RESTRICTED

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INTERNATIONAL BANK FOR RECONSTRUCTION AND DEVELOPMENT

INTERNATIONAL DEVELOPMENT ASSOCIATION

APPRAISAL OF

A FOURTH ROAD PROJECT

MEXICO

June 1, 1970

Transportation Projects Department

CURRENCY EQUIVALENTS

Currency Unit	- Peso (Ps)
U.S. $1.00	- Ps 12.5
Ps 1	U.S. $0.08
Ps million	U.S. $80.000

FISCAL YEAR

January 1 - December 31

UNITS OF WEIGHTS AND MEASURES: METRIC

British/U.S. Equivalent

1 kilometer	- 0.62 miles (mi)
1 meter	- 3.28 feet (ft)
1 square kilometer (km^2)	- 0.386 square mile (sq. mi)
1 hectare (ha)	- 2.47 acres (ac)
1 metric ton (m ton)	- 0.98 lg. ton
1 metric ton (m ton)	- 1.1 U.S. short ton

ABBREVIATIONS

DPP - Directorate of Planning and Programming
SCT - Secretariat of Communications and Transport
SOP - Secretariat of Public Works
Vpd - Vehicles per day

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APPRAISAL OF A FOURTH ROAD PROJECT

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This report was written by Messrs. R. Paraud (Engineer), A. Storrar (Agriculturist) and J. Yenny (Economist) on the basis of an appraisal mission in November 1969, and was edited by Miss R. Mayes.

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APPRAISAL OF A FOURTH ROAD PROJECT

SUMMARY AND CONCLUSIONS

i. Owing to the mountainous topography and scattered population, the economic development of Mexico relies heavily on transport in which the highways play an important role. The federal network, which is well developed, connects the capital of the country, Mexico City, with all the state capitals and main ports of entry, as well as the major centers of production and consumption. The project proposed for Bank financing is for the continuing improvement and extension of this network. The project roads have been selected by the Government in agreement with the Bank as having high priority.

ii. The proposed project comprises five existing roads, totalling 580 km, which will be improved in order to cope with the growing traffic demands, and five new roads, totalling 462 km, which will open shorter routes between regions of economic importance. The estimated cost of the project is US$59.8 million equivalent, including contingencies and interest and other charges during construction. The Bank loan of US$21.8 million equivalent will finance the foreign exchange component of the project; the Government budget will finance the balance of US$38.0 million equivalent.

iii. The main benefits from the project will be road user savings from improved riding surfaces and shorter routes, but increased agricultural output is also expected from the area served by one project road. The rates of return of individual roads range from 10% to 29%.

iv. This will be the sixth Bank loan for highways in Mexico. In 1960, 1963 and 1968 loans (268-ME, 354-ME, and 528-ME for the First, Second and Third Road Projects respectively) totalling US$92.5 million equivalent were made for federal roads and (in the case of the 1963 loan) for the purchase of maintenance equipment. In 1962 and 1965 two loans (317-ME and 401-ME for the First and Second Toll Facilities Projects) totalling US$62.5 million equivalent were made for toll roads and bridges and for the purchase of a ferry boat, all facilities operated by the official Government agency "Caminos" (Caminos y Puentes Federales de Ingresos y Servicios Conexos). In all cases the quality of the works executed has been satisfactory, but delays and cost increases occurred on the first four loans mainly because of insufficient engineering preparation. For Loan 528-ME, however, engineering was much more advanced before the loan was made, and progress to date is satisfactory.

v. Because of cost increases, and construction delays resulting in toll revenues lower than expected, Caminos was unable without resort to heavy borrowing to finance all local costs for projects 317-ME and 401-ME. Caminos' financial position is therefore unsatisfactory, but the Government has recently taken some measures to improve the situation the most important of which was the rescheduling of Caminos' debt to a Government bank, for which a contract is being negotiated. The completion of this rescheduling contract will be a condition for loan effectiveness.

vi. Execution of the project will be the responsibility of the Secretariat of Public Works (SOP). Construction will be by contracts awarded on the basis of international competitive bidding, apart from some bridging and minor or specialized works which will be awarded locally on a competitive basis. Supervision of construction will be by SOP staff. The project is expected to be completed by late 1974.

vii. The project is suitable for a Bank loan of US$21.8 million equivalent, and a term of 25 years, including a grace period of 5 years, would be appropriate.

MEXICO

APPRAISAL OF A FOURTH ROAD PROJECT

1. INTRODUCTION

1.01 The Government of Mexico has requested the Bank to help finance a project consisting of (a) the improvement and paving of five roads totalling 580 km; and (b) the construction including paving of five roads totalling 462 km.

1.02 This will be the sixth Bank project concerning highways in Mexico and the fourth for the improvement and extension of the federal highway system. Details of the previous five projects are as follows:

For Federal Highways

Loan No.:	268-ME	354-ME	528-ME
Date:	October 1960	September 1963	January 1968
Amount US$ mill.:	25.0	40.0	27.5
Works:	3,150 km of Federal Highways	6,000 km of Highways and purchase of maint. equip.	2,200 km of Federal Highways
Present status:	Completed in late 1968	Progress is 95%; to be completed in late 1970	Progress is 20%; works are expected to be completed on schedule by late 1971

For Toll Facilities

Loan No.:	317-ME	401-ME
Date:	June 1962	February 1965
Amount US$ mill.:	30.5	32.0
Works:	384 km of Toll Roads, Five Toll Bridges and Purchase of a Ferry Boat	350 km of Toll Roads and Three Toll Bridges
Present Status:	Completed in mid-1967	Completed in early 1970

1.03 Although the quality of the works executed is satisfactory, cost increases and construction delays were encountered on 268-ME and 354-ME. Problems developed mainly because of insufficient engineering preparation, which led to increased quantities and design changes. In the earlier stages of these projects, delayed provision of local funds, difficulties of acquiring right-of-way, and heavy rains and damaging cyclones also caused delays and cost increases. Under 528-ME, a special office was created to improve the control of Bank highway works and avoid some of these problems; this control will be extended to the proposed project.

1.04 Cost increases and delays encountered on the two toll projects (317-ME and 401-ME) resulted in a deterioration of the finances of Caminos which is responsible for financing these project works (para. 3.11).

1.05 The appraisal of the present project is based on the technical and economic studies prepared by the Secretariat of Public Works (SOP) and on the findings of the appraisal mission, comprising Messrs. Paraud (Engineer), Storrar (Agriculturist) and Yenny (Economist), which visited Mexico in November 1969.

2. BACKGROUND

A. General

2.01 Mexico covers an area of nearly two million km^2, more than three times the size of France. Large areas are sparsely populated because of the difficult topography and inadequate rainfall, and, although extensive schemes for irrigation and agricultural development have increased the area under cultivation, the population is urbanizing rapidly. Close to 60% of the population of 49 million is now urban; this proportion was 52% in 1960 and 43% in 1950.

2.02 Although overall population growth has been 3.5% p.a. since 1960 - one of the highest rates in the world - urban population growth was 5.1% p.a. while rural growth was only 1.5% p.a. In 1968, 15% of Mexico's people lived in the Federal District, centered on Mexico City.

2.03 Since 1960, the growth rate of Mexico's gross national product has been about 6.4% p.a., one of the highest in Latin America. GNP per capita was estimated to be US$600 for 1969.

B. The Transport Sector

2.04 Railways played an important role in Mexico's development. Over the past 20 years, however, as a result of improved highways and growing demands for more flexible and varied services than the railways could offer, there has been a rapid expansion in road transport. Despite very low fares, passenger traffic of the railways has been drastically affected by highway competition, and this has led the railways to concentrate on handling bulk and long distance freight traffic.

2.05 Railways - The length of the railway network - 23,680 km - has not changed very much over the last ten years (Table 1). Total rail freight traffic has increased at an average rate of 5% p.a. since 1960, and in 1968 the railways moved about 45 million revenue earning tons, over 20 billion ton-km. Passenger traffic has increased little over the past ten years and is now leveling off at about 39.0 million passengers and 4.3 billion pass-km. Although the railway freight services are efficient, the case for continuing many of the passenger services appears to be doubtful.

2.06 The financial situation of the railroads is continuously deteriorating. The net annual deficit is now about Ps 1.25 billion (US$100 million equivalent), and the total support from the Treasury in 1969 including investment was approximately Ps 2.0 billion (US$160 million equivalent). The deficit is due to excessively low rates and fares; operating costs are relatively low.

2.07 Highways - In contrast with the railways, the length of the road system more than doubled between 1958 and 1968, from about 32,000 km to 67,000 km (Table 2). This system is described more fully in Chapter 3. On the basis of traffic surveys made in 1967 by SOP, total road freight traffic was estimated at 22 billion ton-km, about 10% more than rail; passenger traffic on roads was estimated at 65 billion passenger-km, fifteen times greater than rail. This growth of road traffic is also reflected by the increase in vehicle registration. Over the last ten years, the number of trucks grew at a rate of 5.5% p.a., while the number of automobiles increased at nearly 10% p.a. and now approaches a million (Table 3).

2.08 Civil Aviation - Air traffic is also increasing rapidly. There are now nine airports capable of accommodating long range flights, 20 airports suitable for medium range flights and 45 airports limited to short range flights. The total number of passengers carried increased from 1.7 million in 1960 to 3.2 million in 1967, an average rate of 9.5% p.a., with the Mexico City airport continuing to handle about half of the total. Freight traffic is still low, about 40,000 tons p.a., and has shown little variation since 1960. In 1964, a program of construction, reconstruction and maintenance of airports was initiated and spending had reached Ps 1.3 billion by 1968, reflecting the emphasis given by the Government to the promotion of air transport, especially in connection with tourism.

2.09 Shipping - While there are about 20 ports along the 6,300 km of coastline, Mexico is not traditionally a maritime nation. Ports have so far received little attention from Government and there have been only small programs of construction and improvement in recent years. However, the Government now realizes the need to improve port services and is preparing programs for port reorganization and new investments.

C. Transport Coordination and Planning

2.10 At the moment, no specific agency is charged with the task of formulating a transport policy, and investment planning for the transport sector is spread among a number of Secretariats and autonomous Government agencies. No formal coordination of these Government agencies exists. The situation has been discussed in detail in previous Bank reports, the latest of which is the "Current Economic Position and Prospects of Mexico", dated December 1969.

