	0
HOURS UNDOCKING-SAIL AS % PORT STAY	11	0	-	0	-	0

(3) Cutuco

Cutuco's main problem is very low traffic volumes. Its deteriorated infrastructure, added to its greater distance to import-export centers, contribute to low traffic demand. Its vicinity to the private sector Port of Punta Gorda further reduces demand.

e. Economic Evaluation

Cargo handling efficiency needs to be improved at Acajutla. This will become worse as traffic, and particularly container traffic increases. Lack of adequate equipment has been part of the problem, but in our view, the port's configuration is the major obstacle.

Because Acajutla does not have dedicated berths, it is difficult to conduct a detailed port throughput analysis. In order to obtain some preliminary indices, the Consultants relied on discussions with port authorities and their observations during a field visit.

Acajutla has eight berths, but port configuration and the size of calling ships reduce the effective number of berths to seven. For the purpose of this analysis, we will assume that two are solid-bulk berths, one is a liquid-bulk berth, and the other four are general-cargo berths.

As shown in Table II.B.26, Acajutla handled 650,000 tons of solid bulk, 76,000 tons of liquid bulk, and 330,000 tons of general cargo in 1988. This represents the following:

PORT OF ACAJUTLA - CURRENT THROUGHPUT

Type of Cargo	Tons/berth/year
Solid Bulk	325,000
Liquid Bulk	76,000
General Cargo	82,500

Table II.B.30 shows an average occupancy of three berths in 1988. Assuming position arrivals and first-come first-served queuing discipline, ships (considering all kinds) wait an average of one percent of their service time, which is very low. An economical and generally accepted waiting time/service time ratio is 0.25.

To plan the port's berthing needs, the Consultants have

forecasted traffic growth and compared expected volumes with practical berth capacities. Considering that traffic follows GDP growth , and assuming increased containerization, traffic would reach the following values:

FORECASTED PORT TRAFFIC
('000 tons)

Type of Cargo	1988	2000	2010
Solid Bulk	649	928	1441
Liquid Bulk	76	109	169
General Cargo (1)	230	283	366
Containers (2)	100	189	366

(1) Not including containers
(2) Containerization rate: 1988 - 30; 2000 - 40 and 2010 -50

A conservative estimate of berth capacities for well laid-out ports is indicated below:

BERTH PRACTICAL CAPACITY(1)

Type of Cargo	Tons/berth/year
Solid Bulk (2)	750,000
Liquid Bulk (2)	750,000
General Cargo (3)	180,000
Containers	750,000

Source: ISA Consultant experience

(1) For modern port configurations. With Acajutla's present lay-out, a practical capacity of about 250,000 tons could be achieved for bulk and containers. This reduced capacity, coupled with the need for acceptable ship queueing times, determines that more berths will be needed in the future, with the port's present configuration.

(2) Includes necessary time to clean the installations following a change of product.

(3) Assumes 25 of the cargo is either containerized or pelletized.

Keeping the 0.25 waiting time/service time ratio as an objective, (see Table II.B.33) the following configuration would meet Acajutla's port requirements for our planning horizon:

TABLE II.B.33

BERTH OCCUPANCY RATES AND NUMBER OF BERTHS IN PORT

	TYPE OF BERTH	
No of Berths	General Cargo	Bulk or Container
1	.30	.37
2	.45	.56
3	.57	.67
4	.65	.74
5	.70	.77
6	.73	.79
7	.76	.81
8	.78	.83
9	.81	.84
10	.82	.85
Ratio Waiting Time/ Service Time (1)	.25	.20
Arrival Service Formula	Poisson	Erlang

(1) The above occupancy ratios relate to delays generally accepted for the types of ships calling at Acajutla.

Type of Cargo	1988	2000
Solid Bulk	2	3
Liquid Bulk	3	3
General Cargo	3	3
Containers	1	1
TOTAL	6	7

It appears from the above that Acajutla will have to enlarge its installations in the near future. Recommended criteria for such an expansion are as follows:

- Minimize construction cost
- Avoid interference and pollution by separating bulk from general cargo
- Provide as much back-up area for containers as possible
- Avoid long piers with poor access
- Remove warehouses on piers, unless needed for fruit

As Figure II.B.4 shows, proposed improvement do not correspond to the above criteria. The proposed 56-million dollar container pier, is being very expensive (probably about 25 million dollars, and does not meet many of these criteria.

Figure II.B.6 shows a preliminary port concept which achieves the objectives stated above. The key to the proposed concept is ample container-handling space directly behind the berth and separation of bulk from general cargo. Table II.B.34 shows rough estimates of container-handling savings which could be obtained from an improved pier lay-out.

The conceptual lay-out presented would be one way to provide sufficient capacity with a relatively low investment. In the mean time, existing deficient cargo-handling equipment should be repaired or replaced. No important investments in new equipment, such as a container-handling crane is warranted. This type of equipment cannot increase the port's capacity as the bottleneck is not the loading/unloading of the ships, but the transfer of cargo to and from storage.

f. Project Needs

(1) Pier A

Repair of Pier A's infrastructure should have the highest priority. In 1988, the German Government offered to finance the project, by way of KfW, and hoped work would start at the beginning of 1991. Necessary works are estimated to cost

FIGURE II. B. 6

ALTERNATIVE LAY-OUT FOR PORT OF ACAJUTLA.

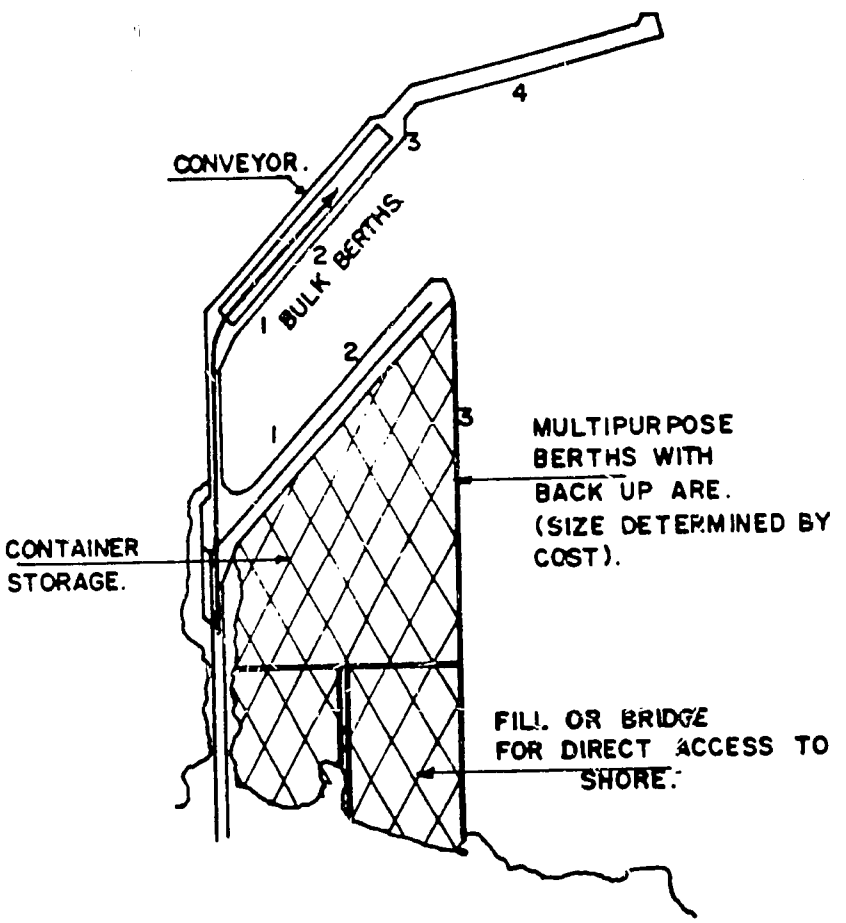


TABLE II.8.34

NEW CONTAINER PIER CONFIGURATION

Cost Savings in Container Handling (1988 US$)

ASSUMPTIONS:

* Two-km distance from pier to yard
* Thirty-km/h speed for container-handling trucks
* Additional ten-minute handling time per container by container-handling forklifts with current lay-out, because of duplication of manouvers (containers are moved from pier to ruck and from truck to yard, as opposed to only from pier to yard)
* 32$/h operating cost for container-handling trucks
* 100$/h operating cost for container-handling fork-lifts (obtained from amortizing the equipment over 1250 hours per year)
* 500$/h operating cost for Acajutla's average size ship (11,000 GRT), when at port (Source: US Corp of Engineers, Lloyds of London, Marine Management Systems)
* An average of 200 containers per general-cargo ship
* An average of 10 tons of cargo per container
* All increases in ship operating costs are transferred by liners to El Salvador
* Only one effective container berth exists today, the other general cargo berths are for break-bulk cargo

1. Average number of containers per year (1988-2000) = $\frac{100{,}000\text{t}}{10\text{t/cont}} + \frac{189{,}000\text{t}}{10\text{ t/cont}} = 14{,}500$

2. Average number of container ships per year = $14{,}500/200 \frac{\text{cont}}{\text{ship}} = 73$ ships

3. Truck operating cost savings = $\frac{2\text{km}}{30\text{ km/h}} * 32\frac{\$}{\text{h}} * 14{,}500 = 31{,}000\ \frac{\$}{\text{yr}}$

4. Fork-lift operating cost savings = 10 min. * $\frac{1\text{h}}{60\text{ min.}} * 100\frac{\$}{\text{h}} * 14{,}500 = 242{,}000\ \frac{\$}{\text{yr}}$

5. Ship operating cost savings:

At pier : $200 \frac{\text{boxes}}{\text{ship}} * \frac{10\text{min}}{\text{box}} * \frac{1\text{h}}{60\text{ min}} - 24.4\frac{\text{h}}{\text{ship}}$ (1) $= 9 \frac{\text{h}}{\text{ship}}$

$9 \frac{\text{h}}{\text{ship}} * 500 \frac{\$}{\text{h}} * 73 \frac{\text{ship}}{\text{year}} = 329{,}000 \frac{\$}{\text{yr}}$

Additional Waiting Period :

W/present configuration $73 \frac{\text{ships}}{\text{year}} * 33 \frac{\text{h}}{\text{ship}} = 2409 \frac{\text{h}}{\text{yr}}$

berth occupancy ratio $= \frac{2409}{7200} = 0.33$

queueing time-service time ratio $= 0.5$ (2)

delay $= 0.5 * 33 \frac{\text{h}}{\text{ship}} = 16 \frac{\text{h}}{\text{ship}}$

W/improved configuration $73 \frac{\text{ships}}{\text{year}} * 24 \frac{\text{h}}{\text{ship}} = 1752 \frac{\text{h}}{\text{yr}}$

berth occupancy ratio $= \frac{1752}{7200} = 0.24$

queueing time-service time ratio $= 0.33$ (3)

delay $= 0.33 * 24 \frac{\text{h}}{\text{ship}} = 8 \frac{\text{h}}{\text{ship}}$

Additional waiting period : $= 16 - 8 = 8\text{h/ship}$

$8 \frac{\text{h}}{\text{ship}} * 500 \frac{\$}{\text{h}} * 73 \frac{\text{ship}}{\text{year}} = 292{,}000 \frac{\$}{\text{yr}}$

6. Total saving costs at container berth(s) = 894,000 $/yr (3)

Notes:

(1) Current number of hours effectively worked per ship, assumed acceptable for comparison purposes.

(2) From queuing time-service time ratio tables. See Jansson, Owen and Shneerson, Dan, "Port Economics", MIT press, Cambridge, Massachussets, 1982.

(3) This figure could justify an investment of 7.5 million dollars at a 12 percent rate of return. Additional benefits are also obtained because of improved efficiency at break-bulk and bulk cargo handling which are not considered in this analysis.

approximately C75 million, and to last 60 months. In the short term, emergency measures are needed to the visibly-deteriorated cells.

(2) Container handling

As container transport increases, the operations at Acajutla will become more expensive, due to the existing pier lay-out. There is a need for a new lay-out, with better container-handling capabilities, and a port study is needed to analyze current pier infrastructure and propose adequate solutions for expected traffic levels.

In the short term, to improve cargo-handling efficiency with the current port lay-out, new operating equipment and rehabilitation of some existing equipment are needed. No major investment, such as a container-handling crane is warranted. CEPA feasibility studies show that on the order of C15.8 million would be required to implement this project in twelve months. Japanese and German financing is available.

Appendix II.B.1 shows a list of minor projects and improvements currently needed at Acajutla.

(3) Cutuco

The Consultants have recommended a national transportation study. On marine ports, such a study should address:

- the economic feasibility of Cutuco

- the potential need for an alternative port to Acajutla, because of possible earthquakes, security reasons, or as an overflow port to some Acajutla traffic during peak periods

- the relationship between Punta Gorda and Cutuco

- the potential need for a modern port to help revitalize Eastern El Salvador.

Until the national transportation study is completed, the Consultants recommend no further investment at Cutuco. The issues mentioned above might commercially could justify one modern port in the East, but certainly not two (Cutuco and Punta Gorda).

4. Airports

The International Airport of El Salvador (Aeropuerto Internacional de El Salvador -AIES- or Comalapa) is situated

in the central zone of the country, in the Department of La Paz. It is 48 km to the Southeast of San Salvador, reached by a modern highway. It was completed in 1978.

A second airport services the San Salvador area, Ilopango International Airport (designated for small plane usage). It lies about 10 km to the east of downtown San Salvador, within the metropolitan area. Its usage is predominantly general aviation and military, and is addressed in this study as an alternate airport to Comalapa.

a. Inventory of Facilities

(1) AIES (Comalapa)

(a) Installations

The airport has a modern passenger terminal with the capacity to serve 7 airplanes simultaneously. It has a cargo terminal on the West, with three airplane parking platforms. A fire-fighter station is located on the East side. The main runway is 3,200 meters long and 45 meters wide. There is also a secondary runway, currently 800 meters long. The airport lies about 30 meters above sea level (Figure II.B.7).

The 1979 airport master plan called for the future expansion of the airport platform facilities. New passenger and cargo positions were envisioned. Prevailing traffic levels do not warrant new airplane positions at the moment. As traffic increases, one or two new passenger plane parking platforms and one cargo-plane parking platform may be needed by the year 2000.

(b) Storage Areas

((1)) Import Warehouses

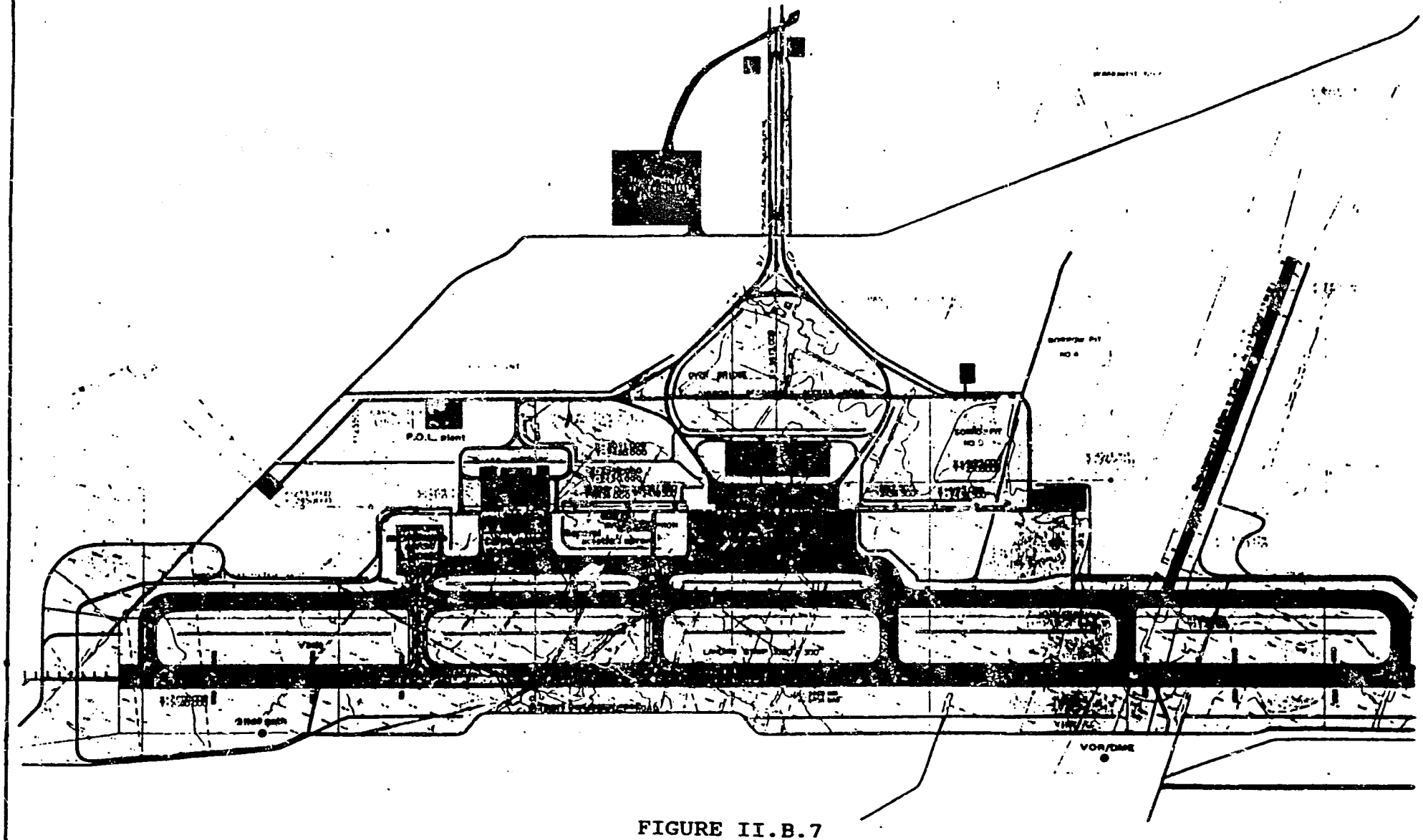


FIGURE II.B.7

EL SALVADOR INTERNATIONAL AIRPORT

W'house No.	Use	Storage (m2)	Passageways (m2)	TOTAL (m2)
1.	Cargo difficult to handle	750.0	120.0	870.0
2.	Frozen Cargo	19.0	8.7	27.7
3.	Refrigerated Cargo	26.0	10.2	36.2
4.	Small packets (weight 1kg)	10.0	9.8	19.8
5.	Valuables, drugs, arms etc	5.5	3.5	9.0
6.	Valuables, drugs, arms etc	7.5	4.5	12.0
7.	Unregistered general cargo	869.0	2165.0	3064.0
8.	Registered general cargo	172.5	562.5	735.0
TOTALS		1849.5	2884.2	4733.7

((2)) Export Warehouses

Use	:	All export cargo
Storage	:	1,563.0
Passageways	:	152.0
TOTAL		1,715.0

((3)) Deposit Area

The deposit area receives import and export cargo, with an 870-square meter roofed area.

(c) Equipment

Each airline owns or rents equipment for handling goods. For handling cargo imports, cargo CEPA has the following equipment:

- Fork-lifts with 2,000- and 3,000-kg capacities;
- a fixed weighbridge with a 5,000-kg capacity;
- mobile weighbridges with 50-, 500- and 1,000-kg capacities;
- hydraulic fork-lifts with a 1000-kg capacity; and four moving platforms.

(d) Current Condition

Airplane parking platforms, runways and taxiways present serious distresses, as do signs of fatigue, with localized damage reaching severe proportions, illustrating a lack of maintenance.

The electrical and navigational aid systems have been badly affected by voltage changes.

(2) Ilopango

Ilopango's main runway is 2,240 meters long and 45 meters wide, with an orientation 15/33. It is located 614 meters above sea level. There are four taxiways with widths varying from 15 to 25 meters and lengths of 100 to 1,000 meters. A 1,600-meter secondary runway is presently not been used.

The airport's design aircraft is a Boeing 707, although the airport has supported DC-10s during part of its 24 years of operation. The runway was designed for 75,000 kg per aircraft wheel. The runway's original pavement structure had a 2.5-inch asphalt layer over a granular base. It has been reinforced twice with a 3-inch layer in 1974 and a 2.5-inch layer in 1976/1977.

b. Projects Underway/Planned

(1) AIES

Projects currently being implemented, and those planned, include the following:

(a) Additional Emergency Generator

The airport currently has two 750-Kw generators which supply electric power to the terminals and airlines for lighting, and another 375 - Kw generator to supply power for radar, telecommunications, and lighting the runway.

Another generator is needed to operate all the systems, especially to operate the air-conditioning system in the terminal and the cold rooms that serve export products. It will have a capacity of 800 Kw and it is expected to be installed in early 1990. Its estimated cost is US$400,000, to be financed by AID.

(b) Additional Fork-Lift

The airport recently acquired a fork-lift to improve its service to airlines, and it is planning to get another fork-lift at an approximate cost of US$18,000.

(c) Mechanical Sweeper

The terminal area has a mechanical sweeper for cleaning outside the building, which is badly deteriorated and in constant need of repair. Another sweeper is budgeted for 1990, with an approximate cost of US$21,000.

(d) Replacement of the Telephone System

The 1986 earthquake, seriously damaged the telephone system. It received temporary repairs which barely maintained its 20 trunk lines and 200 extensions, however, steps are being taken to acquire a new system designed to double present capacity, at an approximate cost of US$70,000. This project will be opened to public bidding.

