CHARLES M. UPHAM ASSOCIATES, INC.
1625 EYE STREET, NORTHWEST WASHINGTON 6, D.C.

THE HIGHWAYS OF LIBYA

Report to

The Libyan American Reconstruction Commission

Under the contract between

The Libyan American Reconstruction Commission

and

Charles M. Upham Associates, Inc.

Dated May 9, 1957, amended and extended May 24, 1958

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July 15, 1959

Mr. Omar Yacoub
Executive Director
Libyan-American Reconstruction Commission
Benghazi, Libya

Ref: Highway Engineering Contract

Dear Mr. Yacoub:

In accordance with the provisions of Article I, Section B, Paragraph 1, of the Highway Engineering Contract between the Libyan-American Reconstruction Commission and Charles M. Upham Associates, Inc., dated May 9, 1957, and amended May 24, 1958, we take pleasure in submitting to you herewith the final report.

We trust that you will find this report useful as well as informative in the improvement of highway activities in Libya.

Respectfully,

CHARLES M. UPHAM ASSOCIATES, INC.

Charles M. Upham

Charles M. Upham
President

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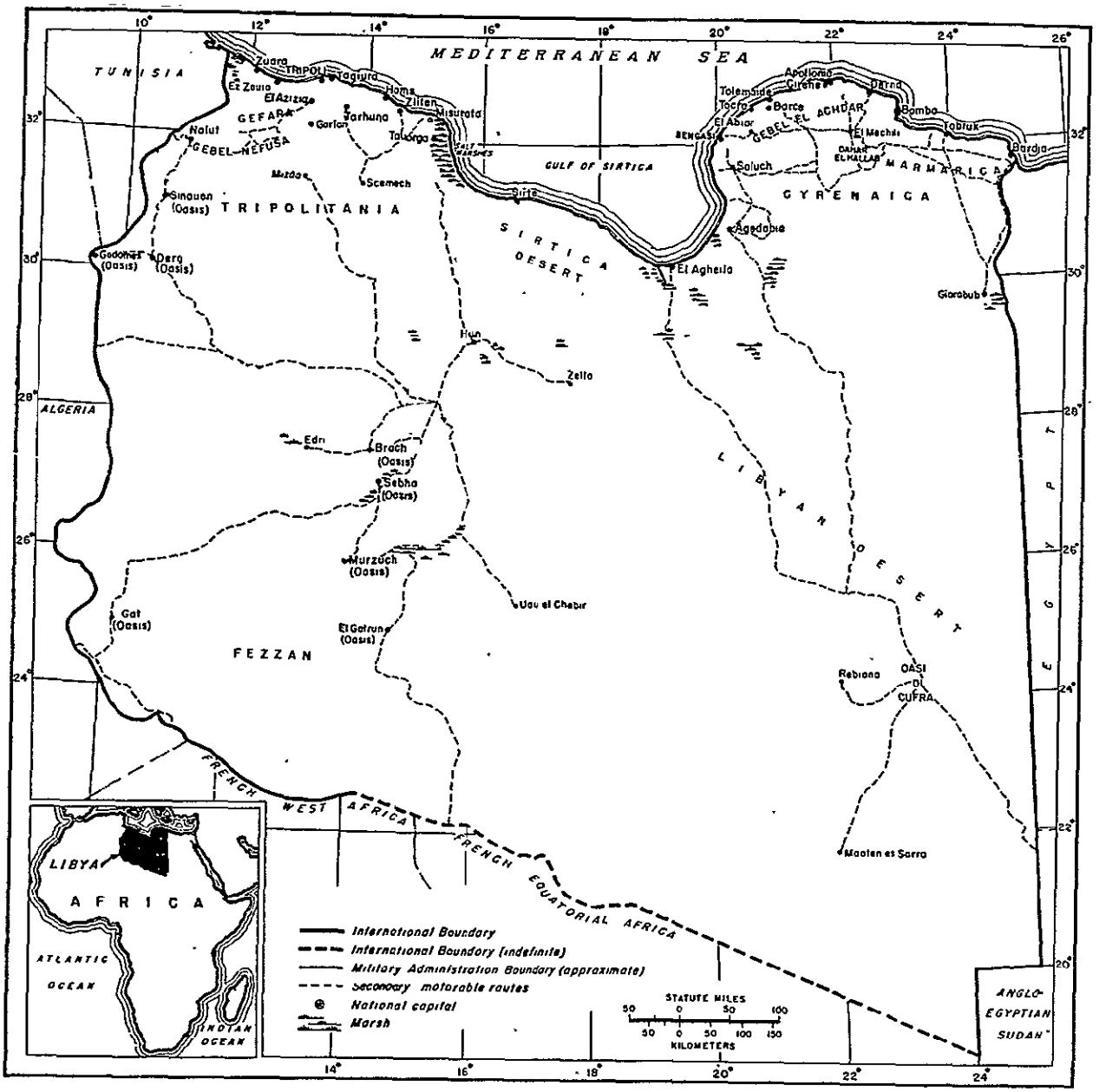
MEDITERRANEAN SEA
TUNISIA
ALGERIA
TRIPOLITANIA
GEFARA
GEBEL NEFUSA
Nalut
Gadames (Oasis)
Derg (Oasis)
Sinauen (Oasis)
Mizdah
Scemech
Tarhuna
Garian
Tagiura
TRIPOLI
Zuara
Ez Zauia
El Aziziya
Homs
Zliten
Misurata
Tauorga
GULF OF SIRTE
Sirte
GULF OF SIRTICA
SIRTICA DESERT
Hun
Zella
Edri
Brach (Oasis)
Sebha (Oasis)
Murzuch (Oasis)
Gat (Oasis)
FEZZAN
El Gofrun (Oasis)
Uau el Chebir
LIBYAN DESERT
Agedabia
El Agheila
Saluch
Apollonia
Cirene
Tolemaide
Tocra
Barce
El Abiar
BENGASI
GEBEL EL ACHDAR
Derna
Bomba
El Machili
DAHAR EL HALLAB
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MARMARICA
CYRENAICA
Giarabub
Rebiana
OASI DI CUFRA
Maaten es Sarra
EGYPT
ANGLO-EGYPTIAN SUDAN
FRENCH WEST AFRICA
FRENCH EQUATORIAL AFRICA
LIBYA
AFRICA
ATLANTIC OCEAN
INDIAN OCEAN
International Boundary
International Boundary (indefinite)
Military Administration Boundary (approximate)
Secondary motorable routes
National capital
Marsh
STATUTE MILES
KILOMETERS

INTRODUCTORY

THE CONTRACT

On December 24, 1952, the United Kingdom of Libya became an independent government and acquired all of the problems of governmental administration including reconstruction from the damage of World War II, and the development of desperately needed economic resources.

The United States Government is fully sympathetic of the Libyan Government problem and has extended substantial financial aid. To administer this aid the Libyan Parliament created the Libyan American Reconstruction Commission in 1954.

A major item in the development program envisaged by the Commission was highway construction. But as the Libyan Government had practically no highway department and very little background of experience in highway engineering the Commission considered it advisable to employ an experienced highway engineering consultant.

Accordingly a contract was effected May 9, 1957, with the Charles M. Upham Associates, Inc. to assist the Commission in carrying out the highway development program in Libya.

PERIODS OF CONTRACT

The original contract was for a period of one year beginning June 17, 1957, and was amended and extended for another year beginning June 18, 1958.

PARTIES TO CONTRACT

The contracting authority of the Libyan Government in this contract is vested in the Libyan-American Reconstruction Commission, which the Libyan Parliament intended to consist of six members. Actually during the life of the contract four members were active; two are Libyan Government officials, and two U.S. Government officials, namely:

Abdul Razeg Shaglouf	-	Permanent Under Secretary of Finance
Fouad Kabazi	-	Permanent Under Secretary of Communications
Marcus J. Gordon	-	Director, U.S.O.M., ICA/Libya
Frederick K. Lundy	-	Economic Officer, U.S. Embassy

Sayed Shaglouf has been Chairman of the Commission throughout.

Administration and execution of the functions of the Commission have been vested in an Executive Director employed by the Commission. Until July 7, 1958, Erwin C. Hannum was the Executive Director employed by the Commission. Since that date Sayed Omar A. Yacoub has been Executive Director, being assisted by Mr. Charles A. Wright acting in the capacity of Advisor. Both Mr. Hannum and Mr. Wright were on loan from ICA.

The contractor was the highway engineering consulting firm of Charles M. Upham Associates, Inc. of Washington, D.C. Mr. Charles M. Upham is president of the firm and Miss Louise Wynne is executive vice-president. Principal offices are maintained in Washington, D.C.

SCOPE OF CONTRACT

The contract anticipated furnishing the following categories of highway engineers:-

One	Chief Engineer
One	Principal Engineer
Two	Construction and Maintenance Engineers
One	Design Engineer
One	Bridge and Drainage Engineer
One	Equipment Engineer and Master Mechanic
Three	Civil Engineers

Objectives of the contract:- It was anticipated that this group would provide such engineering services as:-

1. Supervise the making of field surveys.
2. Supervise the preparation of detail road and bridge plans.
3. Prepare specifications.
4. Analyze bids and assist the Libyan road officials in awarding highway construction and maintenance contracts.
5. Supervise the engineering of road and bridge construction.
6. Direct the construction of Demonstration Road Projects.
7. Prepare lists of highway equipment to be purchased.
8. Assist in setting up a highway maintenance organization.
9. Give on the job training.
10. Other engineering services within the scope of the work.

PERSONNEL

The principal field office for the Upham Associates was maintained in Tripoli until October 1, 1958, and then shifted to Benghazi following the move of the Libyan Federal Government from Tripoli to Benghazi. During the time the field office was in Tripoli, Mr. J. Stanley Williamson was in charge, and after the move to Benghazi, Mr. Peter L. Dito was in charge. The Upham staff consisted of the following:

Alexander W. Muir	-	Construction and Maintenance
Robert T. Turner	-	Construction and Maintenance
James O. Litchford	-	Design Engineer
William Niese, Jr.	-	Bridge and Drainage Engineer
David Alexander	-	Equipment Engineer
M. A. Kalla	-	Civil Engineer

OBJECTIVES OF THE HIGHWAY PROGRAM

Primarily LARC is concerned with financing projects contributing to the development of Libya and improving the living standard of its people. Highway transportation being fundamental to a healthy economy it was therefore the desire of LARC to build a highway system adequate for Libya's needs.

It was also the desire of LARC to provide projects which result in new business and industry. With this in mind efforts were made to encourage and nourish the local highway contracting business. This was done by awarding contracts through competitive bidding for as much resurfacing as was feasible. Particular effort was made to make this a continuing program in order to provide steady contract activities and to establish permanent contractor organizations.

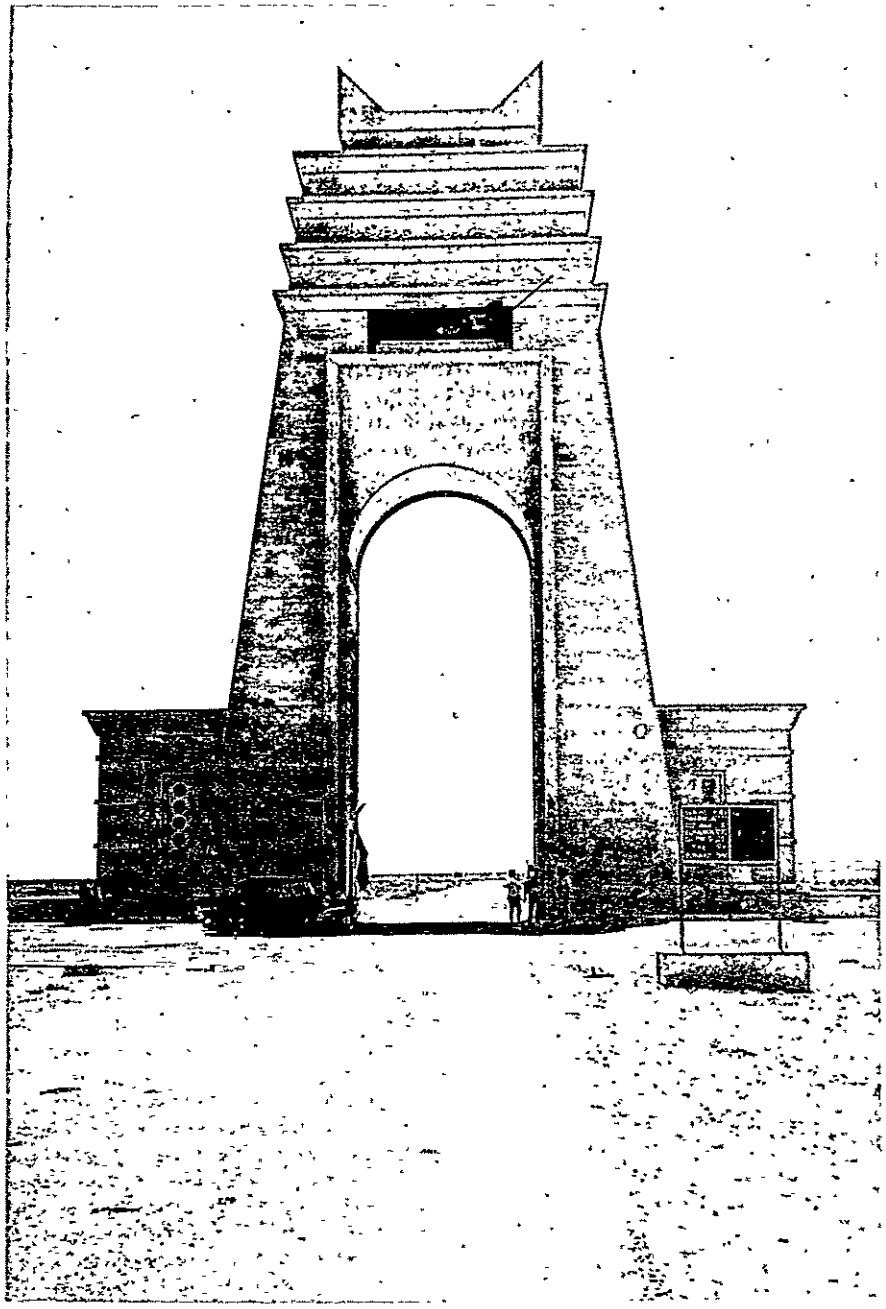
SUMMARY OF RECOMMENDATIONS

It was found that a highway system already exists in Libya which serves present day traffic fairly well. An intensive program of constructing new highways is not needed but a well integrated and continuing program of renovating and improving existing roads is definitely needed. A question may be raised whether the work to be done is maintenance or betterments but there can be no question that the work should be done. Assistance funds can well be used to encourage this important work. Considerable improvement can be made in highway maintenance methods through the use of Assistance funds and the technical assistance that should go with it.

A modest amount of money, say about $1,200,000 annually, will do a great deal to stabilize the highway departments and will gradually improve the roads. Both of these objectives are highly desirable.

Detailed recommendations concerning each phase of highway operations and administration are further elaborated in Parts II and III of this report.

The "Marble" Arch



The country's most impressive monument, presumed to be to the highway engineer, was built by the Italians in the Libyan desert. On the Coastal Highway approximately at the boundary between Tripolitania and Cyrenaica.

PART I
LIBYA AND ITS HIGHWAYS

A. PHYSICAL FEATURES

Libya occupies a goodly portion of the Sahara Desert and except for limited areas of a narrow strip along the Mediterranean coast it is all desert. It lies between Tunisia and Algeria on the west and Egypt on the east.

The areas of the coastal strip contain the bulk of the population; in the west around Tripoli and in the east around Benghazi. In fact 80% of the population of about 1,091,400 (1954) lives within 50 kilometers of the Coastal Highway. These two areas provide conditions suitable for agriculture, both areas having a rainy season and some arable land. Tripoli particularly has a good harbor providing for ocean transportation. Less than 50,000 live in the Fezzan.

For the most part Libya is flat and low-lying, the chief exception of effect on the Coastal Highway being in Cyrenaica where the mountains (gebel) rise abruptly from the Mediterranean and dwindle away in the desert to the south. They reach an elevation of about 2,200 feet and provide the physical feature contributing to the limited rainfall, even to an unusual snowfall. In Tripolitania the Garian rises to 800 meters.

In this gebel area, and in the somewhat similar area of lesser magnitude near Tripoli, there is enough drainage to cut impressive box canyons and deep gullies (wadis), but for the most part drainage areas are ill-defined and the wadis shallow and wide.

Wind and water erosion aided by lack of vegetation has removed the top soil leaving limestone outcrops exposed in much of the coastal strip. Comparatively few sand dunes occur along the coast and deposits of gravel suitable for road surfacing are quite rare.

The climate varies with distance from the coastal area, but is mild and tending toward the warm side although not extremely so. Consequently water and drainage are not serious problems and the problems of frost heaves and boils are unknown.

B. THE LIBYAN PEOPLE

The Libyans are mostly Arabs including a considerable percentage of Bedouins. All inhabitants share the culture of their Middle East neighbors without being intolerant of other nationalities and cultures. The fact that they have gained their independence and are seeking to improve their economic status testifies to their initiative and intelligence.

The official language is Arabic and the spoken language is a local dialect easily understood by non-Libyan Arabs. However much of the business is conducted in the English language. Still the difficulty of translating between Arabic and English presents another hurdle in the program of training technical personnel.

Some Libyans, who have businesses such as mercantile and real estate, are well off but the common man lives meagerly off the land with a few sheep or camels. Professional men and skilled labor in businesses providing services are scarce, especially engineering.

The scarcity of professional men arises from the fact that the Libyans have only recently gained the opportunity to go to school. Having no background of local education and no supply of trained teachers it has been necessary to rely upon the Egyptians to supply teachers for the schools in Cyrenaica and Tunisian's in Tripolitania. Consequently any training program looking toward the development of experienced engineers, particularly highway, is committed to a patient, long enduring course of endeavor starting from the very fundamentals.

C. THE LIBYAN GOVERNMENT

The kingdom of Libya was created as a result of a resolution of the United Nations on November 21, 1950 and independence proclaimed December 24, 1951.

The United Kingdom of Libya is the Union of three Provinces: Tripolitania, Cyrenaica and Fezzan with the two cities of Tripoli and Benghazi as the National Capital. King Idris, I rules by popular acclaim and is looked upon by his people as the symbol of Libyan unity as well as Libya's long struggle for freedom and independence.

The Libyan Parliament is the essential law making body and is quite representative of the people. It is made up of two houses, the lower house consisting of members chosen by popular election.

The executive department is made up of nine Ministries headed by Ministers appointed by the Prime Minister. Federal Roads fall under the jurisdiction of the Minister of Communications.

The Provinces are governed by Nazarates headed by Nasirs corresponding to the Ministers of the Federal Government. Provincial Roads fall under the jurisdiction of the Nazarate of Public Works in Tripolitania, and under the Nazarate of Communications in Cyrenaica and Fezzan.

D. THE HIGHWAY DEPARTMENTS

The Federal Government and the three Provincial Governments each have distinct highway departments.

The Federal Roads Department has jurisdiction over the Coastal Highway through Cyrenaica and Tripolitania, and over the Fezzan Road in the Fezzan.

The Federal Roads Department came into existence with the appointment of Mr. C. M. Teulon as Director General of Highways in the latter part of 1953, who served until May 31, 1958. He was instrumental in getting a half dozen or so highway engineers for the department. These men were mostly Palestinians having the important qualification of being able to read and write the Arabic language. They also have some experience in practical engineering.

During the same period four different Ministers were appointed to the Ministry of Communications, and became nominal head of the Highway Department. Essayed Nasir El Kazza presently is Minister of Communications.

These changes in personnel created a sense of instability and an indifference to long-time planning and development.

In some respects the Provinces were in better condition, but again it has been necessary to import trained engineers. For example in Cyrenaica the Director of Communications is a Britisher, Mr. C. W. Carter, who has a vast background of experience and considerable administrative ability. He employed two road engineers, one Italian, the other German. Both are industrious and capable of handling the road work of the Province.

In Tripolitania the highway work comes under jurisdiction of the Public Works Department. Mr. Meffati Osman is Director. His Chief Engineer is Mr. G. Messana, an Italian. The Roads Engineer, Mr. Augusto Petruzzi, is also Italian and some eight or ten other Italian engineers are at times assigned to the road work.

In all cases, however, there is an absence of trained Libyan assistants such as rodmen, chainmen, inspectors, instrument-men, draftsmen, laboratory technicians, or even young men with adequate basic education adaptable to the advanced type of training contemplated.

Condition of the Highway System - 1

This "Dip" crossing of a Wadi on the Scek-Sciuk-Giosc road typically shows the scour that takes place at the downstream edge of the "dip". This type of crossing affords cheap construction and expensive maintenance.

Garian-Tarhuna Road

The Garian-Tarhuna road is one of the important provincial roads in the Gebel area of Tripolitania and is worthy of consideration for improvement.

E. THE HIGHWAY SYSTEM

The scope of the highway problem in Libya is indicated in the following summary of the highway inventories of the Federal Roads Department, the Province of Tripolitania, and the Province of Cyrenaica. There is no highway inventory for the Province of Fezzan.

	Total Length Klms.	Type of Road			
		Bituminous Surfaced	Macadam	Improved	Unimproved
Federal Roads					
Coastal Highway and South Road	1951	1951			
Fezzan Road					
Burein-Hon-Sebha-Gat	1152	5		780	367
Sirte-Waddan-Hon	280			100	180
Total	3383	1956	—	880	547
Province of Tripolitania					
Total	2551.5	859.7	342.3	740	609.5
Province of Cyrenaica					
Total	1563.5	370.5		222	80 / 891
Grand Totals	7498.0	3186.2	342.3	1842	2127.5

It will be noted from the above that only approximately 42.5% of the total has a bituminous surface, approximately 29.2% has some type of improvement which is for the most part very primitive, and approximately 28.3% is unimproved or non existent.

INVENTORY OF THE HIGHWAY SYSTEM

The Upham engineers found no plans or layouts covering any of the roads previously constructed, including the Federal Coast Road.

To offset this handicap the Upham engineers made notes for logs of the Federal and Provincial Roads from time to time while making field inspections.

In addition a complete physical log by automobile was made of every kilometer of the Coast Road during February and March 1959. This survey indicates the condition of every kilometer of the roadway including: base course, surfacing, shoulders, horizontal and vertical alignment and all longitudinal and surface drainage.