2.11 These reports indicated the need for a comprehensive review of Mexico's transport sector which would lead to recommendations on transport policies, planning and coordination. At the request of the Government, a Bank mission visited Mexico in April 1970 to prepare a report on the transport sector for submission to the Government by October 1970. The mission's task is to review every major mode of transport, to recommend

a sound set of policies, and to formulate an investment strategy for the sector which will be consistent with the major national economic objectives. In regard to public transport sector investment, the mission will:

(a) examine the proposed investment programs of key transport sub-sectors;

(b) identify transport projects crucial to the broad national objectives; and

(c) determine the broad priorities, mix and amount of transport investment over the next six to ten years.

2.12 The mission will also make recommendations on the establishment of effective machinery for transport planning and coordination, and on the role of the Bank in helping to bring about necessary changes.

3. THE HIGHWAY SECTOR

A. Highway Network

3.01 Mexican highways have developed rapidly in the past ten years as shown by the following:

	Length in km	
	1958	1968
Federal and toll highways (primary)	17,293	28,019
State roads (secondary)	12,032	31,030
Local roads (tertiary)	2,750	7,937
	32,075	66,986

These figures represent an increase of about 110% in ten years (see Table 2). In addition, there has been a substantial improvement in quality, the length of paved roads having increased from about 24,000 km in 1958 to 39,000 km in 1968. Mexico's seven mountain ranges, which form deep valleys and high plateaus, induced development along the valleys and influenced the pattern of early highway development. Although some sections of the country are well served by the present network, new highways will have to be built to open up potentially rich areas, to provide shortcuts and to establish cross-connections with existing routes. The continuous growth of traffic also calls for the improvement of existing roads.

B. Highway Administration

3.02 Since the Federal Government pays either wholly or partly for all highways in Mexico, SOP is concerned, directly or indirectly, in the planning and constructing of all highways. The responsibilities for the highway system are divided among various authorities as follows:

(i) Federal Highways - SOP is directly responsible for the planning, construction and maintenance of all federal highways. These are financed 100% from federal funds.

(ii) State Highways - Planning, construction and maintenance of state highways are the responsibility of State Highway Boards which include a SOP representative who is assisted by an adequate staff for the supervision of all highway works. The annual state highway programs are submitted to SOP for review and approval because 50% of the cost of all works, including maintenance, is borne by the Federal Government.

(iii) Local Roads - Planning and construction of local roads are the responsibility of SOP. On completion, such roads are transferred to the corresponding State Highway Board for maintenance with Board funds. Construction is financed from 1/3 federal, 1/3 state and 1/3 local (private contribution) funds.

(iv) Rural Roads - Recently SOP started constructing "Rural Roads" to join small towns and villages with the nearest main road. These are planned and constructed by SOP and are financed entirely with federal funds. Maintenance will be carried out by the towns assisted by SOP.

(v) Toll Facilities - While SOP plans and constructs toll roads and bridges, they are operated and maintained by Caminos. Funds for financing these facilities should be provided from tolls levied on users.

3.03 While the above division of responsibility could lead to confusion or duplication of functions, the system works adequately due to the overriding authority of SOP.

3.04 The organization and staffing of SOP are satisfactory. It has clearly established lines of authority (see Chart).

3.05 The Secretariat of Communications and Transport (SCT) is responsible for control of traffic and road transport using the federal network. The existing legislation for traffic control is satisfactory and the law is enforced by SCT's Federal Highway Police. SCT's Traffic Engineering and Vehicle Control Department is responsible for the regulation of axle loading and vehicle size, for which the federal highway network has been divided into 13 zones; permanent weighing stations exist in 4 zones and portable scales are used elsewhere. There are indications that overloading is not being controlled as vigorously as it should be, but, during loan negotiations, the Government confirmed that the regulations will be applied.

C. Highway Financing and Planning

3.06 A breakdown of expenditures on highways from all sources from 1958 to 1968 is given in Table 4. It shows that over this period the rate of investment increased substantially, providing for greatly improved quality of roads and an increase in length of about 35,000 km. Federal expenditures in highways for the period 1970-1976 are forecast by SOP at about Ps 23.2 billion (US$1.9 billion equivalent), an average of about US$260 million per year. This program represents a considerable increase over recent levels of expenditure and appears very optimistic. The size of the program underlines the need for effective highway planning.

3.07 The Directorate of Planning and Programming (DPP), within SOP, is responsible for planning federal highway investments and for reviewing state highway investment proposals. A satisfactory system for collecting traffic data has been established. A comprehensive federal road inventory has been completed and the inventory of the remaining roads is about 80% complete. Traffic and inventory data are computer-processed.

3.08 DPP staff is competent, but its effectiveness is limited by the general diffusion of planning responsibilities and functions in Mexico (para. 2.10). The 1970-1976 Highway Investment Plan (prepared by DPP) is only a general guide for SOP's annual expenditure programs and, as for previous highway investment plans, is not officially a part of the Government's overall investment plan. The Secretariat of the Presidency ultimately determines the amounts and priorities of investments in the public sector and this gives a degree of coordination of investment at the national level, although there is no formal National Economic Plan on which to base investment decisions.

3.09 Until recently, good federal highway projects could easily be chosen on the basis of three objectives:

(a) To connect the capital, Mexico City, with all state capitals, and main points of entry (ports, border crossings);

(b) To connect the major centers of production and consumption; and

(c) To improve the existing network as traffic demand justifies and to construct new highways to reduce distances.

The first two objectives are nearly met, and future investment in the federal highway network should be aimed at satisfying the third one. However, there is a need to re-examine priorities for future highway investment, in accordance with such other objectives of national economic policy as: (a) the integration of peasant communities with the rest of the economy, which could be helped by the construction of minor access roads, and (b) a more pervasive economic effort, to promote more equitable growth of the different regions of the country; this latter objective could be assisted by further development of the state highway networks. The effectiveness of SOP in planning for these broad objectives is being examined by the transport sector review mission.

3.10 Road user charges in Mexico are a combination of (i) charges levied by the Federal Government on the manufacture of vehicles and tires and on vehicle use; (ii) minor taxes and licenses levied by the state governments; (iii) revenues from toll roads and bridges, and (iv) taxes on fuels and lubricants collected by the national oil company (Petroleos

Mexicanos) through the difference between their sales prices and the costs of production and distribution. None of these charges are earmarked for roads; federal and state taxes go to the general budget while Petroleos Mexicanos retains part of the taxes on fuel and lubricants for the financing of its investments with the remainder going to the general budget. Revenues from all user charges are more than sufficient to cover the annual construction and maintenance outlays on the road system. In 1968, for instance, total revenues amounted to about Ps 3.15 billion as compared with construction and maintenance expenditures of about Ps 1.80 billion. Although this is not the result of a deliberate policy, the Government recovers from the road users at large substantially more than the cost of the infrastructure it provides. However, while users of gasoline carry the main burden of taxation, diesel fuel is in fact, being subsidized. This imbalance has implications for road-rail competition in Mexico and the transport sector review mission (para. 2.11) expects to make recommendations for corrective action by the Government.

3.11 The position is easier to assess for toll traffic, as toll facilities are financed and operated by Caminos, which is expected to be self-supporting and to generate capital resources. It is not, however, operating on a sound financial basis. Its financial situation has deteriorated in recent years mainly because of delays and cost overruns in the construction of toll facilities. The situation improved in 1969 when the Government reimbursed Caminos for constructing non-toll facilities and created a Trust Fund to pay outstanding contracts for works under Loan 401-ME, and will again when Caminos' debt to the Banco Nacional de Obras y Servicios Publicos is rescheduled; the completion of this rescheduling contract is a condition for loan effectiveness.

3.12 The present toll-rate structure does not ensure efficient use of available road capacity. A study, with experiments on rate variations by time of the day, day of week, type of vehicle, etc., will be conducted by the Government in conjunction with Caminos to determine the elasticity of demand on toll roads in Mexico. Such a study would provide a basis for considering a new tariff structure for existing toll roads and for the setting of rates for any possible addition to the system. During loan negotiations, the Government agreed that it will carry out such a study before the end of 1971 and discuss with the Bank the results thereof and the need for introducing new rates to the Mexican toll road system.

D. Highway Engineering

3.13 Highways and bridges are well engineered by the Directorate of Land Transport Projects in the SOP using up-to-date techniques. Before Loan 528 the practice of starting projects on the basis of insufficient engineering was a major cause of construction delays and cost increases (see para. 1.03), but for the present project detailed engineering has been practically completed and such problems are not expected.

3.14 SOP has satisfactory design standards for the federal highway network (Table 5).

E. Highway Construction

3.15 Highway construction is carried out under unit price contracts awarded on the basis of competitive bidding. Supervision of construction is carried out satisfactorily by SOP staff.

3.16 The local construction industry is strong, well equipped and well organized. The National Chamber of the Construction Industry has a membership of about 3,100 contracting firms, 500 of whom specialize in highway works. There is a wide range of work capacity in these specialized firms, which include about five firms able to execute highway works amounting to US$10 to 15 million annually, and 20-25 firms in the US$4 to 6 million range. Competition is intense and this may have discouraged foreign firms from bidding for highway contracts in Mexico.

3.17 In 1967, the Government enacted a law establishing uniform procedures for the registration of contracting firms and for the supervision of public works. A committee was created to study and make recommendations on contract awards, unit prices, specifications and similar matters. In addition, an office was established to register contracting firms. About 3000 firms have been registered and they are obliged to update registration information annually. Foreign contractors need register only if awarded a contract; the procedure takes between two and three months.

3.18 Foreign contractors may import their equipment in Mexico under a temporary importation license with exemption from payment of duties subject to the establishment of a guarantee for the payment of such duties. Upon completion of the works the equipment may be re-exported free of duties, but if the equipment remains in Mexico, the contractor has to pay duties corresponding to its undepreciated value.

F. Highway Maintenance

3.19 SOP, through its Directorate for Maintenance of Federal Highways, is responsible for the maintenance of the Federal highway system. Routine maintenance is carried out by the Government's own forces and, in general, is satisfactory. Only major betterment is carried out by contract. The Directorate, which is well organized and staffed, operates through 16 maintenance divisions, each headed by a chief engineer.

3.20 The maintenance, operation and allocation of SOP equipment is in the charge of the Directorate of Workshops, which operates in close cooperation with the Directorate for Maintenance of Federal Highways. The total estimated depreciated value of the park of equipment is US$20 million, but much of this equipment is old and needs replacing.

3.21 SOP has limited yearly budget allocations for the purchase of maintenance equipment, but has also had foreign aid for this purpose. In 1963, for instance, the Bank (under 354-ME) financed maintenance equipment worth about US$8 million, and in 1969 the Inter-American Development Bank made a loan which included US$5 million for maintenance equipment. However, to bring the pace of equipment replacement up to the required level SOP intends to seek additional budgetary allocations.