(e) Security System

The airport needs an improved security system, particularly in light of the current state of conflict. Steps are being taken to acquire new x-ray machines for access to the terminal (passengers and luggage) and to the transit area, and for control of baggage going planes.

AID has promised a donation of two x-ray machines, but has only provided one until now. The cost of the project is approximately US$41,240.

(f) Repair of Signal Generator and Transceiver

Repairs to the signal generator and transceiver are being considered to improve the system in the tower. Costs have not been updated. However, this project forms part of navigation aids, installed when the airport was built nearly eleven years ago. They are reaching the end of their useful lives. The original equipment is Japanese. New American equipment are recommended to facilitate procurement of spare parts. The cost, estimated by AID, for this navigational system is US$10,900

(g) Enlarging the Refrigerated Storage Area for Exports

The enlargement of the cold room that serves export products is at a conceptual stage.

(h) TACA Passenger Terminal

The airline Transportes Aereos Centroamericanos (TACA) is planning to build its own terminal, which would leave space free in the current terminal for the future incorporation of new airlines.

(i) Expansion of the Secondary Runway

Airport management has considered a possible expansion of the secondary runway to 2,600 meters. It could then serve as an alternate runway for commercial aircraft.

(2) Ilopango

Erosion control is needed to stabilize the gorge located to the South of the main runway. The first phase of this project has recently been finished and the second phase is in need of financing (US$1,000,000). The main runway also needs rehabilitation, for an estimated amount of US$1,400.000.

Other projects which have been identified by the General Directorate for Civil Aviation are:

- Repair/replacement of the field light electric system (US$100,000).

- Improvements to control tower equipment: communication equipment, navigational aid equipment, and miscellaneous (US$30,000).

- Improvements to the weather information system (US$20,000).

- Acquisition of maintenance equipment: a caterpillar, a front loader, 2 pick-ups and a dump truck (US$260,000).

- Safety equipment: two fire-trucks, and others (US$200,000).

c. Traffic History

(1) AIES

This section summarizes available information on international passenger, cargo and aircraft traffic at the AIES. Table II.B.35 lists annual passenger and cargo flows as well as the numbers of commercial flights, since 1980 (first full year of operations).

Passenger movements were 70 percent higher in 1988 than in 1980. Last year, approximately 430,000 passengers arrived or departed. Cargo traffic increased 30 percent from 1980 to 1988, when 13,129 tons were transported. Commercial flights increased 17 percent during the same period, to a 1988-level of 5,715 flights.

Despite these increases, traffic has not reached projected levels when the airport was built. These projections were based on traffic volumes at Ilopango in the 1970s, which are similar to the 1988 traffic levels at AIES. For example, average annual international traffic at Ilopango during 1976-1979 included 327,097 passengers, 18,323 tons of cargo and 5,837 flights.

TABLE II.B.35

INTERNATIONAL TRAFFIC AT A.I.E.S. (COMALAPA)

YEAR AND MONTH	NUMBER OF FLIGHTS (1)	ARRIVALS				DEPARTURES			
		PASSENGERS		CARGO (Tons)		PASSENGERS		CARGO (Tons)	
		TOTAL	AVERAGE DAILY	TOTAL	AVERAGE DAILY	TOTAL	AVERAGE DAILY	TOTAL	AVERAGE DAILY
1982	5,342	123,447	338	4,585	13	120,961	331	2,659	7
1983	5,064	129,488	355	5,255	14	139,820	383	3,677	10
1984	5,181	144,576	396	6,363	17	164,654	451	4,796	13
1985	5,630	161,368	442	6,174	17	171,666	470	4,428	12
1986	5,435	167,186	458	5,676	16	168,457	462	3,160	9
1987	5,764	180,469	494	6,784	19	165,828	454	4,747	13
1988	5,715	220,897	605	6,869	19	211,875	580	6,260	17
JANUARY	624	15,963	515	630	20	21,129	682	348	11
FEBRUARY	559	12,481	446	536	19	14,035	501	390	14
MARCH	583	15,898	513	467	15	13,811	446	472	15
APRIL	521	16,182	539	547	18	17,209	574	420	14
MAY	532	16,117	520	597	19	16,385	529	507	16
JUNE	517	18,204	607	495	17	15,358	512	504	17
JULY	627	24,433	788	566	18	21,397	690	522	17
AUGUST	583	23,000	742	561	18	23,119	746	514	17
SEPTEMBER	576	13,894	463	550	18	16,862	562	557	19
OCTOBER	566	15,921	514	546	18	15,231	491	607	20
NOVEMBER	594	16,775	559	626	21	18,818	627	633	21
DECEMBER	785	32,029	1,033	749	24	18,521	597	787	25

Table II.B.36 lists the airlines which utilize AIES, aircraft types, routes, weekly arrivals and departures.

(a) Passenger Traffic

A complete record of 1988 passenger departures/arrivals by origin or destination is shown in Table II.B.37. Miami and Los Angeles are the two most common points of arrival/departure, accounting for approximately 54 percent of the passenger traffic. Monthly variations in passenger movements are presented in Table II.B.38. As expected, traffic peaks in January and August because of winter and summer vacations.

(b) Cargo Traffic

AIES transports approximately one percent (by weight) of the total Salvadoran exports. Table II.B.39 lists products shipped from Comalapa. Monthly cargo traffic volumes are shown in Table II.B.40. Ports of export/import are presented in Table II.B.41. Miami is the most significant origin/destination, receiving 73 percent of the exports and shipping 53 percent of the imports.

(c) Aircraft Traffic

Table II.B.42 shows monthly landings and take-offs during 1988, by operation type, namely commercial (international), cargo, domestic and air-taxi traffic. Commercial traffic accounted for 81 percent of the flights in 1988, which were 7,066. Last year, cargo traffic originated 10 percent of all landings and take-offs; taxi traffic, 8 percent; and domestic traffic, 1 percent.

Monthly landing-aircraft loads are shown in Table II.B.43. A total of about 425,000 tons landed on the Comalapa main runway in 1988.

(2) Ilopango

In terms of number of take-offs/landings, usage at Ilopango is approximately 50 percent civilian and 50 percent military. International operations represent only seven percent of the airport's traffic. Table II.B.44 summarizes traffic statistics for Ilopango for 1986-1990.

Ilopango serviced a total of 81,154 passengers in 1988, about 19 of the people served by Comalapa. Considering only international passengers, Ilopango served 14,437 passengers, approximately 3 percent of Comalapa's traffic.

The total number of civilian flights at Ilopango was 13,605 in 1988 (Comalapa operated 7,066). The average number of passengers per civilian take-off or landing was 2.98,

TABLE II.B.36

AIRLINES OPERATING AT COMALAPA

AIRLINES OPERATING AT COMALAPA

AIRLINE	AIRCRAFT TYPE	ROUTE	WEEKLY ARRIVALS & DEPARTURES
TACA	B 767 B 737 200 B 737 300	Los Angeles-Guatemala-El Salvador El Salvador-Belize-Miami Honduras-El Salvador-Honduras El Salvador-Guatemala-México -Viceversa San Francisco-El Salvador-San Francisco Panamá-San José-El Salvador-Viceversa El Salvador-Belize-Houston-Viceversa El Salvador-Belize-New Orleans-Viceversa	14 14 14 14 2 14 12 12
PANAM	EA 300	San Francisco-Los Angeles-Guatemala-El Salvador-Viceversa	14
SAHSA	B 727-100	Guatemala-El Salvador-Honduras-Viceversa	14
COPA	B 727-100	Guatemala-El Salvador-Managua-San José-Panamá-Viceversa	14
LACSA	B 727-200	San José-México- Los Angeles-Viceversa	6
EASTERN	B 737	Miami-Honduras-El Salvador-Viceversa	14
CONTINENTAL	B 737	Los Angeles-Guatemala-Houston,Viceversa	14
AVIATECA	B 727	Guatemala-El Salvador-Guatemala	14
EMERALD	DC 9	Houston-Belize-El Salvador El Salvador - Houston	1 1
AERIAL T.C	DC 6	Miami-Belize-El Salvador El Salvador-Guatemala-Miami	Irregul.

TABLE II.B.36

AIRLINES OPERATING AT COMALAPA

AIRLINE	AIRCRAFT TYPE	R O U T E	WEEKLY ARRIVALS & DEPARTURES
AESA	DC 8	El Salvador-Miami-El Salvador	Irregular
MAXES.A	B 707	El Salvador-Miami-El Salvador	Iregular
TAES	B 707 DC 6 B	El Salvador-Miami-El Salvador	Irregular
AEROPUMA	B 727 BC 6-B	El Salvador-Miami-El Salvador	Irregular

TABLE II.B.37

PASSENGERS ARRIVALS AND DEPARTURES

BY ORIGIN AND DESTINATION

ORIGIN AND DESTINATION	PASSENGERS ARRIVED	%	PASSENGERS DEPARTURED	%
MIAMI	61,503	27.84	62,106	29.31
LOS ANGELES	57,939	26.23	52,575	24.81
GUATEMALA	22,974	10.40	20,031	9.46
TEGUCIGALPA	15,208	6.89	13,689	6.47
SAN JOSE	11,648	5.27	11,197	5.29
MEXICO	10,480	4.74	15,092	7.12
SAN FRANCISCO	8,999	4.07	9,033	4.26
HOUSTON	13,601	6.16	11,638	5.49
PANAMA	6,997	3.17	5,676	2.68
NEW ORLEANS	5,695	2.58	5,065	2.39
MANAGUA	4,348	1.97	3,820	1.80
BELIZE	1,505	0.68	1,248	0.59
SAN JUAN	-	-	87	0.04
CARACAS	-	-	143	0.07
BARRANQUILLA	-	-	23	0.01
MARACAIBO	-	-	24	0.01
CANCUN			428	0.20
TOTAL	220,897	93.115	211,875	84.090

TABLE II.B.38

MONTHLY IN TRANSIT PASSENGERS TRAFFIC

MONTH	NUMBER OF PASSENGERS	%
JANUARY	14,927	12.98
FEBRUARY	10,002	8.70
MARCH	8,502	7.39
APRIL	8,267	7.19
MAY	6,732	5.85
JUNE	8,373	7.28
JULY	10,389	9.03
AUGUST	11,814	10.27
SEPTEMBEI	9,242	8.04
OCTOBER	8,044	7.00
NOVEMBER	9,397	8.17
DECEMBER	9,312	8.10
T O T A L	115,001	100

TABLE II.B.39

PRODUCTS EXPORTED VIA COMALAPA

1. **Fabrics**
2. **Clothing Articles**
3. **Cakes**
4. **Horchata**
5. **Areca Seeds**
6. **Zukini**
7. **Handicrafts**
8. Plants
9. Flowers
10. Green Beans
11. Frozen Fruit
13. Pineapple
14. Savory Bananas
15. Birds
16. Frozen Shrimp
17. Fresh Fish
18. Newspapers
19. Other Perishable Goods

TABLE II.B.40

MONTHLY TRAFFIC OF IMPORT AND EXPORT CARGO (Kg.)

M O N T H	IMPORTS	%	EXPORTS	%
JANUARY	629,791	9.17	347,845	5.56
FEBRUARY	535,500	7.80	390,447	6.24
MARCH	467,383	6.80	472,313	7.55
APRIL	546,967	7.96	420,267	6.71
MAY	596,788	8.69	506,608	8.09
JUNE	495,200	7.21	503,518	8.04
JULY	565,698	8.24	521,841	8.34
AUGUST	561,197	8.17	513,531	8.20
SEPTEMBER	549,609	8.00	556,637	8.89
OCTOBER	545,565	7.94	607,035	9.70
NOVEMBER	626,410	9.12	632,526	10.11
DECEMBER	748,535	10.90	786,958	12.57
T O T A L	6,868,643	100	6,259,526	100

TABLE II.B.41

IMPORT AND EXPORT CARGO BY ORIGIN AND DESTINATION

	IMPORT ORIGIN (Kg)	%	EXPORT DESTINY (Kg)	%
MIAMI	3,614,898	52.63	4,561,563	72.87
LOS ANGELES	767,115	11.17	446,381	7.13
NEW ORLEANS	735,198	10.70	551,497	8.81
PANAMA	632,025	9.20	140,416	2.24
GUATEMALA	292,917	4.27	174,895	2.79
MEXICO	280,890	4.09	22,490	0.36
TEGUCIGALPA	131,801	1.92	132,683	2.12
SAN JOSE	126,309	1.84	126,434	2.02
SAN PEDRO SULA	30,453	0.44	-	-
SAN ANDRES	24,902	0.36	-	-
MADRID	15,774	0.23	-	-
HOUSTON	13,652	0.20	26,727	0.43
SAN FRANCISCO	9,658	0.14	19,684	0.31
KENNEDY (N.Y.)	5,408	0.08	280	0.01
MANAGUA	3,769	0.06	41,773	0.67
CARACAS	2,462	0.04	105	-
BOGOTA	813	0.01	-	-
BELIZE	750	0.01	14,064	0.22
CARTAGENA	414	-	-	-
BARRANQUIA	221	-	-	-
MEDELLIN	163	-	-	-
SAN JOSE	110	-	157	0.01
FRAND FORT	2	-	-	-
VARIOUS	178,939	2.61	-	-
MARACAIBO			377	0.01
TOTAL	6,868,643	100	6,259,526	100

TABLE II.B.42

MONTHLY AIRCRAFT TRAFFIC BY OPERATION TYPE

MONTHLY AIRCRAFT TRAFFIC BY OPERATION TYPE (1)

MONTH	COMMERCIAL		CARGO		DOMESTIC		AIR TAXI		TOTAL	
	Laandings	Take Offs	Landings	Take Offs	Landings	Take Offs	Landings	Take Offs	Landings	Take Offs
January	514	515	65	66	4	4	39	39	622	624
February	424	425	77	77	1	1	57	56	559	559
March	446	445	69	71	14	14	52	53	581	583
April	436	439	44	44	3	3	35	35	518	521
May	442	439	37	35	6	6	52	52	537	532
June	442	444	52	53	4	4	16	16	514	517
July	492	492	63	63	6	6	66	66	627	627
August	491	491	59	57	2	2	33	33	585	583
September	452	452	54	54	3	3	67	67	576	576
October	453	454	57	57	5	5	50	50	565	566
November	479	478	72	70	2	2	44	44	597	594
December	643	642	69	71	3	3	69	69	784	785
T O T A L	5.714	5.716	718	718	53	53	580	580	7.065	7.067

(1)Civilian Traffic Only.

TABLE II.B.43

MONTHLY LANDING - AIRCRAFT LOAD AT A.I.E.S

M O N T H	T O N S	%
JANUARY	37,729	8.89
FEBRUARY	29,857	7.03
MARCH	32,589	7.68
APRIL	31,434	7.40
MAY	32,405	7.63
JUNE	30,886	7.28
JULY	36,754	8.66
AUGUST	37,347	8.80
SEPTEMBER	34,535	8.13
OCTOBER	35,404	8.34
NOVEMBER	36,914	8.70
DECEMBER	48,621	11.46
T O T A L	424,475	100

TABLE II.B.44

I L O P A N G O I N T E R N A T I O N A L A I R P O R T

P A S S E N G E R A N D A I R C R A F T T R A F F I C

YEAR	T Y P E O F OPERATION	ARRIVING CIVILIAN PASSENGERS	DEPARTING CIVILIAN PASSENGERS	CIVILIAN FLIGHTS	MILITARY FLIGHTS
1986	DOMESTIC	71,863	73,234	22,119	13,790
1986	INTERNATIONAL	4,833	4,930	1,788	617
1987	DOMESTIC	58,014	59,772	16,958	12,309
1987	INTERNATIONAL	5,424	5,364	1,577	619
1988	DOMESTIC	33,093	33,624	12,146	12,633
1988	INTERNATIONAL	7,322	7,115	1,459	569
1989	DOMESTIC	37,447	39,110	15,546	14,173
1989	INTERNATIONAL	9,206	9,103	1,713	666
1990	DOMESTIC	41,192	43,021	16,324	14,898
1990	INTERNATIONAL	10,127	10,013	1,799	733

FOR 1990 ARE PROJECTIONS

indicating the predominant use of small private planes.

There were 13,202 military flights in 1988. Although this number is similar to the civilian total for the airport, it does not show its real relative importance. Heavier aircraft loads for military traffic should be taken into account when allocating the costs of needed maintenance/rehabilitation work.

Civilian cargo traffic is not significant at Ilopango, and an adjacent free-trade zone ships cargo mainly via Comalapa.

d. Problem Areas

(1) Runways

AIES's runway, taxiway and apron infrastructures show signs of isolated cracking, raveling and potholes. Although the current appearance of the runways is good, the observed damages constitute symptoms of fatigue and oxidation, indicating faster pavement deterioration in the future. This situation will result in higher maintenance costs, and a greater risk to take-offs and landings.

(2) Aeronavigation Systems

Aeronavigation radio-control systems have deteriorated, and the back-up electricity-generation system is currently insufficient.

Another problem of consequence concerns air cargo operations. There is a lack of warehouse space, which is made worse by stringent customs inspection requirements and users who do not remove their cargo promptly.

Ilopango's infrastructure, pavement structures, and terminal structures are badly deteriorated. The short distance between Ilopango and AIES, which is located almost at sea level, has prevented Ilopango from being competitive for cargo transport purposes.

e. Economic Evaluation

The runway problem is detailed in Figure II.B.8. Curve "A" shows a desirable pavement condition variation, or level of service variation, over time. As time passes, the level of service, or pavement condition, becomes lower because of an increased number of pavement distresses.

Curve "A" indicates some basic aspects of pavement

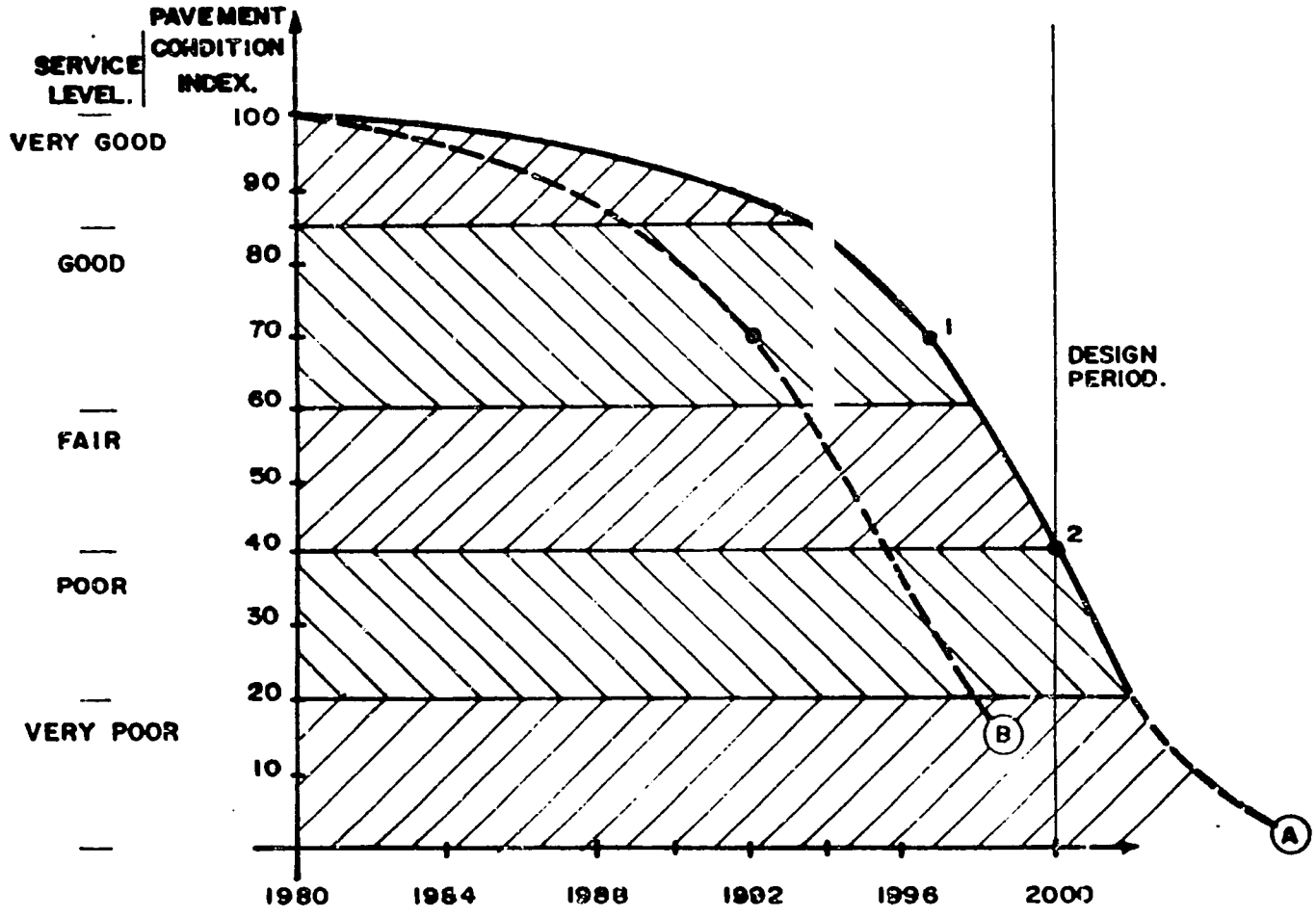


FIGURE II.B.8

DETERIORATION CURVE FOR AN ASPHALT-CONCRETE PAVEMENT RUNWAY

deterioration, especially points 1 and 2, which indicate the start of accelerated deterioration (the segment of curve "A" with maximum gradient) and the end of the design period, respectively. The curve shows that before reaching point 1, a pavement structure deteriorates relatively slowly; after this point, the deterioration accelerates considerably. Point 2 shows the pavement condition at the end of its design period (pavement condition index = 40). After this point, the pavement deteriorates following the curve drawn with a dotted line.