This information was compiled on forms prepared by the Upham engineers, sample copies of which follow.

Some of the important aspects of this type of log is that it can be used as a basis for a planning program for future resurfacing work, indicating areas in need of patching and repairs, and shoulder maintenance, finally but not the least important the need for adequate inspection, maintenance, repair, and replacement of drainage structures and culvert pipes.

The original set of the road inventory notes has been transmitted to the Director of Federal Roads for his use. He has indicated that it is of extreme value to him for reference as well as obtaining information for future rehabilitation and maintenance work. If this inventory is to be of any value in the future, periodical inspection and revisions should be made so that it does not become obsolete.

The following inventory is a summary of the findings:

INVENTORY OF THE COASTAL HIGHWAY SYSTEM

The backbone of Libyan Highways is the Coastal Highway which consists of the following sections:

Province of Tripolitania:		
Tripoli-Tunisian Border	169 Km.	
Tripoli-Cyrenaican Border	682 Km.	
Total in Province of Tripolitania		851 Km.
Province of Cyrenaica:		
Benghazi-Tripolitania Border	348 Km.	
Benghazi-Egyptian Border (North Route)	612 Km.	
Barce-Lamluda (South Road)	140 Km.	
Total in Province of Cyrenaica		1,100 Km.
Total Length of Coastal Highway		1,951 Km.

A detail of the highway system, including the Provincial Roads, follows:

Practically all roads in Libya, without regard to jurisdiction, are deficient of proper drainage and lack adequate maintenance, particularly of the shoulders. The Coastal Highway has a five meter width of bituminous pavement whereas the Provincial Roads have mostly three meters widths. The classification refers primarily to the condition of the pavement and does not attempt to show quality of geometric design or degree of improvement attained.

G - indicates good condition
F - indicates fair condition
P - indicates poor condition

INVENTORY OF ROADS IN LIBYA
as of
DECEMBER 31, 1958

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
COASTAL HIGHWAY IN TRIPOLITANIA					
Tunisian Border to Zavia	126	126 F			
Zavia to Tripoli	43	43 F			
Tripoli to Gasr Garabulli	62	62 G			
Gasr Garabulli to Homs	58	58 P			
Homs to Misurata	91	91 F			
Misurata to Km. 238	27	27 F			
Km. 238 to Km. 262	24	24 P			
Km. 262 to Km. 319	57	57 G			
Km. 319 to Km. 357	38	38 F			
Km. 357 to Km. 464 (Sirte)	107	107 G			
Sirte to Km. 520	56	56 P			
Km. 520 to Km. 609	89	89 F			
Km. 609 to Km. 620	11	11 P			

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
COASTAL HIGHWAY IN TRIPOLITANIA (Cont.)					
Km. 620 to Km. 628	8	8 F			
Km. 628 to Km. 682 (Marble Arch)	54	54 G			
Total length in Tripolitania	851	851			
COASTAL HIGHWAY IN CYRENAICA					
Marble Arch (Km. 348) to Km. 306	42	42 F			
Km. 306 to Km. 282 (Agheila)	24	24 P			
Agheila (Km. 282) to Agedabia (Km. 159)	123	123 P			
Agedabia (Km. 159) to Benghazi (Km. 0)	159	159 P			
Benghazi (Km. 0) to Barce (Km. 100)	98	98 F			
Barce (Km. 100) to Km. 116	18	18 P			
Km. 116 to Km. 200 (Beida)	84	84 G			
Beida to Km. 240) (Lamluda)	40	40 P			
Km. 240 to Km. 265	25	25 P			
Km. 265 to Km. 300 (Derna)	35	35 F			
Derna to Km. 471 (Tobruk)	171	171 P			
Tobruk to Egyptian Border	141	141 G			

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
COASTAL HIGHWAY IN CYRENAICA (Cont.)					
South Road: Barce (100) to Lamluda (Km. 240)	140	140 G			
Total length in Cyrenaica	1,100	1,100			
Total length of Coastal Highway	1,951	1,951			
FEDERAL ROAD IN FEZZAN					
Bugrein to Hon	289	3 G		286 P	
Sirte to Hon	280			100 P	180 P
Hon to Sebha	314	2 G		312 P	
Sebha to Ubari	182			182 P	
Ubari to Gat	367				367 P
Total length in Fezzan Road	1,432	5		880	547
Total Federal Roads	3,383				
PROVINCIAL ROADS IN TRIPOLITANIA					
Tripoli (Tagiura Gate)-Suk el Giuma-Tagiura-Hamidia-Federal Road (Km. 20)	16.7	16.7 F			
Tripoli (Bab ben Gashir)-Ben Gashir-Tarhuna-Cussa-bat-Federal Road (Km. 112)	153.0	153.0 G			

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
PROVINCIAL ROADS IN TRIPOLITANIA (Cont.)					
Tripoli (Bab Azizia)-Suani ben Adem-Azizia-Bugheilan-Garian-Rumia-Zintan-Giado	213.0	213.0 G			
Azizia-Bir Ghenem-Bir Ajad-Jefren-Rumia	97.0	97.0 F			
Zavia-Bir Ghenem	58.0	58.0 F			
Tarhuna-Uestata-Beni Ulid	92.0	91.0 F			1.0 P
Federal Road (Km. 35.5)-Azzahara-Rivio Aairia-Saadia	42.4	24.4 F	18.0 P		
Azzahara-Suani el Kali	8.7	8.7 F			
Federal Road (Km. 24.8) Road n.7 (Km. 26.4)	19.2	14.2 F	5.0 P		
Road n.9 (Km. 7) Mahamira	6.5	6.5 F			
Federal Road (Km. 13.9)-Zanzur	2.0	2.0 G			
Zavia-Nares Dila	5.0	1.0 F	4.0 P		
Federal Road-Seruan Station	2.2	2.2 G			
Seruan-Berrisc	4.5	4.5 F			
Sabratha town-Sabratha Ruins	1.5	1.5 G			
Sabratha-Katabba	3.0		3.0 P		
Sabratha-Alalga	5.0	5.0 F			
Sabratha-Agelat-Tellil-Federal Road	13.0	6.0 F	7.0 P		

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
PROVINCIAL ROADS IN TRIPOLITANIA (Cont.)					
Zuara-El Uotis-low road	115.0	10.0 G	105.0 P		
Bir Ajd-Scek Scuik-Giosh-Nalut	156.0	27.0 G		129.0 P	
Giado-Sceksciuk	15.0	15.0 G			
Giado-Guiebia	124.0			124.0 F	
Nalut-Derg-Gadames	316.0			316.0 P	
Nalut-Uazzen	62.0			62.0 P	
Zintan-Bir Allag-Derg	290.0				290.0 P
Buzaian-Mizda	78.0		25.0 P	53.0 F	
Farian-Tigrinna-Giarian road (Km. 92)	9.4		9.4 F		
Tarhuna road (Km. 78)-Garian road (Km. 83.6)	63.0	10.0 P		53.0 P	
Tarhuna road (75.2)-S. Assed	9.5		9.5 P		
Tarhuna road (82.6)-S. Assed	15.5		15.5 P		
Tarhuna road (Km. 39) Bir Sbea-Sidi Gilani	19.0	2.0 F	17.0 P		
Tarhuna-Sciar Sciara	3.5	3.5 G			
Misurata-Bir Dufan-B. Ulid-Scemek	180.0				180.0 P
Aliten-Bir Dufan-Sedad	107.0	2.0 F			105.0 P
Federal road-E. of Eliten (Km. 170.5)-Dafinia	25.0		25.0 F		
Federal road (Km. 224)-Tammina	3.8	3.8 F			

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
PROVINCIAL ROADS IN TRIPOLITANIA (Cont.)					
Federal road (Km. 252)-Taworga	11.5	11.5 G			
Federal road (Km. 601)-Nufilia	12.0		12.0 P		
Zuara-El Assa	42.0	8.5 G			33.5 P
Ben Gashir-Airport-Suani-ben Adem	12.5	12.5 G			
Bivio Gheran-Suani b. Adem	16.8		16.8 P		
Engila-Biabsa	4.5	4.5 G			
Bivio Gheran-road n.3 (Km. 17)	15.7		15.7 P		
Road n.3-Zuelina	3.0			3.0 F	
Gurgi-Gargaresc-rd. n.43	9.6		9.6 P		
Rd. n.2 (Km.4)-Gurgi	9.3	9.3 G			
Rd. n.2 (Km.2)-Collina Verde	5.0	2.4 G	2.6 P		
Rd. n.2 (Km. 6.200)-Ain Zara-Bir Sta-Milad-Feder.Rd. (Km. 28)	25.7	8.0 F	17.7 P		
Miani deviat.-Ain Zara	10.2	2.9 G	7.3 P		
Miani-Ain Zara	4.6	4.6 G			
Road n.2 (Km. 5.8)-Road n.50	3.1		3.1 P		
Federal Rd. (Km. 7)-Ain Zara alternate	3.0		3.0 P		
Federal Rd. (Km. 9)-Road n.48	6.5	6.5 F			

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
PROVINCIAL ROADS IN TRIPOLITANIA (Cont.)					
Road n.1-Federal rd. (Km. 11.3)-El Gherued	7.4	5.4 F	2.0 P		
Road n.53 Road n.54 Federal road (Km. 11.7)-Roan n.1 (Bellascer)	7.5	4.2 F	3.3 P		
Federal rd. (Km. 17)-El Habrush	5.8		5.8 P		
Taiura-Federal Road (Km. 16)	1.4	1.4 F			
Total length in Tripolitania	2,551.5	859.7	342.3	740.0	609.5
PROVINCIAL ROADS IN CYRENAICA					
Sidi Faraj - Zuetina	9	9 G			
Gheminis - Solluch	24	24 G			
Benghazi - Benina	18	18 G			
Benina - El Abiar	40	40 G			
Tocra - Tolmeta	41				41 P
Farzuga - Hamida	16	16 F			
Sidi Rahuma - Tolmeta	18	18 G			
Zawit Gasur - Gerdis El Abid	36	36 G			
Aweila - Batta	18.5	18.5 P			
Messa - Hannia	18	18 F			
Religious Shrine (Messa)	2	2 F			
Beida - Karnada	19	19 F			

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
PROVINCIAL ROADS IN CYRENAICA (Cont.)					
Shahat - Faidiya	16	16 G			
Shahat - Susa	14	14 G			
Susa - Derna	72	72 G-F			
Lamluda - Ras el Hilal	12	12 G			
Km. 445 - Mrassas	9	9 F			
Tobruk - El Adem	26	26 F			
Tometa - Hannia, Route only	80				80
Hannia - Susa	51				51 P
Agedabia - Hassayet - Gialo	275				275 P
Agheila - El Giofar - Marada	160				160 P
El Adem - Giarabub	250			125 P	125 P
Giaber Bira - Rgabet el Naga	60				60 P
Kasel Libya - Marawa	20				20 P
Kasel Migdem - Omar Mukhtar	20				20 P
Sidi Buzrah - Martuba	85			85 P	
Omar Mukhtar - Ghariga	15	3 P			12 P
Tert - Abbunegia	7				7 P
Solluch - Taileimun - El Magrun	27			12 P	15 P
Ter - Estua	7				7 P

LOCATION	TOTAL LENGTH (Kms.)	TYPE OF ROAD			
		BITUMINOUS SURFACED	MACADAM	IMPROVED	UNIMPROVED
PROVINCIAL ROADS IN CYRENAICA (Cont.)					
El Beida - Shahat	14				14 P
El Abiar - Marj	40				40 P
El Abiar - Bushara	7				7 P
El Hamida - Milatania	10				10 P
Sidi Gibril - Mutaimis	12				12 P
Abu Meriam - Kuf Bugrain	15				15 P
Total length in Cyrenaica	1,563.5	370.5		222	891

ROAD CONDITION SURVEY OF Coast Road (Tripoli - east) SHEET 3 of 27

SECTION: from Km. 61 east to Km. 87 Province Tripolitania

DATE: 23/2/59 BY: Litchford - Niese

E - Excellent
G - Good
F - Fair
P - Poor

Speedometer Readings		Km. to Km.		Pavement Width	Pavement Condition	Shoulders Width	Shoulders Condition	Drainage	Remarks
328.7	336.9	61	69	5	E	2	G Shape	P to F	(SC '58) Rides Rough
	329.3	61.6		Curve Rt. -	Widen 1.5 m.				
336.9	337.6	69	70	5	½ E - ½ P	2	G Shape	P	(½ SC '58) SC other ½
337.6	338.1	70	70.4	Deviation around blown out bridge					
338.1	350.0	70.4	82	5	F to G	1-2	P	P	Resurf.
	339.2	71.5		Curve Rt. -	Widen 1.5 m.				
	339.7	72		Bad Hump -	Lower Grade ± 200 m. (Dangerously low sight distance)				
350.0	355.2	82	87	5	P	2±	P	P	Resurf.
	353.1	84.9						Pipe Req'd. -	Raise Grade ± 200 m.

J.O.L. 16/2/59

UPHAM - LARC.

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Sample of Field Log Prepared by Upham Engineers

STRUCTURE SURVEY COAST ROAD FROM 0 TO 176 Km W. OF TRIPOLI PAGE 1 OF 1

Date 21 Feb 59 By W. Niese Jr. & J.O. Litchford Base Odometer Reading (this page) 67329.4 Km 0

No.	LOCATION Odometer Reading	Adjusted Km	Photo File No	TYPE (see Legend)	Capacity (in tons)	Over head Clearance	Number & Length Of Span (meters)	WIDTH Roadway	WIDTH Surface	Height Above Wadi Bed	COVER	Slab or Arch Ring Thickness	Arch Rise	Size & Spacing Steel Beams or Reinforcing	Remarks
1	67329.5	0.1	SF3-100	Conc Pipe	70	∞	NA	12.0	9.0	NA	0.3m	NA	—	NA	50cm Dia Pipe
2	67329.7	0.3	SF3-27	K	70	∞	7@3.0	9.0	9.0	2.27	None	0.38m	—	See Plans	
3	67330.0	0.6	SF3-87	K	70	∞	1@1.0	12.0	9.0	1.0	2.0m	Un-known	—	Un Known	See Detailed Report Sheet
4	67330.1	0.7	SF3-80	CMP	70	∞	NA	12.0	9.0	NA	0.7m	NA	—	NA	CMP = Corrugated Metal Pipe - 75cm Dia

TYPE LEGEND k-concrete slab, stk-concrete filled steel beam, sa-stone arch ka-concrete arch, st-steel beam kt-concrete truss, sg-steel girder

Note-All measurements are in meters. Capacity is in Metric Tons (1000 Kg)

Sample of Field Log Prepared by Upham Engineers

F. CONDITION OF THE COASTAL HIGHWAY

1. Design. Although this road was constructed over twenty years ago its design is generally good and it is serving present day traffic well enough for the present. Throughout its entire length it has an asphaltic wearing surface of the penetration macadam type. The texture of this surfacing is generally rough due to the large sized aggregate used. The surface is also generally irregular and rough riding owing to the hand methods of construction. With age the asphalt has become brittle and is breaking up in many areas, which are now in need of intensive maintenance and preservative treatment.

2. Surfacing. The width of the surfacing is mostly five (5) meters with a shoulder on each side about one meter in width. This width is sufficient for traffic to pass in opposite directions although they experience some difficulty in passing in the same direction, especially the big, fast moving trucks. It is not necessary to widen the surface until traffic increases, but it is highly desirable to construct new surfaces to a width of at least six (6) meters, and preferably six and a half (6-1/2) or seven (7) with adequate shoulders. However, at present the shoulders are sorely inadequate.

3. Shoulders. The effective width of the 5-meter pavement can be greatly accentuated by simply widening the shoulders (berms) to 2-meters. This can be done easily and cheaply with the motor patrol grader by merely expanding the maintenance work on the shoulders, which should be done by the motor patrol grader at any rate. The present system of maintaining the shoulders by hand labor produces only short stretches of really satisfactory shoulders. For the most part the shoulders are narrow and do not butt firmly or snugly against the pavement. This condition exposes the edge of the pavement to traffic and hastens the destruction of the pavement. Moreover the hole between the pavement and the shoulder creatates an annoying, if not dangerous, traffic hazard.

4. Base. Base courses have been constructed as a sort of Telford Macadam, locally called "soling", which consists of large flat stone or irregular size and shape generally laid flat. These are broken stone about 20 to 25 cm. in size placed on the subgrade, then covered with a layer of coarse-size crushed stone, and then another surface layer of smaller-sized crushed stone placed on top of that. The total thickness of these base surfacing layers are about 25 to 30 cm. and it is evident that this thickness was used without regard to type of subgrade.

5. Subgrade. The terrain from the Tunisian border to Benghazi is strewn with limestone outcrops covered with a thin layer of silt or silty clay on the surface. The material is therefore often granular with a cementing admixture and these conditions especially with the light rainfall, provide a most excellent subgrade on which to build a road. There are but a few areas of poor roadbed which may be attributed to weakness of subgrade, notably on the Gebel in the Beida-Gurba area.

6. Alignment. With a few exceptions the alignment is good. The most objectionable exceptions are the sudden sharp curves occurring on otherwise long, straight stretches of road. This is the case for example between Tripoli and the Tunisian border where several very sharp turns occur at railroad crossings. Also between Misurata and Buerat at least 13 sharp curves occur in flat open country for no

apparent reason other than they are the intersection of two separate surveys. Again between Derna and Ummer Zeim the alignment is unduly sinuous for no other apparent reason than the highway location was made by an inexperienced highway locator. These sharp curves are not merely annoying but are actually serious traffic hazards.

7. Bridges. There are few bridges in Libya and none at all on the Tripoli-Tunisian border section except at the Wadi el Megenin near the city limits of Tripoli. On the section between Tripoli and Marble Arch there are seven (7) large bridges destroyed during the war which are being replaced.

On the Tobruk-Egyptian border section at Km. 590 there is another large bridge completely destroyed during the war and not likely to be rebuilt for a long time.

Between Barce and Beida, on the north road, two Bailey trusses are being used for bridges; one over the Wadi el Kuf (Km. 184) and the other across the face of a cliff over a break in the road near Km. 186 (no stream crossing). They are serving traffic satisfactorily, but are really temporary and will need to be replaced. A section of fill previously washed out at a small bridge at Km. 595 has been replaced and an additional culvert built. Flood waters have frequently damaged the road at Km. 567. Previously the three existing box culverts here were inadequate to carry the flood and four more were built during 1958. By October 1958 these seven proved still insufficient for normal flood and portions of the new fill washed away again. Six additional box culverts are being built which will increase the waterway from 150 square feet to 550 square feet.

Throughout the whole length of highway there are some 1100 small bridges and culverts and also many wadis without structures where the flood water flows over the road, across what is known as a "dip" in the western United States.

Lack of water is the principle problem of Libya but there is enough of it to be a problem for the highway. Occasional floods have to be taken across the highways, usually on dips. (km. 91)

Because floods are infrequent they can be taken across the road without disrupting traffic seriously. (Wadi Caam, km. 144.)

Downstream from the "Dip" crossing of the Wadi Caam (km. 144) the flood waters are eating away the soft limestone streambed.

Temporary "Dip" crossing of Wadi at km. 71

G. TRAFFIC

Except for short sections close to the cities the traffic could be considered as "light". That is to say the daily volume of traffic is less than 300 passenger cars and light trucks, and not more than 20 commercial trucks and busses. A pattern of traffic movement in Cyrenaica is illustrated by the following tabulation:

1.	Tica Village; 21 km. west of Benghazi December 8/9, 1956, 5 p.m. to 5 p.m.	(24 hr. total) (East to West)	78 vehicles
2.	Zuetina Jct.; 139 km. west of Benghazi December 6/7, 1956, 11 p.m. to 11 p.m.	(24 hr. total) (West to East)	92 vehicles
3.	ESSO Station; 260 km. west of Benghazi December 4/5, 1956, 5 p.m. to 5 p.m.	(24 hr. total) (East to West)	36 vehicles
4.	Agheila; 280 km. west of Benghazi December 1/2, 1956, 5 p.m. to 5 p.m.	(24 hr. total) ( )	23 vehicles
5.	Cantoniera; 323 km. west of Benghazi November 29/30, 1956, 5 p.m. to 5 p.m.	(24 hr. total) (West to East)	55 vehicles
6.	Ain Mara Jct.; 266 km. east of Benghazi November 1/2, 1956, 10 a.m. to 10 a.m.	(24 hr. total) (East to West)	39 vehicles
7.	Saf Saf Village; 223 km east of Benghazi November 4/5, 1956, 1 p.m. to 1 p.m.	(24 hr. total) (West to East)	83 vehicles
8.	Messa Village; 189 km. east of Benghazi November 10/11, 1956, 9 p.m. to 9 p.m.	(24 hr. total) (West to East)	65 vehicles
9.	Farzuga Village; 80 km. east of Benghazi November 12/13, 1956, 10 a.m. to 10 a.m.	(24 hr. total) (West to East)	108 vehicles
10.	Coefia; 12 km. east of Benghazi November 15/16, 1956, 10 a.m. to 10 a.m.	(24 hr. total) (West to East)	83 vehicles
11.	Cantoniera; 467 km. east of Benghazi October 27/28, 1956, 7 a.m. to 7 a.m.	(24 hr. total) (East to West)	165 vehicles
12.	Martuba Jct.; 325 km. east of Benghazi October 26/27, 1956, 10 a.m. to 10 a.m.	(24 hr. total) (West to East)	86 vehicles
13.	Timimi Village; 368 km. east of Benghazi October 29/30, 1956, 12 noon to 12 noon	(24 hr. total) (West to East)	151 vehicles
14.	Gambut Village; 525 km. east of Benghazi October 25/26, 1956, 10 a.m. to 10 a.m.	(24 hr. total) (East to West)	17 vehicles
15.	Capuzzo; 602 km. east of Benghazi October 23/24, 1956, 1 p.m. to 1 p.m.	(24 hr. total) (East to West)	

H. PRESENT MAINTENANCE PRACTICE

A large proportion of the maintenance money goes to pay wages to some 800 to 900 laborers. One laborer, or patrolman, is supposed to maintain some five kilometers of road. What he can do by hand with his crude shovel is obviously limited to a little shoulder repair. Even so it is unusual to see a patrolman working on a few meters of newly repaired shoulder, but quite usual to see hundreds of kilometers of road with no sign of a patrolman or his work. It is doubtful that a fourth of the patrolmen actually work on the road.