3.22 The growth of the highway network brings the need for a commensurate growth in maintenance effort. Maintenance expenditures on federal highways increased from Ps 154 million (US$12.3 million equivalent) in 1958 to Ps 460 million (US$36.8 million equivalent) in 1968. These amounts covered some betterment work and the purchase of equipment, but enabled a satisfactory level of maintenance to be achieved. The Government confirmed during loan negotiations that it will continue adequately to maintain the federal highway system.

4. THE PROJECT

A. General Description

4.01 The proposed project consists of:

(i) The improvement (including paving) of the following five roads, totalling about 580 km:

(1) Chilpancingo-Tlapa (Chilpancingo-Chilapa Section)

(2) Puerto Vallarta-Barra de Navidad

(3) Apatzingan-Tepalcatepec

(4) Zapotlanejo-Lagos

(5) Santa Rosa-La Barca

(ii) The construction (including paving) of the following five roads, totalling about 462 km:

(6) Compostela-Chapalilla

(7) Tuxtepec-Matias Romero (Donaji)

(8) Ciudad Victoria-Tampico (Llera-Estacion Gonzalez Section)

(9) Ciudad Aleman-Sayula

(10) Cardel-Veracruz

4.02 The project roads (see Map) have been selected by the Government in agreement with the Bank as having high priority within the federal highway system. Some of the roads (Nos. 2, 4, 6, 8 and 10) are closely related to works financed under previous Bank loans. The project will constitute about 12% of SOP's federal highway construction program for the 1970-1974 period. The Bank loan itself will provide about 4.3% of this road construction investment for the same period.

B. Highways to be Improved or Constructed

4.03 The design standards for project roads are shown in Table 5. They are similar to those used for previous highway projects and are satisfactory. The project roads are described in Chapter 5 - Economic Evaluation -, in Table 6 and in Annex A.

C. Cost Estimates, Financing and Disbursement

4.04 The total cost of the project is estimated at US$59.8 million equivalent, including contingency allowances and interest during construction. Table 7 shows the cost estimates for each highway and Table 8 the breakdown of construction cost by major items (earthworks, drainage etc.). A summary of the project costs and the foreign exchange component (which the loan will finance) follows:

	Ps Millions			US$ Millions			%
	Local	Foreign	Total	Local	Foreign	Total	Foreign Exchange
1. Highways							
(a) To be improved (5)	170.2	83.9	254.1	13.6	6.7	20.3	33
(b) To be constructed (5)	230.7	113.6	344.3	18.5	9.1	27.6	33
Subtotal	400.9	197.5	598.4	32.1	15.8	47.9	
2. Right-of-Way	2.6	-	2.6	0.2	-	0.2	
3. Contingencies (on item 1)							
Physical, 10%	40.1	19.7	59.8	3.2	1.6	4.8	33
Escalaction, about 8%	32.1	15.8	47.9	2.5	1.4	3.9	33
Subtotal	475.7	233.0	708.7	38.0	18.8	56.8	
4. Interest and Other Charges during Construction	-	37.5	37.5	-	3.0	3.0	100
Total	475.7	270.5	746.2	38.0	21.8	59.8	

4.05 Engineering for the proposed project is being carried out by SOP and is about 95% complete. Costs have been estimated by SOP on the basis of almost completed detailed engineering and on unit prices drawn from recently awarded contracts for similar works. These estimates are considered satisfactory.

4.06 The competence of SOP staff is such that the assistance of consultants is only occasionally needed and thus, as for the previous Bank loans to Mexico, consultants will not be employed for supervision. Six percent has therefore been added to the cost of highway works to cover SOP's expenditures thereon. The loan will finance these supervision costs in the same proportion as applied to construction (para. 4.08). Contingency allowances of 10% for quantity increases and about 8% for general price increases from the date of estimation to the completion of construction have been provided.

4.07 Right-of-way will be needed for four of the project roads (Nos. 4, 5, 8 and 10). SOP is already negotiating with land owners and no difficulties are foreseen. The proposed loan will not finance right-of-way costs.

4.08 The foreign component of construction cost has been estimated as 33% on the basis of an analysis of unit prices by SOP, amended by the Bank. This estimate is based on the assumption that about 10% of all works would be carried out by foreign contractors. This compares with the assumption made in earlier loans that 25% would go to foreign bidders, which experience has shown so far to be too high. The foreign exchange component of supervision cost (para. 4.06) has been taken to be of the same order as that for construction.

4.09 It is recommended that the loan will finance the foreign exchange cost of the project, as follows:

(a) 33% of construction costs, and

(b) 33% of supervision costs incurred by SOP calculated as 6% of the corresponding construction cost.

Provision has been made in the loan to meet interest and other charges on the loan during construction of the project. These are estimated to amount to US$3.0 million equivalent.

4.10 The tentative annual breakdown between the estimated local and foreign currency expenditures (excluding interest and other charges on the loan) is as follows:

	Total Expenditures		Government Share		Bank Share	
	Ps	Equiv. US$	Ps	Equiv. US$	Ps	Equiv. US$
	MILLIONS					
1971	99.0	8.0	66.1	5.3	32.9	2.7
1972	240.9	19.3	161.8	13.0	79.1	6.3
1973	202.4	16.2	136.5	10.9	65.9	5.3
1974	166.4	13.3	111.3	8.8	55.1	4.5
Totals	708.7	56.8	475.7	38.0	233.0	18.8

4.11 The local costs will be financed by the Government from budget appropriations. However, since the Government plans to carry out other large highway works concurrently, assurances were obtained during negotiations that the Bank project will be given due priority in the provision of funds and that adequate funds will be made available promptly.

4.12 It is proposed that any surplus remaining in the loan account on completion of the project should be cancelled.

D. Execution

4.13 Past experience in Bank projects has shown that foreign contractors' participation in road works in Mexico has been small, and, in fact, only one foreign firm has recently been awarded a contract. A few foreign firms have established local branches in Mexico or have entered into joint ventures with local firms, but for other than highway work. In order to encourage foreign participation and to maximize competition, the following measures were agreed under Loan 528-ME:

(i) The Government will invite pre-qualification of contractors annually until such time as all contracts have been awarded;

(ii) Invitations to bid for each contract will be issued to eight local and up to eight foreign firms, provided a sufficient number of the latter are prequalified;

(iii) Contracts will be awarded for complete road sections; and

(iv) Contracts will be awarded for the total cost of specific road sections, rather than in annual tranches.

4.14 The above measures were reaffirmed for the present project during loan negotiations. They have not, however, resulted in increased foreign participation in Loan 528-ME. Although many foreign firms requested prequalification documents, only two (one U.S. and one Israeli) completed these and were prequalified; they have been invited to bid but have not submitted proposals. It is probable that the main deterrent to foreign participation is the efficiency of the Mexican contracting industry, coupled with the availability of more profitable work elsewhere in the world. Only if contracts were large could foreign firms expect to bid competitively and profitably against Mexican contractors.

4.15 To enable both local and foreign firms to bid at levels at which each could expect to be competitive, bids will as far as practicable be invited both individually and on the basis of "packaging", whereby contracts of a size suitable for local contractors would be grouped into packages which should also be attractive to foreign bidders, providing up to six possible contracts in the range US$3.4 to US$7.5 million. This arrangement (which is detailed in Table 9) was confirmed during loan negotiations. Together with the measures described in para. 4.13, it should increase the degree of competition.

4.16 Construction contracts will be let on the basis of unit prices after international competitive bidding in accordance with the Bank's normal procedures, except bridges over 15 m span, traffic signs and minor or specialized works, which, in total, account for about 10% of the cost (about Ps 73 million or US$5.8 million equivalent) and which may be awarded after locally advertised competitive bidding. The timing for the award of bridge contracts will be coordinated with the main construction works.

4.17 In 1967 the Government established a control office within SOP to ensure that Bank projects are carried out efficiently as planned. This arrangement has shown positive results for works under Loan 528-ME which, so far, are below the original cost estimates and are being carried out within the scheduled construction periods. The control office will also be made responsible for checking the proposed Bank project.

4.18 SOP intends to begin prequalifying contractors by mid-1970 in order that construction can start by late 1970. The project is expected to be completed by late 1974.

5. ECONOMIC EVALUATION

A. General

5.01 Mexico's rising GDP, associated with more diversified and widespread economic activities, creates growing freight and passenger traffic, much of which can be moved most economically by road. It is thus important to increase the productivity of highway transport by reducing operating costs and travel time. This can be achieved by improving existing highways to allow increased speeds and to reduce congestion, and by constructing new highways to reduce distances. On the five roads to be improved (Nos. 1 to 5), user savings result from better riding quality and reduced congestion, while on the five roads to be constructed (Nos. 6 to 10), savings result primarily from distance shortening. The proposed Tuxtepec-Matias Romero highway is also expected to foster agricultural development in the region. The individual highways in the project have estimated economic rates of return varying between 10% and 29%. It is concluded, therefore, that the project is justified.

B. Calculation of Economic Benefits

5.02 The methodology and factors influencing the evaluation of road user savings and related economic benefits are discussed in Annex B. Following are the results of the evaluation for each road in the project:

(i) Highways to be Improved

5.03 Chilpancingo-Tlapa (Chilpancingo-Chilapa Section No. 1 - 56 km) - This highway penetrates the mountains of the State of Guerrero eastward to the town of Tlapa. Population and agricultural production is largely concentrated in the valleys. The most important towns are Chilapa at km 56, and Tlapa at the end of the road. The traffic has already built up substantially on the first section of the road to Chilapa (56 km) and averages 220 v.p.d. The growing demand for foodstuffs in Acapulco, 133 km from Chilpancingo, will foster agricultural production in the region served by the highway, and transport demand is expected to increase accordingly. On the remaining 120 km to Tlapa, however, the traffic does not exceed an average of 80 v.p.d. at any point.

5.04 Since the traffic characteristics of these two sections are so different, they were evaluated separately. The benefits in terms of reduced vehicle operating costs and reduced maintenance costs are expected to yield a 23% rate of return over a 20-year life for the first section Chilpancingo-Chilapa. Paving of the second section is not justified at this time and is not included in the project.

5.05 Puerto Vallarta-Barra de Navidad (No. 2 - 221 km) - This highway is a section of the Pacific coastal highway, constructed to gravel standards under Bank Loan 354-ME. Traffic has built up substantially, and agriculture - bananas and livestock - has developed in places. The proposed light paving will substantially reduce vehicle operating costs and maintenance costs by providing a better protection from the tropical storms experienced along the Pacific Coast. On its first 20 km after Barra de Navidad, the road would serve the beaches to be developed in the tourism project under consideration by the Government for the Manzanillo region. The benefits, in terms of reduced vehicle operating costs (not including any benefits from tourism) are expected to yield a 14% rate of return over a 20-year life.