Based on runway observations, the Consultants estimate that the pavement will follow a deterioration curve similar to curve "B", in figure II.B.8. Pavement deterioration should accelerate in the short term, reaching a pavement condition index of 40 (end of design life) earlier than planned (accelerated loss of infrastructure capital). Also, pavement maintenance costs should increase as pavement condition becomes worse.

As a result, pavement rehabilitation work will be needed before 1992. This is due to increased risks for aircrafts, and greater runway and airliner maintenance costs, which result from poor pavement condition. A project-level study is needed to determine pavement overlay thickness requirements for the runways, taxiways and aprons.

Passenger-plane aprons need special attention since they present extensive block cracking, indicative of severe fatigue. Since planes operate at low speed in these areas, operating costs and users' risks have not increased, despite insufficient maintenance. Aprons have been seal coated, temporarily preventing raveling, but water has not been prevented from entering the lower layers, and thereby weakening the structure. Necessary corrective measures should be taken to avoid the need for deep reconstruction.

The estimated costs of pavement infrastructure rehabilitation/reconstruction work are presented below:

December, 1988 - in Colones

	Type of Work	Cost
Runways	Overlay	5,230,000
Taxiways	Overlay	4,290,000
Passenger plane aprons	Reconstruction	6,000,000
Other aprons	Joint Sealing	100,000
TOTAL	---	15,620,000

f. Project Needs

(1) Runways

Comalapa's pavement structures require rehabilitation, especially passenger-airplane aprons and the main runway. Rehabilitation work to be carried out cost approximately C15,000,000. A detailed project-level design study should be performed to define overlay thicknesses by means of non-destructive tests (such as Benkelman Beam deflection readings).

(2) Equipment

Improvements to the aeronavigation radio control system are necessary (C600,000) and similarly, the power generation system should be re-enforced (purchase of a new second generator is estimated at C2,000,000). Appendix II.B.2 outlines other project needs for AIES.

(3) Ilopango

Ilopango should continue to be a domestic civilian and military airport. To facilitate these operations, rehabilitation/repair work should take place, however, aircraft loads for military traffic should be taken into account when allocating the costs of needed maintenance work. The Consultants recommend no specific improvement at the moment.

C. INTERMODAL RELATIONSHIPS

Investment priorities and pace of investment in the transportation sector should be defined in light of socio-economic return and national development objectives. There is a need for coordinating the different projects among transportation modes.

The ISA team studied the intermodal and multimodal interfaces and tradeoffs between the road and rail systems, the key relationship between modes in El Salvador. For the three railway corridors described, a comparison of overall transportation costs of several commodities is analyzed to identify the most economical means of transportation. Such an analysis should help analyze the feasibility of the Salvadoran railway system.

1. Traffic Volumes by Mode

1988 total modal traffic levels in El Salvador are presented in Table II.C.1.

Highways constitute the most significant transportation mode, transporting approximately 98 percent of all cargo and 99 percent of all passengers (99.4 percent of all ton-kilometers and virtually all passenger-kilometers). Marine ports handle approximately two percent of the cargo, and the railways 0.5 percent of the cargo. Railway system and the airports each served about half a percent of the passengers last year.

2. Railway/Highway Prospects by Corridor

The proportion of traffic using road and rail varies with the corridor. One mode is more appropriate than the other in serving specific needs. For example, truck is more appropriate for collection and distribution trips, while rail provides a better line-haul capability. Rail provides very limited access and usually requires truck usage for collection/distribution. Figure II.C.1 shows rail and road.

Several factors influence a shipper's choice of transportation mode for a specific cargo. One of the most important factors is the difference in actual and received costs between truck and rail traffic. Other important factors include mode availability (truck-ownership and to accessibility rail), differences in travel time, and comfort or convenience (storage availability close to railway terminals).

Taxation in the highway sector is based on revenue generation, without consideration to its impacts on modal choice between road and rail, gasoline consumption, or even construction and maintenance of highway infrastructure.

Table II.C.2 compares rail and truck transportation costs for products transported in each of the three rail corridors and presents model splits by cargo. Tariffs are used to establish a range for possible rail tariff changes, and identify the products on which each mode should concentrate. In the following paragraphs, inferences are drawn on future cargo market shares and expected rail profitabilities.

TABLE II.C.1

1988 TOTAL PASSENGER AND CARGO TRAFFIC IN EL SALVADOR BY MODE (1)
(in thousands)

Transportation Mode	Cargo Traffic		Passenger Traffic	
	Tons (2)	Ton-kilometers	Passengers (3)	Passenger - kms
Highways (4)	62,058	6,205.826	107,938	10,793,807
Railways	320	36,152	390	6,030
Marine Ports (5)	1,132	-	-	-
Airports (6)	13	-	514(7)	-
TOTAL	63,523	6,241,978	108,842	10,799,837

(1) Interurban traffic only

(2) Assumes an average load of 10 tons per heavy truck and 3 tons per light truck.

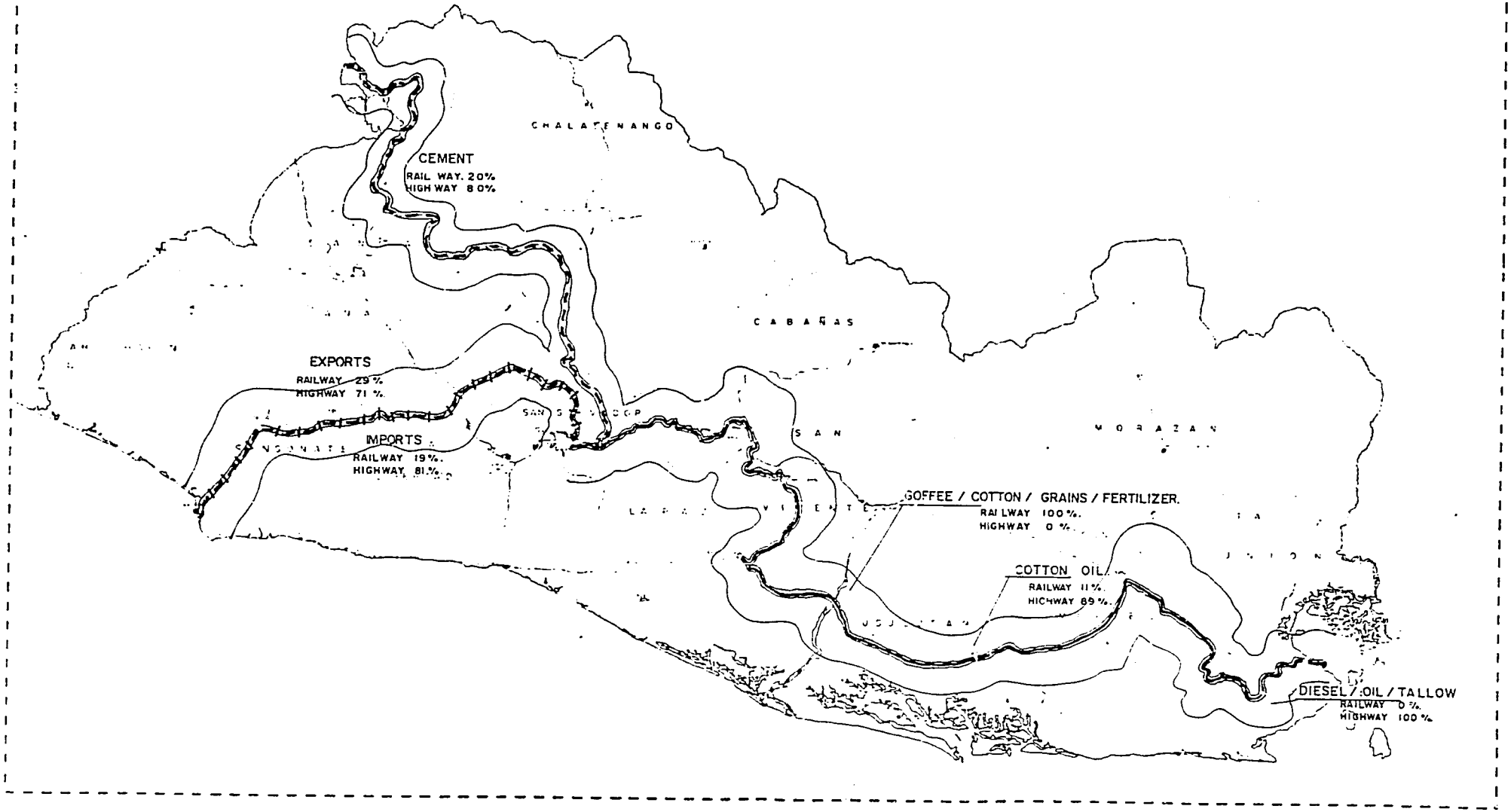
(3) Assumes an average of 1.5 passengers per car, 35 passengers per bus and 0 passengers per truck

(4) Assumes average ADT's and load distributions for paved roads from Table II.A.23, 200 vehicles per day, for tertiary roads, and 50 vehicles per day for rural roads. An average trip distanc of 100 km for passenger and cargo traffic is also assumed.

(5) Considers traffic at Acajutla and Cutuco only.

(6) Considers traffic at AIES and Ilopango only.

(7) Includes arriving and departing passengers.



F I G U R E I I I - C . 1

RAILWAY / HIGHWAY MODAL SPLIT ALONG DIFFERENT CORRIDORS.

TABLE II. C. 2

COMPARISON OF TRUCK AND RAIL TRANSPORTATION COSTS FOR SELECTED PRODUCTS

PRODUCT PER DISTRICT	ORIGIN	DESTINATION	TRUCK TRAFFIC		RAIL TRAFFIC			
			TARIFF (C/Ton-Km)	MARKET SHORE (%)	TARIFF (C/Ton-Km)	COLLECTION/ DISTRIBUTION COST (C/Ton-Km)(1)	MARGIN (C/Ton-Km (2)	MARKET SHORE (%)
DISTRICT No 1								
COFFEE (3)	VARIOUS	CUTUCO	0.64	0	0.14	0.24	0.07	100
COFFEE (3)	VARIOUS	CUTUCO	0.72	0	0.16	0.16	0.10	100
GRAINS (3)	CUTUCO	VARIOUS	0.44	0	0.13	0.17	0.02	100
COTTON OIL (3)	CUTUCO	VARIOUS	0.41	89	0.14	0.15	0.09	11
TALLOW (3)	CUTUCO	VARIOUS	0.45	100	0.14	0.15	0.12	0
DISTRICT No 2								
CEMENT	METAPAN	SAN SALVADOR	0.30	80	0.14	0.11	0.05	20
DISTRICT No 3								
COFFEE	VARIOUS	ACAJUTLA	0.64	71	0.14	0.24	0.07	29
COTTON	VARIOUS	ACAJUTLA	0.72	71	0.16	0.17	0.10	29
HONEY	VARIOUS	ACAJUTLA	0.41	71	0.19	0.08	0.02	29
BALSAM	VARIOUS	ACAJUTLA	0.41	71	0.19	0.08	0.02	29
MILK & FOOD	ACAJUTLA	VARIOUS	0.47	81	0.15	0.17	0.05	19
GRAINS	ACAJUTLA	VARIOUS	0.44	81	0.13	0.17	0.03	19
STEEL PRODUCTS	ACAJUTLA	VARIOUS	0.49	81	0.12	0.12	0.12	19
CHEMICAL PROD-BARRELS	ACAJUTLA	VARIOUS	0.41	81	0.14	0.15	0.09	19
CHEMICAL PROD-BAGS	ACAJUTLA	VARIOUS	0.45	81	0.14	0.15	0.12	19
PAPER	ACAJUTLA	VARIOUS	0.44	81	0.14	0.15	0.11	19

(1) COLLECTION/DISTRIBUTION COSTS TRHOUGH BEING FIXED COSTS, ARE APPLIED TO THE AVERAGE TRIP LENGTH TO OBTAIN COSTS PER TON-KILOMETER

(2) MARGIN FOR POSSIBLE TARIFF INCREASES. THE THREE COLUMNS UNDER RAIL TRAFFIC DO NOT ADD UP TO THE COLUMNS UNDER TRUCK TRAFFIC BECAUSE RAIL DISTANCES FOR SOME ORIGIN/DESTINATIONS ARE LONGER THAN HIGHWAY DISTANCES.

(3) ASSUMING DISTRICT 3'S AVERAGE TARIFFS PER TON-KILOMETER

SOURCE : FENADESAL AND 1986 DAMAGE ASSESSMENT REPORT

a. District 1 (San Salvador-La Union)

Though District 1 is currently handling as much traffic as any of the other two lines (about 100,000 tons per year), its traffic and profitability prospects are the least brilliant. Given the fact that is the system's longest line, its maintenance and operation costs for similar traffic levels are higher. With current traffic levels, the Consultants do not believe these costs are recovered for coffee, cotton, grains nor cotton oil. Nor will they be, should tariffs be increased by the allowable marketing margins shown in Table II.C.2.

Overall traffic along the San Salvador-La Union corridor is not expected to increase significantly in the next few years (at least until the end of the war). Eastern El Salvador is depressed and badly affected by the war. In particular, import/export traffic via Cutuco should not noticeably increase since it is expected that Acajutla will continue to be the country's main marine port, handling most of the expected traffic.

The Consultants foresee little chance of increasing rail market share in this corridor. The railway is 27 percent longer than the highway alternative and less reliable. Exports and imports to and from Cutuco, in addition to the local distribution of cement should continue to constitute most of the traffic.

In 1986, Development Associates established that District 1 should transport at least 350,000 tons per year to be considered economically viable. With current traffic levels of about 100,000 tons per year and little prospects for improvement, the line has limited possibilities of becoming viable. Given its geo-political importance, further decisions on this line's future should not be taken until a national transportation study is made. District 1 provides a link to the Salvadoran East, and could help revitalize the region together with an improved Cutuco or Punta Gorda.

b. District 2 (San Salvador-Metapan-Guatemalan Border)

District 2 transports 123,000 tons per year. Cement is virtually the only cargo, representing a 20 percent market share of the cement traffic. This occurs even as current railway fares (about C0.14/ton-km) added to truck train-to-door service in San Salvador (about C0.11/ton-km) are approximately 17 percent less than truck fares. Only increased reliability and train frequency could allow the railway to increase its market share and reduce its fare

differential.

Today, rail cement revenues do not cover operating and maintenance costs. As Table II.B.20 shows, three efficiently-run full loaded cement trains per day (360,000 tons per year) should make District 2 profitable based only on cement traffic, with a small increase in fares which would still keep the railway competitive with trucks (e.g., increasing fares from C0.14/ton-km to C0.16 or 0.17/ton-km). But this represents 60 percent of the cement market, which is unlikely to be obtained.

In summation, cement is and will continue to be the most significant cargo transported on District 2, but it does not and will not by itself make this line profitable. Capturing some market share of the Santo Tomas de Castilla/Puerto Barrios-San Salvador traffic is needed to assure this line's viability.

Santo Tomas de Castilla presently handles 150,000 tons of Salvadoran exports and imports (no data is available for Puerto Barrios). Assuming this traffic will follow GNP growth, capturing a small portion of the Atlantic traffic (e.g., 20 percent), coupled with increasing cement traffic levels, could make District 2 profitable.

The railway is ideally suited for the 400-kilometer distance to the Atlantic and could offer the added advantage of travelling in bond through Guatemala. The railway could easily achieve the above-mentioned market share at competitive yet profitable fares.

As explained in Section II.B.2.G, the proposed Santa Ana-Santa Lucia-Metapan-Guatemalan border project could help reduce operating costs in District 2. In this case, break-even traffic levels could be somewhat less than those stated.

c. <u>District 3 (San Salvador-Acajutla)</u>

In 1988, the railway carried 16 percent of the exports and five percent of the imports to/from Acajutla. This represents an overall market share of about seven percent for Acajutla-based traffic (22 percent if we consider only general cargo traffic).

As Table II.B.21 shows the railway could remain competitive with an annual cargo of about 270,000 tons. To do this, it should increase its market share to/from Acajutla to about 25 percent of the port's current traffic. The government could choose to subsidize the railway in this corridor to avoid congestion along the highways between Acajutla and the capital. Break-even traffic levels with a 20-to-30 percent

subsidy level, would be around 180,000 tons per year.

Assuming estimated year-2000 Acajutla traffic, the railway will need a market share of about 12 percent to achieve the stated goal of 180,000 tons per year. This can be achieved by means of a more aggressive marketing policy.

D. SECTOR PROJECT RECOMMENDATIONS

This section summarizes ISA's recommendations for the transportation sector. The Consultants have completed an analysis for each of the transportation modes, and have performed an intermodal study. Based on these studies, a specific set of sector recommendations is provided.

1. Investment Needs

Table II.D.1 lists the proposed capital project needs, with their current financing status. In the case of highway projects, Table II.D.1 deals with proposed programs as opposed to individual segments. A total of 1.9 billion colones is proposed to be spent in the highway sector, of which about C245 million is already funded. About 50 percent of the total, should be spent during 1989-1994 and the rest spent during 1995-2000.

Ports require a total investment of 96 million colones for work to be executed before 1994. Current financing is available by 6 million colones, although German financing for Pier A's reconstruction is very likely.

The ISA team recommends an investment of C15 million in the international airport's pavement rehabilitation. This project should take place within the 1989-1994 fiver-year period, preferably before 1992. It does not have available financing. Electric and navigational aid equipment should be purchased, for a total amount of C2 million. Other proposed airport projects amount to C2.2 million.

TABLE II.D.1

SUMARY OF TRANSPORTATION INVESTMENTS NEEDS
1990-2000
(in thousands of Colones)

MODE / PROJECT	1990 - 2000		1995 - 2000	TOTAL
	FUNDED	TO BE FUNDED	TO BE FUNDED	
HIGHWAYS				
1.- FIVE - YEAR REHAB. / IMPROVEMENT PLAN				
PAN-AMERICAN HIGHWAY	0.00	383,960	0.00	383,960
COASTAL HIGHWAY	50,000	62,500	0.00	112,500
SPECIAL AND PRIMARY HIGHWAYS	87,914	76,425	0.00	164,339
SECONDARY HIGHWAYS	87,740	116,054	0.00	203,794
TERTIARY HIGHWAYS	19,940	33,545	0.00	53,485
RURAL ROADS	0.00	67,108	0.00	67,108
2.- SIX - YEAR REHABILITATION PLAN	0.00	0.00	850,000	850,000
3.- SIX - YEAR BRIDGE RECONSTRUCTION PLAN	0.00	0.00	109,000	109,000
SUB-TOTAL HIGHWAYS	245,594	739,592	959,000	1,944,186
PORTS				
1.- REPAIR OF ACAJUTLA'S PIER "A"	0.00	75,000	0.00	75,000
2.- REPAIR OF DAMAGED CARGO-HANDLING EQUIP.	15,800	0.00	0.00	15,800
3.- OTHERS (APPENDIX II. B. 4.)	0.00	5,000	500	5,500
SUB-TOTAL PORTS	15,800	80,000	500	96,300
AIRPORTS				
1.- AIES'S PAVEMENT STRUCTURE REHABILITATION	0.00	15,000	0.00	15,000
2.- PURCHASE OF ELECTRICAL AND NAVEGATIONAL AID EQUIPMENT	2,000	600	0.00	2,600
3.- OTHERS (APPENDIX II. B. A.)	205	1,000	1,000	2,205
SUB-TOTAL AIRPORTS	2,205	16,600	1,000	19,805
TOTAL ALL MODES	263,599	836,192	960,500	2,060,291

E. PROJECT IMPLEMENTATION

1. Highways

The consultants recommend that the following activities be performed to improve the efficiency of DGC-performed routine maintenance work.

- Establish an adequate reporting system for work execution and control (this should later be an integral part of the proposed maintenance management system).

- Purchase small pieces of versatile highway equipment, such as three-cubic-meter pavement mixers, and hand carried asphalt sprayers.

To carry out the proposed five-year highway improvement/rehabilitation program (Figure II.E.1), the following activities should be performed:

- Prepare project-level designs for highway segments in the five-year plan. Rehabilitation work should be estimated by means of pavement structure evaluation with non-destructive testing devices, such as Benkelman beams.

- Adopt terms of reference for rehabilitation contracting.

- Update road construction and develop road rehabilitation technical specifications.

- Analyze slope stability problems, establish monitoring systems to define whether to modify or maintain existing center line alignments.