So the Federal Road Department suffers from a glut of manpower with indications that its labor force is operated as an unemployment relief project. There is still a shortage of proper equipment and at the same time a failure to make full use of what equipment is available. Thousands of man hours are being spent dressing up shoulders by hand when the work could be done more economically, quickly and correctly with a motor grader. It is true that some shoulder work is being done with a motor grader but the percentage is relatively low.

For a short time one division engineer made use of a motor patrol grader at Agedabia not merely to maintain and shape the shoulders but also to bring in additional material to widen them. The extra meter of shoulder width he gained on each side of the 5-meter pavement increased effective width of roadbed tremendously.

Unfortunately the work was not continued, or attempted anywhere else. In fact most divisions do not have a grader at all, nor is there any demand for them. This is mostly due to inexperience and lack of familiarity with the machine and its uses.

Patching and some re-surfacing is done by day labor forces using the simplest of hand methods. This generally consists of spreading hot asphalt (S-125) by hand over coarse aggregate, also placed by hand in the patch. Such patches are most difficult to smooth out with adequate machinery and impossible by hand. Consequently the riding surface becomes rougher with each subsequent patching operation.

Bitumens are heated in pails over small wood fires when making premixes for patching pot holes in pavements. The mixing is done by hand while mechanical mixers stand idle. Some of the patching is fairly satisfactory in character while some is definitely poor. Just west of El Aghelia a large number of patches were made in a section where there was much pot holing and edge ravelling. The mix was apparently good, the patches fairly smooth, but almost without exception, much too high with the result that bad riding bumps in the road were produced.

In Libya the favored method of constructing surfaces is to start with large rock, usually hand placed, and cover this with layers of successively smaller sized rock, finishing with a fine sized cover aggregate. The practice is continued over into the maintenance. Headers, or curb stones, are still used although they do little more than outline the edge of the pavement, and are a serious handicap to shaping shoulders with a motor grader.

On the Fezzan Road it was found that the standard method of dealing with soft spots in the road was to excavate the sand, fill the hole with large stones, frequently transported for long distances, and lightly surface the stones with some granular

material. Under traffic this light surfacing was soon displaced and the large stone left exposed causing a very hard riding surface and one extremely damaging to tires and the vehicle as a whole. The presence of these large stones also made it impossible to use a motor grader for maintenance work.

After repeated advice by Upham Associates at least a part of the labor force on the Fezzan Road ceased using big stones in soft spots in the road and found they were able to produce better riding and more durable surfaces with fine granular materials.

Very little attention is given to providing longitudinal and transverse drainage. In numerous places the rain water is carried long distances at the edge of the pavement because of improper shoulder contour. There are also long sections where at some time ditches were constructed outside the road to intercept sheet flows and carry the water to cross drainage structures. These intercepting ditches are not being properly maintained with the result that the flood water damages shoulders and pavements. In numerous places intercepting ditches could be constructed and cross drains installed to carry the water under the highway to a point of disposal where it would not cause damage. The utilization of manpower in such activities would be more productive of results of lasting value, than shaping shoulders by hand.

There is another situation which occurs only during the rainy season and which in many cases seems to be taken as a necessary evil to be dealt with when it occurs. This has to do with an accumulation of mud on the highway carried there by the failure to make proper provision for adequate drainage facilities with the result that the highway becomes in effect a canal. When the mud collects it is disposed of by merely throwing it up into a bank along the highway. Preventive measures might involve a change in grade, construction of adequate facilities, or a combination of both.

One of the problems encountered at intervals along the Coastal Highway is the handling of drifting sand. At five locations positive measures have been taken to control this situation by the construction of dikes to cause the deposition of the sand outside the limits of the highway. For the most part, however, the sand is merely thrown off of the highway by hand into a windrow where it is shortly blown back into the highway and then acts as a barrier which causes additional build up. Eventually the highway becomes in effect a deep cut in which sand collects in steadily increasing quantities. In many cases positive drift control facilities should be constructed while in others the problem would be much alleviated if the sand were hauled away to a point of disposal where it would not aggravate the problem as is now the case.

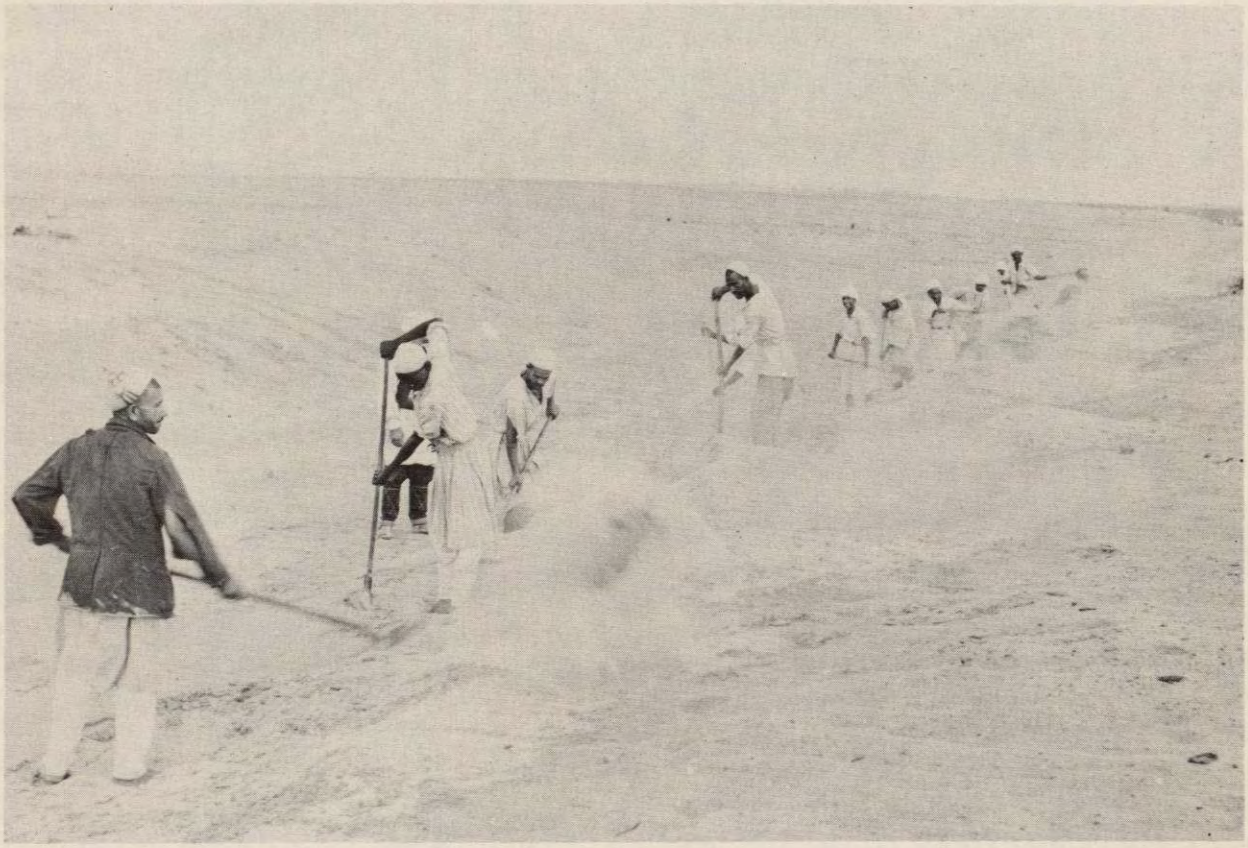
Much the same problem exists on the Fezzan Road and on various Provincial Roads. There are, however, two much more serious problems on the Fezzan Road and on some of the other desert roads. The first of these is the problem of shifting dunes which may be found on one side of the highway today and in a matter of days be either in or on the other side of the highway. The other, and more serious problem, is that of heavy shifting dunes such as are encountered in the vicinity of Kneiorn on the Fezzan Road. These dunes are shifting for the most part in one direction and are so high and extensive as to make necessary repeated relocations of the highway. Some study has been made of possible relocations of the highway to avoid both of the above conditions but so far without successful results. Unquestionably these conditions are of sufficient importance to warrant thorough investigation

and the adoption of measures to avoid or control this problem. An aerial reconnaisance survey might well be found to be the most practical basic step in any investigation.

There is every evidence of the lack of a competent and well-planned organization, of proper districting, cost accounting, and funding of maintenance operations.

If the highways were divided into relatively short sections, a reasonably simple classification of operations adopted, and costs kept in accordance therewith, it would readily be apparent where the costs were out of line on certain sections and steps could be taken to correct the cause and bring the costs into line. Such cost keeping would also be extremely valuable in determining the relative efficiency of supervisory personnel.

By far the most valuable use for cost accounting and its use is determining fiscal requirements. Without costs to support highway budgetary requests the highway official lacks his most valuable argument for favorable action on his estimated requirements.



Removing drifted sand from the road by hand methods.

PART II
ACTIVITIES OF THE UPHAM ENGINEERS

A. FIELD SURVEYS

The highways of Libya are administrated under four separate agencies. In discussing the surveying, and later the planning, of highways it should be kept in mind that most criticism and recommendations will apply in general to all of the highway agencies, but that others may apply specifically to only one or maybe two of the agencies.

At the time that the Upham engineers arrived in Libya in 1957 there was found to be no uniformity of surveying practices between the various highway agencies and in some instances there was a lack of uniformity within an agency itself. In addition to the lack of uniformity there were a number of surveying practices in use that were, to say the least, not good.

A few of these practices were as follows:

1. In leveling work no Bench Marks were established and no checks were made to determine the precision or accuracy of the leveling work. The common practice was to assume a ground elevation at the beginning of the project profile and to run a continuous line of differential levels to the end of the project. Great care was exercised in balancing back-sights and fore-sights, but no Bench Marks were established and all turning points were points on the ground line profile. Even more serious, no check such as "closing the circuit" was used to determine the precision of the survey. Errors in the work were discovered only after the contractor had begun work, necessitating re-surveys and causing delay of the construction.

2. On surveys where the proposed work was to be performed on an existing road no surveys were made or at the best only a profile was run. It was a common practice not to establish the alignment or to take cross-sections.

3. The use of "Pickets" was the common practice in measuring center line distances. While not an inaccurate method it is a cumbersome method of measuring, recording and referencing. The practice was to establish points along the line "Pickets", and measure between them. There was no relationship between the distance from one picket to another with the result that all measure distances were variable distances. Each picket was numbered in order and cross-sections, when taken, were referred to the picket numbers. This was awkward, for when looking at a cross-section at Picket No. 106, for example, the profile had to be referred to in order to find out where Picket No. 106 was on the project. As a grade line was to be plotted and earthwork computations made, the odd distances, usually measured to the closest centimeter, unnecessarily complicated the mathematics involved.

4. On the surveys where it was essential to run-in the alignment, the methods used were slow, awkward and often inaccurate. The running-in of curves is an example. The common practice was to determine the interior angle of the proposed curve to the nearest full degree by the use of a level equipped with a horizontal circle. The field party might turn one or a number of angles in a day's work but they

always returned to the office to compute the curve data. Another trip to the field was necessary to stake out the curve or curves. The curves were staked out by an offset method, most commonly used was the method of "middle ordinates". No chainage equations were computed to allow for the difference in length as measured around the curve as against being measured along the tangents.

5. On surveys requiring the staking out of the center line, insufficient or no information was recorded of the physical features adjacent to the center line. The lack of adequate detailed information made it difficult to design a proper roadway and virtually impossible to properly design intersections. During the period of the consultants' stay in Libya every effort was made to introduce a uniform system of surveying based on the methods generally in use throughout the United States. Upham engineers worked closely with the engineers and geometers of the Federal Roads and Provincial Roads at all levels, both in the field and in the office. Every effort was made to not only train these people in the proper methods of highway surveying but to also prove to them the many advantages of these methods.

The consultants distributed to the personnel making surveys, field notebooks, for both level and transit notes, and explained the methods for best keeping notes in them. This not only simplified note keeping but was done in an effort to show that field notes should be kept in such a manner that they can be plotted by someone other than the notekeeper. Also, brief written instructions on surveying requirements were prepared and distributed.

The surveying role of the Upham engineers was varied. On some projects the consultants actually made the surveys with the local surveyors acting in an assisting capacity. Projects of this kind were the Zuara-Gemil and the Zuara-Regdalin surveys. On other projects the consultants went to the field in an advisory capacity only and helped the local engineers with the survey. Examples of this are the Scek Sciuk-Giosc Project, the Sidi Mesri Project and bridge projects.

Still another type of assitance consisted of making field surveys with the local surveyors and after a survey was complete offering constructive criticism. Examples are the Tocra-Tolmeta Project, the Hon-Socna Project and the Ben Gashir Road-Bir Langer Project.

The foregoing is three of many methods used by the consultants in an attempt to improve the surveying methods already in use. In addition, the Upham engineers made numerous reconnaissance surveys for reporting the condition of roads to determine requirements for resurfacing roads that were impassable but on which future improvement might be contemplated and on roads recently constructed with certain critical items omitted, such as adequate drainage, and for which additional LARC funds had been requested. Reports of the reconnaissance surveys were usually made in the form of written memoranda.

It should be pointed out that the caliber of the surveys being made at this time (Spring 1959) is far superior to that when the consultants first arrived in Libya in the Spring of 1957. This is due to two major factors: (1) The various highway agencies have obtained the services of better trained personnel and (2) The consultants have been able to introduce and to effect better methods and techniques.

The recommendations to obtain uniformity in the surveys, to eliminate certain omissions of the past and to bring the surveying results up to a higher standard and efficiency, follows:

1. The method of measuring along the center line by using "Stations" should be universally adopted and the old method of using numbered pickets discarded. The "Station" method of recording distances is simple and convenient. It is an easy method for locating and referencing points along the line, it conveniently ties all parts of the resulting plans together and simplifies grade line and earthwork computations.

2. In leveling, Bench Marks should be established at convenient intervals along the route. Bench Mark elevations should be established and checked by "closing the circuit" or by some other means before the profile is run. Bench Marks should be at convenient intervals along the center line and should be located at a convenient distance outside of the proposed limits of construction. They should be of a permanent or semi-permanent nature.

3. Profile elevations along the center line should be taken at uniform distances, at the full station, and at all breaks in the ground. If the ground is fairly rough it may be desirable to take elevations at shorter intervals, such as every 50 meters, 20 meters or 10 meters.

4. Cross-sections should normally be taken at least every 100 meters (at the full station) and at every break in the ground between, which will have an effect on the earthwork quantities.

5. Line hubs should be placed at every P.I. and a maximum distance of 500 meters apart on long tangents. It is also convenient to place hubs at the P.C. and P.T. of every curve. Hubs should be driven flush with the ground, or slightly below, and tied or referenced in so that they can readily be replaced if disturbed. Reference points should be located outside the limits of the proposed construction.

6. The deflection angle method of running in horizontal curves should be adopted. This is the simplest method for laying out curves consistent with the use of Stations. Curve data is based on the definition of D (Degree of Curve) being subtended by an arc of 100 meters.

7. The transit field notes, besides showing all the data necessary for running in the center line, should show the location of all pertinent physical features for at least five meters outside of the limits of the proposed construction. This latter information should be kept in the form of a line map recorded on the right hand side of the transit notebook page. This information should be recorded at the same time as the center line is run in. The practice of running in the center line only and then going back into the field on another survey to record the physical features is an unnecessary waste of time and manpower.

8. Curve data should be computed in the field and the curve run in at the time the survey is made. The practice of turning the angle at the P.I., returning to the office to compute the curve data, and then going back into the field to run in the curve is a waste of time. An exception to the recommended procedure, of course,

is the preliminary survey to establish a traverse in which case no curves are to be run in.

9. The use of aerial photographs and aerial surveys should be considered for projects involving major relocations and for proposed projects of considerable length. They are fast, efficient and the most economical way of determining where the line should go.

Another detail omitted from the field surveys is sampling and testing local materials. The Upham engineers investigated sources of material and demonstrated new ideas for their use. For example on the Wadi Meginin the local material is sufficiently granular and non-plastic to serve excellently as a base for the road. By using this material it was possible to eliminate the use of "soling" and avoid hauling in hand picked rock from some distant quarry.

Another illustration of making use of available material was the demonstration project of placing seal coat between Km. 723 and 729 where a pile of waste fines discarded by the contractor during the earlier surfacing contract was used for cover aggregate.

But these material surveys are very elementary. Complete and thorough materials surveys were neither feasible nor warranted. In the first place neither equipment nor personnel were available to do the sampling and testing; in the second place the survey data would be little used during construction. For example, control of compaction of embankments requires construction engineering inspectors trained to make the tests and they were not available.

B. ROAD AND BRIDGE PLANS

Without field survey notes and data it is of course impossible to prepare a realistic set of plans. Failing in the first place to make surveys and obtain field data it follows that the highway departments did not prepare plans for construction. This is another phase of the highway work needing development and therefore the Upham engineers did much of the actual work of plotting the field notes and making up plans.

All highway work at the time consisted of the improvement of existing roads and the theory seems to have been that no plans were required to resurface, pave or widen an existing road. However, there were a few exceptions. On a few projects, cross sections had been taken and occasionally a profile was run. Neither the cross sections or profiles were used for design purposes nor were they used as an aid to compute quantities. The results of the lack of planning and plans were quite evident. A few of the most obvious undesirable results were:

1. The grade and alignment of the existing roads were never improved.

2. A number of the contract items could not be closely estimated or were completely overlooked.

In many cases token items were used in order to secure a bid price. In other cases items were overlooked and prices had to be negotiated with the contractor after work was started. The use of token items encouraged unbalanced bids and negotiated prices were usually higher than bid prices would have been. In almost all cases the result was an increase in the cost of the project causing large over-runs. An extreme example of this was the case of the South Road between Barce and Lamluda that over-ran some 230%.

3. The lack of adequate plans caused delays in the construction and was often the cause of long and bitter arguments between the contractor and the contracting agency. At times it became necessary to negotiate what was in effect a second contract to cover overlooked items of work. Negotiated prices and contract supplements seldom proved satisfactory to both parties.

4. Construction errors resulting in poor design were made. With no plans as a guide, these errors became evident only during construction or after completion of the work. Often the poor design was accepted but at times it was corrected at additional cost to the project.

Shortly after the arrival of the consultants, with approval of the Executive Director of LARC, Mr. E. C. Hannum, instructions were given to the Highway Agencies that no LARC funds would be transferred for highway construction until adequate plans had been submitted and approved by the Upham engineers for LARC. It was at this time that the inadequacies in the methods of preparing plans became evident. The method of preparing plans was generally as follows:

1. Profile. The profile was plotted on unlined tracing paper necessitating the drawing and inking of many horizontal and vertical lines. The main objection to the method used was the loss in both time and convenience that could have been corrected if prepared printed profile paper had been used.

2. Grade Line. On many projects grade lines were not shown. Quite often they were not essential; such as on a seal coat or resurfacing project where the existing grade was satisfactory. When grade lines were super-imposed on the profiles they were satisfactory except for one important item: never was a vertical curve shown connecting two tangents.

3. Plan. In no case was a plan, that is a planimetric strip map shown. This was evidently deemed unnecessary. There was on one project a plan of sorts consisting of details of intersections along the route. However, there was no plan showing the alignment from beginning to ending of the project.

4. Cross Sections. Cross sections, when included, were usable although they were plotted on plain, unlined tracing paper. They lacked the advantages and conveniences of cross sections plotted on prepared ruled paper.

5. Intersection Details. Base maps prepared for the design of intersections were generally good. It is true that they were plotted on odd sized sheets and often lacked much critical information. The lack of information was a fault of the survey and not of the drawing. The major criticism of the drawings was that they were of too large a scale for convenient overall design with the drafting tools available. A smaller scale drawing for overall design with sections plotted to a large scale for detail design would have been better.

6. Typical Cross Section of Improvement. This item was in most cases not included in the plans, specifications or contract. Supposedly, it was assumed that a description of the work to be performed as outlined in the contract proposal eliminated the need for a drawing showing a typical cross section of improvement.

There are a number of obvious disadvantages to the system of preparing plans as outlined above in addition to those enumerated. Some others are; the lack of uniform size sheets and prints; no co-ordination of referencing between plan, profile, cross sections and other design details; the plan is not plotted directly over the profile for easy referencing; and the entire set of plans is not assembled together as a complete unit.

The consultants attempted to correct the deficiencies in plans and planning by a number of means. The first to be initiated was to improve the quality and completeness of the surveys and survey notekeeping. The second step was to procure and furnish to the Highway Agencies standard size printed plan and profile, and cross section sheets. These sheets are similar to what is known in the United

States as "Federal Aid Sheets" except that they were printed to be used with the metric system. The third and most important step was to work directly with the personnel preparing the plans. The work with the personnel preparing plans was carried on with various degrees of intensity. Some examples follow:

1. Zuara-Gemil Project. This project consisted of 8.7 Km. of resurfacing of an existing road and approximately 1.5 Km. of new location from the existing road into the village of Gemil. No survey or plans were made for the resurfacing portion. The survey of the connection from the existing road into Gemil was made by the consultants. A complete set of plans on standard size printed sheets was prepared by the consultants for the 1.5 Km. of new location. The plans included alignment with complete curve data plotted above a profile showing the proposed grade line complete with percent grades and vertical curve data, and cross section sheets showing the existing ground with the proposed template superimposed thereon. In addition there was a complete, thorough, and accurate estimate of quantities, and a typical cross section of improvement.

2. Zuara-Regdalin Project. This project was surveyed soon after the Zuara-Gemil Project so an effort was made to shift more responsibility onto the local personnel. During the survey the Upham engineers made the alignment survey while a P.W.D. engineer ran the profile and cross sections. The plans were plotted accordingly. The profile was plotted on printed sheets furnished by the consultants to the P.W.D. engineer and submitted to the LARC offices. An Upham engineer then plotted the alignment, including all pertinent physical features and the profile, and a proposed grade line was drawn.

3. Tocra-Tolmeta Project. This project was located east of Benghazi in the Province of Cyrenaica. At the time the consultants were called in the Provincial Roads engineer had already run in a traverse line some 40 Km. in length and had taken level notes for a profile and for cross sections. A field inspection was made of the traverse line and several changes were suggested, approved and adopted by the Provincial Roads engineer. The Provincial Roads engineer was furnished with the standard printed plan and profile, and cross section sheets and was given instructions on how the plans should be prepared.