5.06 Apatzingan-Tepalcatepec (No. 3 - 67 km) - This road serves an agricultural region of Michoacan State on the left flank of the Balsas Valley. The population of the municipalities served by the road doubled between 1950 and 1960, and is estimated to have doubled again during this last decade to reach some 120,000. This growth has been reflected by an increase in agricultural production and a shift from ranching to more intensive farming, such as sugar cane and citrus. The traffic on the first section of the road (Apatzingan-Buenavista 33 km) already averages 640 v.p.d. and the road is deteriorating rapidly. The situation is less critical on the Buenavista-Tepalcatepec section where traffic averages about 250 v.p.d. The saving in vehicle operating costs which will result from improving the alignment and paving the road are estimated to yield a rate of return of 30% on the first section, and 14% on the second section over a 20-year life, an average rate of 23% for the road as a whole.

5.07 Zapotlanejo-Lagos (No. 4 - 158 km) - This highway branches off the recently opened Guadalajara-Zapotlanejo toll-road built under Loan 401-ME. Both this highway and No. 5 below converge toward Guadalajara, the second largest city of the country with a population of 1.3 million. The improvement of highway connections between this city and other regions of the country is important for Guadalajara's accelerated future development, a goal of the Government related to its policy to reduce the degree of economic concentration in Mexico City. Because of the high traffic volumes, averaging from 1300 to 2400 v.p.d. on different sections, the highway (built about 30 years ago to carry much lower and lighter traffic) is deteriorating rapidly. Some sections close to Zapotlanejo are now being strengthened and, if the project were not executed, this would have to be done for the entire length over the next five years, at an estimated cost of 200,000 pesos/km (US$16,000 equivalent). The reconstruction of the highway will also lead to savings in maintenance costs. The proposed widening of the pavement from 6.0 and 6.6 m to 7.2 m, and the by-passes of four towns (Zapotlanejo, Tepatitlan, Guadalupe and Jalostotitlan) will lead to increased travel speeds and provide savings in vehicle operating costs. On the basis of savings in operating and maintenance costs alone, benefits over a 20-year life would yield a rate of return of 18% or more for each section, with an average rate of 23% for the road as a whole.

5.08 Santa Rosa - La Barca (No. 5 - 78 km) - This is part of an alternative route from Guadalajara to La Piedad on the main Mexico City-Guadalajara highway (via Irapuato). It also serves the northern shore of Lake Chapala. Although the region is still predominantly agricultural, some industry has recently located in towns served by the highway because of the proximity to Guadalajara and the availability of water from the Santiago River. The new Guadalajara airport, halfway between the city and Santa Rosa, will favor further development of the city toward the east. The growing urban market for foodstuff will also put heavier demand on the agricultural production in the rich Santiago River Valley. Traffic will soon exceed what the present highway can efficiently handle. Average daily traffic varies from 1600 to 1850 vehicles according to the section. Benefits will be similar to those described above and are expected to yield a rate of return of 17% over a 20-year life.

(ii) Highways to be Constructed

5.09 Compostela-Chapalilla (No. 6 - 37 km) - The growing population of Guadalajara and the increasing income of its residents have generated substantial demand for recreation and tourism. This short new highway will reduce the distance between Guadalajara and the coastal area of Puerto Vallarta by 49 km and is expected to foster the touristic and recreational development of the coast. The benefits resulting from savings in time and distance are expected to yield a 29% rate of return over a 20-year life.

5.10 Tuxtepec-Matias Romero (Donaji) (No. 7 - 169 km) - This road will reduce the travel distance between the more developed part of the country centered on Mexico City and the region of the Gulf of Tehuantepec (States of Oaxaca and Chiapas), and will integrate into the national economy the agricultural municipalities of the foothills of the Sierra Madre de Oaxaca. Given the present highway network in the region, the new highway would represent an immediate reduction in distance of some 115 km on all itineraries between the region of Mexico City and the Gulf which would, however, be lowered to 44 km after construction of the Ciudad Aleman-Sayula highway (No. 9), in 1974.

5.11 The expected advantages are thus a reduction in distance of 44 km for through traffic, reduced cost for farm-to-market transport presently done over tracks in the portion of the zone of influence immediately south of Tuxtepec (30 km), and the value added in agricultural production resulting from access to credit, extension services, etc. in the rest of the area served by the road. The estimate of the value added to agricultural production is based on conservative assumptions regarding the agricultural development of the region (see Annex C). The benefits resulting from increased agricultural production amount to slightly more than half the total benefits. These combined benefits are expected to yield a 10% rate of return over a 20-year life. Although low, this rate of return is not very sensitive to changes in construction costs or agricultural benefits.

5.12 One of the purposes of this highway is to foster the agricultural development of the area and this necessitates the construction of about 100 km of feeder roads, which the Government agrees will be built with Government funds concurrently with the project road. The estimated cost of these feeders, about Ps 6 million, has been included in the economic evaluation. Their location is shown in the Map to Annex C.

5.13 Ciudad Victoria-Tampico (No. 8 - 90 km) (Llera-Estacion Gonzalez Section) - The solution proposed by SOP will reduce the distance between ciudad Victoria and Tampico (292 km) by 45 km. It comprises the improvement and paving of an existing 27 km long gravel road and the construction of 63 km of new road. In addition to the distance reduction, there will be extra benefits from the local traffic presently served by the gravel road, which is through a well-cultivated valley. The benefits resulting from savings in distance only are expected to yield an 11% rate of return over a 20 year life.

5.14 Ciudad Aleman-Sayula (No. 9 - 135 km) - Both this highway and No. 7 above reflect the policy to encourage economic development of the southeast of the country and its integration into the national economy. This road is designed both to serve the rich and rapidly developing region of the lower Papaloapan and San Juan Rivers and to reduce the travel distance between the region of Mexico City and the southeast of the country. The proposed highway is parallel to a trunk line of the Mexican Railway, but according to railroad statistics of composition of freight on this line, a distribution of goods between rail and road has already taken place in the region and no further shifts of traffic are expected from rail to road.

5.15 The expected advantages are a reduction in distance of some 50 km in all itineraries between Mexico City and the southeast, and reduced vehicle operating costs for local traffic on tracks and penetration roads. Because of the difficulty of assembling reliable data on local traffic, only benefits from distance savings have been considered. They are expected to yield a 23% rate of return over a 20-year life.

5.16 Cardel-Veracruz (No. 10 - 31 km) - This new road will provide more direct access to the city of Veracruz from the North, with distance savings for traffic from Jalapa (8 km) and from the coastal highway (42 km). The benefits due to relief of potential congestion on the old road have not been included. The benefits resulting from savings in time and distance are expected to yield an 18% rate of return over a 20-year life.

C. Other Benefits from the Project

5.17 While the rates of return calculated above adequately justify all the elements of this project, there are additional benefits which, although not easy to measure, are important to the national economy and to the success of the Government's policy objectives. For example, the opening of the two highways from Ciudad Aleman and Tuxtepec toward the east and the southeast will foster the agricultural development of the potentially rich area of the lower Papaloapan River Basin, while improving the communications between the peripheral regions of Chiapas and Yucatan and the rest of the country. The proposed improvement of roads in the region of Guadalajara will help to strengthen the growth potential of this important urban center, thus contributing to the diffusion of economic development away from Mexico City.

6. RECOMMENDATIONS

6.01 During negotiations agreement was reached with the Government on the following principal points:

(i) The appropriate application of regulations on axle loading and vehicle size (para. 3.05);

(ii) The study (in collaboration with Caminos) of toll rates, and subsequent discussion with the Bank on the need for introducing new rates (para. 3.12);

(iii) The arrangements for packaging contracts (para. 4.15); and

(iv) The construction of about 100 km of feeder roads concurrently with the Tuxtepec-Matias Romero road (para. 5.12).

6.02 The completion of the contract rescheduling Caminos' debt will be a condition for the effectiveness of the proposed loan.

6.03 The proposed project constitutes a suitable basis for a Bank loan of US$21.8 million. On the basis of the economic life of the roads in the project and their construction period, a term of 25 years, including a grace period of five years, would be appropriate.

June 1, 1970

ANNEX A

THE PROJECT ROADS

The economic impact of the project roads is given in Chapter 5 -- Economic Evaluation - and their design standards are given in Table 5. The description of each project road follows:

A. Roads to be Improved

1. Chilpancingo-Tlapa (No. 1) (Chilpancingo-Chilapa Section - 56 km) - The Chilpancingo-Tlapa road (176 km) which is gravel surfaced was built between 1954 and 1964; bridges have recently been completed. The road, which crosses six mountain ranges with elevations from 1,600 to 2,300 m, has two well defined sections: from Chilpancingo to Chilapa, agricultural development has taken place and traffic averages 220 v.p.d. while traffic on Chilapa-Tlapa section is about one third of the above figure. The proposed loan will finance only the works on the Chilpancingo-Chilapa section. These will comprise the widening of earthworks to 7.00 m, the construction of additional drainage structures and of the base, and a single bituminous surface treatment.

2. Puerto Vallarta-Barra de Navidad (No. 2) - The construction of this 221 km road up to the sub-base was partially financed under Loan 354-ME, overall progress is 95% and bridge construction, the only pending work, will be completed by December 1970. This road is a part of the Pacific coastal highway, and its completion is expected to foster the agricultural development of the area. It will link the important tourist center and beach resort of Puerto Vallarta with Manzanillo, where the Government has already undertaken the study of a comprehensive tourist development project, which would include the construction of an international airport. The work proposed includes the construction of additional drainage structures, the provision of base and a double bituminous surface treatment 8.00 m wide.

3. Apatzingan-Tepalcatepec (No. 3) - The main purpose of this 67 km road is to serve the adjacent agricultural areas; the present road, which crosses flat and rolling terrain, was opened to traffic in the early sixties. It is only paved for 10 km, and the condition of the remaining 57 km is poor, drainage is insufficient and most of the bridges are still to be built. The proposed improvement works will include some realignment, earthworks, additional drainage structures, eighteen bridges with a total length of about 346 m. and the provision of a sub-base, base and a double bituminous surface treatment 7.00 m wide.

4. Zapotlanejo-Lagos (No. 4) - This 158 km long road, which was built thirty years ago is a part of the trunk road joining Guadalajara with the important cities of San Luis Potosi and Leon (the capital of the state of Guadalajara). The road is not suitable for present heavy traffic and

the pavement is deteriorating rapidly. In addition, the road crosses several towns, where congestion delays through traffic. The works proposed will comprise the widening of the roadway and drainage structures, the construction of 14 bridges with a total length of about 415 m, the strengthening of the base, a 7.20 m wide asphaltic-concrete surface and the construction of by-passes of the cities of Zapotlanejo, Tepatitlan, Guadalupe and Jalostotitlan.