To carry out both routine maintenance work and to implement the five-year major maintenance/improvement plan, the following activities should be performed:

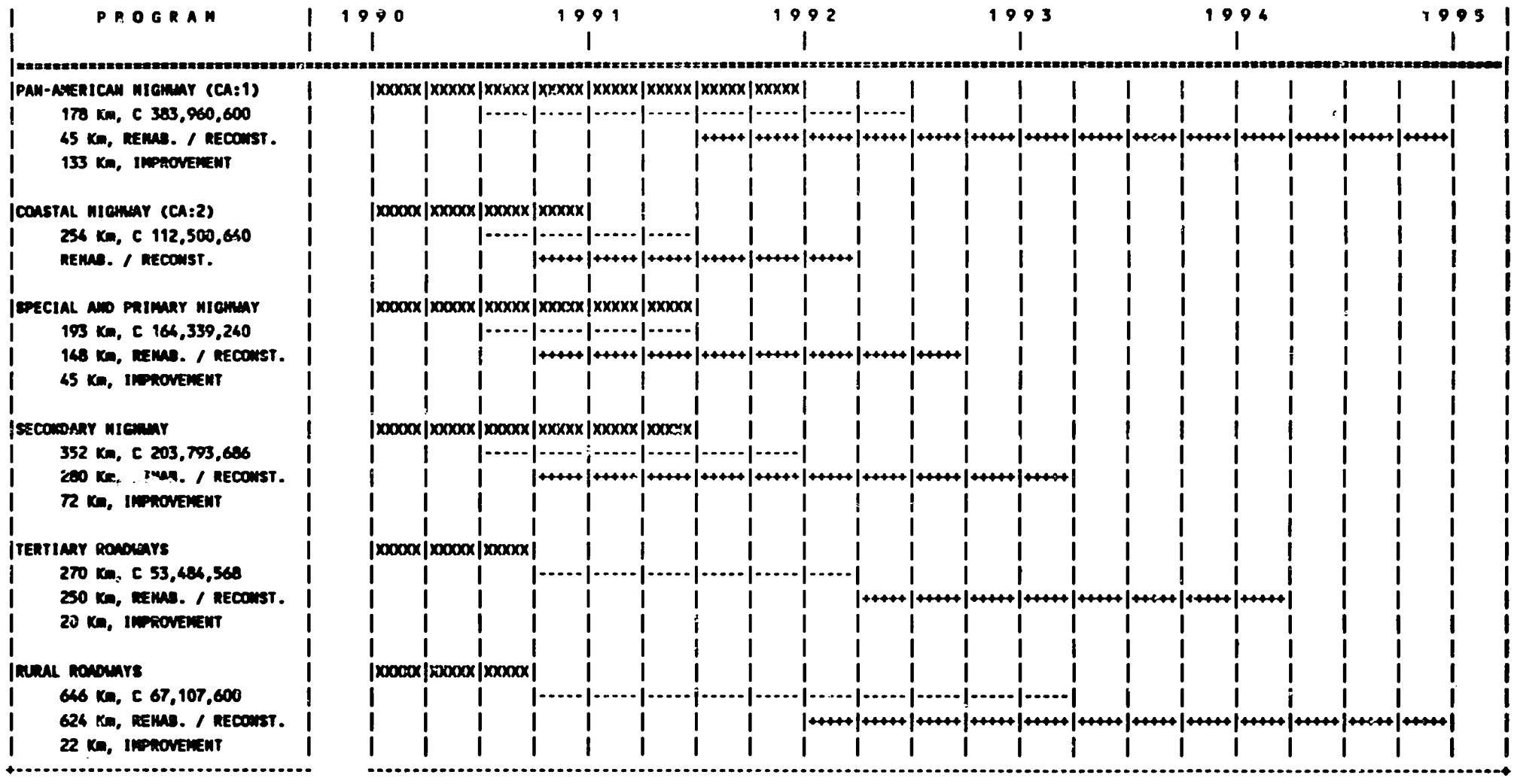
- Improve quality control by means of enhanced field supervision and improved existing soil and material labs

- Define sources of construction materials, as they relate to the different maintenance units.

- Use asphalt emulsions to minimize the use of liquid asphalt (RC-2), reducing the need for imported asphalt.

FIGURE II. E. 1

PROPOSED SCHEDULE FOR FIVE-YEAR HIGHWAY IMPROVEMENT / REHABILITATION PROGRAM



NOTES : FINANCING = XXXXXX
DESIGN = ------
CONSTRUCTION = <++++++

2. Other Modes

To implement the proposed pier infrastructure repair at Acajutla, a detailed study of structural requirements should be carried out. A German firm has been selected for this purpose.

A design study should define the required thicknesses for AIES's pavement structure rehabilitation. Airport maintenance personnel should receive training in the area of pavement evaluation and maintenance.

To monitor better the performance of AIES and Ilopango pavement structures, airline operations need to be classified by aircraft type and a runway pavement condition number need to be estimated.

APPENDICES

A P P E N D I X I I . A . 1

GEOMETRIC DESIGN CHARACTERISTICS

AND

TYPICAL CROSS SECTIONS FOR

DIFFERENT ROAD CATEGORIES

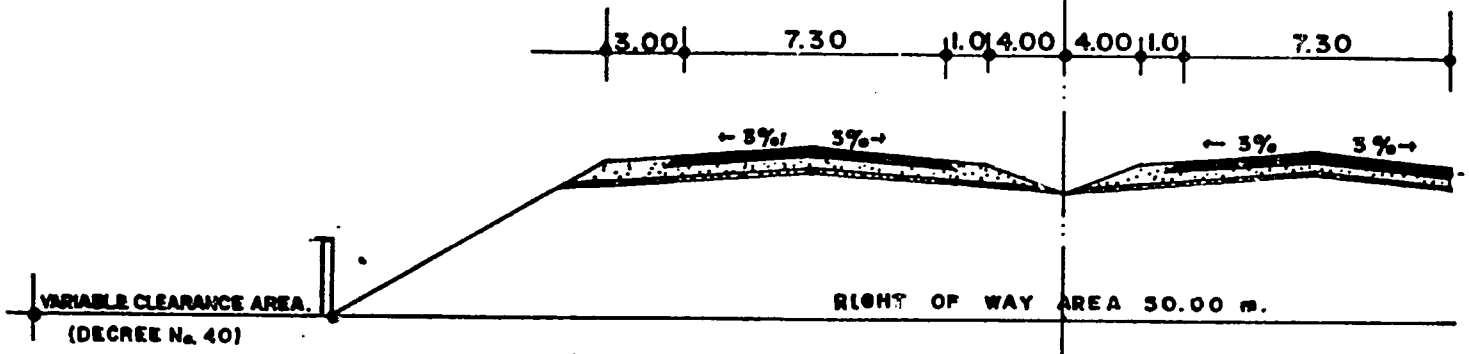
D E S I G N S T A N D A R D S

SPECIAL CATEGORY

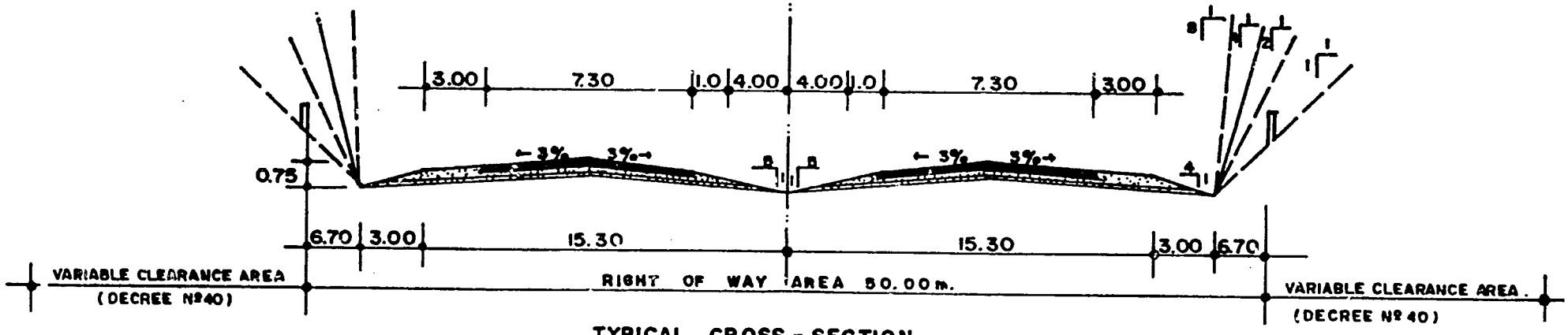
DESIGN CRITERIUM	LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAINOUS TERRAIN
DESIGN SPEED	90 k/h.	70 k/h.	50 k/h.
MAXIMUM GRADE	3.5 %	6 %	7 %
MINIMUM RADIUS	327.46 m	191.07 m	127.45 m
MINIMUM DISTANCE BETWEEN HORIZONTAL CURVES	60.00m	60.00m	60.00 m
MINIMUM SIGHT DISTANCE	160.00m	130.00m	100.00 m.
ROADWAY WIDTH	30.60m	30.60m	30.60 m.
PAVEMENT WIDTH	7.30 m.	7.30m	7.30 m.
SHOULDER WIDTH	EXTERNAL 3.00 m INTERNAL 1.00 m		
BRIDGE LANE WIDTH	8.50 m.	8.50 m.	8.50 m.
MEDIAN	8.00 m	8.00m.	8.00m.
RIGHT OF WAY	80.00m	50.00m.	50.00m.
HORIZONTAL CLEARENCE	10.00m	10.00m.	10.00m.
DESIGN BRIDGE LOAD	H20-S16	H20-S16	H20-S16
PAVEMENT TYPE	ASPHALT CONCRETE		
SHOULDER TYPE	DOUBLE SURFACE TREATMENT		

DESIGN STANDARDS.
TYPICAL CROSS-SECTIONS.

CLASSIFICATION : HIGHWAYS .-



TYPICAL CROSS-SECTION
OF EMBANKMENT.



TYPICAL CROSS-SECTION
OF CUT

NOTE: - ANY TYPE OF CONSTRUCTION IS STRICTLY PROHIBITED IN THE RIGHT OF WAY AREA.
- PERMANENT CONSTRUCTION IS STRICTLY PROHIBITED IN THE CLEARANCE AREA (DECREE No 40)

NOT TO SCALE.
ALL DIMENSIONS IN METERS.

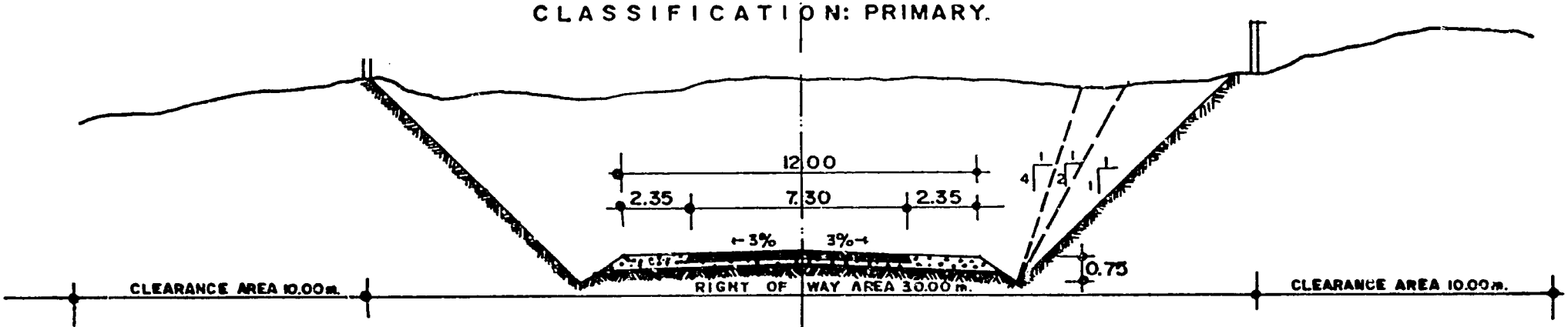
D E S I G N S T A N D A R D S

CLASSIFICATION : PRIMARY
(A.A.D.T. > 2000)

DESIGN CRITERIUM	LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAINOUS TERRAIN
DESIGN SPEED	90 k/h.	70 k/h.	50k/h.
MAXIMUM GRADE	5 %	6 %	7 %
MINIMUM RADIUS	250.00m	200.00 m.	80. 00 m.
MINIMUM DISTANCE BETWEEN HORIZONTAL CURVES	60.00m.	60.00m.	60.00m.
MINIMUM SIGHT DISTANCE	160.00m.	130.00m.	100.00m.
ROADWAY WIDTH	12.00 m.	12.00 m.	12.00m.
PAVEMENT WIDTH	7.30m.	7.30m.	7.30m.
SHOULDER WIDTH	2.35m.	2.35 m.	2.35m.
BRIDGE LANE WIDTH	7. 90m.	7.90 m.	7.90m.
RIGHT OF WAY	30.00m.	30.00 m.	30.00 m.
HORIZONTAL CLEARANCE	10.00m.	10.00 m.	10.00 m.
DESIGN BRIDGE LOAD	H 20 - S 16	H 20 - S 16	H 20 - S 16
PAVEMENT TYPE	DOUBLE SURFACE OR ASPHALT CONCRETE	DOUBLE SURFACE OR ASPHALT CONCRETE	DOUBLE SURFACE OR ASPHALT CONCRETE
SHOULDER TYPE	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL.

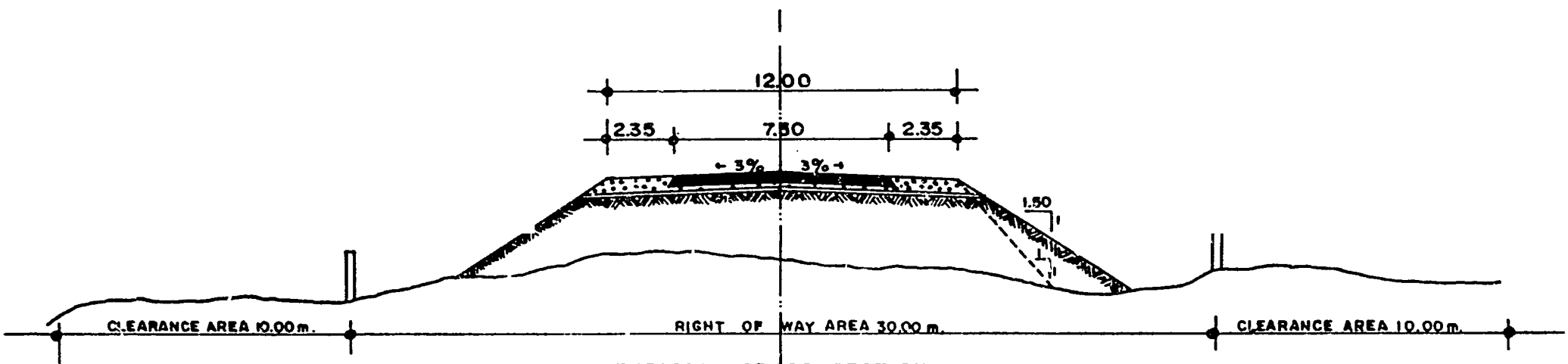
DESIGN STANDARDS.
TYPICAL CROSS SECTIONS.

CLASSIFICATION: PRIMARY.



TYPICAL CROSS-SECTION
OF CUT

NOTE: -ANY TYPE OF CONSTRUCTION IS STRICTLY
PROHIBITED IN THE RIGHT OF WAY AREA.
-PERMANENT CONSTRUCTION IS STRICTLY
PROHIBITED IN THE CLEARANCE AREA. (DECREE No. 40.)



TYPICAL CROSS-SECTION
OF EMBANKMENT.

ALL DIMENSIONS IN METERS.
NOT TO SCALE

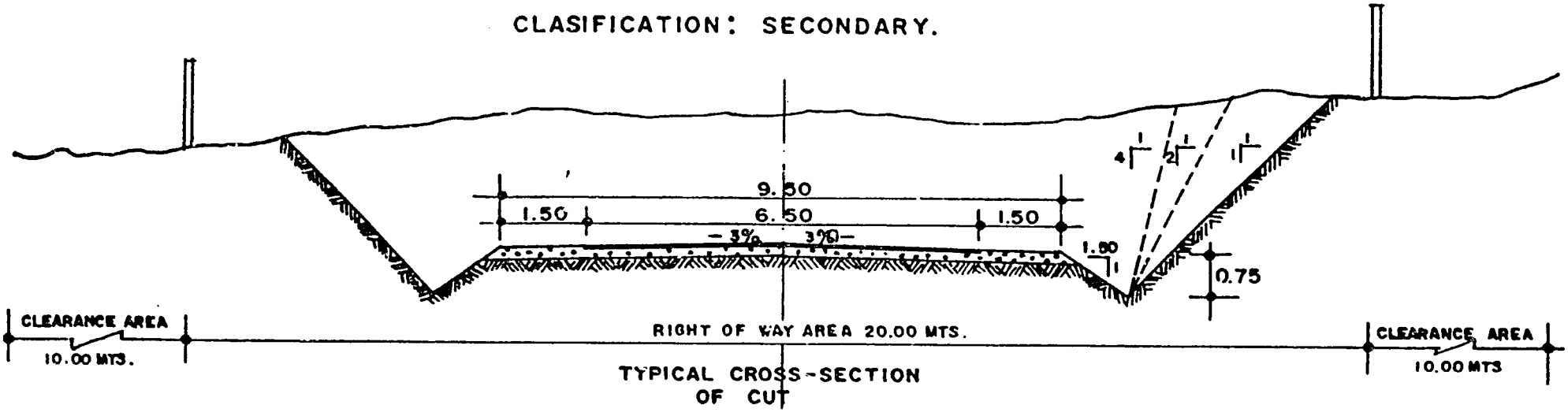
D E S I G N S T A N D A R D S

CLASSIFICATION : SECONDARY
(A.A.D.T. 500-2000)

DESIGN CRITERIUM	LEVEL TERRAIN	ROLLIN TERRAIN	MOUNTAINOUS TERRAIN
DESIGN SPEED	80 k/h.	70 k/h.	50 k/h.
MAXIMUM GRADE	5 %	6 %	8 %
MINIMUM RADIUS	150.00 m.	100.00 m.	60.00 m.
MINIMUM DISTANCE BETWEEN HORIZONTAL CURVES	60.00 m.	60.00 m.	60.00 m.
MINIMUM SIGHT DISTANCE	130.00 m.	100.00 m.	90.00 m.
ROADWAY WIDTH	9.50 m.	9.50 m.	9.50 m.
PAVEMENT WIDTH	6.50 m.	6.50 m.	6.50 m.
SHOULDER WIDTH	1.50 m.	1.50 m.	1.50 m.
BRIDGE LANE WIDTH	7.40 m.	7.40 m.	7.40 m.
RIGHT OF WAY	20.00 m.	20.00 m.	20.00 m.
HORIZONTAL CLEARANCE	10.00 m.	10.00 m.	10.00 m.
DESIGN BRIDGE LOAD	H 15 - S 12	H 15 - S 12	H 15 - S 12
PAVEMENT TYPE	SINGLE SURFACE TREATMENT	SINGLE SURFACE TREATMENT	SINGLE SURFACE TREATMENT
SHOULDER TYPE	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL

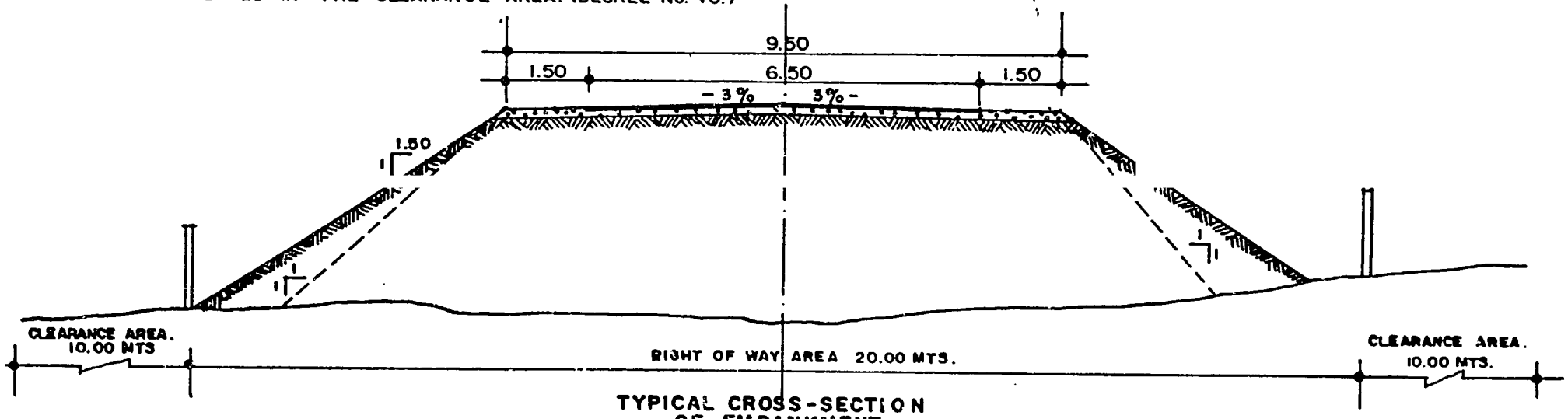
DESIGN STANDARDS.
TYPICAL CROSS-SECTIOS.

CLASIFICATION: SECONDARY.



TYPICAL CROSS-SECTION
OF CUT

NOTES: - ANY TYPE OF CONSTRUCTION IS STRICTLY PROHIBITED IN THE RIGHT OF WAY AREA.
- PERMANENT CONSTRUCTION IS STRICTLY. PROHIBITED IN THE CLEARANCE AREA. (DECREE No. 40.)



TYPICAL CROSS-SECTION
OF EMBANKMENT.

ALL DIMENSION IN METERS.
NOT TO SCALE.