After several weeks of work by the Roads engineer and a number of trips to Benghazi by an Upham Engineer it was realized that closer supervision and more help with the preparation of plans was required if the plans were to be complete in a reasonable length of time. Consequently, permission was asked for and granted to bring the Provincial Roads engineer to Tripoli. In the Tripoli office, Upham engineers and LARC draftsmen worked full time with the Roads engineer in preparing a complete set of plans.

The money available for construction was limited so plans were prepared and an estimate of quantities computed for the length of project that could be constructed with the funds available. The completed plans were for approximately 9 Km.

It might be pertinent to add that the preparation of these plans definitely proved to the Roads engineer the many advantages of using standard printed sheets and of the method of "stationing".

4. Sidi Mesri Project. This project, approximately 5 Km. in length, consisted of constructing a 6 meter wide bituminous surfaced road parallel to the existing paved road. The result was a dual lane divided highway with a 3 meter wide median strip. The project began at the city limits of Tripoli at Bab Ben Gashir and followed the Coast Road through the little village of Miana where it ended. The plans consisted of a profile of the existing road, cross sections and individual planimetric maps of the intersections along the route.

This project was to be a demonstration project constructed by the personnel and equipment of the Federal Roads Department. There never was a complete set of plans prepared as the project was more or less stage constructed. The planning portion of this project soon evolved into the preparation of detail plans for the main intersections along the route. The procedure was generally as follows: The Federal Roads Department furnished the consultants with a base map, usually to a scale of 1:200; the map was taken to the field and checked for accuracy and completeness of detail; if not complete and accurate the map was returned with notations of the additional work required; if satisfactory, a detailed design for the proposed intersection was superimposed on the base map and returned to Federal Roads for approval and preparation of a final tracing.

In case of all but the most simple intersections, the final planimetric design was taken back into the field and sufficient elevations taken so that the final grade elevations could be computed. Final grade elevations were placed on the design sheets so that the engineer in charge of constructing the intersection could do all of his layout work from a print of the design.

There were some 17 intersections and cross-overs on the project. Two of these were designed in three dimensions, that is to line, distance and grade, and one was constructed according to the design of the consultants. This was at Bab Ben Gashir, Km. 0. The other was constructed as designed, except for the omission of two small channelizing islands. Six other intersections were designed as to horizontal details and were turned over to the Federal Roads Department. The base maps for the remaining intersections did not have sufficient details for design purposes and were returned to Federal Roads for additional information. At lease 3 of the major intersections on the project have been constructed or are under construction by the Federal Roads Department. These intersections were designed by and constructed under the supervision of the Federal Roads Department.

The following recommendations are made in the hope of encouraging thorough planning, the preparation of more adequate plans for all highway projects and of

establishing a uniform system of plans between all of the highway agencies. It is recommended that:

1. Uniform size sheets should be used for the preparation of all plans.

2. Plan and profile, and cross section sheets should be standard printed forms similar to those furnished by the consultants and known in the United States as "Federal Aid Sheets".

3. Plans should be prepared for all projects; for some projects such as seal coating or resurfacing abbreviated plans might suffice, but they should be prepared.

4. Uniform standards for design should be prepared, adopted by all highway agencies and included in all sets of plans. Such standards as the superelevation and widening of curves, horizontal and vertical sight distances, length of vertical curves required, etc. are a must if uniformity of design and construction is to be achieved in Libya.

5. The method of measuring known as "stationing" should be adopted and used exclusively.

6. During construction there should be adequate inspection to see that the plans are rigidly adhered to.

7. Every effort should be made to get the proper legislative authorities to adopt legal speed limits and maximum sizes of vehicles allowed to use the highways. These limits are extremely critical to the proper design of a modern highway

C. SPECIFICATIONS

There are no really complete Standard Specifications covering the legal aspects of contracts, the materials of construction, and methods of performing various items of construction. The preparation of such a volume is a large undertaking involving both legal and technical knowledge and ability to set forth the information with brevity, and clarity, and with due regard to sound and equitable procedures. In view of the language situation in Libya the specifications probably should be written in more than one language which would require unusual care to ensure that meanings are not lost in interpreting from one language to another. Such a standard specification should be prepared as soon as possible and officially adopted by all agencies.

It is quite natural that the existing form and wording of specifications used in Libya conformed to British practices, since British administrators have been responsible for writing them.

Specifications have been composed of two parts: one the General Conditions, the other Technical. The General Conditions refer to the administrative details of the contract and define such items as authority and responsibilities, financing, and related items all of which are of a nature common to all contracts, and were intended to be basic in all construction or supply contracts.

The Technical Specifications too were standardized as much as possible but nevertheless usually required modification to fit the particular project under consideration.

A favorite clause of the General Conditions was the requirement of a maintenance period by the contractor following completion of the work. Two principal arguments were presented in support of this clause: first that the contractor being held responsible for the quality of his work for a year or two after completion did a good job to avoid exposure of defects, and also to reduce his costs of maintenance; second, the government got a period of "free" maintenance. Obviously the contractor intended to be paid for any work he might have to do since he could not afford to work "free" any more than the government. It is merely a hidden charge added to the cost of the contract. The clause merely invites sloughing off responsibility and avoiding inspection during construction.

Another defect arising from this "maintenance" clause showed up in trying to determine when a project was complete, that is to say, when did construction end and maintenance begin. Most projects had some minor item of construction incomplete that the contractor promised to finish during his maintenance period.

At the same time the contractor devoted much effort to trying to collect final payment, and often obtained an "advance" on account. Payments on advance have been common practice in Libya, and take the place of monthly engineering estimates.

A dominating idea in both the General and Technical specifications was that responsibility for performance of contract fell upon the contractor. Engineering is thought to consist essentially of outlining the end result desired and inspecting at the end to see that the result is there. Engineering and inspection during construction has been inadequate if not entirely lacking. Consequently most changes in the specifications have been written with the thought in mind of what is obtainable rather than of what is desirable, as limited by construction engineering.

This affects several items, for example, placing embankment. The customary United States system is to pay for excavation, or borrow, used to make the embankment. In Libya, on the contrary, it is customary to pay for embankment. One reason for this is that field engineering to stake and measure excavation or borrow is inadequate.

Another item of considerable importance is compaction of fills. The specifications state merely that the embankment must be compacted to the satisfaction of the engineer. Nothing is said about test procedures or standards of compaction since there are no inspectors to control compaction procedures or measure the amount of compaction obtained. Application of water in placing fills is not mentioned either, although it is essential. This requires rather careful control of the quantity of water based on test analysis of the soils involved but again no facilities are available to provide the test data or apply the control. This is highly regrettable because the riding quality of the final surface depends on good compaction.

Similarly placing concrete is still crudely done. Batching is still based on volume measurements, if there is any control at all. A specification limiting the amount of water to about 6.0 gallons per cubic yard has been introduced, by specifying a maximum slump of 15 cms. Maximum size of aggregate is specified but no attempt has been made to introduce detail grading specifications. Thus the subject of design of concrete mixes has not been introduced.

Local building practice makes use of plain bars in all reinforced concrete work and attempts to introduce the use of deformed bars in structures for highways met with little success because of the comparatively small quantity of steel reinforcement required.

Neither has any serious attempt been made to control quality of materials. This refers to a quality such as hardness or durability of the aggregate. It applies to aggregates for both concrete and surfacing. Neither was it feasible to make

grading analysis which is highly useful for design of mixes, both concrete and surfacing.

Modern bituminous surfacing courses are usually carefully designed to produce the most suitable surfacing economically with materials locally available. This refinement has no more than been suggested, nevertheless, the most radical change in specifications was introduced in this category since the resurfacing program is by far the most important job to be done. Because very substantial savings in resurfacing costs can be realized by adopting a simpler method than the heavy bitumen grouting (penetration) the new process introduced successfully during 1958-1959 is described here in some detail.

This resurfacing process consists simply of spreading an application of cut-back asphalt on the existing bituminous pavement to soften the hardened bitumen and to provide a sticky surface on which to spread a thin layer of aggregate. In this case the asphalt consisted of cut-back asphalt, grade RC-2, heated to 175° F. and spread with a pressure distributor at the rate of 0.21 gallons per square meter.

Immediately following this initial application of asphalt, dump trucks with a simple spreader box at the tail gate spread a crushed aggregate on the free bitumen at the rate of about 100 M^3 per kilometer. This amount provides a layer of aggregate averaging 2 centimeters in thickness, but as the existing surface is irregular the thickness of the course varies. For that reason the maximum size of aggregate must be something less than 2 centimeters and therefore 1 centimeter was specified.

In order to improve distribution of the aggregate the surface was brushed with a broom drag and to further smooth the surface and consolidate the aggregate it was then rolled with a flat wheel roller. This process corrects a lot of the surface irregularities by varying the thickness of the course of aggregate. But the amount of variation possible is limited and cannot be less than the maximum size of aggregate. Neither should it be excessive because the application of asphalt to follow cannot be varied to correspond to the variations in thickness.

The second application of asphalt immediately follows after spreading and rolling of the aggregate. The same grade of cut-back asphalt, RC-2, is spread at the rate of about 0.35 gallon per square meter. This application of cut-back asphalt penetrates the voids in the aggregate and holds it together. It can be left to dry and cure without further attention, however in order to permit the traffic to use the road immediately the fresh bitumen is covered with enough clean sand to cover the surface and prevent the tires from picking up the bitumen.

A serious effort was made to introduce the use of cut-back asphalts. Several advantages attend the use of cut-back, all amounting to economy. The full extent of this economy will not be fully realized until the dealers provide bulk storage and

transporters come into the business of hauling the asphalt in bulk. Without stability or assurance of continuing business no one is likely to invest in the equipment needed to handle the asphalt in bulk.

D. BIDS AND CONTRACTS

The Libyan Government intends bidding to be competitive and has set up definite procedures to assure this. Bidding is done by submitting sealed proposals to a Tenders Board set up for the purpose of receiving and analyzing the bids. The Board is made up of interested heads of the Ministries, including Finance. It does not award contracts, but recommends and sanctions award by the action agency.

One point of considerable interest in the procedure is the matter of opening and reading the bids in public at a fixed time and place. This is an innovation reluctantly accepted, because it has not been free of some complications. However, this comes about mostly through the form, or manner, in which proposals are submitted. The problem really arises from the specifications and instructions to bidders which are frequently vague and incomplete, making it necessary for the bidder to qualify his bid in some way or other. Comparison of bids becomes difficult when alternate considerations are involved.

Frequently the bidder makes an error, especially in working in the English language, which confuses the matter but sometimes the error is deliberate in order to unbalance the bid. Allowing these matters to become public information embarrasses the board and makes their decision more difficult, which might not be the case when discussions of the bidders qualifications are held in closed conference.

To circumvent these difficulties as much as possible the idea of bidding unit prices has been emphasized by the Upham engineers. Estimates have been made as realistic as possible and the items of work to be done more clearly defined. A bidding form has been introduced by the consultants which allows the bidder to indicate his unit price (in words and figures) for each of the specific items of work. Should an alternate bid be desired it is specifically called for, but the intent is to eliminate alternates and especially counter proposals of the bidder's own volition.

Another problem arises in analyzing bids when the qualifications of the bidders must be considered. Presently anyone is permitted to submit a bid and frequently the low bid is submitted by a bidder totally unfamiliar with the work to be done. To avoid this condition and encourage bona fide bidding the action agencies have been urged to give plans and specifications only to prospective bidders known to be qualified to do the job.

Contract work has been encouraged as much as possible to create and nourish much needed private industry within Libya.

A list of the contracts awarded for highway work in which LARC funds were involved follows:

ABSTRACT OF CONTRACTS FOR HIGHWAY CONSTRUCTION
FINANCED FROM LARC FUNDS
1955 - thru - 1958

CONTRACT NO.	LOCATION	TYPE OF IMPROVEMENT	LENGTH	CONTRACT AMOUNT
LARC File E 2 L	Fezzan Road			
	Equipment Purchases	four graders		LL 26,773.484
7.	Equipment Purchases (Purchased under E3L) (Contract Number 7)	three trucks		6,780.000
1.	Town of Hon			5,560.000
2.	Bu-Njem			7,980.000
	TOTAL FOR E 2 L			LL 47,093.424
LARC File E 3 L	Federal Coast Road			
1.	West from Tripoli; km. 78 to km. 169	Furnish crushed stone		LL 4,650.000
2.	East of Tripoli; km. 555	Cantoneria repairs		1,756.000
3.	West from Tripoli; km. 78 to km. 169	Supply 600 tons s-125		10,911.000
4.	East from Tripoli; km. 620	Cantoneria repairs		1,398.000
5.	Rejected bid; Federal Roads Department did direct labor			
6.	East of Benghazi; km. 176	Repair culvers; see E 7 L		
7.	Equipment Purchases			14,480.000
8.	West of Tripoli; km. 0 to km. 5.15	Widening	5.15	16,575.310
9.	West of Tripoli; km. 96	Cantoneria repairs		1,599.000
10.	Matratin - El Aghelia; km. 620 to km. 722	Resurfacing	94	210,668.000
11.	East of Tripoli; km. 655	Cantoneria repairs		980.000
12.	East of Derna; km. 18	Repair wall		731.600
13.	East of Tripoli; km. 504	Cantoneria repairs		1,300.000

CONTRACT NO.	LOCATION	TYPE OF IMPROVEMENT	LENGTH	CONTRACT AMOUNT
14.	Vicinity of Agedabia; km. 178	Cantoneria repairs		LL 1,190.000
15.	West of Derna; km. 283 to km. 284	Repair wall		3,928.700
16.	Traffic Signs (1037 each)	Furnish only		3,520.000
17.	Tobruk - Capuzzo; km. 495 to km. 558	Resurfaced	77	108,146.600
18.	East of Tripoli; km. 306	Cantoneria repairs		589.085
19.	East and West of Tripoli; km. 0 to km. 5 km. 0 to km. 1	Furnish bitumen		6,292.000
20.	East and West of Tripoli; km. 0 to km. 5 km. 0 to km. 1	Resurfaced	6	13,710.000
21.	Barce Area; km. 89 to km. 98	Resurfaced	9	10,000.000
21a	South Road, Barce to Lamluda km. 100 to km. 240	Resurfaced	140	414,902.000
22.	East of Tripoli; km. 408 to km. 436	Resurfaced	17	28,000.000
23.	Buerat - Sirts; km. 436 to km. 464	Resurfaced	28	15,000.000
24.	Wadi Megenin	Box Culvert) See File E 7 L		
25.		Approach Road)		
26.	Tripoli - Homs	Furnish Crushed Aggregate		4,800.000
27.	Gambut - Capuzzo; km. 567	Five Culverts) See File E 7 L		
28.	South Road, Wadi Gheigab (included in No. 21a)	See File E 7 L		
29.	Tripoli	2500 M^3 Crushed Aggregate		2,975.000
30.	East of Tobruk; km. 557 to km. 588	Resurfaced 31; Resealed 66		48,540.000
31.	Misurate - Beurat; km. 291 to km. 320	Resurfaced	25.7	23,130.000
32.	Sirte - Marble Arch; km. 520 to km. 609	Resurfaced 22; Resealed 89		51,816.000
33.	Sidi - Mesri; contract to furnish coalina			4,127.123
34.	Sidi - Mesri; Force Account by Federal Highway		5	15,000.000

CONTRACT NO.	LOCATION	TYPE OF IMPROVEMENT	LENGTH	CONTRACT AMOUNT
35. Esso contract of May 15, 1958	to furnish	500 tons RC-2 Tripolitania 350 tons RC-2 Cyrenaica		LL 11,788.380 7,902.000

LARC FILE E 3 L - Federal Coast Road (cont.)

Equipment Purchases

Transportation	LL 23,033.913
Shop Equipment	1,400.000
Paving Equipment	8,930.000
Paving Equipment	15,939.000
	49,302.913

TOTAL FOR E 3 L . . . . . LL 1,089,708.711

LARC FILE E 4 T - Coastal By Pass Road

No Expenditures

LARC FILE E 7 L - Federal Coast Road Bridges

24.	Wadi Megenin, West of Tripoli	Box Culvert	LL 7,355.874
25.	Wadi Megenin, West of Tripoli	Approaches	4,146.000
27.	Gambut - Capuzzo; km. 567	Five Culverts	7,201.027
	Km. 176	Repair Box Culvert	700.000
	Wadi Gheigab	Box Culvert	2,400.000
	Wadi Kuf	Repair Culvert	2,007.036
	Km. 620; east of Tripoli	Box Culvert	8,612.917
	Km. 262; east of Tripoli	Box Culverts	12,086.629
		Miscellaneous	3,142.133
	TOTAL FOR E 7 L		LL 47,651.616

LARC File E 11 L - Equipment Purchases

File E 11 L -	P.W.D. Workshop Equipment		
	Two Motor Patrol Graders	LL 23,900.000	
	Direct LARC charges	131.000	
			LL 24,031.000

CONTRACT NO.	LOCATION	TYPE OF IMPROVEMENT	LENGTH		CONTRACT AMOUNT
LARC File E 11 L - Equipment Purchases (cont.)					
File E 11 C - Provision of Workshop Tools, Transport Division, Cyrenaica					
	Financial Statement, June 30, 1958	Tools		LL	2,388.379
File E 11 F - P.W.D. Workshop Equipment, Fezzan					
	Financial Statement, December 31, 1958				4,369.000
	E 11 F a Garage Shop Equipment Report of February 13, 1958	Shop Tools			2,982.000
	E 11 F b Road Graders and other equipment				26,548.355
	TOTAL EQUIPMENT E 11 L			LL	60,268.734
LARC File E 20 T - Provincial Roads, Tripolitania					
1.	Sceksciuk - Giosc	Portions Surfaced	27	LL	41,218.346
2.	Tauroga - Federal Coast Road	New Construction Bit. Surfaced	8		12,367.232
3.	Hamida - Homs Road	Surfaced			7,286.504
4.	Tarhuna - Ben Ulid	Surfaced	11.5		22,790.732
5.	Sidi Abu - Vjeila	Not Built	1.5		
6.	Swani - Ben Adem A Biabsa	Resurfaced	4.5		7,649.840
7.	Alalea Road (Tweilifel - Gaitoun)	Not Built	2.5		
8.	Setman and Railway Station	Not Built	1.8		
9.	El Ghiran - Suani Ben Aden	Not Built			
10.	Zuara - Gamil	Surface New Construction	8.2 1.5		16,696.680
11.	Zuara - Regdalin (active	New Construction	9.0		19,750.000
	TOTAL FOR E 20 T			LL	127,759.334

CONTRACT No.	LOCATION	TYPE OF IMPROVEMENT	LENGTH	CONTRACT AMOUNT
LARC File E 20 C - Provincial Roads, Cyrenaica				
1.	Zawiat el Gusur - Gardes el Abid	Surfaced	36	LL 43,261.637
2.	Messa - el Hania	Surfaced	18	15,673.547
3.	Benina - El Abiar	Surfaced	40	39,488.503
4.	Ghemines - Solluch	Surfaced	24	21,055.250
5.	Tocra - Tolmeta; km. 0 to km. 9 (active)	Surfaced	9.2	36,877.800
6.	Sidi Farag - el Zweitina	Surfaced	9	16,905.500
	TOTAL FOR E 20 C			LL 173,262.237

SUMMARY

AMOUNT OF CONTRACTS

BY LARC FILE ACCOUNT

E 2L	Fezzan Road	LL	47,093.484
E 3L	Federal Coast Road		1,089,708.711
E 7L	Federal Coast Road Bridges		47,651.616
E11L	Equipment Purchases		60,268.734
E20T	Provincial Roads - Tripolitania		127,759.334
E20C	Provincial Roads - Cyrenaica		173,262.237
	TOTAL AMOUNT OF CONTRACTS	LL	1,541,744.116

E. CONSTRUCTION

1. Early Projects

It is difficult to determine what highway work was done in the period from 1952 to 1957 because accurate records were not kept. It is known that at least eight cantonieras were renovated and that some of the most urgent repair work on the Coastal Road pavement had been done. At the time the Upham engineers came into Libya the following contracts were already active on the Federal Coast Road:

Contract No. 8, West of Tripoli, km. 0 to 5.15, widening resurfacing

Contract No. 17, Tobruk-Capuzzo, km. 495 to km. 558, reseal, resurfacing

Contract No. 22, East of Tripoli, km. 408 to km. 439, resurfacing

Contract No. 21A, South Road, Barce to Lamluda, resurfacing

Contract No. 8 - Widening km. o.o to km. 5.15 West of Tripoli

One of these early projects, Contract No. 8, provide for widening the existing road and replacing an old pavement (west of Tripoli, from km. 0 to 5.15). The project included such excavation as was necessary to widen the pavement and construct shoulders. The pavement was widened from the existing 6 meters to a final width of 9 meters. Shoulders were made 2 meters wide.

Large rocks were placed by hand to form the base for the widened pavement. This type of foundation or base, locally known as "soling", makes use of rock of varying sizes and is difficult to place. Even after intensive rolling the surface remains uneven, rough and is likely to shift under traffic.

The "soling" was covered with a good grade of crushed rock and the final surfacing constructed by the penetration method, using 80-100 penetration asphalt.

The rock for constructing the base course on the widened part was hauled seven kilometers and for the surfacing from a quarry 50 kilometers away, because rock of the proper quality for surfacing was not found nearer.

The asphalt was heated in a semi-portable kettle, equipped with a small power driven pump and applied through a hand hose.

The only power equipment on the project was one 3-wheel 10-ton roller and trucks.

The contract time for the project was 3 months but actually required over a year to complete. The original contract was on a lump sum basis and did not

include an itemized bid or schedule of quantities. A supplemental contract did contain some itemization and unit prices.

The original contract in the amount of LL9,780 was supplemented by LL5,999.950 early in the life of the project. This was caused by a dispute concerning the specifications and the quantities of work required. The supplement contract intended to cover all work necessary to complete the job. It was, however, later found necessary to authorize more extra work involving an additional LL795.360. Payment upon completion of the work was therefore LL16,575.310. Upon completion of the work the contractor submitted two claims in a total amount of LL14,062.000 which have not yet been paid. The contractor has refused to sign a release of claims and for that reason his claims remain as a possible outstanding obligation. At the direction of the Permanent Undersecretary of Communications his Guarantee Check was returned to him.