5. Santa Rosa-La Barca (No. 5) - This 78 km road, in flat terrain along the Chapala lake, offers an alternative route between Guadalajara and La Piedad. Reconstruction would cover the same works as for the Zapotlanejo-Lagos Road, except that neither new bridges nor by-passes are needed.

B. Highways to be Constructed

6. Compostela-Chapalilla (No. 6) - This 37 km long road will cross rolling and mountainous terrain and will provide a shortcut for through traffic from Guadalajara to Puerto Vallarta, reducing the distance by 49 km, and avoiding the city of Tepic. Proposed works comprise earthworks, five bridges, drainage structures, one railway overpass, and sub-base, base and a 8.00 m wide double bituminous surface treatment.

7. Tuxtepec-Matias Romero (Donaji) (No. 7) - This new road, 169 km long, starts in the foothills of the Sierras bordering the Papaloapan River basin (a very rich agricultural area), but for the last 30 km to Donaji, the terrain is mountainous and heavily forested. The proposed works include earthworks, 32 bridges with a total length of about 1,670 m, drainage structures, sub-base, base and a 7.00 m wide double bituminous surface treatment.

8. Ciudad Victoria-Tampico (No. 8) (Llera-Estacion Gonzalez Section) - The existing road between Ciudad Victoria and Tampico is about 292 km long and the proposed direct route will shorten this distance considerably. This route will involve (a) 63 km of earthworks and drainage structures between Estacion Gonzalez and Zaragoza, 350 m of bridging, sub-base, base and 7.00 m single bituminous surface treatment; and (b) the improvement of the existing secondary road 27 km long between Zaragoza and Llera comprising the widening of earthworks and drainage structures and the provision of a base and 7.00 m single bituminous surface treatment.

9. Ciudad Aleman-Sayula (No. 9) - The construction of this 135 km long road will provide a route about 50 km shorter for the traffic between the center and the southeast of the country. It will cross the Papaloapan river over a 286 m long toll bridge financed in 1965/66 under Loan 317-ME. The proposed works include earthworks, 23 bridges with a total length of about 1,020 m, three railroad overpasses, drainage structures, sub-base, base and a 8.00 m single surface treatment.

10. Cardel-Veracruz (No. 10) - This 31 km long road will be part of the coastal highway along the Gulf of Mexico and will provide a route 8 km shorter for the traffic to Veracruz from the Northern and Central part of the country. The proposed works comprise earthworks, three bridges with a total length of about 215 m, drainage structures, sub-base, base and 7.20 m asphaltic concrete pavement.

June 1, 1970

ANNEX B

ROAD USER SAVINGS AND OTHER ECONOMIC BENEFITS

1. Following are the details of the methodology and the discussion of the various factors influencing the evaluation of road user savings and related economic benefits. The results of the evaluation for each item in the project are given in Chapter 5.

2. The main elements influencing the evaluation of road user savings and related economic benefits are:

a) the base year traffic;
b) the rate of traffic growth; and
c) the costs of vehicle operation.

3. Base year traffic - For improvement projects, base year traffic was determined from traffic counts. For new roads, since they are all short-cuts, base year traffic was determined by origin/destination surveys on existing routes. In all cases, the data appear reliable.

4. Traffic growth rates - The system of annual traffic counts on most segments of the federal highway network is too recent to forecast trends of traffic growth for individual highways. SOP has made the following assumptions to forecast traffic on the project highways:

a) between 1969 and opening, growth rates would be similar to those observed over the past 2-3 years (around 7% p.a.); and

b) following opening, growth rates would progressively increase to 15-16% p.a. and decline again toward a constant growth of 8% p.a. for the last 10 years of project life.

The high growth rates in the years following opening are justified in the case of new roads as they reflect traffic generated by the roads, but may be optimistic for existing highways; for evaluation, therefore, traffic growth rates have been limited to 10% and rates of 3% to 8% have been used for years beyond 1980. The rate of return is not greatly affected by a change in the rate of traffic growth after 10 years.

5. As the forecasts of growth rates in the distant future are unreliable, the minimum levels of traffic necessary to generate constant annual benefits that would yield a 10% rate of return over a 20-year life have also been determined for each road. They are given in Table 1 and compared with 1969 traffic and traffic estimates at project completion date. If existing traffic or estimated traffic at the time of road completion is already higher than or equal to the minimum level of traffic needed to justify the investment - this is the case for five of the roads in the project (Nos. 1, 2, 3, 6, 9) - the estimate of future growth rates is not important. If existing, or estimated traffic at opening is lower than the

minimum level, the justification will depend more upon the rate of traffic growth, and the further the base year traffic is from the minimum required traffic, the greater the risk that the investment might not be justified. This is the case for the five remaining roads in the project. However, for four of those (Nos. 4, 5, 8, and 10), estimated traffic at opening is already 80% or more of the minimum needed to justify the investment without further growth, and the risk that the investment might not be justified is small since traffic is expected to grow on all four roads. For the Tuxtepec-Matias Romero Road (No. 7) estimated traffic at opening is only about a third of the minimum level, and it is clear that the project cannot be justified on the basis of road user savings only. Benefits resulting from increased agricultural production have been considered (see Annex C). This check thus provides a test of sensitivity.

6. Vehicle operating costs - the costs of vehicle operation have been updated by SOP for this project and are satisfactory (Table 2). The influence of congestion on vehicle operating costs has been taken into account using speed/volume relations of the Highway Capacity Manual. Operating costs include bus and truck drivers' salaries, but no passenger time savings have been included in the benefits.

7. Other economic benefits - It has been estimated that improvement of existing highways (Nos. 1 to 5) would reduce annual maintenance costs on these roads by almost 40%; however, the contribution of these benefits to the economic rates of return of these roads is negligible (1 to 2 percentage points on rates of return ranging from 15% to 25% with user savings only). Great precision is not important in the estimation of annual maintenance costs to justify the investment.

8. In the case of the Tuxtepec-Matias Romero road, benefits resulting from user savings have been complemented by benefits expected from agricultural development triggered by the opening of the road.

MEXICO

FOURTH ROAD PROJECT

Economic Evaluation

HIGHWAYS	Economic Cost 1/	Constant Annual Benefits (20 years) giving a 10% rate of return	Corresponding Minimum Traffic giving a 10% rate of return	1969 Traffic		Estimated traffic at opening date 2/	Rate of Return (best estimate)
			Veh/Day	Vehicle/ day	As % of min. traffic	Veh/Day	%
To be improved	----------Ps Million-------						
1. Chilpancingo-Tlapa (Chilpancingo-Chilapa Section)	18.3	2.1	200	220	110	290	23
2. Puerto Vallarta-Barra de Navidad	73.0	9.7	200	150	75	220	14
3. Apatzingan-Tepalcatepec 2/	39.9	5.0	500	440	88	700	23
4. Zapotlanejo-Lagos 2/	99.2	13.7	2,400	1,850	77	2,200	23
5. Santa Rosa-La Barca 2/	59.8	7.4	3,000	1,670	56	2,400	17
To be constructed							
6. Compostela-Chapalilla	26.5	3.3	320	400	127	590	29
7. Tuxtepec-Matias Romero 3/	154.8	21.3	1,400	250	18	350	10
8. Ciudad Victoria-Tampico (Llera-Estacion Gonzalez Section)	56.5	7.4	420	250	60	340	11
9. Ciudad Aleman-Sayula	126.3	17.6	820	770	94	1,080	23
10. Cardel-Veracruz	34.0	4.2	1,420	1,000	70	1,360	18

1/ Includes engineering, physical contingencies and right-of-way.

2/ Weighted average of traffic on the individual sections.

3/ Only about half of the benefits resulting from the construction of this highway result from road user savings, other benefits result from stepped-up agricultural development.

May 1970

ANNEX B
Table 1

ANNEX B
TABLE 2

MEXICO

FOURTH ROAD PROJECT

Estimated Vehicle Operating Costs
(in US$ equivalent per 1000 km)

Vehicle Speed km/h	CAR 1/			BUS			TRUCK 2/		
	Paved	Gravel	Earth	Paved	Gravel	Earth	Paved	Gravel	Earth
20	57.36	62.56	72.88	144.5	175.0	221.9	129.4	161.5	235.8
30	44.16	49.36	59.28	121.9	152.3	198.5	111.8	144.6	217.1
40	37.28	42.56	52.00	111.0	141.7	187.5	104.0	137.3	209.0
50	33.60	38.80	48.00	105.6	136.6	181.9	101.1	134.4	206.0
60	30.96	36.32	45.20	102.9	133.8	179.1	101.1	134.6	206.4
70	29.60	35.04	43.92	102.6	133.2	178.9	103.4	136.9	209.2
80	29.04	34.32	42.88	103.6	134.2	180.6	107.2	140.4	-
90	28.88	-	-	105.8	-	-	112.2	-	-
100	29.60	-	-	109.0	-	-	-	-	-

1/ Weighted average of operating costs of small, average and large cars according to the composition of the fleet.

2/ Weighted average of operating costs of 2 axles, 3 and 4 axles, and 5+ axles trucks according to the composition of the fleet.

Source: SOP

February 1970.

ANNEX C

TUXTEPEC-MATIAS ROMERO (DONAJI) ROAD (169 km)

Impact on Agricultural Development

1. The economic benefits expected from increased agricultural production due to the construction of the proposed Tuxtepec-Matias Romero (Donaji) road are as follows:

2. Area of Influence - The road will run through largely undeveloped areas of the states of Veracruz and Oaxaca, in the foothills of the Sierra Madre de Oaxaca. The area of influence, calculated to be 6,600 km^2, extends some 20 miles on either side of the proposed alignment (see Map).

3. Ecology, Soils and Climate - The ecology of the area of influence is uniform, characterized in its virgin state with humid tropical forest 10 to 15 m high and in its secondary state with thick bush 3 to 5 m high. Most of the original millable wood has been removed from the area, and no significant benefits are likely to result if a road is constructed. The soils are lateritic and generally well drained, suitable for a wide variety of crops such as sugar, fruit, cereals, and beans; the alluvial soils are suitable for rainfed rice. Average temperatures for the area are 30° - 32°C from March to October, falling to about 25°C for the remainder of the year. Rainfall averages 2,200 to 2,400 mm per annum.