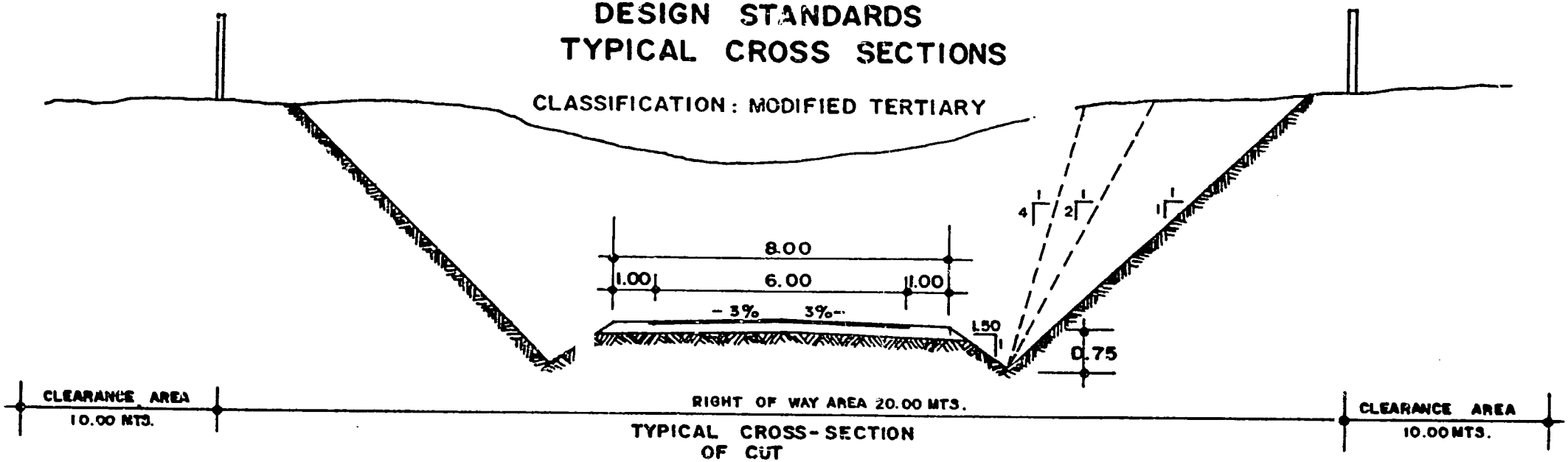
D E S I G N S T A N D A R D S

CLASSIFICATION: MODIFIED TERTIARY ROADS (A.A.D.T. 100-500)

DESIGN CRITERIUM	LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAINOUS TERRAIN.
DESIGN SPEED	60 k/h.	50 k/h.	40 k/h.
MAXIMUM GRADE	6 %	8 %	10 %
MINIMUM RADIUS	150.00m.	100.00 m.	40.00m.
MINIMUN DISTANCE BETWEEN HORIZONTAL CURVES	50.00m.	50.00m.	50.00m.
MINIMUN SIGHT DISTANCE	130.00m.	100.00m.	80.00m.
ROADWAY WIDTH	8.00 m.	8.00 m.	8.00 m.
PAVEMENT WIDTH	6.00 m.	6.00 m.	6.00 m.
SHOULDER WIDTH	1.00 m.	1.00 m.	1.00 m.
BRIDGE LANE WIDTH	7.40 m.	7.40 m.	7.40 m.
RIGHT OF WAY	20.00 m.	20.00 m.	20.00 m.
HORIZONTAL CLEARANCE	10.00 m.	10.00 m.	10.00 m.
DESIGN BRIDGE LOAD	H 15 - S 12	H 15 - S 12	H 15 - S 12.
PAVEMENT TYPE	SINGLE SURFACE TREATMENT	SINGLE SURFACE TREATMENT	SINGLE SURFACE TREATMENT
SHOULDER TYPE	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL

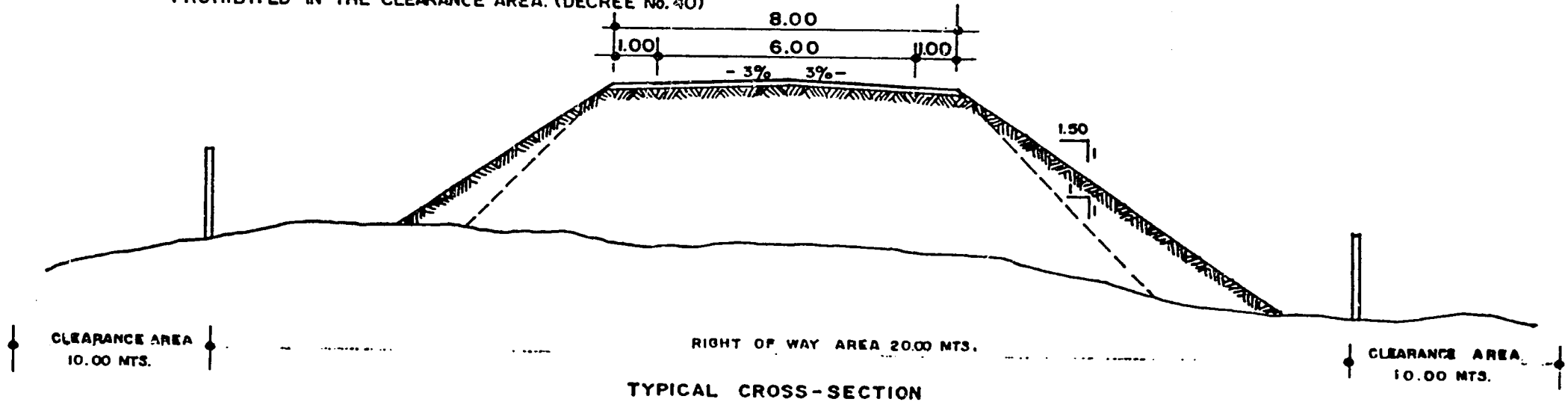
DESIGN STANDARDS
TYPICAL CROSS SECTIONS

CLASSIFICATION : MODIFIED TERTIARY



TYPICAL CROSS-SECTION
OF CUT

NOTES – ANY TYPE OF CONSTRUCTION IS STRICTLY PROHIBITED IN THE RIGHT OF WAY AREA.
– PERMANENT CONSTRUCTION IS STRICTLY PROHIBITED IN THE CLEARANCE AREA. (DECREE No. 40)



TYPICAL CROSS-SECTION
OF EMBANKMENT.

ALL DIMENSIONS IN METERS.
NOT TO SCALE.

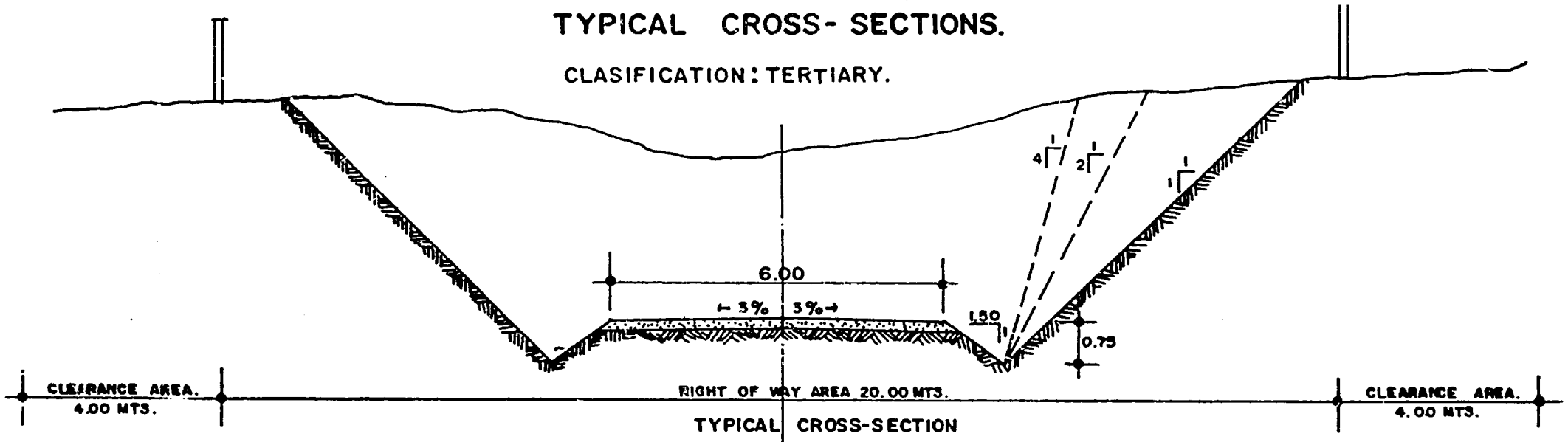
D E S I G N S T A N D A R D S

CLASSIFICATION: TERCIARY ROADS
(A.A.D.T. 100-500)

DESIGN CRITERIUM	LEVEL TERRAIN	ROLLIN TERRAIN	MONTAINOUS TERRAIN
DESIGN SPEED	60 k/h.	50 k/h.	40 k/h.
MAXIMUN GRADE	6 %	8 %	10 %
MINIMUM RADIUS	150.00m.	100.00 m.	40.00 m.
MINIMUM DISTANCE BETWEEN HORIZONTAL CURVES	50.00m.	50.00m.	50.00m.
MINIMUM SIGHT DISTANCE	120.00m.	100.00 m.	80.00m.
ROADWAY WIDTH	6.00 m.	6.00 m.	6.00m.
BRIDGE LANE WIDTH	6.50 m.	6.50 m.	6.50m.
RIGHT OF WAY AREA WIDTH	20.00m.	20.00 m.	20.00m.
HORIZONTAL CLEARANCE	4.00 m.	4.00m.	4.00m.
DESIGN BRIDGE LOAD	H 15 - S 12	H 15 - S 12	H 15 - S 12
TYPE OF SURFACE	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL	COMPACTED SELECTED MATERIAL

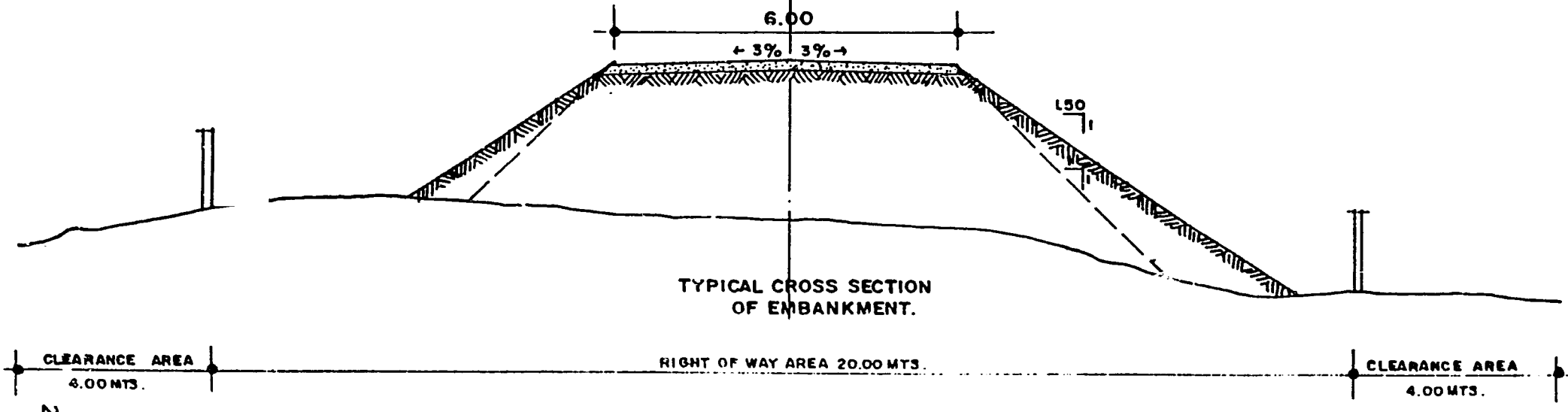
DESIGN STANDARDS
TYPICAL CROSS- SECTIONS.

CLASIFICATION: TERTIARY.



TYPICAL CROSS-SECTION
OF CUT

NOTES - ANY TYPE OF CONSTRUCTION IS STRICTLY PROHIBITED IN THE RIGHT OF WAY AREA.
- PERMANENT CONSTRUCTION IS STRICTLY PROHIBITED IN THE CLEARANCE AREA.(DECREE No.40)
- DISTANCES IN METERS.



TYPICAL CROSS SECTION
OF EMBANKMENT.

ALL DIMENSIONS IN METERS.
NOT TO SCALE.

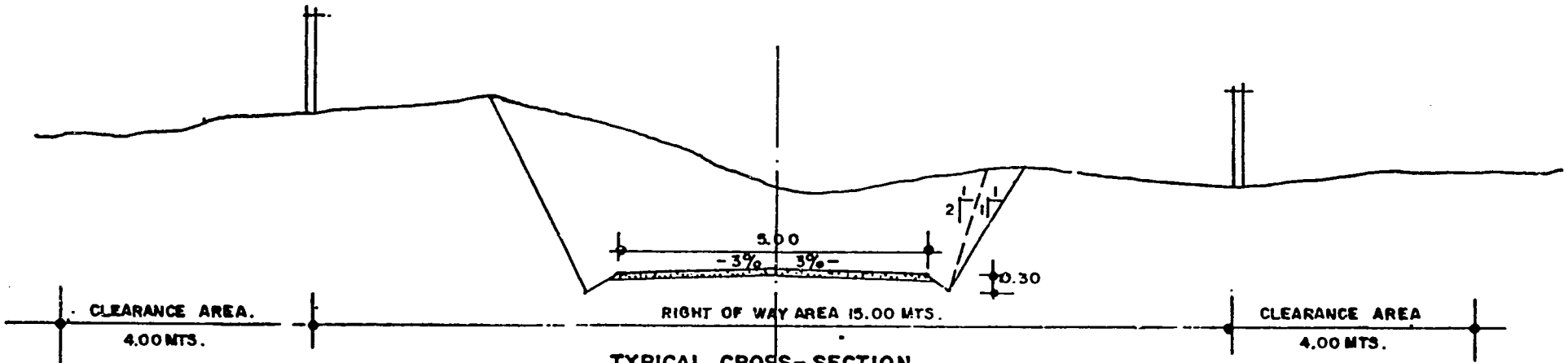
D E S I G N S T A N D A R D S

CLASSIFICATION: RURAL
(A.A.D.T. <100)

DESIGN CRITERIUM	LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAINOUS TERRAIN
DESIGN SPEED	50 k/h.	40 k/h.	30 k/h.
MAXIMUM GRADE	6 %	8 %	12 %
MINIMUN RADIUS	67.00 m.	53.00 m	20.00 m.
MINIMUM SIGHT DISTANCE	90.00m.	60.00m.	45.00 m.
ROADWAY WIDTH	5.00 m.	5.00 m.	5.00 m.
BRIDGE LANE WIDTH	3.00m.	3.00 m.	3.00 m.
RIGHT OF WAY	15.00 m.	15.00 m.	15.00 m.
HORIZONTAL CLEARANCE	4.00 m.	4.00 m.	4.00 m.
DESIGN BRIDGE LOAD	H 15.44	H 15.44	H 15.44
TYPE OF SURFACE	GRAVEL BALLAST	GRAVEL BALLAST	GRAVEL BALLAST

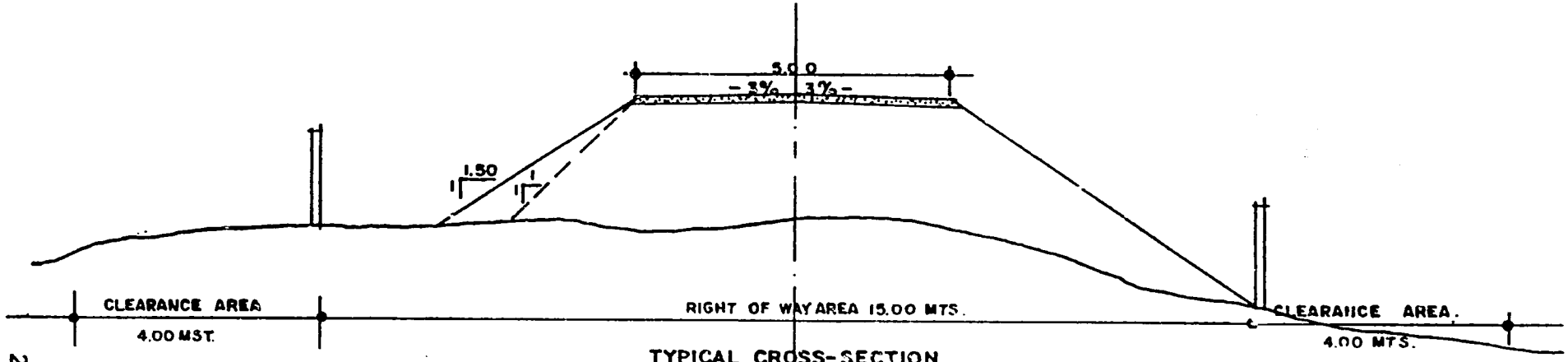
TYPICAL CROSS-SECTIONS.

CLASSIFICATION: RURAL.



TYPICAL CROSS-SECTION
OF CUT

NOTE: -ANY CONSTRUCTION IS STRICTLY PROHIBITED IN THE ROAD WAY AREA.
-PERMANENT CONSTRUCTION IS STRICTLY PROHIBITED IN THE CLEARANCE AREA.
(DECREE No. 40).



TYPICAL CROSS-SECTION
OF EMBANKMENT.

ALL DIMENSIONS IN METERS
NOT TO SCALE

D E S I G N S T A N D A R D S

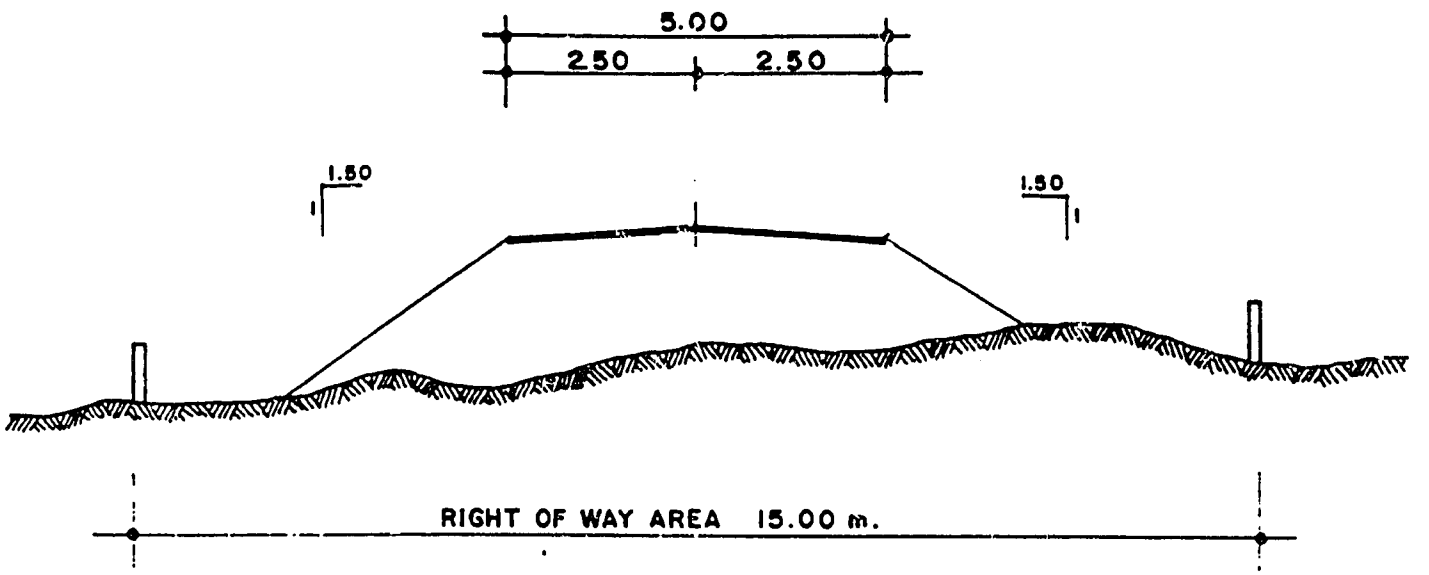
CLASSIFICATION: LOCAL ACCESS

DESIGN CRITERIUM	LEVEL TERRAIN	ROLLING TERRAIN	MOUNTAINOUS TERRAIN
DESIGN SPEED	50 k/h.	40k/h.	30 k/h.
MAXIMUM GRADE	7%	10%	15 %
MINIMUM DISTANCE BETWEEN HORIZONTAL CURVES	67.00 m.	52.00 m.	22.00 m.
MINIMUM SIGHT DISTANCE	90.00m.	60.00 m.	45.00 m.
ROAD WAY WIDTH	5.00 m	5.00 m.	5.00 m.
BRIDGE LANE WIDTH	3.00m.	3.00 m.	3.00 m.
RIGHT OF WAY	15.00 m.	15.00 m.	15.00 m.
DESIGN BRIDGE LOAD	H 15. 44	H 15.44	H 15.44
TYPE OF SURFACE.	RE-SURFACED EARTH	RE-SURFACED EARTH	RE - SURFACED EARTH

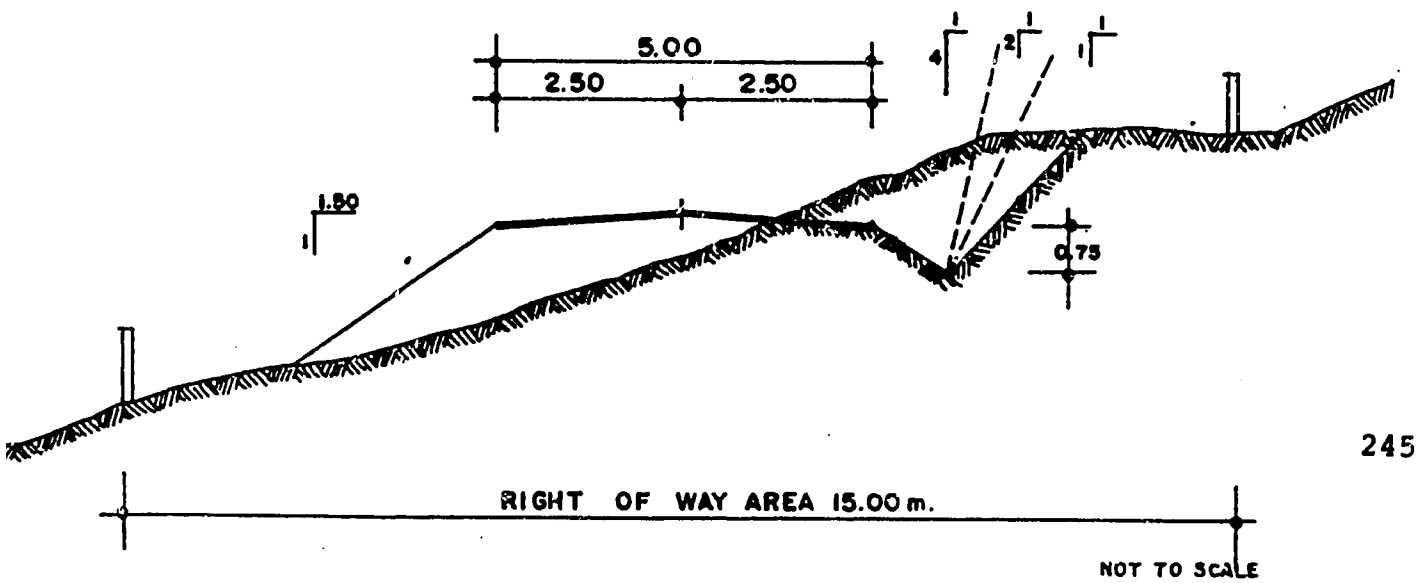
NOTE : THE MAXIMUM GRADE CAN NOT BE LONGER THAN 200m, AS IT MUST BE FALLOWED BY A RUN OFF NO LESS THAN 300m LONG, WITH A MAXIMUM GRADE OF 5%.
THERE SHOULD BE A MINIMUM FILLING OF 0.60m. AT THE ENTRANCE TO CULVERTS.