Contract No. 17 - Resurfacing Tobruk and Gambut

Contract No. 17 was one of the early projects for resurfacing a badly worn section of the Coastal Highway between km. 471 and km. 558, east of Benghazi. This contract provided for resurfacing 53 km. and resealing 24 km. over the existing bituminous surfacing.

The bitumen was an 80-100 Penetration Asphalt. It was heated in semi-portable kettles, each equipped with small power-operated pumps, and sprayed on the road through a hand hose. The project also included an item of 36,000 cubic meters of embankment for construction of berms, or shoulders, and the repair of some nine culverts using concrete and rubble masonry in small quantities. This project was completed soon after the arrival of the Upham engineers in Libya.

Contract No. 22 - Resurfacing Sirte Area

Contract No. 22 provided for resurfacing portions of roadway totaling 20 km. from km. 408 to km. 457, Sirte Area. This contract originally contemplated resurfacing a total of 20 km. in short stretches between km. 408 and km. 457. It was later changed to the limits of 408 to km. 412 and from km. 423 to km. 439. The stretch from km. 412 to km. 423 had previously been resurfaced and was in satisfactory condition.

The specifications originally provided for scarifying the entire existing surface and for the construction of a new penetration macadam surface on the resulting base. This base, however, was very rough and uneven. The contract contemplated widening the berms (shoulders) to a width of 2 meters. The Upham engineers considered the method of scarifying and disposing of the scarified material wasteful and not productive of the best results. A dispute arose as to the manner in which the width of 2 meters was measured.

Negotiations were entered into between the Contractor and the Federal Roads Department for a revision of the specifications for resurfacing and a clarification of the berm question. As for a result a Supplemental Agreement was signed under date of June 23, 1957. This revision eliminated the scarifying and provided for a width of berm 2 meters on each side of the pavement. The final and adjusted cost was 28,000, an increase of 4,100.

The portion of the work from km. 408 to km. 412 and from km. 423 to approximately km. 427 was completed under the original plan. The remaining portion to km. 439 was done according to the revised specifications. As a result of cooperation between the contractor and the Upham engineers by using the revised specifications the results were superior to those obtained under the original specifications.

Throughout the project an 80-100 Penetration Asphalt was used, being heated in semi-portable kettles and applied under pressure by hand hose. The only power equipment were two 3-wheel rollers and a few trucks. All scarifying, excavating, and stone spreading was done by hand methods. Stone was produced adjacent to the site of the work, by small crushers fed by hand with material gathered from nearby sources. The stone was of somewhat variable quality but the best available.

Contract No. 21a - South Road

Another early construction project is Contract No. 21a, the South Road. This project also consisted of widening and resurfacing. Terms of the contract were rather indefinite and the specifications vague. There were no plans. Construction proceeded with little or no construction engineering or inspection. As a consequence the final cost overran the original contract amount fantastically (230%). The major overrun occurred in the quantity of embankment claimed to rebuild the shoulders. Only a token quantity of 1,000 cubic meters was included in the original estimate and as no original cross sections were taken it was not possible to measure the final actual quantities used. Payment for the embankment was made on the finally guessed quantity of 298,996 cubic meters.

This project contemplated resurfacing the entire 140 km. of the South Road from Barce to Lamluda together with constructing a short stretch of new alignment at Barce to by-pass the business section of the town. The specifications originally provided that only a very small amount of the existing surface was to be scarified. During construction, however, the Libyan authorities directed the contractor to scarify the entire existing surface. As a result the contractor demanded and was granted an increased unit price for the resurfacing. The Upham engineers made strenuous efforts to eliminate the scarification of the existing surface and at one time arrangements were made with the contractor's organization to construct a one kilometer demonstration stretch without scarification. These arrangements, however, were later cancelled by the contractor. The net result of the above developments was an increase from LL177,480 to LL414,902.400 in the total cost of the contract.

The materials used on this job were locally collected stone, crushed by small hand fed crushers, 80-100 Penetration Asphalt heated in semi-portable kettles and applied under pressure by hand hose. The principal power equipment consisted of rollers and trucks. Excavation and scarifying were done by hand methods.

This one project forcefully revealed that the weakest link in the chain of actions directed toward realizing a completed highway project in Libya is constructing engineering and inspection during construction. The function of construction engineering is not understood and the importance of close inspection is not fully appreciated even now by the engineers in charge of the work.

2. Projects Developed During Upham Contract

The following projects were developed and completed or placed under contract with cooperation of the Upham engineers.

Federal Roads:-

Coastal Highway

1. Wadi Megenin Bridge
2. Wadi Megenin Bridge approaches
3. Sidi Mesri Project
4. Bridge at km. 262
5. Bridge at km. 620
6. Bridges and embankment near Capuzzo
7. Resurfacing km. 291 to km. 313 and km. 315.3 to km. 319
8. Resurfacing km. 520 to km. 538 and km. 587 to km. 609. Seal Coat km. 538 to km. 587.
9. Resurfacing km. 557 to km. 588 and Seal Coat km. 530 to km. 540 and km. 557 - km. 613.
10. Resurfacing and Seal Coat work on a force account basis by Federal Road forces.

Fezzan Road

11. Hon-Socna Road

Provincial Roads:-

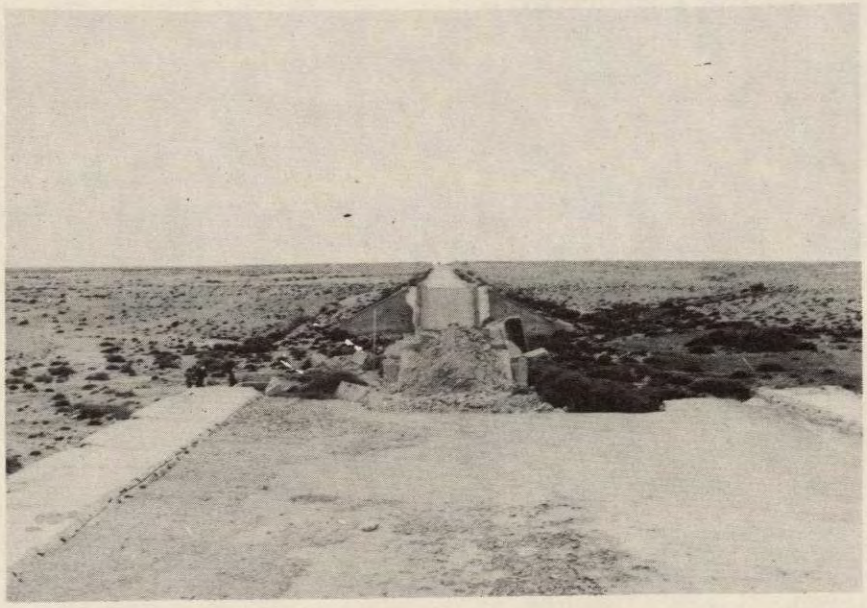
Province of Tripolitania

1. Zuara-Gamil Road
2. Zuara-Regdalin Road
3. Tripoli-Ben Ghashir Road
4. Suani Ben Aden-Bivio Gheran Road
5. Outer Loop Road from Bab Gen Ghashir toward Accra

Province of Cyrenaica

1. Tocra-Tolmeta Road - Sec. 1-A

Site of war-destroyed concrete bridge at km. 262.

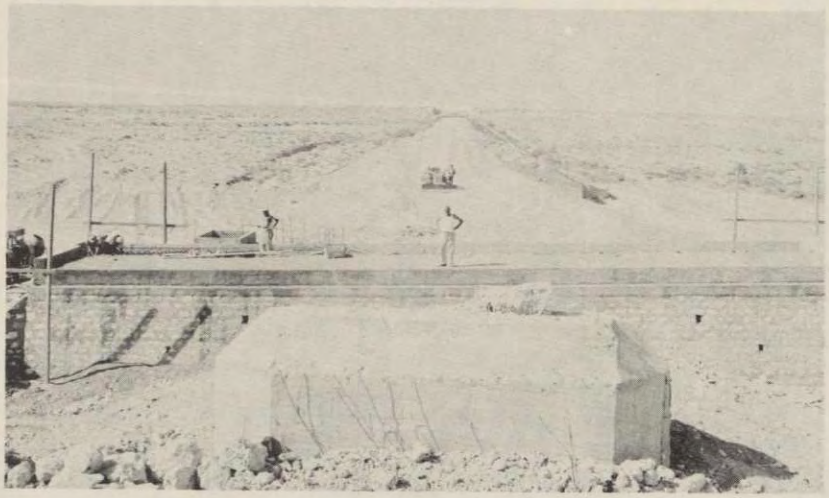


Site of destroyed bridge at km. 262 as seen from center line of highway, looking east.

Bridge Replacement

at

km. 262



One of the box culvert openings completed at km. 262

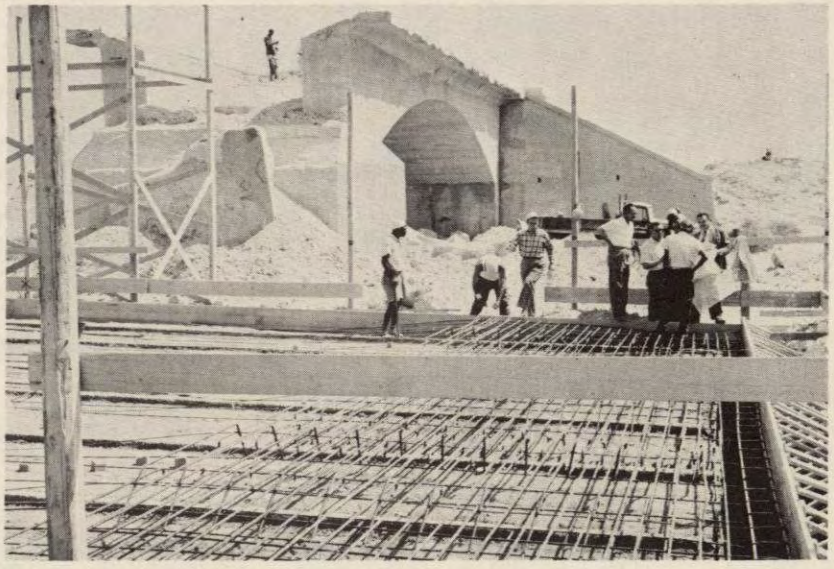
Much of the work is done by hand methods

Bridge Replacement

at

km. 262

It is not unusual to start placing the steel bars before the excavation is finished.



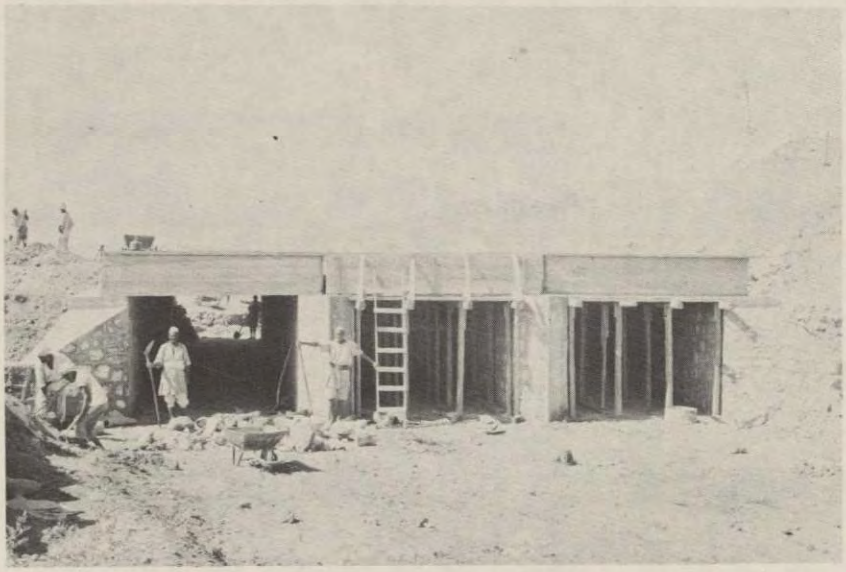
The use of plain steel rods for reinforcement is common practice in Libya.

Bridge Replacement

at

Km.262

The triple 3.0 meter by 3.0 meter box culvert at km. 262 is the same as the one at km. 620.

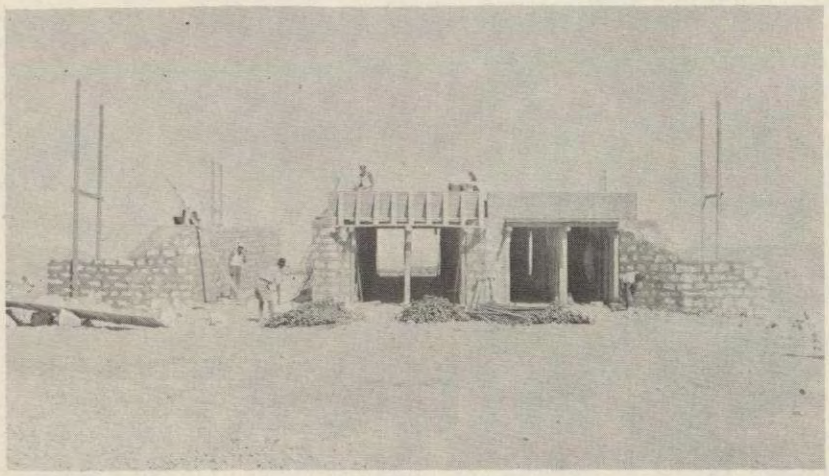


The completed triple 3.0 meter by 3.0 box culvert at km. 262.

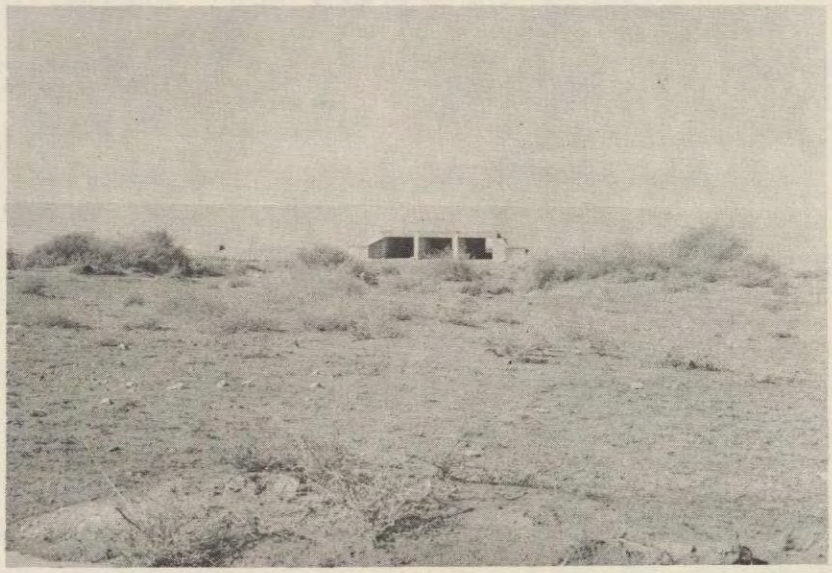
Bridge Replacement

at

km.620



Site of the war-destroyed concrete bridge at km. 620.

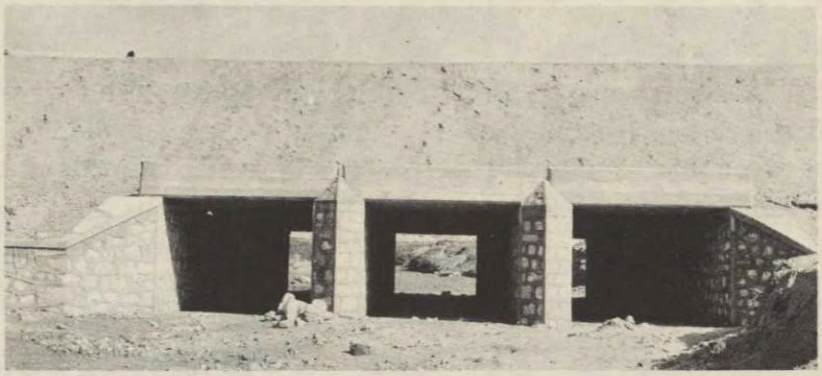


Partially completed three opening box culvert at km. 620.

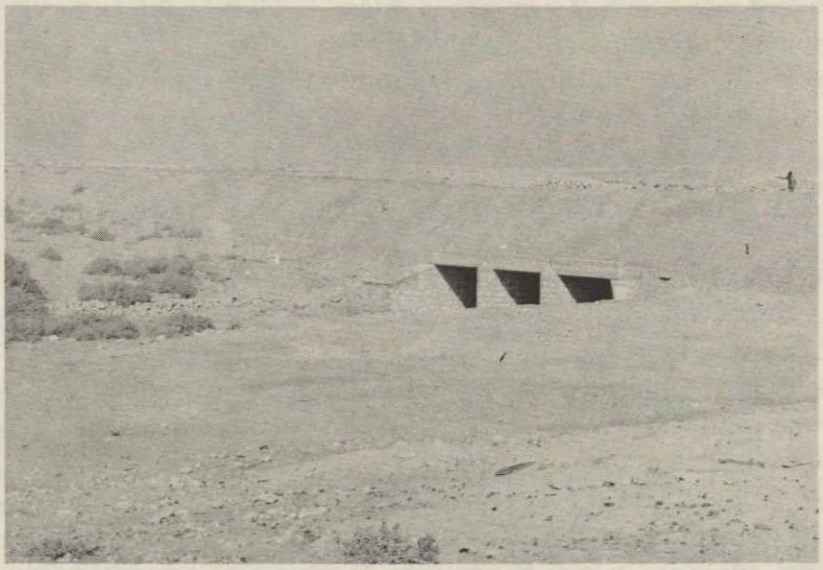
Bridge Replacement

at

km. 620



The completed triple opening box culvert at km. 620. Each opening is 3.0 meters. The structure consists of reinforced concrete top and bottom slabs with masonry side walls made of local limestone.



Consruction of the box culvert also involving placing 2361 cubic meters of embankment.

Contracts 24 and 25 - Wadi Meginin

The need of experienced and dependable engineering inspectors was continually emphasized and Upham engineers spent considerable time on construction projects actually doing example work and demonstrating ways and means of using equipment.

One of the first projects on which the Upham engineers did demonstration work was the Wadi Meginin, Contract No. 24. This was a good project for practical demonstration because being in Tripoli it was readily available to the greatest number of people who might be interested in seeing how the work is done.

On this project the structure layout was carefully staked out on the ground to start with and each step carefully checked thereafter. This meant checking dimensions for the erection of forms and the placement of reinforcing steel, and supervising concrete pours, backfilling and final cleanup. Pouring concrete especially was carefully supervised through all the long hours required for a monolithic pour.

Construction of the box culvert at Wadi Meginin was followed by another project, No. 25, to place embankment base course and mixed inplace surfacing for 900 meters.

This project was carried out in two stages. During the first stage, a contract was let for furnishing and placing embankment, to be spread and compacted by Federal Roads forces, and for furnishing and spreading base course material to be compacted by Federal Road forces.

The Embankment and Base Course Contract:-

Contractor:	Saasco
Bids Received:	August 19, 1957
Bid Price:	LL3,784.000
Final Cost:	LL4,146.000
Completion Date:	(Check returned May 26, 1958)
Length of Project	0.914 km.

Under the second stage the Federal Roads forces primed the base course and constructed the Surface Course pavement, together with some incidental drainage items.

The base course on this job was constructed of a granular soft lime rock, locally known as "Coalina". In the Tripoli area it is a waste product in quarries producing stone block for building construction. The base was constructed for a compacted depth of 15 cm. and primed with Cub-Back Asphalt, Grade MC-0.

Before priming the base course was roughly spread, then thoroughly saturated with water, scarified, mixed and spread with motor graders and compacted with a 13 ton rubber tired roller drawn by a rubber tired tractor. The result was a thoroughly compacted, bound and cemented base almost like a lean concrete. It has gone through one rainy season under the heaviest traffic in Libya without any sign of failure.

The equipment used on the Wadi Megenin embankment, base course and mixed in place surfacing project, was as follows:

2 - Aveling-Barford Motor Graders, 100 brake horsepower, 22,500 lb.
1 - Ashurst Bitumen Distributor, 100 Imp. Gal. capacity with pressure spraybar, truck mounted
2 - Ashurst Bitumen Heaters, 1000 Imp. Gal. capacity
10 - Dump trucks, 2-1/2 cubic yard capacity
1 - Greens Griffen Road Roller, 3 wheel, 6-8 tons
1 - Tamp Pneumatic Tired Compactor, 13 tons ballasted
1 - Phoenix Road Broom, Traction Powered
1 - International Harvester Pneumatic Tired Tractor
1 - Land Rover Station Wagon, with tools and equipment for field repairs, adjustment and service

The unreliability of some of the equipment used on the project, particularly the two old motor graders, due to obsolescence and previous hard use required a mechanic from the Federal Roads Department to remain at the site to make repairs and adjustments as they were needed. The repairs, adjustments and servicing of the equipment were supervised by the Upham equipment engineer. The actual repairs were sometimes made by him with the assistance of the Federal Roads Department personnel.

There was no mechanical loading equipment on this project and all dump trucks were loaded from the stock piles by hand labor.