4. Present Land Use - It is estimated that out of a zone of influence of 660,000 ha, some 78,000 ha are presently cultivated, and another 122,000 ha are in pasture. The population of the area is estimated at some 95,000. The area immediately south of Tuxtepec is quite heavily cultivated and the most important crop is sugar cane, planted on 12,000 ha (this cane is delivered to the Tuxtepec sugar mill which has ample capacity for the crop); in addition, there are some 2,000 ha of citrus, and 21,000 ha of maize, beans and sesame, and 20,000 ha of pasture. Further south, in the municipalities of Playa Vicente, Choapan & Mixe, the population is scattered and cropping activities center around rice, beans, sesame, and maize in units of 3 to 5 hectares (total 43,000 ha). Cultivation is by hand, and farmers keep livestock on 100,000 ha of rough pasture.

5. Future Land Use - The agricultural potential of the area is good. Where roads have been constructed and credit made available in similar agricultural areas nearby, development has been quite impressive; for instance, in the vicinity of Tuxtepec alone there is a large sugar mill (capacity 100,000 tons) and four pineapple factories which are at present fully supplied with fruit. There is little doubt that the less developed part of the zone of influence could grow good crops of sugar, pineapple and citrus, but in the absence of plans for factory expansion, it is more realistic to look at the expansion possibilities in terms of maize, rice, beans, sesame and livestock. Those crops are well known to the people, they require relatively little in the way of extra on-farm investment, and little or no additional investment for marketing.

6. It is estimated that by supplying small amounts of credit for drought animals, plows and breeding stock, cultivation will rise by 2 hectares per family for those that avail themselves of credit and that the growth of the cattle herd will increase significantly beyond the present. It is further estimated that over a 10-year period some 10,000 farmers would avail themselves of credit facilities, or 50% of the 20,000 farmers expected to be in the area at this time.

7. Before calculating the estimated benefits due to the road it is necessary to project the estimated development without it, except in the Tuxtepec Municipio, where it is considered that a new road would not contribute to increased agricultural development. Allowing for a normal growth rate in agricultural production, in sympathy with the population increase of 3%, it is calculated that all the arable land and most of the pasture land would be developed over a period of 20 years (Table). However, with a modest credit program, made possible by the new road, peak development would be reached in Year 11 (Table) and the ensuing benefits attributable to the new road. No provision is made for improved seed or fertilizer and no increase in yield levels has been assumed, because, where land is not the limiting factor, farmers will tend to increase the gross area under production rather than increase yields.

8. Benefits - Based on the former assumptions, the net benefits from increased agricultural production attributable to the road have been estimated as follows for the 20 years following road construction:

Year	1	2	3	4	5	6	7	8	9	10
Million Ps	-	-1.5	0.9	3.3	5.8	8.5	11.4	14.5	17.6	20.7

Year	11	12	13	14	15	16	17	18	19	20
Million Ps	23.8	23.7	22.3	23.7	22.0	19.2	17.6	16.6	13.4	27.9 /1

/1 Includes residual value of livestock.

Road user savings both on local transport and on through traffic have been added to these increases in value added to agriculture to determine the total benefits of the investment (Chapter 5).

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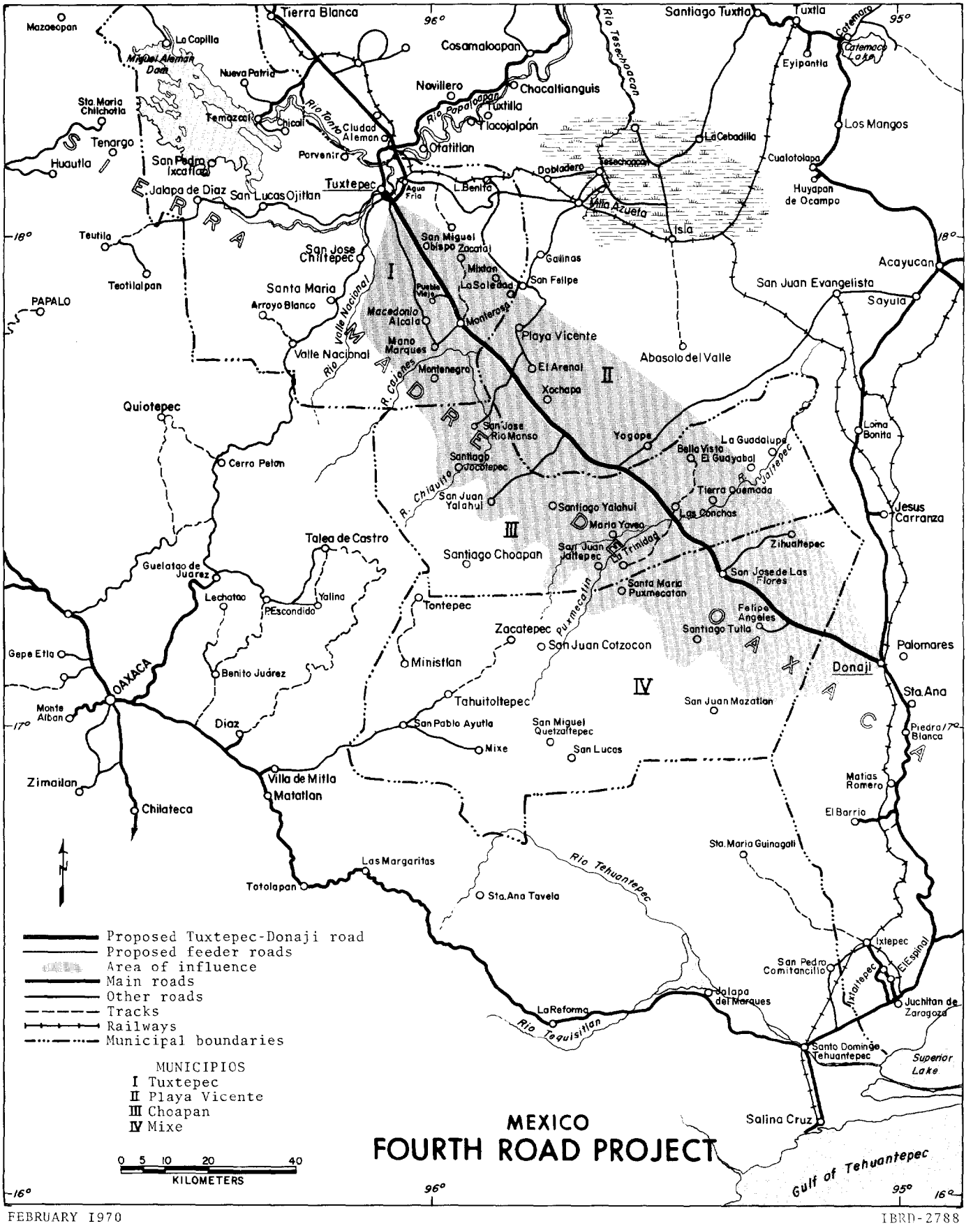
Estimated Growth of Agriculture with and without the proposed

Matias Romero-Tuxtepec road (excluding the Tuxtepec Municipio)

	'000 hectares																				
Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CROPS																					
without road	53	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	91
with road	53	55	59	63	67	71	75	79	83	87	91	91	91	91	91	91	91	91	91	91	91
Increase resulting from road	-	1	3	5	7	9	11	13	15	17	19	17	15	13	11	9	7	5	3	1	0
PASTURES																					
without road	102	105	108	111	114	117	120	123	126	129	133	137	141	145	149	153	157	161	166	171	
with road	-	107	114	123	132	141	150	159	168	175	187	190	190	190	190	190	190	190	190	190	
Increase resulting from road		2	6	12	18	24	30	36	42	48	54	53	49	45	41	37	33	29	24	19	

March 20, 1969

ANNEX C
TABLE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Santiago Tuxtla
Tuxtla
Cosamaloapan
Novillero
Chacaltianguis
Tuxtilla
Tlacojalpán
Otatitlan
Ciudad Alemán
Porvenir
Temazcal
Chical
Nueva Patria
La Capilla
Mazaecopan
Sta. Maria Chilchotla
Tenango
Huautla
San Pedro Ixcatlan
Jalapa de Diaz
San Lucas Ojitlan
Tuxtepec
Agua Fria
L. Benito
Dobladero
Tesechoacan
La Cebadilla
Villa Azueta
Isla
Eyipantla
Los Mangos
Cuatotolapa
Huyapan de Ocampo
Catemaco Lake
Teutila
Teotitlan
PAPALO
San Jose Chiltepec
Santa Maria
Arroyo Blanco
Valle Nacional
Macedonio Alcalá
Mano Marques
Montenegro
Puente Viejo
Monterosa
San Miguel Obispo
Zacatal
Mixtan
La Soledad
San Felipe
Gallinas
Playa Vicente
El Arenal
Xochapa
Abasolo del Valle
Acayucan
San Juan Evangelista
Sayula
Quiotepec
Cerro Peton
San José Rio Manso
Santiago Jocotepec
San Juan Yalahui
Santiago Yalahui
Maria Yaveo
Yogopa
La Guadalupe
Bella Vista
El Guayabal
Tierra Quemada
Las Conchas
Loma Bonita
Jesus Carranza
Zihuatlepec
San Jose de Las Flores
Santa Maria Puxmecatan
Felipe Angeles
Santiago Tutla
Talea de Castro
Santiago Choapan
San Juan Jaltepec
La Trinidad
Guelatao de Juarez
Lechatao
Yalina
P. Escondido
Tontepec
Zacatepec
San Juan Cotzocon
Ministlan
Tahuitoltepec
San Juan Mazatlan
San Pablo Ayutla
San Miguel Quetzaltepec
San Lucas
Mixe
Gape Etla
Benito Juárez
OAXACA
Monte Alban
Diaz
Zimatlan
Chilateca
Villa de Mitla
Matatlan
Totolapan
Las Margaritas
Sta. Ana Tavela
Sta. Maria Guinagati
Rio Tehuantepec
Rio Tequisitlan
La Reforma
Jalapa del Marques
Santo Domingo Tehuantepec
Salina Cruz
Gulf of Tehuantepec
Superior Lake
Ixtepec
El Espinal
San Pedro Comitancillo
Juchitan de Zaragoza
Matias Romero
El Barrio
Piedra Blanca
Sta. Ana
Donají
Palomares
Rio Papaloapan
Rio Tesechoacan
Rio Tonto
Rio Valle Nacional
R. Colones
R. Chiquito
R. Jaltepec
Rio Puxmecatlan
Rio Ixtepec
Ixtepec
Proposed Tuxtepec-Donaji road
Proposed feeder roads
Area of influence
Main roads
Other roads
Tracks
Railways
Municipal boundaries
MUNICIPIOS
I Tuxtepec
II Playa Vicente
III Choapan
IV Mixe
0 5 10 20 40
KILOMETERS
MEXICO
FOURTH ROAD PROJECT
96°
95°
16°
17°
18°

TABLE 1

MEXICO

FOURTH ROAD PROJECT

Railway Statistics 1958-1968

	Total Length of Railway Routes (km)	Passenger Traffic		Freight Traffic	
		Millions of Passengers	Millions of Passengers-km	Millions of Tons	Millions of tons-km
1958	23,456	29.3	3,491	28.2	12,809
1959	23,292	30.6	3,725	28.5	12,230
1960	23,368	32.6	4,127	32.2	14,004
1961	23,487	33.6	4,287	30.6	13,524
1962	23,501	34.5	3,769	30.6	13,521
1963	23,793	35.7	3,898	34.2	14,960
1964	23,618	37.5	4,097	37.4	16,330
1965	23,672	37.3	3,881	41.0	18,326
1966	23,672	38.0	4,100	40.4	18,400
1967	23,677	38.9	4,252	43.4	19,732
1968	23,677	38.8	4,398	45.0	20,654
Average annual growth rate:			2.4%		5.0%
Average length of journey in 1968			113 km		462 km

Source: SCT and SOP

February 1970.