TYPICAL CROSS-SECTIONS
CLASSIFICATION: LOCAL ACCESS.

TRANSVERSE SECTION OF EMBANKMENT.

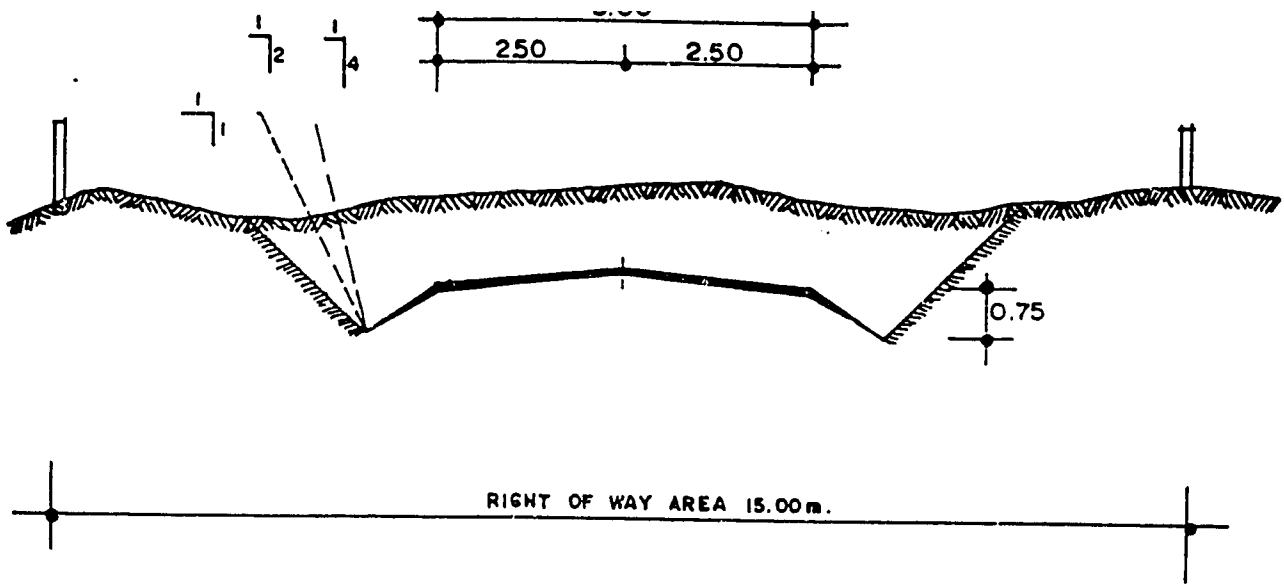


TRANSVERSE SECTION OF EMBANKMENT AND CUT

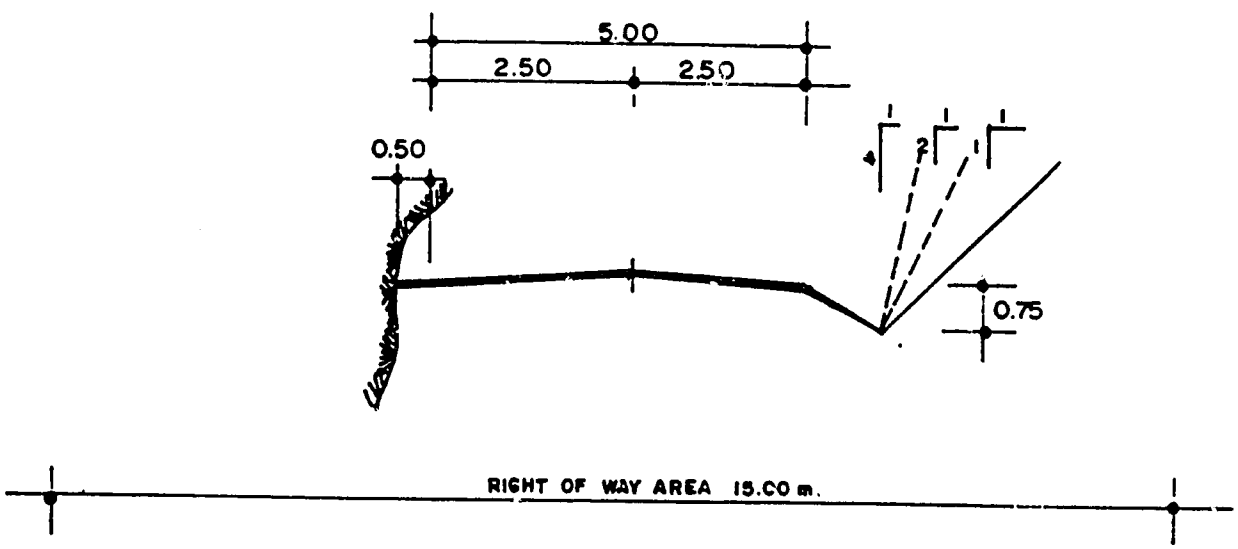


NOT TO SCALE
ALL DIMENSIONS IN METERS.

TYPICAL CROSS-SECTIONS
CLASSIFICATION: LOCAL ACCESS.



TRANSVERSE SECTION OF BALCONY CUT



NOT TO SCALE
ALL DIMENSIONS IN METERS

A P P E N D I X I I . A . 2

CURRENT CONDITION

OF THE

SALVADORAN ROADWAY NETWORK

APPENDIX II. A. 2

CURRENT CONDITION OF THE SALVADORAN ROADWAY NETWORK

ROAD CLASS / DEPARTMENT	TERTIARY				RURAL A				RURAL B				TOTAL UNPAVED ROADS			
	Length (Kms)	Good (%)	Fair (%)	Poor (%)	Length (Kms)	Good (%)	Fair (%)	Poor (%)	Length (Kms)	Good (%)	Fair (%)	Poor (%)	Length (Kms)	Good (%)	Fair (%)	Poor (%)
AHUACHAPAN	150.35	30	30	40	130.00	10	15	75	352.00	5	15	80	632.35	15	20	65
SANTA ANA	52.14	40	40	20	165.80	15	15	70	360.00	10	15	75	577.94	22	24	54
SONSONATE	88.78	30	30	40	86.80	10	20	70	193.40	10	15	75	368.98	17	22	61
LA LIBERTAD	183.70	30	35	35	89.40	15	20	65	172.70	10	10	80	445.80	18	22	60
SAN SALVADOR	62.15	25	40	35	92.40	10	20	70	255.10	5	15	80	409.65	13	25	62
CHALATENANGO	180.96	35	30	35	171.80	20	20	60	367.[illegible]	15	10	75	719.86	23	20	57
CUSCATLAN	83.65	30	30	40	79.60	20	30	50	377.33	5	30	65	540.38	18	30	52
CABANAS	117.66	40	40	20	82.90	15	15	70	373.30	10	20	70	573.86	22	25	53
LA PAZ	109.20	35	35	30	130.60	20	15	65	494.60	15	15	70	734.40	23	22	55
SAN VICENTE	154.40	30	40	30	76.60	15	15	70	227.30	15	15	70	458.30	20	23	57
USULUTAN	164.30	15	10	75	194.00	15	15	70	384.70	2	20	78	743.00	11	15	74
SAN MIGUEL	110.30	20	20	60	321.79	100	10	30	270.20	5	10	85	702.29	12	[illegible]3	75
MORAZAN	125.50	15	15	70	22.90	10	10	80	230.85	5	10	85	379.25	10	12	78
LA UNION	153.40	20	20	60	62.20	10	20	70	316.30	5	15	80	531.90	12	18	70
TOTAL	1736.49	28	30	42	1706.59	14	17	69	4374.88	8	16	76	7817.96	17	21	62

APPENDIX II. A. 2

CURRENT CONDITION OF THE SALVADORAN ROADWAY NETWORK

ROAD CLASS / DEPARTMENT	SPECIAL				PRIMARY				SECONDARY				TOTAL PAVED ROADS			
	Length (Kms)	Good (%)	Fair (%)	Poor (%)	Length (Kms)	Good (%)	Fair (%)	Poor (%)	Length (Kms)	Good (%)	Fair (%)	Poor (%)	Length (Kms)	Good (%)	Fair (%)	Poor (%)
AHUACHAPAN					39.16	25	50	25	41.2	25	35	40	80.36	25	43	32
SANTA ANA	24.79	50	45	5	59.9	40	30	30	104.26	35	40	25	188.95	42	38	20
SONSONATE					87.8	30	40	30	81.34	30	50	20	169.14	30	45	25
LA LIBERTAD	35.00	25	40	35	104.00	20	45	35	38.00	30	35	35	177.00	25	40	35
SAN SALVADOR	38.4	40	40	20					118.10	25	35	40	156.50	32	38	30
CHALATENANGO					37.00	10	30	60	60.64	40	30	30	97.64	25	30	46
CUSCATLAN	2.00	100							49.70	30	50	20	51.70	65	25	10
CABANAS									42.52	40	30	30	42.52	40	30	30
LA PAZ	20.05	45	35	20	36.00	35	30	35	85.42	30	30	40	141.47	37	32	31
SAN VICENTE	16.00	100	0	0	31.40	35	40	25	49.35	45	30	25	96.75	60	23	17
USULUTAN					42.00	25	60	25	103.60	50	10	40	145.60	37	30	33
SAN MIGUEL					42.34	30	40	30	135.97	40	30	30	178.31	35	35	30
MORAZAN					14.00	10	40	50	58.20	30	40	30	72.20	20	40	40
LA UNION					101.10	40	30	30	42.70	30	30	40	143.80	35	30	35
TOTAL	136.24	60	27	13	594.70	27	39	34	1,011.00	34	34	32	1,741.94	36	34	30

A P P E N D I X I I . A . 3

CURRENT CONDITION OF

SELECTED HIGHWAY PROJECTS

PROJECT NAME	ROADWAY CLASS	LENGTH (KM)	ROADWAY CONDITION GOOD	FAIR	POOR
CA: 1					
- Sitio del Niño- Nueva San Salvador	Special	22.00	x	x	
- San Salvador-San Rafael Cedros	SECONDARY	31.50	x	x	
- Oriente del Río Lempa- San Miguel	SECONDARY	24.10+ 20.00	X (under const.)		X km.
- San Miguel-Bifurcación La Unión	SECONDARY	23.00			x
- San Cristóbal-Santa Ana	SECONDARY	31.50		x	
CA: 2					
- La Hachadura- CA; 12	PRIMARY	45.00			x
- CA; 12- La Libertad	PRIMARY	81.50			x
- La Libertad- Comalapa	PRIMARY	27.40			x
- Zacatecoluca- Río Lempa	SECONDARY	29.00		x	
- Usulután- La Unión	PRIMARY	87.96			x
- CA; 4- Troncal del Norte					
- San Salvador- Apopa	SPECIAL AND PRIMARY	10.00			x
- Apopa- Aguilares	SECONDARY	19.00			x
- Aguilares- Tejutla	SECONDARY	31.00			x
- Tejutla-Citalá (Frontera con Honduras)	PRIMARY	32.00			x
CA : 12					
- Acajutla-Sonsonate	PRIMARY	17.90		x	

PROJECT NAME	ROADWAY CLASS	LENGTH (KM)	ROADWAY CONDITION		
			GOOD	FAIR	POOR
- Sonsonate Santa Ana	SECONDARY	37.30		x	
- Santa Ana- Metapán	PRIMARY	47.90			x
- Metapán- Anguiatú	PRIMARY	59.90			x
CA: 8					
- Sonsonate- Empalme con CA:1	PRIMARY	41.90		x	
Otras Vias.					
- Ahuachapán- Tacuba (Ahuachapán)	TERTIARY	17.20		x	
- Santa Ana-Ahuachapán (Santa Ana, Ahuachapán)	SECONDARY	30.70		x	
- Juayúa-Sn José La Majada- El Arenal (Sonsonate)	SECONDARY	10.60		x	
- Cerro Verde-Empalme con ruta El Congo-CA:8 (Sta. Ana, Sonsonate) Nº 17	RURAL A	11.00		x	
- Ruta El Congo-Valle Nuevo: Empalme a Cerro Verde (CA:8 Sonsonate)					
- El Congo-Oclupse Arriba-Planes de La Laguna (Sta Ana) Nº 171	RURAL B	7.00			x
- Sta. Ana-San Pablo Tacachico (Sta. Ana, La Libertad)	TERTIARY	30.80		x	

PROJECT NAME	ROADWAY CLASS	LENGTH (KM)	ROADWAY CONDITION GOOD	FAIR	POOR
- Apopa-Quezaltepeque-Sitio del Niño (La Libertad-San Salvador)	SECONDARY	25.00			x
-- CA:2- La Libertad (La Libertad)					
- Nueva San Salvador-Quezaltepeque ((La Libertad)	TERTIARY AND RURAL B	11.70+13.30			x
- El Refugio-El Castillo-San José La cueva-Moncagua					
- Intercones. con sta. Ana-San Pablo Tacachico (Sta. Ana)	TERTIARY	20.80		x	
- El coco-Chalchuapa (Sta. Ana)	RURAL A	14.80		x	
- CA:1 El Porvenir- Sta. Ana/Ahuachapán (Santa Ana)	RURAL A	5.00		x	
- CA:1- San Antonio Pajonal (Santa Ana)	RURAL A	14.20			x
- El Ronco-Ostua-San Jerónimo - Santa Ana)	RURAL B	15.00		x	
- Mejicanos- Mariona-Nejapa (San Salvador)	SECONDARY	10.50			x
- San Salvador-San Marcos (San Salvador)	SECONDARY	3.5			x
- Apopa-San José Las Flores (San Salvador)	-	-			
- San Salvador-Los Planes (San Salvador)	SECONDARY	7.94		x	
— CA;8-Tepecoyo (La Libertad)	TERTIARY	6.00			x
- Quezaltepeque-San Juan Opico La Libertad)	RURAL A AND RURAL B	13.00			x
- Empalme CA:2- La Herradura (por San Marcelino),(La Paz)Nº 14	TERTIARY	19.00		x	

PROJECT NAME	ROADWAY CLASS	LENGTH (KM)	ROADWAY CONDITION GOOD	FAIR	POOR
- Lo Planes-Panchimalco- Rosario de Mora (San Salvador)	SECONDARY	5+4		x	
- Tonacatepeque-Soyapango (San Salvador)	TERTIARY	11.00		x	
- Berlín-Alegría- Santiago de María (Usulután)	SECONDARY	11.60		x	
- Santiago de María-Tecapán- Ozatlán Usul. (Usulután)	SECONDARY	26.00			x
- Tejutepeque-San Antonio Buena Vista - Corral Viego (Cabañas) Nº 44	RURAL B	5.00			x
- CA:12-Las Casitas-San Antonio Masahuat-Los Horcones-Guarnecia(Santa Ana)	RURAL B	16.00			x
- San Antonio Masahuat- CA:2 (La Paz) Nº 36	RURAL A	15.00		x	
- Ciudad Barrios-Moncagua (San Miguel)	TERTIARY AND RURAL A	11.70+14.80 = 26.50			x
- San Miguel- El Delirio (Sn. Miguel)	SECONDARY	15.30		x	
- Ruta Militar San Miguel-Santa Rosa de Lima-Pasaquina (Morazán-la Unión)	PRIMARY	34.98		x	
- Empalme CA:- San Antonio Silva- San Alejo (San Miguel)- La Unión) S.M.Nº85 L.U. Nº 14, L.U. Nº 17, L.U. Nº 22, L.U. Nº 39 y Nº 77	RURAL B	9.00			x
- Empalme CA;L- La Unión (La Unión)	PRIMARY	8.00		x	
- CA:2-San Dionisio (Usulután) Nº 32	RURAL A	9.00		x	

A P P E N D I X I I . A . 4

DGC-RECOMMENDED HIGHWAY IMPROVEMENT PROJECTS

DGC-RECOMMENDED HIGHWAY IMPROVEMENT PROJECTS
(BASED ON TRAFFIC COUNTS)

ROAD CLASS	A D T					LIGHT %			HEAVY TRUCK %									
									LOAD DISTRIBUTION									
	1984	1985	1986	1987	1988	Pass cars	Trucks	Buses %	C2	C3	T2S1	C3R2	T2S2	T3S1	T3S2	C3R2	ESPE	TOTAL
TO SPECIAL																		
Ilopango-San Martín	6820	6902	6965	7024	7103	21	35	25	91	5					4			19
San Martín-Cojutepeque	4485	4396	4308	4341	4895	22	34	24	90	6					4			20
Cojutepeque-San Rafael Cedros	1948	1983	2003	2056	2483	21	35	20	84	12					4			24
San Salvador-Apopa	8391	8410	8590	8999	9654	23	35	24	86	8					6			18
La Cuchilla-Sensenate	3852	3910	4082	4135	4316	24	35	10	74	6					20			31
Acajutla-Sensenate	2679	2963	3030	2973	3110	18	33	8	63	7			.4	.4	29		.2	41
TO PRIMARY																		
Santa Ana-Ahuachapán	3161	3246	3352	3277	3557	27	37	17	88	5					7			19
CA-4 La Garita-Seyapango		7181	7257	7277	7362	27	40	18	92	6			1		1			15
Apopa-Sitio del Niño	2048	2137	2454	2244	2594	19	39	14	89	5					6			28
San Salvador-Los Planes de R.		2699	2718	2743	2791	46	30	12	97	2					1			12
TO SECONDARY																		
Ateos-Tepecoyo	601	623		704	854	13	48	5	89	7					4			34
Seyapango-Tenacatepeque				836	882	16	42	20	99	1								22
CA-1-San Ramón					779	12	61	9	98	1	1							18
Chalchuapa-El Ceco	707	718	885	700	719	13	51	16	98	2					1			20

DGC-RECOMMENDED HIGHWAY IMPROVEMENT PROJECTS
(BASED ON TRAFFIC COUNTS)

ROAD	A D T					LIGHT &			HEAVY TRUCK &									
						Pass cars	Trucks	Buses &	LOAD DISTRIBUTION									
	1984	1985	1986	1987	1988				C2	C3	T2S1	C2R2	T2S2	T3S1	T3S2	C3R2	ESPEC	TOTAL
CA-2-La Herradura, Ramal a San																		
Marcelino					921	21	39	13	94	6								27
Sensenate-San Antenio del Monte	949	1015			1104	24	42	20	100									14
Atoes-Jayaque					1053	13	44	5	83	9					8			33
Sensenate-Nahuilingo	679	756			997	16	44	15	98	2								25
TO TERTIARY																		
El Ronce-Ostúa-San Jerónimo					552	11	47	4	81	3					16			3
CA-1-San Antenio Pajonal		143			189	16	42	22	100									20
CA-1-El Pervenir	292	298	319	324	333	15	49	4	100									32
Santa Ana-Ahuachapán, Ramal a																		
El Pervenir	116	128	130	138	154	17	39	7	100									37
CA-2-Metalío	136	145		197	215	26	45	93	7									29
San Juan Opico-San Matías		75		87	147	5	52	9	100									34
San Matías-Quezaltepeque		80			294	15	57	9	100									19
CA-8-Sacacoyo		81		89	268	12	35	17	80	20								36
Panchimalco-Rosario de Mora				437	495	13	34	19	100									34
CA-2-San Luis Talpa					572	19	57	5	92	5					3			19