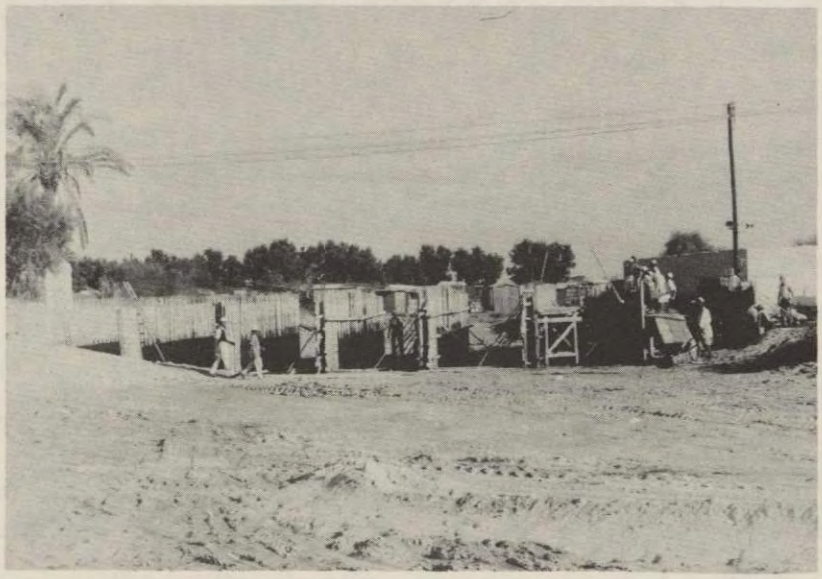
After the prime coat had thoroughly cured, the base course was tack coated with approximately 0.25 British Imperial Gallson per square meter using Asphalt Cut Back Grade RC-2. The surface course stone, which was Crusher Run all passing a 2.5 cm. screen, was then spread for a depth to furnish a 5.0 cm. finished depth. There was then applied approximately 1.0 British Imperial gallon per square meter of Asphalt Cut Back, Grade RC-2. Following this motor graders were used to thoroughly mix the stone and bitumen in place on the road, the material being left in a windrow overnight to permit of partial curing. The windrow was then broken down and further mixing done after which the material was spread and shaped with the motor graders and rolled with a standard 3-wheel steel tired roller. After rolling it was found that the stone had not furnished the density of surface expected

and it was decided to apply a Seal Coat of approximately 0.25 Imperial Gallons per square meter of RC-2 and cover it with a very light coat of fine stone grits. The resulting pavement furnished excellent riding conditions and has so far given good results.

Both the stone and bitumen were purchased on advertised contracts. The labor and equipment for this second stage were furnished by the forces of the Federal Roads Department. All bitumen was heated in 1000-gallon semi-portable heating kettles and applied by truck mounted pressure distributor.

Considering the fact that the motor grader operators and all other personnel of the Federal Roads Department were entirely unfamiliar with this type of construction and the materials used the project was a definite success.

Site of the Wadi Meginin Crossing. After each flood the approach ramps cut in the wadi banks become filled with a deposit of silt.



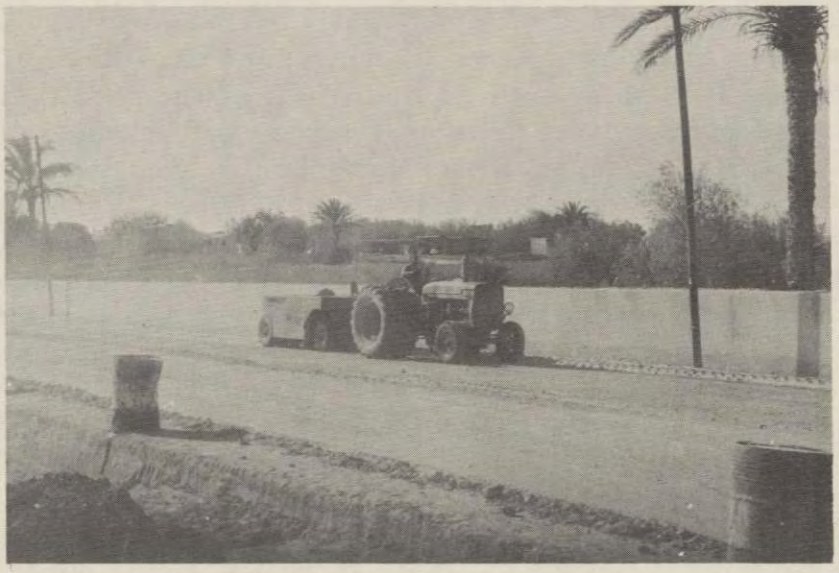
Pouring concrete in the sidewalks of the seven opening multiple box culvert.

The Wadi Meginin multiple box culvert consists of seven 3.0 m. by 3.0 m. openings.

The multiple opening box culvert at Wadi Meginin has demonstrated its serviceability several times. This flood is in November 1958.

Wadi Meginin Approaches

This was one of the first projects to demonstrate the construction of subgrades by other means than hand placing "soling". This demonstration made use of waste fines from a nearby rock quarry and showed how to place the material with the motor grader.



The importance of thorough compaction of subgrades was stressed continuously and how to do it was demonstrated on this early project.

Contracts No. 33 and 34 -Sidi Mesri

The Sidi Mesri (Porta Benito-Miana) project, Contracts 33 and 34, is a dual roadway with base course and mixed in place surfacing from Porta Benito Intersection, km. 0 to Miana Intersection, km. 5, east of Tripoli on the Coastal Road.

This project consists of the construction of an additional 6 meter wide pavement parallel to the existing road for a length of approximately 5 km. starting at Tripoli and extending east along the Coastal Highway to Maini. A median island approximately 3 meters in width was left between the two pavements which for most of the length is occupied by large trees.

Materials were purchased on advertised bids, Contract No. 33, and labor and equipment were furnished by the Federal Roads Department. Engineering field work was done by the Federal Roads Department but unfortunately the planning was inadequate. The result was that numerous undesirable conditions developed in laying out the work which could have been avoided by proper planning. In approximately all of the last kilometer on the Miana end the advice of the Upham engineers was completely disregarded, an inferior alignment was adopted and the grade was changed in such a manner as to require a large amount of extra earthwork.

Throughout the length of the job the base course was constructed of "Coalina" with a 15 cm. compacted thickness, following the same procedure as was used on the Wadi Megenin Bridge Approaches. Asphalt Cut Back, Grade MC-0 was used for the Prime coat. For approximately 4 km. a 5-cm. course of mixed in place surface pavement was constructed using crusher run stone and Asphalt Cut Back, Grade RC-2. In the last kilometer, however, the work was done by the Penetration method using the same stone, but first screening out some of the fines. Cut Back Asphalt RC-2 was also used but for some reason the application reverted back to the hand hose instead of by truck mounted distributor. The result was a very uneven distribution. Some very "fat" areas have developed which pushed so badly that they have had to be removed and the areas patched. Some defects have also developed in the mixed in place pavement, probably due to excess dirty fines in the stone. These defects represent only a minor part of the total and even that part could have been avoided by the application of a seal coat. The consultants have recommended the application of a seal coat but to date it has not been done.

At the Porto Benito end of the Sidi Mesri project, a channelized intersection was constructed in general accord with plans prepared by Upham engineers. The curb construction on the islands and the penetration macadam paving both leave much to be desired. The intersection, however, appears to be operating in a satisfactory manner. One other minor intersection has been partially constructed in accordance with Upham engineers' plans but not completed. Just east of km. 1 there is a very large and complicated intersection problem. A detailed design was prepared by

Upham engineers but no action has been taken on construction. At the Miani intersection construction has been carried out without the advice or approval of Upham engineers. Some of this work has been needlessly elaborate and expensive.

The Upham engineers spent many hours working with the labor forces and operators doing the actual work on this project. This project includes work with the motor patrol grader in fine grading and laying down surface courses.

The equipment used on the project is as follows:

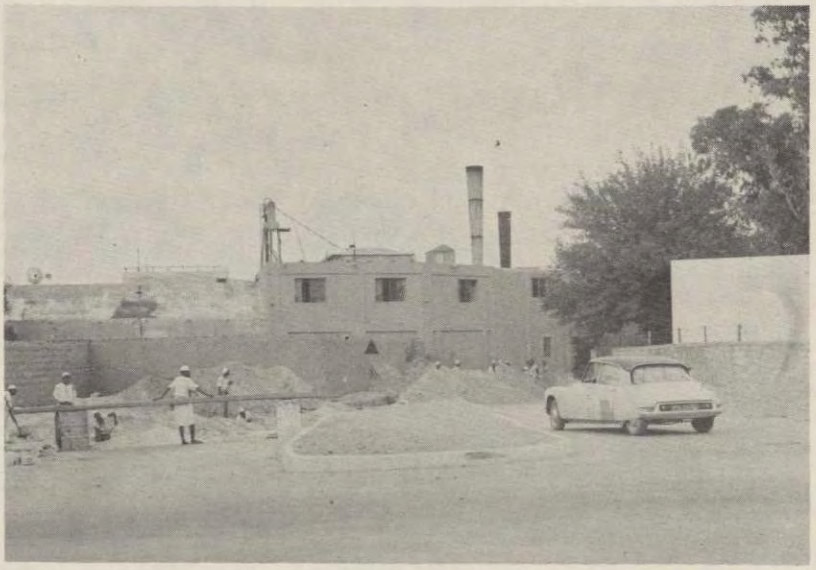
2 - Aveling-Barford Motor Graders, 100 brake horsepower, 22,500 lb.
1 - Ashurst Bitumen Distributor, 100 Imp. Gal. capacity, with pressure spraybar, truck mounted
2 - Ashurst Bitumen Heaters, 1000 Imp. Gal. capacity
10 - Dump trucks, 2-1/2 cubic yard capacity
1 - Greens Griffen Road Roller, 3 wheel, 6-8 tons
1 - Tamp Pneumatic Tired Compactor, 13 tons ballasted
1 - Phoenix Road Broom, traction powered
1 - Littleford Road Broom, engine powered
1 - International Harvester Pneumatic Tired Tractor
1 - Land Rover Station Wagon, with tools and equipment for field repairs, adjustments and service
1 - Littleford Bitumen Distributor, 1000 gal. capacity (U.S.), truck mounted, used as a sprinkler truck.

The Littleford Bitumen Distributor mentioned above was obtained as surplus equipment from the Corps of Engineers, Wheelus Air Base, at no cost to the Federal Roads Department. The distributor was not suitable for bitumen due to burned out flues and heater tubes, which allowed the bitumen to drain into the heater tubes and flues. It was suitable for a water sprinkler truck and it was used in this capacity on the Miani Project for wetting the base course for compaction. Service, repairs and adjustments were made in the field during the construction period. The Upham equipment engineer remained with the Federal Roads Department personnel and supervised repairs, service and adjustments for the purpose of training the personnel in this work.

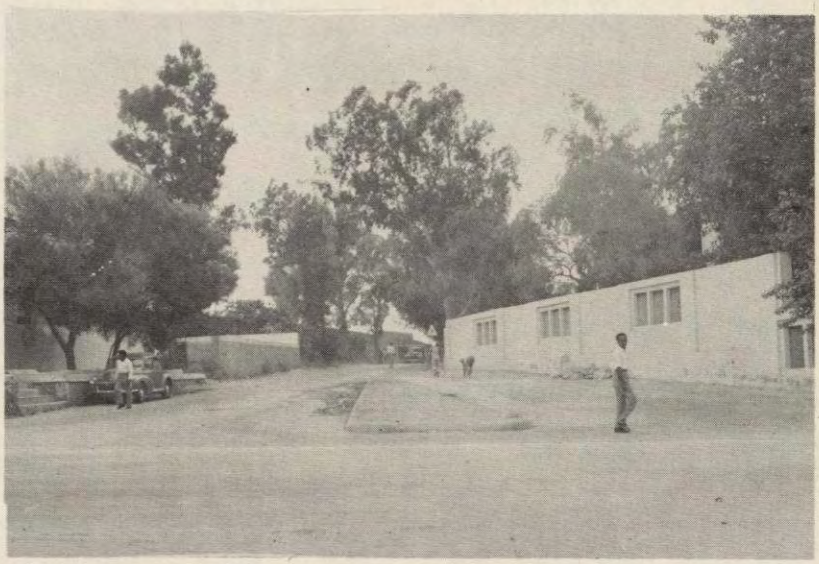
The Sidi Mesri project was one job where concentrated effort was made to demonstrate the versatility and utility of the motor grader.

Skilled motor grader operators are extremely scarce in Libya and many of the highway authorities do not fully appreciate the potential results available with the motor grader. Not many of the existing Libyan highways are smooth and uniform owing to hand methods of construction.

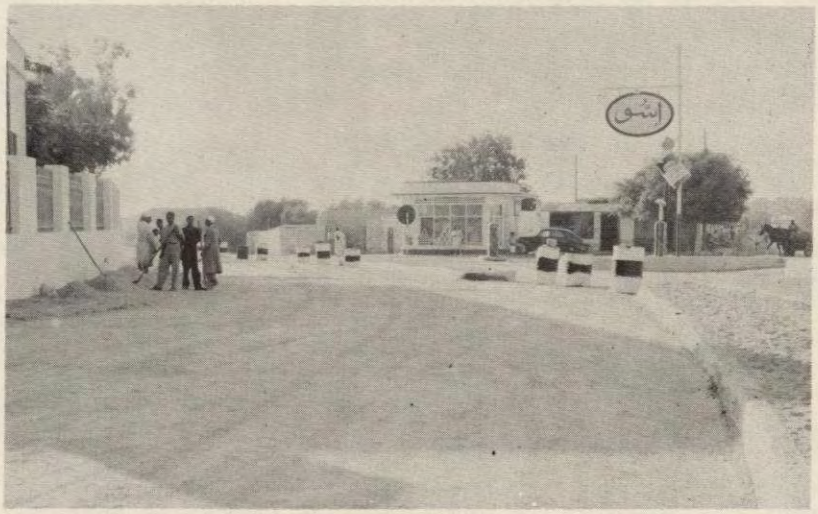
Excavating a trench, four meters deep, for drain pipe. The loose rubble wall was built to stop the backfill from sloughing in.



One of the islands on the Sidi Mesri project. This one at the Bab Ben Gashir intersection is made up of poured-in-place concrete.



Another view of the intersection at Bab Ben Gashir



The design of the intersection at Bab Ben Gashir involved facilitating traffic movements in and out of the local service station.

Demonstration Project

of

Resurfacing at Sirte

Following the final application of cut-back asphalt a light covering of sand was applied to allow traffic to use the road immediately without picking up the fresh asphalt.

This process is an economical way to save the rapidly detiorating bituminous pavements of Libya and does a great deal toward smoothing up the rough pavement.

Demonstration Project

of

Resurfacing at Sirte

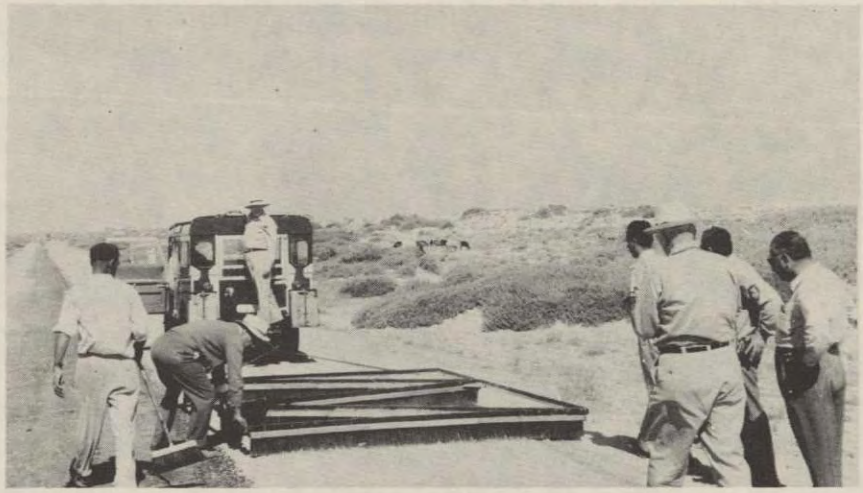
After brooming the newly laid aggregate it was rolled to aid the inverted penetration and to help smooth the surface.

Following the rolling another application of RC-2 cut-back asphalt (170^{O}) at the rate of 0.35 gallon per square meter was sprayed over the aggregate.

Demonstration Project

of

Resurfacing at Sirte



The aggregate was smoothed and shaped with the broom drage made locally for this work.

The broom drag, pulled by a Land Rover, made several passes over the newly laid aggregate to smooth out irregularities.

Demonstration Project

of

Resurfacing at Sirte

An application of RC-2 cutback, of the rate of 0.21 gallon per square meter, was sprayed on the existing bituminous pavement.

Immediately following the distributor, crushed rock aggregate (chips) was spread with spreader boxes attached to the dump trucks. This application of aggregate was at the rate of 100 cubic meters per kilometer.

Contract No. 10 - Resurfacing Matratin - El Aghelia

Under contract No. 10 some 94 km. of resurfacing were finished between km. 620 and 722 and another 8 km. partly finished when funds were exhausted on May 11, 1957. That part between Marble Arch and km. 722 was especially well done and the seal coat with its crushed limestone cover aggregate is nice appearing. An additional 6 km. between km. 722 and 728 had not been sealed and this section became the first demonstration project to illustrate the use of cut-back asphalt with salvaged fine aggregate in a low cost penetration type of resurfacing.

The job was done in January 1958, under adverse conditions. Wind and low temperatures made handling the RC-2 cut-back difficult particularly because the asphalt had to be heated in the distributor as no equipment to pre-heat the asphalt was available.

The process used on this project consisted simply of spreading a thin course (about 14 pounds per square meter) of the fine aggregate on the existing bituminous surfacing, spraying with this approximately 0.3 gallon of RC-2, and covering this with an additional 14 pounds of the same aggregate.

Another demonstration project using this same process with some refinements was done near Sirte in May 1958. This demonstration made use of a good crushed aggregate laid down in a thicker course with an application of RC-2 before as well as after placing. Also an effort was made to smooth up the riding surface by dragging with a drag broom and by rolling. This because the prototype of the three major resurfacing contracts awarded in 1958 (Nos. 30, 31, and 32.). The process is described under Specifications.

Contract No. 31 - Resurfacing - Sirte Area

Contract No. 31 provided for resurfacing from km. 291 to km. 313 and km. 315.3 to km. 319.

Contractor:	Tatanaki Bros.
Bids Read:	May 20, 1958
Contract Amount:	LL23,130.000
Completion Date:	February 11, 1959
Final Cost:	LL23,254.314

This contract was one of the first to be let on the basis of the revised procedures developed by Upham engineers. The bids were received on May 20, 1958, but the contract was not executed until July 23, 1958, because the Project Agreement between the Government of Libya and the ICA had not been signed and the necessary funds were not available. While there was this unavoidable delay there was also an unnecessary delay on the part of the contractor in starting the work. The contractor was warned both by letter and verbally that he would be penalized for failure to complete the job on time. Being late, he was penalized 1-1/2% of the total amount of the contract or an amount of LL354.126. The final cost shown above is that after deduction of the penalty.

The resurfacing consisted of a tack cost of approximately 0.25 to 0.3 Imperial Gallons per square meter of Asphalt Cut Back, Grade RC-2 applied on the surface and then spread over this tack coat was a layer of stone for an average depth of 3 cm. The grading for this stone called for 100% to pass a 1.5 cm. screen, 90-100% to pass a 1.0 cm. screen and 0-5% to pass a 2 mm. screen. After spreading the stone was evened up with hand brooms and then dragged with a broom drag to further even up the surface. The surface was then rolled with a steel wheeled roller and any further necessary evening up done by hand. There was then applied from 0.4 to 0.45 Imperial Gallons per square meter of Asphalt Cut Back, Grade RC-2. After the application of the bitumen the surface was then covered with a light application of sand or stone screenings.

In the first kilometer of this work the contractor applied the bitumen by hand hose and the results were decidedly unsatisfactory. However, he then obtained a trailer mounted distributor, which though far from modern in several respects, did give a reasonably uniform and satisfactory application. The contractor was required to apply a light seal coat on the first kilometer of work in order to remedy the faulty hand hose application.

Contract No. 32 - Resurfacing - Sirte - Marble Arch

Contract No. 32 provided resurfacing from km. 520 to km. 538 and km. 587 to 609, and Seal Coat from km. 538 to km. 587, east of Tripoli.

Contractor:	Saasco
Bids Read:	September 4, 1958
Contract Amount:	LL51,816.000
Completion Date:	February 20, 1958
Final Cost:	LL52,138.500

This contract was also let on the basis of the revised resurfacing specifications devised by Upham Associates. Shortly after the contractor was notified of the approval of the award of the contract he made application for a revision of the specifications to permit of the substitution of a different grade of bitumen than the specified Asphalt Cut Back, Grade RC-2. This request, after considerable negotiation, was finally denied and the contract signed on November 3, 1958. In the meantime, however, the contractor had proceeded vigorously with the preparation of the stone and sand for the work. In this case the contractor had an old trailer mounted distributor and later a new truck mounted distributor. Some difficulty was experienced with the application by the old distributor. This contract called for the seal coat before resurfacing as well as resurfacing. In error, an extra kilometer from km. 609 to km. 610 was sealed. Inasmuch as this sealing was highly desirable and the added cost only approximately LL200., this extra work was allowed. While there was some readon for complaint with respect to the work during its progress, the job when finally completed appears to be reasonably satisfactory with the possible exception of some limited areas where there seems to be a slight excess of bitumen.

One of the notable factors in connection with this job is the speed in which a contract of this size was performed using modern methods and equipment. The price at which the work was done is also noteworthy as Seal Coat 5.0 meter wide was applied at a cost of LL200 per km. and Resurfacing for the same 5.0 meter width at a price of LL825 per km.

Typical installation for crushing rock. The raw material consists of hand gathered rock completely lacking of small sized rock or fine aggregate. The jaw crushers are fed by hand and the end products stockpiled by wheelbarrows.

Contract No. 30 - Resurfacing Gambut - Capuzzo

Contract No. 30 provided for resurfacing between Gambut and Capuzzo, km. 557 to km. 588 and for Seal Coat from km. 557 to km. 613, ten km. from km. 530 to 540 were also sealed under this contract.

In the case of the Gambut-Capuzzo resurfacing project it was possible to induce the contractor to purchase an asphalt distributor, and abandon the common practice of spraying the bitumen by hand which, of course, is not only slow but also highly erratic. The pressure distributor corrected these faults and gave uniform spreads. The increased productivity pleased the contractor.

The use of crusher-run aggregates was introduced and again on the Gambut-Capuzzo resurfacing job the contractor grasped the idea of using the right screens. Using a battery (4) of hand-fed jaw crushers he separated out the oversize and re-crushed it in steps according to the jaw settings. Crushing rock is still pretty much a hand process and not a great deal can be done about using naturally graded aggregate because it doesn't exist. Considerably more demonstration is needed to show that crusher-run, or a well graded mixed aggregate, is not only better material for base and surfacing courses, but also considerably cheaper than the separated aggregates now commonly used. In the locally accepted current method of crushing rock the screens are used to separate crushed rock into four different sized aggregates, which are then placed in layers with the largest size on the bottom and the finest on top, to make bituminus surfacing; or they are re-combined in mixing concrete.