TABLE 2

MEXICO

FOURTH ROAD PROJECT

Length of Highways, 1958 to 1968
(Kilometers)

Year	Federal	State	Local	Toll	Total
1958	16,997	12,032	2,750	296	32,075
1959	21,001	13,314	2,900	296	37,511
1960	21,495	20,243	2,920	296	44,954
1961	23,647	22,396	3,267	296	49,606
1962	22,685	27,093	3,310	452	53,540
1963	23,723	28,503	4,360	452	57,038
1964	24,663	29,514	5,765	498	60,440
1965	25,195	28,807	6,695	555	61,252
1966	25,773	31,361	5,826	741	63,701
1967	26,042	31,302	6,865	886	65,095
1968	27,058	31,030	7,937	961	66,986
Average annual growth rate	4.9%	10%	11.2%	12.5%	7.7%

Source: Secretaria de Obras Publicas

February 1970.

TABLE 3

MEXICO

FOURTH ROAD PROJECT

Number of Motor Vehicles Registered 1958 to 1968
(Thousands)

Year	Automobiles	Buses	Trucks	Total
1958	378.9	22.7	273.8	675.4
1959	437.7	25.9	300.9	764.5
1960	483.1	26.1	293.4	802.6
1961	520.7	33.4	300.2	854.3
1962	548.2	26.1	327.9	902.2
1963	618.0	27.6	352.7	998.3
1964	687.8	29.5	364.1	1,081.4
1965	771.1	30.7	388.1	1,189.9
1966	812.4	27.5	408.5	1,248.4
1967	917.4	27.6	440.3	1,385.3
1968	999.9	29.4	465.8	1,495.1
Average annual growth rate	9.8%	2.6%	5.5%	8.3%

Source: Anuario Estadistico de Los Estados Unidos Mexicanos and SOP February 1970.

TABLE 4

MEXICO

FOURTH ROAD PROJECT

Highway Expenditures 1958-1968 1/
(Ps million)

Year	Highways			Total
	Federal	Toll	State and Local	
1958	554	65	261	880
1959	688	67	280	1035
1960	625	59	257	941
1961	484	161	259	904
1962	647	105	262	1014
1963	711	141	323	1175
1964	953	300	463	1716
1965	844	320	540	1704
1966	910	436	481	1827
1967	912	383	499	1794
1968	912	272	604	1788

1/ Construction, maintenance and administration

Source: Secretaria de Obras Publicas

February 1970.

TABLE 5

MEXICO

FOURTH ROAD PROJECT

Design Standards

Geometric Design	Unit	Flat and Rolling Country	Hilly Country	Medium Mountainous	Heavy Mountainous
Special					
Design speed	Km/h	100	90	70	60
Width of roadway:					
two lanes	Meter	9 to 13	9 to 13	9 to 13	9 to 13
four lanes	Meter	21.8	21.8	21.8	21.8
Width of surfacing:					
two lanes	Meter	7.2	7.2	7.2	7.2
four lanes	Meter	2 x 7.5	2 x 7.5	2 x 7.5	2 x 7.5
Maximum radius of curvature	Meter	316	251	145	105
Maximum grade	%	4.0	5.0	5.5	6.0
Type A Modified (Primary)					
Design speed	Km/h	100	90	70	60
Width of roadway	Meter	9 to 11	9 to 11	9 to 11	9 to 11
Width of surfacing	Meter	7.2	7.2	7.2	7.2
Minimum radius of curvature	Meter	316	251	145	105
Maximum grade	%	4.0	5.0	5.5	6.0
Type B (Secondary)					
Design speed	Km/h	90	80	60	50
Width of roadway	Meter	8	8	7.5	7.5
Width of surfacing	Meter	8	8	7.5	7.5
Minimum radius of curvature	Meter	251	194	105	71
Maximum grade	%	4.5	5.5	6	6.5
Type C (Tertiary)					
Design speed	Km/h	80	70	50	30
Width of roadway	Meter	7.0	7.0	7.0	6.5
Width of surfacing	Meter	7.0	7.0	7.0	6.5
Minimum radius of curvature	Meter	194	145	71	25
Maximum grade	%	5	6	6.5	7

Load design for bridges: HS-15 (AASHO)
Axle Load: 10,880 kg

Source: Secretaria de Obras Publicas

February 1970.

TABLE 6

MEXICO

FOURTH ROAD PROJECT

Project Highways: Length, Type and Surface

	Length in Km	Type (See Table 5)	Surfacing 1/
A. Highways to be improved			
1. Chilpancingo-Tlapa (Chilpancingo-Chilapa Section)	56	C	SST
2. Puerto Vallarta-Barra de Navidad	221	B	DST
3. Apatzingan-Tepalcatepec	67	C	DST
4. Zapotlanejo-Lagos	158	A modified	AC
5. Santa Rosa-La Barca	78	A modified	AC
	580		
B. Highways to be constructed			
6. Compostela-Chapalilla	37	B	DST
7. Tuxtepec-Matias Romero (Donaji)	169	C	DST
8. Ciudad Victoria-Tampico (Llera-Estacion Gonzalez Section	90	C	SST
9. Ciudad Aleman-Sayula	135	B	SST
10. Cardel-Veracruz	31	A modified	AC
	462		
Total	1042		

1/ SST = Single Surface Treatment
DST = Double Surface Treatment
AC = Asphaltic Concrete

May 1970

MEXICO

FOURTH ROAD PROJECT

Cost Estimate of Project Highways

	Highways	Length Km	Construction Cost	Supervision 6%	Sub Total	Contingencies Physical (10%)	Contingencies Escalation (8%)	Total
			Pesos Millions					
(a)	To be improved							
1.	Chilpancingo-Tlapa (Chilpancingo-Chilapa Section)	56	15.1	0.9	16.0	1.6	1.3	18.9
2.	Puerto Vallarta-Barra de Navidad	221	60.4	3.6	64.0	6.4	5.1	75.5
3.	Apatzingan-Tepalcatepec	67	33.0	2.1	35.1	3.5	2.8	41.4
4.	Zapotlanejo-Lagos	158	82.1	4.9	87.0	8.7	7.0	102.7
5.	Santa Rosa-La Barca	78	49.1	2.9	52.0	5.2	4.2	61.4
		580	239.7	14.4	254.1	25.4	20.4	299.9
(b)	To be constructed							
6.	Compostela-Chapalilla	37	23.1	1.4	24.4	2.4	1.9	28.7
7.	Tuxtepec-Matias Romero (Donaji)	169	122.9	7.4	130.4	13.0	10.4	153.8
8.	Ciudad Victoria-Tampico (Llera-Estacion Gonzalez Section)	90	46.7	2.8	49.5	5.0	4.0	58.5
9.	Ciudad Aleman-Sayula	135	104.0	6.2	110.2	11.0	8.8	130.0
10.	Cardel-Veracruz	31	28.1	1.7	29.8	3.0	2.4	35.2
	Sub Total	462	324.8	19.5	344.3	34.4	27.5	406.2
	Total	1,042	564.5	33.9	598.4	59.8	47.9	706.1 1/

(US$56.6 mill. equivalent)

1/ Does not include right-of-way costs totalling about Ps 2.6 million (US$208.000 equivalent); including right-of-way the total cost is Ps 708.7 million (US$56.8 million equivalent).

May 1970

TABLE 7

MEXICO

FOURTH ROAD PROJECT

Analysis of Construction Cost Estimates by Items

Highways	Length Km	Earthworks	Drainage	Pavement	Sub Total	Bridges over 15m Span	Signs & Misc.	Sub Total	Total Construct. Cost (without Contingencies)
		Pesos Millions							
(a) To be improved									
1. Chilpancingo-Tlapa (Chilpancingo-Chilapa Section)	56	0.3	3.2	11.2	14.7	-	0.4	0.4	15.1
2. Puerto Vallarta-Barra de Navidad	221	-	9.6	48.1	57.7	-	2.7	2.7	60.4
3. Apatzingan-Tepalcatepec	67	8.4	6.6	12.0	27.0	5.5	0.5	6.0	33.0
4. Zapotlanejo-Lagos	158	16.5	5.6	51.5	73.6	7.4	1.1	8.5	82.1
5. Santa Rosa-La Barca	78	12.3	3.5	32.3	48.1	0.4	0.6	1.0	49.1
	580	37.5	28.5	155.1	221.1	13.3	5.3	18.6	239.7
(b) To be constructed									
6. Compostela-Chapalilla	37	8.5	5.5	7.2	21.2	1.6	0.3	1.9	23.1
7. Tuxtepec-Matias Romero (Donaji)	169	33.7	18.1	42.4	94.2	27.7	1.0	28.7	122.9
8. Ciudad Victoria-Tampico (Llera-Estacion Gonzalez Section)	90	18.3	5.9	17.8	42.0	4.1	0.6	4.7	46.7
9. Ciudad Aleman-Sayula	135	33.8	12.1	42.9	88.8	14.2	1.0	15.2	104.0
10. Cardel-Veracruz	31	9.5	1.9	12.5	23.9	4.0	0.2	4.2	28.1
	462	103.8	43.5	122.8	270.1	51.6	3.1	54.7	324.8
Totals	1,042	141.3	72.0	277.9	491.2	64.9	8.4	73.3	564.5 1/

1/ Does not include right-of-way costs: total including right-of-way if Ps 567.1 million