DGC--RECOMMENDED HIGHWAY IMPROVEMENT PROJECTS
(BASED ON TRAFFIC COUNTS)

ROAD CLASS	A D T					LIGHT %		Buses %	HEAVY TRUCK %									
									LOAD DISTRIBUTION									
	1984	1985	1986	1987	1988	Pass cars	Trucks		C2	C3	T2S1	C3R2	T2S2	T3S1	T3S2	C3R2	ESP	TOTAL
CA-2-Tapalhuaca					170	16	60		100									24
CA-2-San Dienisie					192	21	52	3	97	3								24
CA-2-San Pedro Masahuat-San																		
Antonie Masahuat					264	10	47	14	100									29

A P P E N D I X I I . A . 5

UNIT PRICE ANALYSIS

CHART

Unit Price Analysis

Activity No.	Description: Granular Base	Unit: M^3

(A) Mechanical Equipment	No. of Items	Hours Worked	Hourly Cost	Cost ¢ F	Cost ¢ E
Motor Grader, 125 Hp	1	7	200	1400	
Static Tandem Roller, 8-12 Ton	1	7	120	840	
			TOTAL (A)	2240	2688

(B) Labor (Force Account)	No. of Persons	Hours Worked	Hourly Salary	Cost ¢ F	Cost ¢ E
Land Moving Equipment Operator	2	7	11.46	151	
Operator's Chief	2	7	7.81	109	
Field Chief	1	7	10.58	74	
Controller	1	7	7.66	54	
Construction Worker	6	7	6.95	292	
			TOTAL (B)	690	605.3

(C) Daily Performance: 350 M^3	DAILY TOTAL COST (A) + (B)	2930	3293.3
(D) Unit Cost without Materials $\frac{(A)+(B)}{(C)}$		8	9.41

(E) Materials for Production Unit	Measuring Unit	Consumption	Unit Cost	Cost ¢ F	Cost ¢ E
Granular Base	M^3	1.25	55	69	
Water	M^3	0.115	50	6	
			TOTAL (E)	75	90

(F) Direct Unit Cost (D) + (E)			83	99.41
Indirect Cost	(G) Overhead	% x (F)		
	(H) Unforeseen Expenses	% x (F)		
	(I) Benefits	% x (F)		
	(J) Supervision	% x (F)		
	(K) Total (G + H + I + J)	40 % x (F)	33.2	30.88
(N) Unit Price			116.2	130.29

(O) Observations: 1 US$ = 5 colones

Date: December 1988

NB: F - Financial : E - Economic

A P P E N D I X I I . A . 6

FORMULAS AND ASSUMPTIONS

FOR ECONOMIC EVALUATION

APPENDIX II.A.6

1. Inputs to the HDM-III model

To estimate unit vehicle operating costs, the Consultants assumed default values presented by the model, except for the following inputs (ordered by input screen):

a. Screen # 1

- Surface type: 1 and 0, depending on road type. No significant variation in vehicle operating costs were observed between these two; the Consultants used the average of these two sets of results for calculations.

- Roughness: Roughness levels were input ranging from 2000 mm/km to 20,000 mm/km to cover all possible conditions.

- Average positive gradient: Given El Salvador's rolling terrain, the Consultants assumed five percent.

- Uphill travel proportion: 25 percent

- Average negative gradient: One percent

- Average horizontal curvature: 270 grades

- Elevation: 600 m.

- Effective number of lanes: (code): 1

b. Screen # 2

Three different sets of vehicles were assumed medium size car, bus and medium-load truck.

c. Screen # 3

- Load carried by trucks: 15,000 Kg

- Fuel consumption adjustment factor. This is a dimensionless parameter which was obtained calibrating the model's fuel consumption forecasts to achieve the following values: 10 km/l for cars, 4 km/l for trucks and 15 km/l for buses.

- Desired speed: Values from 10 to 100 km/h were assumed to cover all possible road conditions.

d. Screen # 5

- Average annual utilization (km): 18,500 km/year for cars, 37,000/year for buses and 39,000 km/year for trucks.

- Average annual utilization (hours): this value was calculated dividing average annual utilization in km by the desired speed.

- Average vehicle service life: 10 years for cars and 12 years for buses and trucks.

- Use constant service life: the Consultants used 1, indicating vehicle service life is constant and equal to the specified value, regardless of operating speed.

- Average life in kilometers by vehicle type: annual kilometers multiplied by service life.

- Average number of passengers per vehicle: 1.5 for passengers, 35 for buses and 0 for trucks.

e. Screen # 6

- Vehicle cost: C80,000 for cars, C270,000 for buses and C200,000 for trucks.

- Fuel cost: The Consultants assumed international fuel prices: C1.44/liter for cars, and C1.30/liter for buses and trucks.

- Lubricant cost: C11.62/liter

- New tire cost: C250. for cars, C1,200 for buses and C1,400 for trucks.

- Crew time cost: C13.98 per hour for buses and C9.32 per hour for trucks.

- Passenger delay cost: The Consultants assume no passenger delay cost. Previous runs with delay costs of C4.65 per hour for car passengers, and C1.03 per hour for bus passengers gave results not significantly different to the ones used.

- Maintenance labor cost: C7.98 per hour for cars and C13.3 per hour for buses and trucks.

- Cargo delay cost: the Consultants assumed this to be zero for conservative purposes.

- Annual interest rate: twelve percent.

A brief description of the HDM-II model and its capabilities is presented below.

f. The HDM III Model

The Highway Design and Maintenance Standards Model (HDM) was developed by the World Bank, in particular to meet the needs of highway administrations in developing countries. The model simulates life-cycle conditions and costs and provides economic decision criteria for multiple road design and maintenance alternatives for any road, group of roads, or road network. The model can be used for both paved and unpaved roads.

With HDM the user can compare cost estimates and economic evaluations of different construction and maintenance options, including time staging strategies.

The HDM model can be used to examine such questions as:

- What is the economic benefit of spending a dollar on maintenance as compared to spending it on new roads, or alternatively of improving the alignments of existing roads?

- How much should be spent on paved roads and how much to maintain and upgrade earth and gravel roads?

- To determine at what traffic level to upgrade unpaved roads to paved roads and when is the optimum time to apply an asphalt concrete overlay to a surface dressed paved road.

- What is the effect of deferring maintenance of a road or road network?

- What maintenance policy or combination of maintenance policies yields the lowest overall economic costs (Total Transport Costs = Construction Cost + Maintenance Cost + Vehicle Operating Costs (VOCs)) for a specified level of maintenance funding?

The model can be used as a planning, budgeting and programming tool by a Ministry of Public Works and is particularly useful in that the output of the model can be used to justify requests to government and external donor agencies to fund individual projects and to provide adequate funding for maintenance.

A version of HDM-III is specifically adapted for use on micro-computers, HDM-PC, Version 2.0, which includes the core HDM-III model, data input facilities, interfacing facilities with LOTUS 123 and a modified version of the Expenditure Budgeting Model (EBM).

HDM-III comprises a number of modules as follows:

- Construction Cost Module
- Road Deterioration Module
- Traffic Module
- Vehicle Operating Cost Module
- Expenditure Budgeting Module (EBM)

The first four modules are used interactively to develop traffic levels, construction costs, maintenance costs and road user costs, these costs are then summed and discounted to arrive at the total transport costs for the road under review for any length of analysis period up to 30 years.

Economic benefits are then determined by comparing the total cost streams for various maintenance and construction alternatives with a base case (the null alternative), usually representing minimal routine maintenance.

The model demonstrates clearly the benefits derived from maintenance and allows the optimization of maintenance strategies. This is of particular importance to El Salvador at the present time where a number of major roads need rehabilitation.

The Expenditure Budgeting Model is an extremely useful module with which limited resources can be optimally utilize, e.g., for limited funds, the maintenance strategy which makes best use of the monies available can be determined.

2. Pavement Deterioration Curves

The following deterioration curves were assumed:

Do nothing alternative - paved roads

$R = Ro + 0.8 * t$

R = roughness in years in m/km

Ro = initial (current) roughness in m/km

t = time in years

Do nothing alternative-unpaved roads with ADT's <250

$R = Ro + 2 * t$

Do nothing alternative-unpaved roads with ADT's >250

$R = Ro + 3.33 * t$

Rehabilitation/improvement alternative - paved roads

$R = 2 + 0.253 * (t)\ 1.5$

Rehabilitation/improvement alternative-unpaved roads with ADT's <250

$R = 4 + 0.8944 * (t)\ 1.5$

Rehabilitation/improvement alternative-unpaved roads with ADT's >250

$R = 4 + 1.9245 * (t)\ 1.5$

3. Roughness/Pavement Condition Relationship

The following roughness levels were assumed for roads in different conditions:

Paved roads-excellent condition (just rehabilitated/improved):	2,000 mm/km
Paved roads-good condition:	4,000 mm/km
Paved roads-fair condition:	6,000 mm/km
Paved roads-poor condition:	10,000 mm/km
Paved roads-Complete failure:	14,000 mm/km
Unpaved roads-excellent condition(just rehabilitated/improved):	4,000 mm/km
Unpaved roads-good condition:	6,000 mm/km
Unpaved roads-fair condition:	10,000 mm/km
Unpaved roads-poor condition:	14,000 mm/km
Unpaved roads-complete failure:	20,000 mm/km

4. Speed curves

A segment's average running speed is estimated based on volume-over-capacity ratios and predominant roughness levels.

The formula used to calculate speeds is presented below:

$$V = Vo * (1-0.55 \frac{ADT * 0.08}{C}) 1.25 * (1 - \frac{(R-2)}{32})$$

V = Speed in year t

Vo = Free-flow speed for road category: 100 km/h for special roads, 50 km/h for primary roads, 75 km/h for secondary roads, 60 km/h for tertiary roads and 50 km/h for rural roads.

ADT = Road's average daily traffic in year t

C = Road's capacity which is a function of road class.

R = Road's roughness in m/km

5. Work-type code

All possible rehabilitation and improvement combinations were analyzed. For calculation purposes the different types of work were coded. These codes are presented below:

Type of Work	Code
Rehabilitation	
Special Roads	0
Primary Roads	1
Secondary Roads	2
Tertiary Roads	3
Rural	4
Improvement	
Rural to Tertiary	5
Rural to Secondary	6
Tertiary to Secondary	7
Tertiary to Primary	8
Secondary to Primary	9
Secondary to Special	10
Primary to Special	11
Special (4 lanes) to Special (6 lanes)	12

A P P E N D I X I I . A . 7

PROPOSED 1990 - 94 FIVE-YEAR PLAN
FINANCIAL RATIOS

APPENDIX II.A.7

ESTIMATION OF FIRST FIVE-YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

SECONDARY HIGHWAYS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (3)	N.B./I. (12%)	N.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																		
APOPA-KM 20	2	7	2	P	339910	2379370	10241560	15764525	9278862	0	0	142938675	75428360	73048990	4.435	31.701	34.784	27.82
CA:4 KM 17-KM 20	2	3	2	P	339910	1019730	3899411	6007446	3517995	0	0	54372008	28707354	27687624	3.954	28.152	30.887	24.70
SAN MIGUEL-EL DELIRIO	2	15	2	F	211940	3242682	6290079	17017575	17813275	0	0	181370661	84744002	81501320	2.297	26.134	29.222	22.32
SAN SALVADOR-LOS FLORES	2	9	2	F	211940	1907460	3455675	9312091	9071505	0	0	95901126	45283295	43375835	2.163	23.740	26.503	20.32
KM 20-REJAPA	2	3	2	P	339910	1019730	3321776	5233081	2489410	0	0	44300352	23906664	22886934	3.395	23.444	25.646	20.65
REJAPA-KM 27	2	6	2	P	339910	1359640	4284950	6745824	3205204	0	0	57094603	30817010	29457370	3.288	22.666	24.794	19.97
CA:4 KM 20-AGUILARES	2	16	2	P	339910	4758740	14448750	22798195	10857615	0	0	193001827	104125471	99366731	3.173	21.881	23.937	19.27
KM 27-QUEZALTEPEQUE EXIT	2	3	2	P	339910	1019730	2988478	4784721	2301130	0	0	40508091	21802036	20782306	3.073	21.380	23.398	18.82
CA:4 AGUILARES-SAN IGNACIO	2	56	2	P	339910	19034960	39264504	77382001	41066076	0	0	651710635	340773322	321738362	2.279	17.902	19.680	15.66
MILITAR ROUTE EXIT-PASAQUINA	2	30	2	F	211940	6358200	9473791	21653471	21999683	0	0	231123510	109677879	103319679	1.758	17.250	19.237	14.79
BERLIN-ALEGRIA-SANTIAGO DE MARIA	2	12	2	F	211940	2458504	3663199	8372675	8506544	0	0	89367757	42408780	39950276	1.758	17.250	19.237	14.79
QUEZALTEPEQUE EXIT-SITIO DEL NIÑO	2	13	2	P	339910	4418830	8947718	16125132	9505693	0	0	142660853	74113134	69694304	2.206	16.772	18.647	14.66
CA:12 SONSONATE-SANTA ANA	2	36	2	F	211940	7705960	7586704	16132982	17458215	0	0	178856252	84537968	77332003	1.277	11.732	13.089	10.05
MEJICANOS-MARIONA-MEJAFA	2	16	2	P	339910	5438560	7443106	12610527	7211397	0	0	111612118	58485849	53047289	1.518	10.754	11.811	9.42
ZACATECOLUCA-TECOLUCA-SAN VICENTE	2	21	2	F	211940	4450740	3991547	8549926	9107876	0	0	93992916	44505307	40054567	1.116	10.000	11.154	8.57
APOPA-SAN JOSE LAS FLORES	2	9	2	F	211940	1907460	1433757	3140671	3432098	0	0	34877903	16425976	14518516	0.968	8.611	9.614	7.37
LOS PLACES-PANCHIMALCO	2	7	2	F	211940	1483580	1065073	2324713	2411129	0	0	25179531	11952536	10468956	0.930	8.057	8.984	6.91
SANTIAGO DE MARIA-TECAPAN-OZATLAN-CA:2	2	17	2	P	339910	5778470	5454437	8915320	5439256	0	0	79951313	41494738	35716268	1.021	7.181	7.900	6.27
PANCHIMALCO-ROSARIO DE MORA	2	4	2	F	211940	847760	429579	907224	799940	0	0	9156153	4459549	3611789	0.681	5.260	5.843	4.53
EL COMCO-CA:8 FROM CERRO VERDE TO CA:8	2	3	2	F	211940	635820	164749	369961	237389	0	0	3263641	1650958	1015133	0.380	2.597	2.869	2.25
IMPROVEMENT																		
CA:4 SAN SALVADOR-APOPA	2	13	10	P	3500000	45500000	55254453	133036528	117874196	99525468	124533527	2197393110	778158252	732658252	1.492	17.102	19.698	14.08
SAN SALVADOR-SAN MARCOS	2	5	10	P	3500000	17500000	21251713	51167896	45336229	38279026	47896703	845151196	299291635	281791635	1.492	17.102	19.698	14.08
CA:4 APOPA (KM 13)-KM 15	2	2	9	P	1186440	2372880	3747188	6493826	3426150	-93680	8450215	80603180	32671416	30098536	(2)	13.684	15.396	11.63
CA:4 KM 15-KM 17	2	2	9	P	1186440	2372880	3286265	5652427	3438404	-93680	-93680	49194168	25831292	23458412	(2)	10.886	11.961	9.53
SANTA ANA-ANUNCHAPAN	2	34	9	F	1186440	40338960	20096138	46672424	52788858	7937965	-1592550	559122489	251479696	211140736	(2)	6.234	7.009	5.29
SAN MIGUEL-MILITAR ROUTE EXIT	2	16	9	F	1186440	18983040	8690273	20972805	25396584	-769440	-769440	237089707	111032153	92049113	(2)	5.849	6.542	4.99
TOTAL	2	352	-	-	-	203,793,686	269,774,872	527,943,967	433,970,531	144,805,620	178,442,664	6,429,393,775	2,743,564,630	2,539,770,944	1.452	13.662	15.151	11.43

(1) In colones. (2) Multiple IRRs (3) IRR = 1.0 (100 Percent)

APPENDIX II.A.7

...N OF FIRST FIVE-YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

COASTAL HIGHWAY (CA:2)

	PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (%)	B/C (12%)	B/C (10%)	B/C (15%)
CA:2	USULUTAN-SANTA ELENA (KM 114)	1	3	1	P	466340	1399020	2987667	5598508	3666161	0	0	50993157	26097225	26698205	2.333	18.654	20.566	16.25
CA:2	SANTA ELENA (KM 114)-LA UNION	1	86	1	P	466340	40105240	69027524	125522573	79679270	0	0	1135816739	585054375	544949135	1.902	14.588	16.068	12.73
CA:2	LA LIBERTAD (KM 32)-SAN DIEGO (KM 37)	1	5	1	P	466340	2331700	3209238	5635547	3300703	0	0	49891072	26033485	23701785	1.538	11.165	12.274	9.77
CA:2	ZACATECOLUCA (KM 56)-LEMPA RIVER (KM 83)	1	27	1	E	245980	6641460	6987586	14309786	13176493	0	0	147755466	71692305	65050845	1.261	10.795	11.996	9.30
CA:2	LA LIBERTAD-CA:12	1	67	1	P	466340	31244780	34862529	59107509	33293934	0	0	520014782	273471716	242226936	1.259	8.753	9.611	7.67
CA:2	SAN DIEGO (KM 37)-COMALAPA (KM 61)	1	24	1	P	466340	11192160	17487521	29487019	11332477	0	0	179072485	94845832	83653672	1.238	8.474	9.295	7.44
CA:2	LA HACHADURA-CA:12	1	42	1	P	466340	19586280	21560565	35275856	18196907	0	0	303402304	161699224	142117944	1.231	8.256	9.048	7.25
TOTAL		1	254	1	-	-	112,500,640	151,122,632	265,977,798	162,647,867	0	0	2,386,946,005	1,238,894,162	1,126,393,522	1.505	11.012	12.115	9.62

APPENDIX II.A.7

ESTIMATION OF FIRST FIVE-YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

PAN-AMERICAN HIGHWAY (CA:1)

	PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (%)	N.B./I. (12%)	N.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																			
CA:1	SITIO DEL NIÑO-SANTA TECLA	0	15	0	F	491960	7379400	31765464	70742793	68631473	0	0	739663590	[illegible]	346217646	4.532	47.917	53.377	41.153
CA:1	JUNCTION - LA UNION	1	7	1	F	245980	1721860	4471132	6212605	8632369	0	0	82296401	38815918	37094058	2.691	22.543	25.139	19.365
CA:1	KM73-EL PORVENIR	2	3	2	F	211940	635820	574569	1200575	1238561	0	0	13031811	6210977	5575157	1.114	9.768	10.885	8.387
CA:1	EL PORVENIR-SAN CRISTOBAL	2	17	2	F	211940	3602980	3171749	6628862	6792476	0	0	71721630	34215797	30612817	1.089	9.497	10.580	8.155
CA:1	EL PORTEZUELO-KM 73	2	3	2	F	211940	635820	522290	1069758	1020277	0	0	11220773	5477241	4781401	1.019	8.520	9.475	7.336
IMPROVEMENT																			
CA:1	SAN SALVADOR - SANTA TECLA (LIBERTAD EXIT)	0	5	12	F	2200000	9900000	24398505	51790414	74452508	13788145	140311243	1156190115	366075606	356175606	2.718	36.977	43.170	29.960
CA:1	SAN SALVADOR-SAN MARTIN (KM 18)	2	18	10	F	3500000	63000000	69071970	295073744	223772349	188697685	235850304	3865412855	1285815672	1222815672	1.458	20.410	25.748	16.580
CA:1	SAN RAFAEL ORIENTE EXIT -SAN MIGUEL	2	6	10	P	3500000	21000000	15213120	26631416	18597843	38674911	54106962	606558827	184081787	163081787	0.863	8.766	10.284	7.069
CA:1	SAN MIGUEL-LA UNION EXIT	2	38	9	F	1186440	45084720	25468806	60803861	61400560	-1779920	170465607	1166798409	365716708	320631988	(2)	8.112	9.430	6.622
CA:1	SAN MARTIN (KM 18)-COJUTEPEQUE (KM 33)	2	15	10	F	3500000	52500000	14809600	29977349	32100638	8760933	79051973	613385844	195052613	142552813	0.412	3.715	4.325	3.026
CA:1	EAST OF LEMPA RIVER- S.RAFAEL ORIENTE EXIT	2	40	10	P	3500000	140000000	47098073	75495834	57924904	14886223	23140677	865954087	293744669	253744669	0.408	2.812	3.135	2.421
CA:1	SANTA ANA-EL PORTEZUELO	2	4	10	F	3500000	14000000	3273330	6599598	6776186	1884411	2502576	89695231	37330491	23330491	0.346	2.666	3.013	2.251
CA:1	COJUTEPEQUE-SAN RAFAEL CEDROS	2	7	10	F	3500000	24500000	3752311	6429778	6160475	1611977	2230485	83868492	36162526	11462526	0.198	1.476	1.659	1.256
TOTAL		-	178	-	-	-	383,960,600	243,090,919	548,656,585	562,700,569	266,524,365	707,663,821	9,345,798,065	3,302,237,211	2,918,276,611	0.848	8.600	9.901	7.096

(1) In colones.