PROVINCIAL ROADS

Province of Tripolitania

Ezot Contract No. 1 - Resurfacing 27 km. Scek Sciuk - Giosc

Contractor:	Saasco
Bids Received:	July 3, 1956
Bid Price:	LL39,160
Final Cost:	LL41,218.346
Completion Date:	Job not completed but contract terminated early in 1957

As originally bid this contract contemplated the resurfacing of 27 km. of the road from Scek Sciuk to Giosc. As finally terminated the work started 3 km. south of Scek and terminated approximately 3.4 km. short of Giosc. There were in addition 18 gaps left in the resurfacing, of varying lengths, at wadi crossings. The principal item causing the depletion of funds was the construction of concrete and masonry structures at wadi crossings which were not contemplated under the

original bid and were therefore entirely extra items. As a result of the exhaustion of funds it was decided to terminate the contract, make proper plans and estimates for completion and let a new contract. The surveys have been completed, the plans are complete except for drainage structures, but have not yet been submitted for approval. There is one very large wadi crossing involved which it seems probably will require a very large and expensive structure so that as a result consideration of the availability of funds will be necessary to include construction of the structure. All of the wadi crossings already constructed have been of the overflow, or "dip" type. It is believed that the use of pipe culverts and composite masonry and concrete box culverts will result in material savings in the construction of wadi crossings. The overflow type is not only expensive in first cost but expensive to maintain because of the necessity of cleaning off dirt and trash after a storm.

This project involved resurfacing for a width of 3 meters by the Penetration method using locally produced stone and 80-100 Penetration Asphalt.

Contract No. 4 - Resurfacing Tarhuna - Ben Ulid Road

Contractor:	Saasco
Bids Received:	March 5, 1957
Bid Price:	LL21,628
Final Cost:	LL22,790.732
Completion Date:	Project not completed but funds exhausted on September 17, 1957

As originally contemplated this project consisted of resurfacing 13 km. of the road southerly from Tarhuna. In the middle of the project there was considerable trouble with drifting sand. As a result a considerable quantity of extra work was authorized to control this sand drifting with the result that the funds were exhausted with only 11.5 km. of resurfacing completed. In addition, the drift control work was so designed and constructed that it actually deposited the sand in the roadway instead of preventing it from reaching the road. The Provincial authorities, however, proceeded, without approval from LARC, to authorize the contractor to continue with the work and completed approximately 16 km., later requesting LARC to allocate the necessary funds which were denied. After a change in administration in the Department of Public Works it was proposed to complete a gap of approximately one km. of resurfacing, completely redesign and reconstruct the sand drift control facilities and stabilize the shoulders under a LARC sponsored project. It was finally decided to do this work on a force account basis with the Department of Public Works forces and equipment.

The work performed consisted of resurfacing the existing pavement for a width of 3 meters, using locally produced stone and 80-100 Penetration Asphalt. While the stone used was not properly sized the resulting pavement is serviceable. The shoulders were in many places so soft as to be incapable of carrying passing traffic, hence the later proposal to stabilize them by the use of a sand clay material known as "Tinn".

Contract No. 10 - Zuara - Gemil Road

Contractor:	Libya Construction Co.
Bids Read:	July 29, 1957
Bid Price:	LL12,584.550
Final Cost:	LL16,969.680 (12,132.303) Pending final decision
Completion Date:	
Length of Project:	10.2 km.

The bid price did not include the bitumen which was furnished to the contractor by the Department of Public Works at a cost of LL4,564.377. This project consisted of two parts of an entirely different character. The first part having a length of 8.7 km. consisted of the resurfacing of an existing road which had been constructed with the familiar "Soling" base course. The second part was new alignment from the old road to the square in the village of Gemil and involved grading, base course and surface for a length of 1.5 km.

On the existing road a considerable portion of the "Soling" was exposed and was very rough and uneven both longitudinally and transversely. The surface was thoroughly cleaned and primed with Cut-Back Asphalt, Grade MC-0 which was allowed to cure. A tack coat of Cut-Back Asphalt, Grade RC-2, was then applied, stone spread, rolled and penetrated with Cut-Back Asphalt, Grade RC-2 and lightly covered with fine stone chips. Due to very high points sticking up in the "soling" it was difficult to obtain a perfectly smooth surface, but a firm well bonded and thoroughly serviceable surface was obtained. In retrospect it seems probable that much better results would have been obtained by first constructing a leveling course and then a uniform surface course. The cost would of course have been greater but the results much superior.

On the new alignment the embankment was constructed with a top width of 7 meters, a macadam base course of crusher run stone with a width of 3.3 meters and a depth of 15 cm. constructed thereon, and primed with Cub-Back Asphalt, Grade MC-0, and allowed to cure. On the base course a tack coat of Cut-Back Asphalt, RC-2, was applied, 2 cm. of stone spread, rolled and penetrated with Cut-Back Asphalt, Grade RC-2, and lightly covered with fine stone chips. A serviceable surface was obtained but due to careless workmanship on the surface course the riding qualities leave something to be desired.

Contract No. 11 - Zuara - Regdalin Road

Contractor:	Guiseppe Lunetto
Bid Price:	LL16,230.600
Length of Project:	8.65 km.

The bid price in this case does not include the bitumen which was furnished by the Department of Public Works to the contractor.

This project is a complete construction project involving grading, base course, and surface course between the Coastal Highway and the village of Regdalin.

Width of Embankment	7 meters
Width of Base Course	3.3 meters
Thickness of Base Course	15 cm.
Width of Surface Course	3 meters
Depth of Surface Course	2 cm.

Several difficulties arose on this job. In the first place the contractor early claimed that the profile and grade line were in error. This was found to be correct and it was necessary to replot the profile and lay a revised grade thus delaying the work. The only convenient source of supply for stone was a small commercial quarry operation some twenty odd kilometers away. At first the rock did not remotely meet specifications as to maximum size, were deficient in fines and were accordingly rejected. After repeated visits to the quarry it was finally possible to get a closer adherence to size but there was still difficulty with fines and much segregation. Unfortunately the producer was inclined to take an uncooperative attitude. However, it was possible to produce a bonded base with the material as delivered.

The base was primed with Cut-Back Asphalt, Grade MC-0, allowed to cure and then tack coated with Cut-Back Asphalt, Grade RC-2. The surface stone was then spread, rolled and penetrated with Cut-Back Asphalt, Grade RC-2, and covered with fine stone chips. Workmanship on the surface was not perfect but a thoroughly serviceable road resulted. For a considerable portion of the job the material was borrowed from alongside the roads and although it had a high salt content it made an excellent fill and firm shoulders. The Regdalin end, however, was through some sand dunes which did not provide stable slopes and shoulders. As a result an extra in the amount of LL500 was authorized to provide for surfacing the shoulders and slopes with a 10 cm. layer of "Tinn" to stabilize them.

PROVINCE OF CYRENAICA

Contract No. 1 - Zawiat El Gasur - El Abid Road Resurfacing 36 kms.

Contractor:	Saasco
Bid Price:	LL 43,261.637
Completion Date:	June 3, 1957

This project consisted of resurfacing 36 km. of road for a width of 3 meters. It was completed in July, 1957. The Upham engineers were requested to visit the job and make recommendations for the correction of defects which had developed as a result of inadequate planning of drainage facilities.

Contract No. 3 - Benina - El Abiar Road Resurfacing of 40 kms.

Contractor:	Tatanaki Bros.
Bids Received:	August 25, 1956
Bid Price:	LL31,790
Final Cost:	LL39,488.503
Completion Date:	July 6, 1958

This project consisted of resurfacing a length of 40 km. for a width of 3 meters by the Penetration macadam method. Some defects developed due to the lack of proper drainage facilities.

These projects exceeded the original contract amounts due to the inclusion of token items in bids and failure to include essential items in the quantities bid upon. Some contracts were, furthermore, let on a lump sum basis without giving the contractor adequate information as to the quantities of work involved so that claims for extra compensation were practically inevitable. There was, in short, a failure to properly and accurately plan the work to be performed.

Contract No. 5 - Construction of 9.2 k-m. of Road Tocra - Tolmeta

Contractor:	Tatanaki Bros.
Bid Price:	LL36,877.800
Completion Date:	Still active

The Tocra-Tolmeta route extends from Tocra, which is on the coastal highway, some 40 kilometers to Tolmeta which is on the coast but not on the coastal highway. The coastal highway leaves the coast at Tocra and ascends the gebel to reach the Barce plains. The Tocra-Tolmeta route, if extended from Tolmeta on to Susa (Apolonia) would become the coastal highway (including Susa-Derna route).

Because the Tocra-Tolmeta might become an extension of the main highway it was given a standard of design comparable to the existing coastal highway. This means that the ultimate bituminous surfacing is 5 meters in width and shoulders each 2 meters wide.

Using this high standard of design limited the amount of new construction possible with the limited allotments for provincial roads. Consequently the first contract was awarded to Tatanaki Brothers for 9.200 kilometers of construction, including all new embankment, concrete pipe culvert, crushed rock base course, and a penetration type bituminous surfacing, beginning at Tocra.

Contract prices are based on bid unit prices although there was some doubt at first that it would be possible to furnish adequate engineering to measure quantities. As it is the specifications call for measuring embankment rather than excavation for the reason that it would be possible to pay for plan quantities if the field engineering became unavailable.

On this project the Upham construction engineer worked directly in the field with the engineering crew doing each of the various jobs required of each member of the survey crew to demonstrate how the slope staking is done by U.S. standards. Previously the contractors were turned loose on a project to furnish their own construction stakes, if any. The idea of setting slope stakes was therefore an innovation to both the contractor and the engineer. Computing "catch points" and setting the stake is a confusing arithmetical process and a bit difficult to learn, nevertheless, one of the Libyans on the survey party grasped the idea and eventually became able to check the arithmetic, and calculate catch points.

The contractor's foreman also became familiar with the slope stakes and learned to use them to his advantage. This was not easy since it revolutionized the long standing practice of building the fills right up to the grade by the end dumping process. End dumping effectively precludes any chance of compacting the fill and is prohibited in modern construction. Therefore the contractor was

required to place the fill material in layers, not exceeding 15 cms. and to compact each layer. With slope stakes this is simple enough but the workmen hauling fill material in wheelbarrows were thoroughly confused unless they were filling to the grade line at all times.

A great deal of effort was devoted to showing the operators how to best use their equipment. Truck drivers were shown how to spread their load in a thin layer; the grader operator was shown how to drift material to obtain uniformity, and the foreman how to keep the excavator close to the fills and avoid long hauls; how to make fill ahead so that the trucks would drive over the new fill and help with compaction.

Setting slope stakes also demonstrated the comparative simplicity of computing earthwork quantities and revealed an effective and workable control of costs. It also made the preparation of monthly estimates quite easy and eliminated the habit of making "advance" payments to the contractor.

Concrete pipe culvert was specified for this project in order to help local industry. The pipe is made in Tripoli and hauled by truck to the project. The quality of the pipe may be questioned and it might not withstand standard tests, but it serves the purpose.

The lighthouse at Tolmeta.

Roman ruins at Tolmeta.

The field survey of the Tocra-Tolmeta route (40 kilometers) included a study of drainage and structure needs. This is Wadi Um El Amain at km. 10 + 370.

To encourage local industry, concrete pipe culverts were specified. These are 50 centimeter diameter pipe made in Tripoli and hauled by truck to Tocra.

This is Wadi Umm, 37 kilometers from Tocra. Looking toward the Mediterranean Sea which is less than a kilometer away.

This is Wadi Asra at km. 16 + 240. There are at lease fourteen such wadis between Tocra and Tolmeta, all of which will require large box culverts.

FEZZAN ROAD

Excepting two contracts all the work on the Fezzan Road has been done by day labor force account. The work is in the form of improvement, or betterments, scattered over a length of about 1000 kilometers. Expenditures are as follows:-

EXPENDITURES FROM LPD & SA FUNDS

Purchase of	1954-55	1955-56	1956-57
Vehicle & Plant	LL 2,711.747	LL 1,575.000	LL 1,925.000
Supply & Stone Chippings			
Coalina	2,200.000	4,704.422	103.958
Upkeep of Mech. Transport	600.000	3,473.777	1,599.159
Salaries, Allow. & Wages	6,170.000	26,103.454	17,893.701
Small Tools & Equipment	700.000	1,003.253	286.233
Stationery & Office Equip.		200.000	10.500
TOTAL	LL 12,381.747	LL 37,059.906	LL 21,818.551

FROM LARC FUNDS

From August 8, 1956 to January 31, 1959

1.	Bitumen Work - Hon Town (Contract)	LL 5,560.000
2.	Bitumen Work - Bu Ngem Village (Contract)	7,980.000
3.	Vehicles and Plants (Includes LL 26,773.484 for 4 motor patrols)	58,341.730
4.	Bitumen	2,180.000
5.	Small Tools and Equipment	7,988.135
6.	Stationery and Office Equipment	440.014
7.	Rehabilitation of Offices	727.293
8.	Insurance	340.275
9.	Salaries, Allowances and Wages	192,550.241
10.	Supply of Stones, Chippings and Coalina, including transportation	8,112.083
11.	Upkeep of Mechanical Transportation	33,745.988
12.	Accommodations of officials, Sebha	4,500.000
13.	Hire of Plants	242.000
14.	Survey Instruments	1,279.455
	TOTAL	LL 323,987.214

On December 15, 1958, a contract was awarded to S.A.A.S. Co. for the construction of approximately 600 kilometers of roadway consisting of a base course and an asphaltic surface. The work ostensibly is to be financed without the benefit of American financial assistance.

The award was made on the basis that plans would be furnished as the construction progressed and the need for them arose.

It is inconceivable that an organized highway department would let to contract a project of this magnitude, without first preparing complete plans and specifications and a corresponding realistic estimate of quantities. Expediency and urgent need for this improvement is not an excuse for the lack of adequate surveys and plans. It is not efficient and certainly not economical for any agency to finance a project in this manner since it is not possible to determine what the estimated total quantities should be without surveys and plans.

In this connection, it was not possible for the contractors to bid intelligently, for example, on such an item as concrete when not knowing the location, quantity or types of concrete structures required. Many other contract items such as earthwork, culverts, and other drainage structures were equally vague. All items are a determining factor in the cost of such work and consequently this information is necessary for a contractor to present an intelligent bid.

Furthermore, experience has shown that even with adequate plans available, it is incumbent on a competent field engineer to be diligent at all times in checking to see that contract items are not being overrun unnecessarily. Primarily this is necessary to keep the cost of the work within the limits of the funds allocated for the project. Without plans this control is lost.

Established highway departments normally have a set of standard specifications which have been developed and revised periodically over a long period of time which attempt to cover all general items and as much detail as may be practical and feasible. In addition to these, there are special provisions covering matters peculiar to a particular project and which in effect are additional specifications. Even under these conditions problems still arise which are not covered by the specifications.

The Federal Roads Department also has a set of specifications which are normally used as a basis for highway contracts, but in the case of the Fezzan Road, the technical specifications particularly, were written especially for this proposed contract. For the most part these specifications are incomplete, inadequate, vague and fail to describe the work to be done with a sufficient degree of accuracy to avoid becoming a prolific source of argument if a serious attempt is made to construct the road to acceptable engineering standards.

But the most serious aspect of the whole contract is the substantial overrun in final actual cost which is inevitable with the conditions under which this contract has been awarded.

The final matter which is considered very important and should be brought to the attention of all concerned is proper maintenance of the Fezzan Road after completion. It is illogical to construct a road of this length without definite consideration being given to the cost of proper maintenance. Such maintenance begins almost from the first day after construction.

It has been estimated that at least $300 per kilometer per year would be necessary for proper maintenance on the Coast Road and this amount likewise can be used as the requirement for the Fezzan Road. This estimated amount contemplates an intelligent program of patching, blading of shoulders, removing sand drifts, and maintenance of drainage, all effected promptly and efficiently.

The total annual cost of maintenance then if carried on efficiently, will be approximately $180,000 which is considerably less than has been expended on the road previously.

The life of any pavement or surfacing depends to a considerable extent on how well the road was constructed and how intelligently it is maintained, as well as the quantity and weight of the traffic it carries. The useful life of a surface of this type is therefore difficult to determine, however, it can be assumed that, even with proper construction and normal maintenance, within five years of completion the surface will require a seal coat and in approximately ten years will need resurfacing.

Present estimated costs for seal coat work and surfacing are $700 and $2600 per kilometer respectively.

Based on these prices the following is a brief summary of estimated costs to protect the investment and to provide a useful facility for a minimum of 20 years:

Routine Maintenance	
$ 300 per km. x 600 km. x 20 years	$3,600,000
Seal Coat 5th and 15th years	
$ 700 x 600 km. x 2 applications	840,000
Resurfacing 10th year	
$2600 x 600 km.	1,560,000
Total Cost 20 years for 600 km.	$6,000,000
Total Annual Cost 6,000,000 ÷ 20	$ 300,000
Annual Cost per kilometer 300,000 ÷ x 600	$ 500

HON-SOCNA ROAD:

The total length of this project was supposed to be approximately 15 km. Owing to still existing mine fields on the Hon the survey and plans were completed for only about 11.7 km. pending the mine clearing. The original plan was to grade the road for a width of 9.0 meters, construct thereon a base course, using local granular material, having a width of 5.0 meters. The project was intended to connect existing bituminous pavements at Hon and Socna and to serve as a demonstration project to be done by Federal Roads forces and equipment on a force account basis.

At the time the project was selected no particular difficulty in construction was contemplated. When the survey was under way, however, it was found that much of the length of the job consisted of a thin layer of earth over bed rock some of which had a top layer of flat, slabby, partially decomposed material of variable depth. A tentative grade line was laid on the plans and grading started. The grading proceeded rather slowly due to the unavailability of expected equipment. It was also found that the equipment available was not adequate to handle the material so there was a scarcity of available material to construct the embankment to the tentative grade line. This made it desirable to drop the grade line closer to the existing ground surface to avoid excessive borrow. On this basis the grading proceeded to a point near the end of the plans where temporary connection was made to the old road. An available supply of "Coalina" was found and a base course placed on the embankment. No action toward constructing the surface course was taken and it has been included in the Fezzan Road Project now under way without aid funds. Traffic is, however, using the new alignment for a distance of about 11 kilometers.

RESURFACING AND SEAL COAT WORK BY FEDERAL ROADS ON A FORCE ACCOUNT BASIS:

During the 1958 year, a considerable quantity of satisfactory Seal Coat and Resurfacing work was done. A criticism against the work has been the relatively low production rate which has been attained. At best, no more than 3 distributor loads of 1000 gallons each has ever been applied in a single working day. A rate double this should be a minimum, and 12,000 gallons per day is well within the realm of possibility. To be entirely fair, however, it should be stated that one of the factors

limiting production is that all bitumen are available only in drums. It is, therefore, necessary to empty the bitumens first into heating kettles and then again transfer them to the distributor after heating. Unless a whole battery of kettles is available only a limited amount can be heated in one day.

The low production rate was aggravated by the use of hand hose application over a considerable portion of the work. This means even less productivity and is never satisfactory from the standpoint of the uniformity of application.

Part of the Seal Coat has been done with Cut-Back Asphalt, Grade RC-2, and part with Cut-Back Asphalt, Grade S-125. In some cases sand cover has been used and in others stone chips. Specific locations are:

Seal Coat:

Km. 61 to km. 69 - Full width
Km. 69 to km. 70 - 1/2 width
Total: 8.5 km.

All of the following work was done by hand hose method:

Km. 245 to km. 261.5
Km. 262.2 to km. 319
Total: 71.3 km.

The following was done by truck mounted distributor:

Km. 385 to km. 395
Total: 10 km. - Truck Distributor
Km. 441 to km. 464
Total: 23 km. - Truck Distributor

From point west of El Aghelia for a distance of 19.9 km.
This last item was done using Cut-Back Asphalt, Grade S-125, hand hose application, and stone cover.

Summarizing the Seal Coat and Resurfacing done both by contract and Federal Roads force account shows the following total:

Combined Seal Coat and Resurfacing	116.7 km.
Seal Coat Only	172.0 km.

The following projects have been approved, bids have been received, and recommendations for award made but work has not yet started:

Tripoli - Ben Ghashir Road

Contractor:	Jusseby Spicuglio
Bids Read:	January 24, 1959
Bid Price:	LL 3396.800
Completion Date:	

This project calls for raising the grade of the road between km. 2.656 and km. 3.000 and between km. 4.314 and km. 4.880 and paving the embankment at the new grade.

Suani Ben Adem - Bivio Gheran Road

Contractor:	Guilbirto Lucantonio
Bids Read:	January 24, 1959
Bid Price:	LL 2891.801
Completion Date:	

This project calls for the surfacing of the existing base for a length of 2 km. between existing surfaced pavements.

Outer Loop Road between Bab Ben Ghashir and Accra

Contractor:	Amelio Teresi
Bids Read:	April 15, 1959
Bid Price	LL 1628.000
Completion Date:	

This project involves raising the grade of the Outer Loop Road for a distance of about 0.4 km. and paving the surface of the new embankment.

SPECIAL PROJECTS

Sebha Airstrip

The Sebha Airstrip was the subject of a special report submitted by the Charles M. Uphan Associates, Inc., under date of November 27, 1957, and it was also the subject of an inspection report submitted by the LARC Regional Representative, Tripolitania and Fezzan, under date of August 4, 1958.

The consultant's report covered the possible future paving of the airstrip for use of aircraft heavier than the DC-3 type now using the airstrip and the LARC

representative's report covered the removal of a hump one meter high on the north half of the north-south airstrip.

An aircraft passing over this hump at landing speed would again become airborne, causing danger of possible damage to the landing gear of the aircraft. Since funds were not available for paving the airstrip, it was decided to remove the hump in order to make the airstrip safer for DC-3 type aircraft. The consultant's equipment engineer obtained an air compressor and air tools and arranged to have them shipped to Sebha, although it was later found that these tools were not needed for the removal of the hump. Several test holes were drilled across the hump in order to find the extent and depth of the rock outcropping and it was found to be very shallow, decomposed rock.

A motor grader belonging to the Public Works Department, Province of Fezzan, was brought to the airstrip and the scarifier was used to rip up the rock and the mouldboard was used to windrow the scarified material for loading into trucks for removal from the airstrip. The rock in the hump being extremely soft, decomposed rock, in the form of a thin sheet over compacted earth ripped out easily.