Source: Secretaria de Obras Publicas

May 1970

TABLE 8

TABLE 9

MEXICO

FOURTH ROAD PROJECT

Schedule of Individual
Contracts and Packages of Contracts

		Construction Cost		Number of Individual Contracts	Value of Individual Contracts	Packages of Contracts
		Ps Millions	US$ Millions		US$ Millions	
1.	Chilpancingo-Tlapa (Chilpancingo-Chilapa Section)	14.7	1.1	1	1.1	
2.	Puerto Vallarta-Barra de Navidad	57.7	4.6	2	2.3	4.6
3.	Apatzingan-Tepalcatepec	27.0	2.2	1	2.2	
4.	Zapotlanejo-Lagos	73.6	6.0	3	2.0	6.0
5.	Santa Rosa-La Barca	48.1	3.8	2	1.9	3.8
6.	Compostela-Chapalilla	21.2	1.7	1	1.7	
7.	Tuxtepec-Matias Romero (Donaji)	94.2	7.5	3	2.5	7.5
8.	Ciudad Victoria-Tampico (Llera-Estacion Gonzalez Section)	42.0	3.4	2	1.7	3.4
9.	Ciudad Aleman-Sayula	88.8	7.2	3	2.4	7.2
10.	Cardel-Veracruz	23.9	1.9	1	1.9	
	Total	491.2	39.4	19		

1/ Excluding engineering and contingencies and Ps 73 million for contracts to be awarded through local bidding (see para. 4.15)

May 1970

TABLE 10

MEXICO

FOURTH ROAD PROJECT

Project Highways: Traffic Forecasts
(Vehicles per day)

	Chilpancingo-Tlapa (No.1) (Chilpancingo-Chilapa Section)	Puerto Vallarta-Barra de Navidad (No.2)	Apatzingan-Tepalcatepec (No.3)
1969	220	150	440
1975	390	270	780
1980	550	350	1,110
1985	770	450	1,560
1990	1,070	560	2,200

	Zapotlanejo-Lagos 1/ (No.4)	Santa Rosa-La Barca 1/ (No.5)	Compostela-Chapalilla (No.6)	Tuxtepec-Matias Romero (No.7)
1969	1,850	1,670	400	250
1975	2,760	2,640	720	350
1980	3,690	3,880	1,070	500
1985	4,660	5,290	1,300	675
1990	5,400	7,080	1,510	910

	Ciudad Victoria-Tampico (No.8)	Ciudad Aleman-Sayula (No.9)	Cardel-Veracruz (No.10)
1969	250	770	1,000
1975	360	1,230	1,590
1980	480	1,870	2,330
1985	640	2,620	3,430
1990	860	3,670	5,030

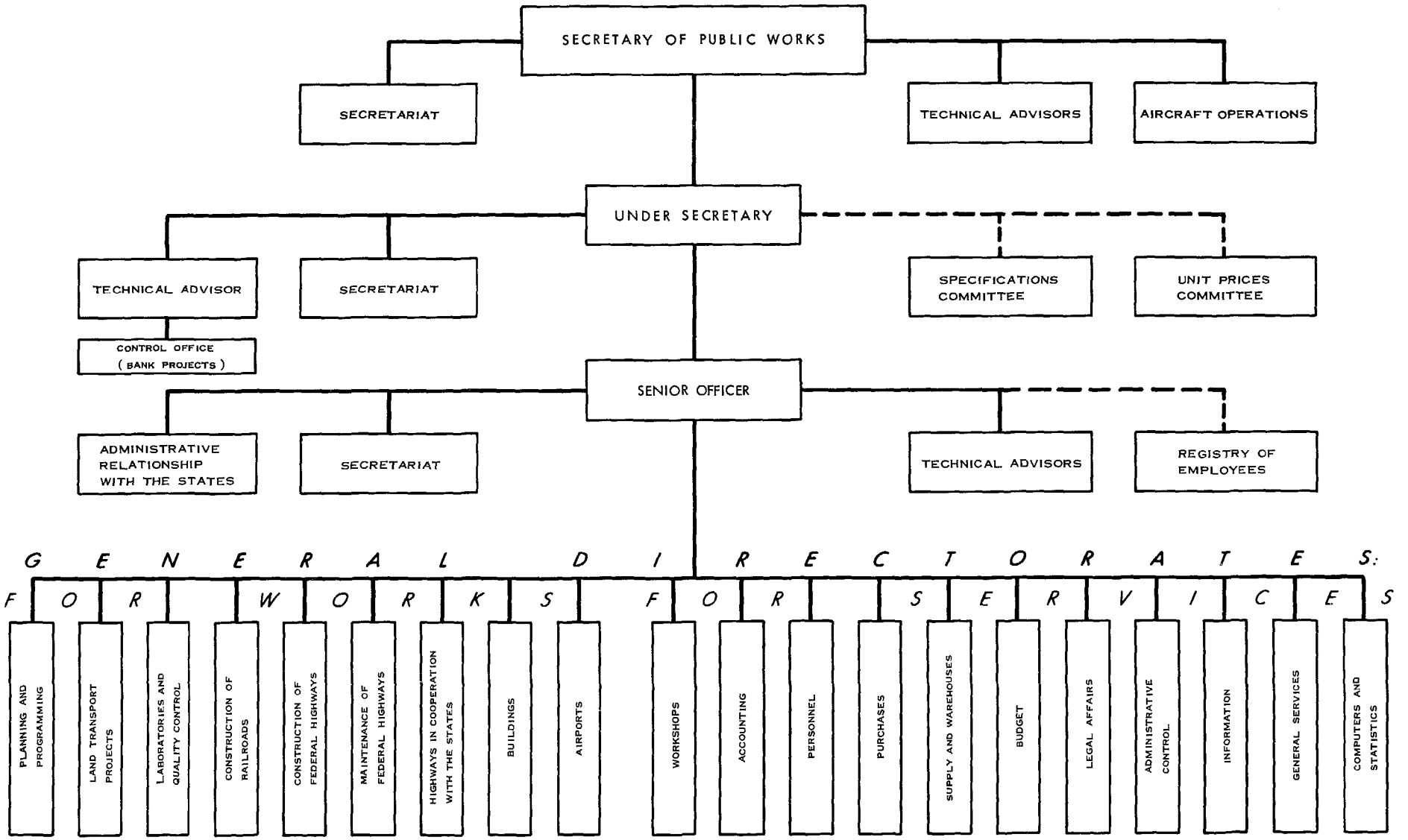
1/ Weighted average of traffic on the individual sections.

Source: SOP and BANK

February, 1970

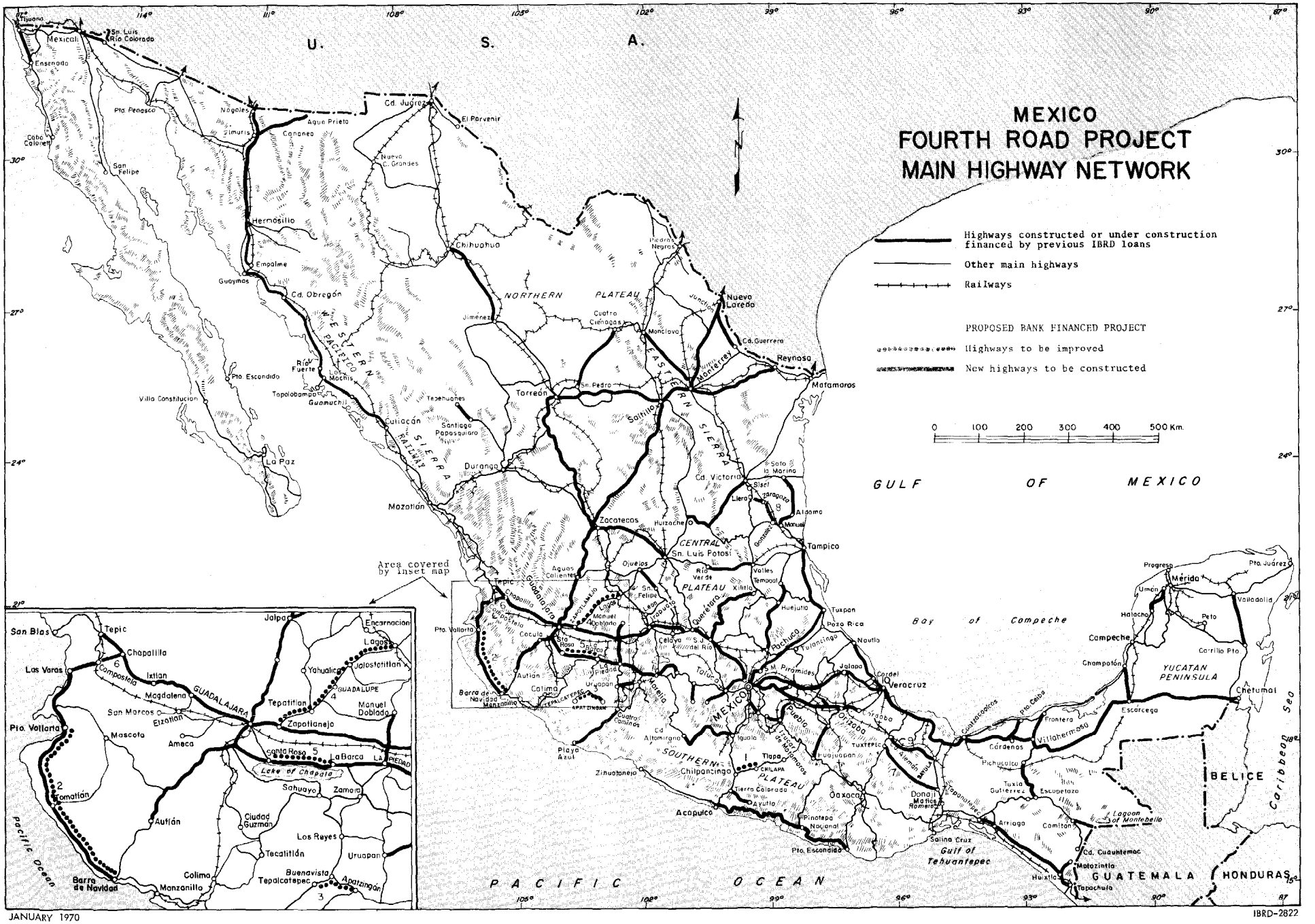
MEXICO: FOURTH ROAD PROJECT

ORGANIZATION CHART OF THE SECRETARIAT OF PUBLIC WORKS



FOR COORDINATION

IBRD-4737



JANUARY 1970

IBRD-2822