(2) Multiple IRRs.

APPENDIX II.A.7

RECOMMENDED FIVE-YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

SPECIAL AND PRIMARY ROADWAYS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (2)	B/C (12%)	B/C (10%)	B/C (15%)
REHABILITATION/RECONSTRUCTION																		
CA:12 SONSONATE [illegible]	1	14	1	F	245980	3443720	11098195	24010604	21358011	0	0	244583260	119995830	115952110	3.693	34.671	38.493	29.922
CA:12 KM 80-ACAJUTLA	1	6	1	F	245980	1475880	3754767	7486846	7859942	0	0	82332432	39286487	37810607	2.771	26.619	29.654	22.865
EL CIMARRON-LA LIBERTAD	1	5	1	F	245980	1229900	2151259	4870214	5834578	0	0	56467003	26173504	24943604	2.020	21.291	23.817	18.157
NUEVO CUSCATLAN EXIT-SN. JOSE VILLANUEVA EXIT	1	9	1	F	245980	2213820	4154919	8753513	9626391	0	0	97910062	46200285	43986463	2.129	20.769	23.290	17.879
SN JOSE VILLANUEVA EXIT-EL CIMARRON	1	8	1	F	245980	1967840	3481701	7357087	8058327	0	0	82102777	38755723	36787883	2.011	19.695	21.978	16.874
SAN SALVADOR - COMALAPA FREEWAY	0	42	0	F	491960	20662320	35684957	71989222	71320473	0	0	769766255	370029781	349367461	1.949	17.908	19.928	15.486
CA:12 SANTA ANA-TEXISTEPEQUE	1	16	1	P	466340	7461440	14038914	23364591	13148261	0	0	205979249	108508303	101046663	2.092	16.543	15.966	12.753
CA:12 TEXISTEPEQUE-METAPAN	1	30	1	P	466340	13990200	13712692	21848208	10910367	0	0	187153204	100353796	86363596	1.098	7.173	7.854	6.113
CA:12 METAPAN-ANGUIATU	1	12	1	P	466340	5596080	3785759	5711754	2596959	0	0	48152085	26216123	20620043	0.763	4.685	5.118	4.136
CA:4 SAN IGNACIO-EL POY	1	6	1	P	466340	2798040	777276	889400	159869	0	0	6732333	4064938	1266896	0.234	1.446	1.558	1.300
IMPROVEMENT																		
CA:1-NUEVO CUSCATLAN EXIT	1	1	11	F	2300000	2300000	1540978	3070504	3390861	1183432	7430902	62833883	28221581	17921581	0.851	8.792	10.226	7.167
CA:8 TEPECOYO EXIT-CA:1	1	10	11	F	2300000	23000000	12056690	19648302	23716416	6745861	8679401	298248672	122904752	99904752	0.643	5.344	6.044	4.502
CA:8 SACACOYO EXIT-TEPECOYO EXIT	1	2	11	F	2300000	4600000	2316501	3831419	3912838	1268048	1634789	53841420	22509714	17909714	0.616	4.893	5.520	4.145
CA:8 IZALCO EXIT-CALUCO EXIT	1	1	11	F	2300000	2300000	1042988	1733239	1761606	567568	734576	24256648	10151454	7851634	0.562	4.414	4.978	3.739
CA:8 EL CONGO EXIT-ARMERIA EXIT	1	6	11	F	2300000	13800000	6175767	10323567	10643812	3478510	4498555	146002696	60777817	46977817	0.558	4.404	4.971	3.727
CA:8 CALUCO EXIT-SAN JULIAN EXIT	1	9	11	F	2300000	20700000	9354977	15539692	15746665	5051310	6540400	216922620	90890203	70190203	0.560	4.391	4.951	3.720
CA:8 ARMERIA EXIT-SACACOYO EXIT	1	6	11	F	2300000	13800000	6067052	10111343	10341487	3369869	4363169	142319562	59576674	45576674	0.548	4.303	4.855	3.663
CA:8 SAN JULIAN EXIT-EL CONGO EXIT	1	4	11	F	2300000	9200000	3675204	6565767	6727642	2184089	2830904	91785326	38041526	28841526	0.520	4.135	4.671	3.495
CA:8 SONSONATE-IZALCO EXIT	1	6	11	F	2300000	13800000	4913278	8784314	8829558	1074875	3671328	112348759	48831480	35031480	0.468	3.539	3.974	3.013
TOTAL	0/1	379	-	-	-	160,895,520	128,680,697	232,178,579	214,575,051	24,923,563	40,384,021	2,655,150,494	1,233,274,139	1,072,378,619	0.955	7.665	8.558	6.576

(1) In colones. (2) IRR = 1.0 (100 Percent)

APPENDIX III.A.7

ESTIMATION OF FIRST FIVE YEAR HIGHWAY YEAR ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

TERTIARY ROADWAYS

PROJECT NAME	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (3)	N.B./I. (12%)	C.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																		
CA:12-EL ROSCO	3	7	3	P	113240	826652	6825536	0	0	0	0	17065839	13688763	12862111	7.999	16.559	17.136	15.757
TONACATEPEQUE-SOYAPANGO	3	12	3	F	88050	1056600	4427961	0	0	0	0	11069853	8880335	7823735	3.924	8.405	8.697	7.997
[illegible] TECLA-SN. JUAN LOS PLANES-QUEZALTEPEQUE	3	17	4	P	94400	1604800	2460769	2930931	3230	3230	3230	19381855	12299761	10694461	1.573	7.464	9.205	6 953
[illegible]APAN-TACUBA	3	17	3	F	88050	1514460	1606654	2962145	0	0	0	17341287	10652098	9137638	1.222	7.034	7.571	6.331
SANTA ANA-SAN PABLO TACACHICO	3	26	3	F	88050	2289300	2425640	4477661	0	0	0	26213574	16102098	13812700	1.222	7.034	7.571	6.331
CERRO VERDE-(EL CONGO-CA:8)	3	10	3	F	88050	880500	932938	1722177	0	0	0	10082144	6193080	5312580	1.222	7.034	7.571	6.331
SAN JUAN OPICO-SAN PABLO TACACHICO	3	14	3	F	88050	1232700	1306114	2411648	0	0	0	14115001	8670312	7437612	1.222	7.034	7.571	6.331
JAYAGUE DETOUR-TEPECOYO	3	5	3	P	113240	566200	1681791	0	0	0	0	4954477	3976526	3408326	3.230	7.070	7.264	6.680
CA:2-GUAYMANGO-JUJUTLA-ATACO-AMUACHAPAN	3	35	3	P	113240	3850160	4917679	5855603	0	0	0	38643010	24557098	20706928	1.314	6.378	6.827	5.787
SAN PEDRO NORUALCO-JERUZALEN	3	13	3	P	113240	1449672	1851786	2204387	0	0	0	14547957	9245021	7795549	1.314	6.378	6.827	5.787
S ANTONIO NORTE-STO DOMINGO GUZMAN-S PEDRO PUNTLA	3	13	3	P	113240	1472120	1880213	2238851	0	0	0	14775269	9389475	7917355	1.314	6.378	6.827	5.787
CA:2-TEOTEPEQUE-SANTA TECLA	3	44	3	P	113240	4982560	6363796	7577580	0	0	0	50008602	31779761	26797201	1.314	6.378	6.827	5.787
CA:1-SAN ANTONIO SILVA-SAN ALEJO	3	10	3	P	113240	1163724	1491206	0	0	0	0	3728014	2990646	1846922	0.998	2.615	2.706	2.488
CIUDAD BARRIOS-NONCAGUA	3	28	3	P	113240	3170720	4134035	0	0	0	0	10335038	8290899	5120179	0.998	2.615	2.706	2.488
IMPROVEMENT																		
CA:8 JAYAGUE DETOUR	3	2	7	P	1372250	2744460	2612521	883375	1127146	1430978	106830	22976367	10620059	7875599	(2)	3.870	4.281	3.378
CA:2-LA HERRADURA (VIA SAN MARCELINO)	3	19	7	F	1372250	26700160	7952391	6207350	7972184	10171458	12912221	177269073	58965505	34245365	0.299	2.385	2.760	1.963
TOTAL	3	270	-	-	-	53,484,548	53,167,810	39,470,888	9,102,559	11,605,646	12,808,621	452,505,411	236,278,838	182,794,270	0.921	4.418	4.811	3.934

(1) In colones. (2) Multiple IRRs (3) = 1.0 (100 Percent)

APPENDIX II.A.7

ESTIMATION OF FIRST FIVE YEAR HIGHWAY PLAN ECONOMIC BENEFITS - FINANCIAL RATIOS (1)

RURAL ROADWAYS

PROJECT BASE	CATEGORY	LENGTH (km)	TYPE OF WORK	CONDITION	PROJECT COSTS UNIT	PROJECT COSTS TOTAL	FIRST YEAR BENEFITS	FIFTH YEAR BENEFITS	TENTH YEAR BENEFITS	15TH YEAR BENEFITS	20TH YEAR BENEFITS	TOTAL BENEFITS	DISC. TOTAL BENEFITS (12%)	N. P. V. (12%)	I. R. R. (3)	N.B./I. (12%)	N.B./I. (10%)	N.B./I. (15%)
REHABILITATION/RECONSTRUCTION																		
TAPALHUACA-CA:2(ANTIGUA CORALAPA)	4	8	4	P	94400	755200	1401454	1157089	0	0	0	8688037	5701980	4946780	1.008	7.550	8.041	6.902
ATIQUIZAYA-SAN LORENZO-EL PORTILLO	4	9	4	P	94400	877920	3301004	0	0	0	0	8252509	6620236	5742316	3.491	7.541	7.803	7.176
SAN MATIAS-SAN JUAN OPICO	4	5	4	P	94400	472000	792712	647828	0	0	0	4897006	3215619	2763619	1.630	6.813	7.255	6.228
QUEZALTEPEQUE-SAN MATIAS	4	19	4	P	94400	1793600	5614640	0	0	0	0	14036600	11260285	9666685	2.858	6.270	6.697	5.974
SANTO TOMAS-SAN MIGUEL TEPEZONTES-COJUTEPEQUE	4	24	4	P	94400	2257280	3376982	2747957	0	0	0	20808260	13669005	11431725	1.458	6.110	6.506	5.586
CA:1-SAN ANTONIO PAJONAL	4	14	4	P	94400	1321600	2696492	1032755	0	0	0	11386376	7998466	6676866	1.874	6.052	6.379	5.614
SAN PEDRO MASAHUAT-SAN ANTONIO MASAHUAT	4	3	4	F	73395	220185	187035	349703	0	0	0	2041253	1252734	1032549	1.003	5.689	6.125	5.120
SAN JULIAN-CUISNAHUAT	4	10	4	P	94400	944000	2587638	0	0	0	0	5968595	4788060	3844060	2.251	5.072	5.249	4.826
CHALCHUAPA-LAS CRUCES	4	8	4	P	94400	755200	726510	570618	0	0	0	4379057	2885070	2129870	0.996	3.820	4.066	3.495
CA:2 -TAYANTIQUE	4	15	4	P	94400	1368800	1002374	778889	0	0	0	6010936	3965017	2996217	0.657	2.897	3.083	2.651
CA:2 - HAC.CHILANGUERA	4	6	4	P	94400	585280	563392	298357	0	0	0	2251087	1477561	892281	0.551	2.525	2.689	2.308
HAC. SANTA ELENA-I.(TAYANTIQUE)	4	10	4	P	94400	944000	586116	481222	0	0	0	3630786	2383163	1439163	0.551	2.525	2.689	2.308
CA:2 - TIERRA BLANCA	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
CA:2 - LLANO DE LAS ROSAS	4	7	4	P	94400	660800	410281	336855	0	0	0	2541550	1668214	1007614	0.551	2.525	2.689	2.308
LA UNION-TOLOQUAL COOP.-EL PASO	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
SAN MIGUEL-LA PUERTA	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
CA.2 - HACIENDA LA CABAÑA	4	12	4	P	94400	1132800	703339	577466	0	0	0	4356943	2859795	1726995	0.551	2.525	2.689	2.308
PANAMERICANA-CA:2-LA UNION	4	12	4	P	94400	1132800	703339	577466	0	0	0	4356943	2859795	1726995	0.551	2.525	2.689	2.308
MILITAR ROUTE-MAYUCAGUIN COOPERATIVE	4	9	4	P	94400	849600	527504	433099	0	0	0	3267708	2144846	1295246	0.551	2.525	2.689	2.308
CA:2 GUALPIROLE COOP.	4	8	4	P	94400	755200	468892	384977	0	0	0	2904629	1906530	1151330	0.551	2.525	2.689	2.308
CA:2-CANTON LA CANOA	4	18	4	P	94400	1727520	1072591	880436	0	0	0	6644339	4361187	2633667	0.551	2.525	2.689	2.308
SAN ALEJO-EL TAMARINDO	4	11	4	P	94400	1038400	644727	529344	0	0	0	3993865	2621479	1583079	0.551	2.525	2.689	2.308
CA:2 - EL RANCHITO COOPERATIVE	4	7	4	P	94400	660800	410281	336855	0	0	0	2541550	1668214	1007614	0.551	2.525	2.689	2.308
TEJUTEPEQUE-SAN ANTONIO BUENA VISTA-CORRAL VIEJO	4	10	4	P	94400	925120	574393	471597	0	0	0	3558170	2335499	1410379	0.551	2.525	2.689	2.308
ULUAZAPA-COOPERATIVE 21 DE MARZO	4	11	4	P	94400	1047840	650588	534156	0	0	0	4030173	2645310	1597470	0.551	2.525	2.689	2.308
OSTUA-SAN JERONIMO	4	8	4	F	73395	587160	847224	0	0	0	-717143	-33369	1437041	849801	(2)	2.447	2.372	2.480
CA:2 - SAN DIONISIO	4	8	4	F	73395	587160	213716	384977	0	0	0	2316689	1434879	847719	0.453	2.444	2.627	2.204
BARRILINGO-LA CHAPINA COOP.	4	8	4	P	94400	708000	431358	323692	0	0	0	2535008	1677449	969449	0.521	2.369	2.520	2.170

CALICO - EL CARMEN COOPERATIVE.	4	10	4 P	94400	925120	563661	422957	0	0	0	3312610	2191866	1266746	0.521	2.369	2.520	2.170
CA:2 - PALO CORO COOPERATIVE	4	8	4 P	94400	755200	460115	345271	0	0	0	2704008	1789279	1034079	0.521	2.369	2.520	2.170
CA:2 - BARRA CIEGA COOPERATIVE	4	8	4 P	94400	755200	460115	345271	0	0	0	2704008	1789279	1034079	0.521	2.369	2.520	2.170
SAN JOSE EL NARANJO-LAS DELICIAS-CA:2	4	8	4 P	94400	736120	448632	336639	0	0	0	2636408	1744547	1008227	0.521	2.369	2.520	2.170
TACUBA-CONCEPCION DE ATACO	4	13	4 P	94400	1227200	747687	561066	0	0	0	4394013	2907573	1680378	0.521	2.369	2.520	2.170
HACIENDA SAN MARTIN-CA:2	4	16	4 P	94400	1483200	904173	668963	0	0	0	5239016	3466727	2003527	0.521	2.369	2.520	2.170
CA:2 - CARA SUCIA	4	8	4 P	94400	755200	460115	345271	0	0	0	2704008	1789279	1034079	0.521	2.369	2.520	2.170
CA:12-LAS CASITAS-S ANTONIO MAS-L NORCONES-GUAMUECIA	4	19	4 P	94400	1831360	1115779	837283	0	0	0	6557220	4339001	2507641	0.521	2.369	2.520	2.170
ISTAGUA-CRATONIO DE CONCEPCION-MONTEPEQUE	4	9	4 P	94400	849600	517629	388430	0	0	0	3042009	2012939	1163339	0.521	2.369	2.520	2.170
LA CRILATA-SAN RAMOS	4	16	4 P	94400	1510400	920230	690542	0	0	0	5408016	3578557	2068157	0.521	2.369	2.520	2.170
SAN JOSE EL NARANJO-(JUJUTLA-ATACO)	4	25	4 P	94400	2350560	1432108	1074657	0	0	0	8416225	5569130	3218571	0.521	2.369	2.520	2.170
SAN LORENZO-HACIENDA SAN MARTIAL	4	6	4 P	94400	604160	368092	276217	0	0	0	2163206	1431423	827263	0.521	2.369	2.520	2.170
EL REFUGIO-EL CASTILLO-SAN JOSE LA CUEVA-NONCAGUA	4	9	4 P	94400	849600	517629	388430	0	0	0	3042009	2012939	1163339	0.521	2.369	2.520	2.170
CA:2 - SAN JOSE DE LA MONTAÑA	4	16	4 P	94400	1510400	920230	690542	0	0	0	5408016	3578557	2068157	0.521	2.369	2.520	2.170
TACUBA-CONCEPCION DE ATACO	4	13	4 P	94400	1227200	747687	561066	0	0	0	4394013	2907578	1680378	0.521	2.369	2.520	2.170
COMALAPA FREEWAY-LAS HOJAS COOP.	4	19	4 P	94400	1812680	1104276	828651	0	0	0	6489619	4294269	2481789	0.521	2.369	2.520	2.170
NARUIZALCO-JUAYUA	4	9	4 P	94400	862400	488872	366851	0	0	0	2873009	1901109	1098709	0.521	2.369	2.520	2.170
CA:2 - HOJA DE SAL COOPERATIVE	4	11	4 P	94400	1036400	632658	474748	0	0	0	3718011	2460258	1421858	0.521	2.369	2.520	2.170
CA:2 - EL ZARZAL	4	12	4 P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
EL COMCO-FLOR AMARILLA	4	12	4 P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
CA:2 - SAN BENITO	4	11	4 P	94400	1036400	632658	474748	0	0	0	3718011	2460258	1421858	0.521	2.369	2.520	2.170
SAN JULIAN-EL SALSAMAR COOPERATIVE	4	12	4 P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
CA:2 - SIHUAPILAPA	4	12	4 P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
FLOR AMARILLA-PLANES DE LA LAGUNA	4	12	4 P	94400	1132800	690173	517907	0	0	0	4056012	2683918	1551118	0.521	2.369	2.520	2.170
CA:2 - AGUA FRIA	4	11	4 P	94400	1036400	632658	474748	0	0	0	3718011	2460258	1421858	0.521	2.369	2.520	2.170
CA:3-EL CHAPERNO CASERIO SAN ISIDRO	4	8	4 P	94400	783520	477369	358219	0	0	0	2805408	1856377	1072857	0.521	2.369	2.520	2.170
JUAYUA-SAN JOSE LA MAJADA-EL ARENAL	4	10	4 F	73395	733950	287395	431589	0	0	0	2660912	1659731	925781	0.423	2.261	2.428	2.043
CA:1-EL PORVENIR-(SANTA ANA-ARUACHAPAN)	4	9	4 F	73395	660555	258754	388430	0	0	0	2394821	1493758	833293	0.423	2.261	2.428	2.043
CA:2-SAN PEDRO MASAHUAT	4	6	4 F	73395	440370	172503	258953	0	0	0	1596547	995839	555469	0.423	2.261	2.428	2.043
IMPROVEMENT																	
EL MONCO-OSTUA	4	8	5 F	413970	3311760	5955456	-1520	-1520	-1520	-1520	14862039	11935493	8623733	(2)	3.606	3.729	3.430
EL COCO-CHALCHUAPA	4	14	5 F	413970	5795580	8163466	-2660	-2660	-2660	-2660	20312065	16317328	10521768	(2)	2.815	2.913	2.679
TOTAL	4	646	- -		67,107,600	64,503,056	29,704,234	(4,180)	(4,180)	(721,323)	292,720,924	203,634,920	136,527,320	(2)	3.034	3.205	2.867

(1) In colones. (2) Multiple IRRs (3) IRR = 1.0 (100 Percent)

A P P E N D I X I I . B . 1

MARINE PORTS

OTHER PROJECTS REQUIREMENTS

APPENDIX II.B.1

MARINE PORTS

OTHER PROJECT REQUIREMENTS

1. Repair the berth protection system at Pier "B", which has deteriorated because of friction produced by deep-draft ship. An approximate cost of C2 million Colones is estimated. Financing not yet available.

2. Repair cargo warehouse roofs, at an estimated cost of C3 million Colones.

3. Improve the workshop to allow the maintenance of heavy equipment. C450,000 Colones would be required.

4. Improve maintenance of electrical systems, transportation equipment and buildings.

5. Complete the maritime signage system, at an estimated cost of C100,000 Colones.

A P P E N D I X I I . B . 2

AIRPORTS

OTHER PROJECTS REQUIREMENTS

APPENDIX II.B.2

AIRPORTS

OTHER PROJECT REQUIREMENTS

1. Improve the airport security system. It is estimated that US$41,000 would be sufficient to purchase and install another metal-detection system.

2. Improve or replace rescue equipment (US$200,000).

3. Increase refrigerated warehouse space. Also, more space is needed for customs facilities and temporary luggage storage. (US$200,000).

4. Create a monitoring unit to review systematically the state of runway infrastructure, program maintenance and rehabilitation work.

5. Update the 1979 AIES master plan to determine when additional parking platforms and warehouse space will be needed.