Recommendations were made to Engineer Said Hakim, Director of Public Works, Fezzan, for the use of a steel drag to keep the airstrip surface smooth, especially at the ends of the airstrip where the aircraft propeller wash causes severe washboarding of the surface.

Drawings and directions were furnished to Engineer Hakim for the construction of a steel drag and he reports that the removal of the hump and the use of the steel drag has resulted in a satisfactory surface for the use of aircraft.

F. EQUIPMENT

According to the scanty information available, the first purchase of equipment was made in the 1954-1955 fiscal year. This equipment consisted entirely of surplus military trucks which were purchased from the Surplus Property Office at Wheelus Air Base, Tripoli. These trucks proved to be highly unsatisfactory, due to frequent breakdowns, difficulty in obtaining spare parts and high operating costs.

As funds were made available by the Libyan-American Reconstruction Commission, purchases were made of new modern equipment. The first contract for new equipment was let in June 1956 for the following equipment:

7 - Mercedes-Benz dump trucks, 4-1/2 tons
2 - Mercedes-Benz w/1000 gallon water tanks
1 - Mercedes-Benz flat bed truck, 4-1/2 tons

The total cost of this equipment was LL 21,260.000.

Additional equipment was purchased with Federal Roads Department budgetary funds. The date of purchase is not known, but it is assumed that it was purchased in 1956. This equipment was as follows:

1 - Ashurst Bituminous Distributor, Truck Mounted, 1100 Imp. Gal. Capacity Pressure Spray Bar
3 - Ashurst Bitumen Heaters 1000 Imp. Gal. Capacity
1 - Greens Griffen Road Roaler 3 wheel, 6-8 tons
1 - Thornycraft 10 ton flat bed truck
1 - Dyson 12 ton full trailer
3 - Spreader Boxes, truck tail gate type
1 - Road Broom, Traction Powered

These units were purchased for the "Surface Dressing Plant" of the Federal Roads Department and were based in Tripolitania.

During February 1957, orders were placed for additional equipment to form another "Surface Dressing Plant", as follows:

1 - Thornycraft 10 ton truck
1 - Dyson 12 ton full trailer
2 - Road Brooms, traction type
3 - Spreader Boxes, tail gate type
1 - Aveling Barford 3 wheel roller, 6-8 tons
3 - Ford diesel dump trucks, 3 ton capacity
1 - Ford 1/2 ton pickup truck
1 - Ashurst Bitumen Distributor, truck mounted with pressure spray bar 1000 Imp. Gal. capacity

The total cost of this equipment was LL 15,939.000.

Four motor graders were also purchased in 1957 for use on maintenance of the Fezzan Road which is not surfaced. The cost of these graders was LL26,773.484.

The equipment found in possession of the Federal Roads Department as of June, 1957, was almost new and in good condition, with the exception of six motor graders which were in very poor condition. Not one of the six could be operated. Two of these machines were repaired and placed in service on the Wadi Megenin Surfacing Project. The two oldest machines were sold as obsolete and unrepairable. One was used for spare parts and one is still awaiting repair. The two machines repaired and placed in service have been costly to operate due to frequent breakdowns and lost time.

From time to time, prior to June, 1957, the Federal Roads Department purchased small dump trucks as funds became available. The trucks were assigned to the various road maintenance districts as needed.

The Federal Roads Department of Libya operates repair shops in Tripoli, Sirte, Hon, and Benghazi for the repair and service of Road Machinery. These shops are not equipped with tools or shop equipment in sufficient quantity to enable the Federal Roads Department personnel to undertake any heavy repairs of road machinery.

When the equipment breaks down, the Federal Roads Department makes arrangements with the agent or dealer from whom the equipment was purchased, to make the necessary repairs and installation of new parts. When a large quantity of replacement parts are needed to make repairs the dealer rarely has them in stock and the parts must be ordered from England or Europe. This causes a delay of 6 to 8 weeks before the required parts arrive in Libya.

The Roads Department personnel service the equipment only to the extent of washing and greasing of motor graders. Trucks and other light equipment are sent to commercial establishments in Tripoli and Benghazi for this service. In Sirte, Hon, and Sebba, where commercial services are not available, the equipment is serviced to the extent of availability of tools for this purpose.

Early in 1958, the sum of LL 1,400.000 was made available to the Federal Roads Department for the purchase of shop equipment. This money was expended for washing and greasing equipment for the shop, operated under the direction of the Controller of Federal Transport. The Controller of Federal Transport is, in turn, under the direction of the Ministry of Communications. The duties of the Controller of Federal Transport, and his asistant, are to supervise and effect repairs and service on all equipment owned and operated by the Ministry of Communications. The Federal Roads Department is a unit of the Ministry of Com-

munications and all roads department equipment, in theory, is serviced and repaired by the Controller of Federal Transport.

This does not work out in practice to the advantage of the Road Department because the efforts of the Transport Shop are expended entirely on the service and repair of vehicles used by the officials of the various departments under the Ministry of Communications. This system allows no priority for repair of road equipment which is often urgently needed for road maintenance.

During the two year term of the consultant's contract, several recommendations were made concerning the repair shops and the equipment and tools needed to put the shops into efficient operation. Lists of shop equipment and tools, along with specifications, were drawn up and submitted for approval but no action was ever taken on the consultant's recommendations. It was pointed out that the repair and service of the road machinery should be under the direct control of the Roads Department in order to ensure first priority for repairs and service.

Some of the equipment repairs have been made by the consultant's equipment engineer in order to arouse interest in the Roads Department personnel. During the course of the repairs, the actual manual work was turned over to the ones who were interested in learning to make the repairs. Since some interest was shown by Roads Department personnel, it was recommended to the Department that a training course be established for mechanics.

As yet no real action has been taken by the Federal Roads Department toward equipping repair shops or training personnel.

G. MAINTENANCE

Both the Federal Roads Department and the Provinces have some sort of maintenance organization. All of these organizations were notable for their dependence on hand labor and the scarcity of mechanical equipment. By reason of the lack of any bulk storage facilities in Libya all bitumens, regardless of type, had to be shipped and handled in drums. The greater part of the bitumen were heated in medium sized kettles, equipped with small power pumps, and applied by hand hose or by even more primitive methods. The Federal Roads Department had one truck mounted distributor and had recently acquired another. Unfortunately, however, both pieces of equipment depended on pressure from a power take-off from the truck motor instead of having adequate auxiliary motors as is the case with a properly designed modern distributor. The result of this situation was an evident lack of uniformity in application of bitumens and excessive costs by reason of low production. Many pavements had suffered severely from war-time traffic and from lack of attention in the post-war period. Maintenance activities were largely a matter of rehabilitation rather than normal maintenance. Notably on the Fezzan Road, methods in use were such that even under the very light traffic it could not be satisfactorily maintained.

Shoulders and longitudinal drainage were for the most part completely unsatisfactory. This was particularly unfortunate by reason of the fact that the usual maximum paved width is only five meters with the result that traffic must use the shoulders to pass. The bad shoulder condition also resulted in causing water to flow along the edge of the pavement for long distances causing erosion, dangerous traffic conditions, and expensive sand and mud removal, and repair costs.

Possibly the worst condition of all was the lack of a competent and well organized supervisory force to plan and direct the work. Along with this went a lack of proper cost accounting so that there was inadequate fiscal control. The result of this situation was recurring financial emergencies due to the expenditure of funds on unauthorized projects and consequent lack of funds to complete the projects to which the funds had been allocated.

H. SIGNS AND MARKINGS

Prior to 1957, there had been little or no signing and marking of the highways of Libya. There were a number of old signs in places, but these, besides being too few, were mostly either not legible or of a non-standard design. Pavement markings consisted almost exclusively of the use of metal buttons to make the center line, and there was very little of this type of marking.

In the latter part of 1957, the Federal Roads Department began signing the Coast Road. In 1958, the Public Works Department of the Provincial Government of Tripolitania began a signing program and the Traffic Police Department began a signing and marking program in Tripoli. Only the signing program of the Federal Roads Department was financed by LARC, so this was the only program in which the Upham Associates participated.

Prior to the arrival of the consultants, the Federal Roads Department had contracted for the purchase of 977 regulatory and warning signs. It had been estimated that these would be sufficient to sign the Coast Road from Tunisia to Egypt, but additional signs had to be purchased later.

In the fall of 1957, the Federal Roads Department requested the consultants to organize and advise crews for the placing of the signs. It was decided to organize two crews, the first to mark the proposed locations and the second to erect the signs. The marking crew was organized out of the Tripoli office. This crew worked the entire length of the Coast Road marking with yellow paint on the pavement the location and type of sign to be erected. The erection crews followed the marking crew and placed the proper sign where indicated. Erection crews were drawn from the personnel of the Division in which the signs were erected.

The Coast Road now has regulatory and warning signs from border to border. To date the Federal Roads Department has orderered no distance and direction signs to be used at the intersections. However, Federal Roads has been for some time in the process of tabulating the distance and direction signs that will be required.

Following is a report prepared in January, 1958, by a member of the consultant's staff for consideration. The paper never was discussed, however, it is felt that its contents are still applicable.

Introduction

Uniformity in traffic laws and regulations is widely recognized as one of the most important objectives in a program to reduce accidents and facilitate the flow of traffic.

No attempt will be made to go into the strictly legal end of the problem but it is hoped to point out the desirability and necessity of having a uniform system of signing and marking the highways and streets of Libya from the standpoint of safety and orderly movement.

The commonest device for controlling, safeguarding, or expediting traffic is the traffic sign. Signs are essential where special regulations apply at specific places or at specific times only, or where hazards are not self-evident. They also are needed to give information as to highway routes, directions, destinations, and points of interest.

It is of the utmost importance that highway signs be uniform and simple in design so that they can be recognized and understood at a glance. It is of the utmost importance that all signs be standardized as to size, shape, color and location. Markings also have definite functions to perform in a proper scheme of traffic control. They can be used to supplement the regulations or warning or other devices such as traffic signs or signals. In other instances they obtain results, solely on their own merits, that cannot be obtained by the use of any other device. In such cases they serve as effective means of conveying certain regulations and warnings that could not otherwise be made clearly understandable. As in the case of signs it is highly desirable that markings should be uniform in design, position and application.

The Present System

The discussion of the present system will be confined to signing only as there is no program for marking except in the major cities and this is confined mostly to the marking of pedestrian cross-walks, lane lines, directional arrows and stop lines.

At the present a signing program is being carried out by the Federal Roads Department, the Public Works Department of Tripolitania,, and in the Tripoli area by the Traffic Department of the Tipolitania Police. Other agencies authorized to sign highways are the Nazirates of Communications of Cyrenaica and Fezzan. The number of agencies involved is in itself an argument for the need of standardization.

Fortunately there is a certain standardization of signing in present use. The signs now being erected conform to the designs of those recommended by the 1949 United Nations Protocol (Geneva) commonly known as the "International System". This system of signs was designed to eliminate the language barrier by the use of distinctive shapes and easily understood symbols. In general the signs are divided into three broad categories, as follows:

I. Danger Signs; triangular in shape

II. Signs giving definite instruction; circular in shape--subdivided into:

A. Prohibitory signs
B. Mandatory signs

III. Informative signs; rectangular in shape--subdivided into:

A. Indication signs
B. Direction signs
C. Advance direction, place and route identification signs

This is an excellent system; the one used throughout Europe. The colors in general are a red border, white background and black symbol. A blue background is used on certain of the Informative Signs.

Suggested System Based on 1952 U.N. Protocol Signs

At a meeting in New York in 1952, of the Transport and Communications Commission Group of Experts on Road Signs and Signals of the United Nations drafted a new protocol on a uniform system of road signs and signals. It appears to be the intent of this protocol to recommend a system of signs that would combine the best features of the American System and the "International" System.

This system adopted the American sign shapes but retained the "International" System symbols, in some cases with slight modifications. It also divides the types of signs into three broad categories, namely:

I. Danger; warning signs--diamond shaped or triangular

II. Regulatory signs; rectangular with the long axis vertical or circular. (Except the "Stop" sign with its octagonal shape.)

III. Informative; rectangular with the long axis generally horizontal

The colors recommended are as follows:

For the danger; warning series, a yellow background with black symbol

For the regulatory signs, a white background, a red circle (and red cross bar on prohibitive signs) with a black symbol.

For informative signs, white background and black lettering.

Advantages and Disadvantages of Each System as Pertains to Libya

1949 U.N. Protocol (present system)

Advantages

1. Familiarity with system because of current use.
2. Have been adopted by the greatest number of nations and are in widespread use in Europe.
3. Will probably be more economical, sign for sign, until such time as Libya purchases its own sign shops.

Disadvantages

1. Involves a complicated system of shapes and colors especially for reflectorization purposes.
2. Considerable waste of materials due to circular and triangular shapes. There is about 22% waste in cutting a circular sign from a square sheet and considerable waste in fabricating the triangular shapes.
3. Wide red border, if reflectorized, tends to impair legibility of the symbol.
4. Less susceptible to mass production and more expensive production machinery required for producing circular signs.
5. The white background and small symbols make the signs difficult to see against a background of the sky, as in the case of the desert roads.

1952 U.N. Protocol

Advantages - (based on using diamond shaped danger-warning signs and rectangular shaped regulatory signs)

1. Simplification of shapes and color schemes especially for danger-warning series.
2. Danger-warning signs present larger target area and allow for larger symbols.
3. Minimum of material waste in manufacture.
4. Ease of fabrication including reflectorization.
5. Provisions for adding appropriate word messages to augment International symbols.
6. Already in use in Turkey, Jordan and Egypt and approved in principle by Lebanon, Iraq and Syria. Opportunity is afforded for this system to be used throughout this region.
7. The symbols used are already familiar to the motorists.
8. A change over from the present system to this system could be gradually accomplished.

9. The "Stop" sign is octagonal in shape. It is the only sign of this shape and is therefore easily recognizable for what it is even from long distances.

Disadvantages

1. Introduction of a new or partially new system.
2. Although possible adoption on a regional basis appears feasible, world-wide adoption does not appear promising.
3. The cost per sign may be more at the beginning, particularly if signs will continue to be purchased from Europe where International signs are standard.

Recommendations

1. It is recommended that Libya adopt the sign and marking standards as recommended by the 1952 (N.Y.) United Nations Protocol. These signs can be gradually integrated with the old signs, replacing the old signs after they have deteriorated beyond effective use.
2. If it is decided not to adopt the 1952 U.N. Protocol but to continue to use the present system it is strongly recommended that the background of the danger signs be changed from white to yellow. This is permissable in the 1949 U.N. Protocol. The yellow background will greatly improve the daytime visibility of these signs.
3. The Government of Libya should authorize some agency to prepare a manual for a uniform system of signing and marking highways and streets and should pass the necessary legislation to cause all signing and marking agencies to adhere to the standard set forth in the manual.
4. A committee should be appointed to study the feasibility, economic advantages and legislation required for purchasing, setting up and operating a central sign shop that could manufacture and supply the signs required by all of the road and street agencies in Libya.
5. Agencies that are in charge of roads and streets whose safety and ease of traffic flow could be benefited by paving marking should be encouraged to purchase modern pavement painting machines.

During 1958 the first traffic signal lights ever installed in Libya were put into operation in Tripoli.

These being something entirely new for the majority of the posters showing the proper use of signal lights should be initiated before the lights were put into operation. The consultants were requested by Lt. Col. Ali Aghil, Superintendent of Police, Traffic Department of the Tripolitania Police, to participate in the safety campaign to the extent of designing safety posters.

The most difficult problem faced was that of getting ideas for the posters. It was necessary first to determine the message to be carried, to whom should the message be conveyed, and what was the best way to show this message on a poster. In order to get ideas for the posters the Ground Safety people of the 17th Air Force were contacted. They furnished copies of safety posters published by the National Safety Council and other helpful safety material. Additional safety material was requested from and furnished by the following organizations:

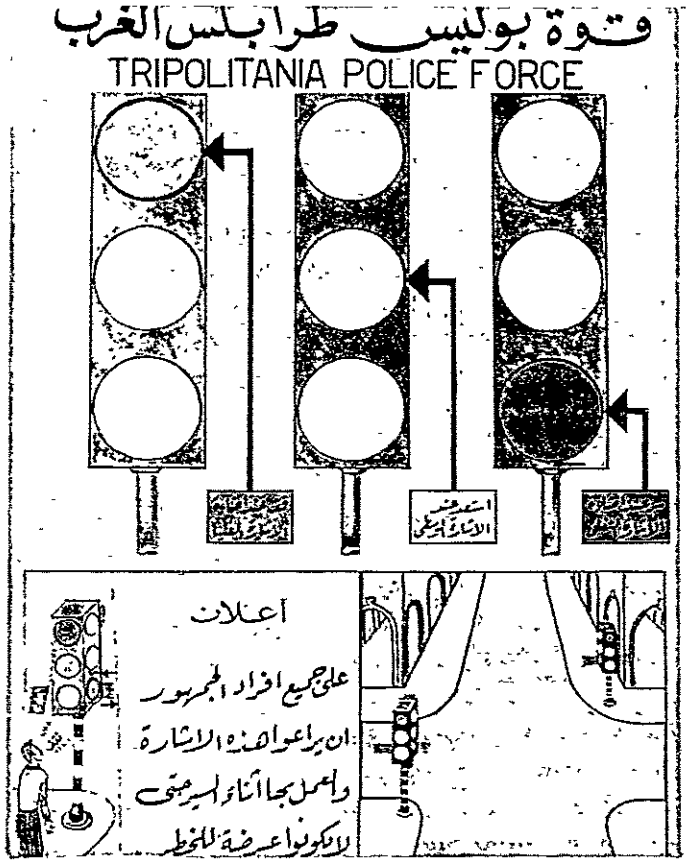
American Automobile Association
National Association of Automotive Mutual Insurance Companies
Automobile Manufacturers Association
The Travelers Insurance Companies

The material received from the above organizations was gone through to extract all ideas dealing with the safe use of traffic signal lights. These ideas and others thought up by the personnel involved furnished the basis for the design of the posters.

The actual drawing of a poster was rather routine once the idea for it had been discussed and decided upon. However, the layout was complicated by the fact that any written message had to be written in 3 languages, Arabic, English and Italian. The drawing process was as follows: the idea to be expressed was gone over thoroughly with a LARC draftsman, the draftsman then sketched out the poster, next an Upham engineer carefully checked the layout and returned it to the draftsman, with suggested changes, to be drawn in its final form for presentation to the printer. In all, some 18 posters have been prepared, 9 of which have been approved to date by the Traffic Police and printed by the Government Press in Tripoli.

There were 5000 copies made of each poster, most of them in 4 colors. The posters were 37.5 x 50 centimeters. Posters were distributed throughout the Province of Tripolitania. They were posted on walls and buildings in the cities and villages, and distributed to all schools. In addition they were posted in bars, cafes, filling stations, stores and many other public places.

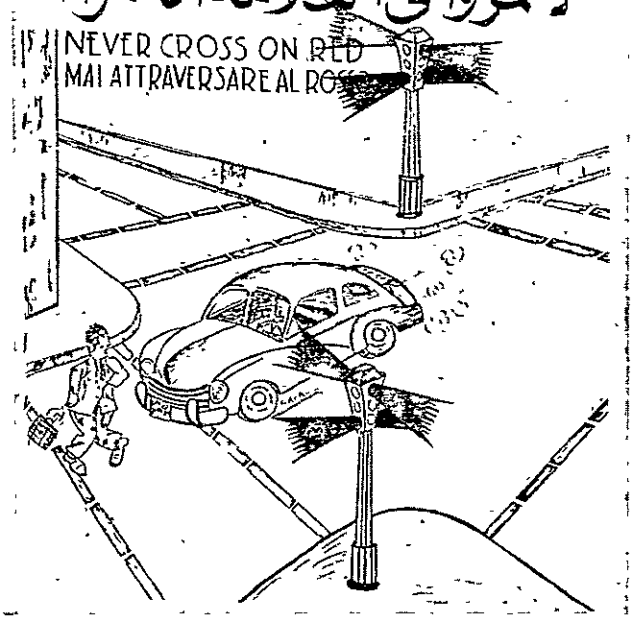

قوة بوليس طرابلس الغرب
TRIPOLITANIA POLICE FORCE
STOP
قف
ALT
WARNING
استعد
ATTENZIONE
GO
سر
VIA


قوة بوليس طرابلس الغرب
TRIPOLITANIA POLICE FORCE
اعلان
على جميع افراد الجمهور
ان يراعوا هذه الاشارة
ويعملوا بها اثناء السير حتى
لا يكونوا عرضة للخطر

قوة بوليس طرابلس الغرب

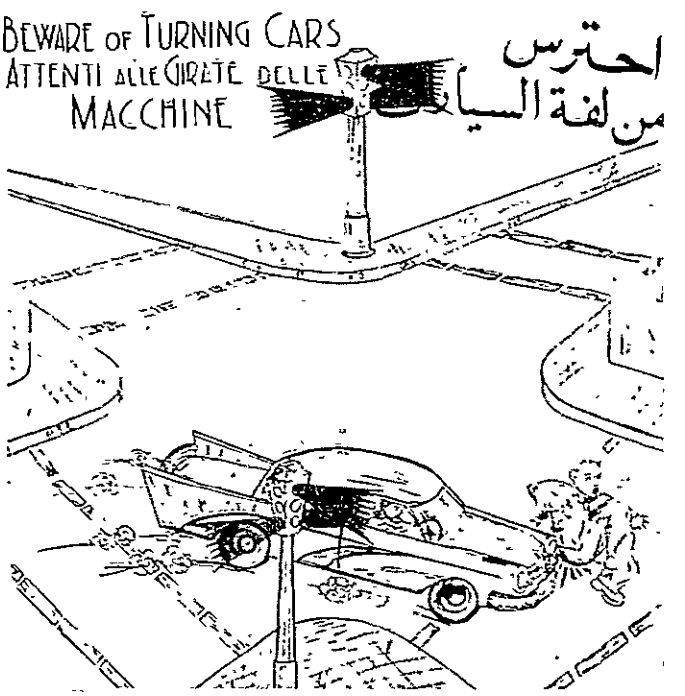
TRIPOLITANIA POLICE FORCE

لاتمروا فى العلامة الحمراء



قوة بوليس طرابلس الغرب

TRIPOLITANIA POLICE FORCE




انظر الى الاطفال قبل مرورهم على الطريق
WATCH FOR CHILDREN CROSSING
TENER I BIMBI NELL'ATTRAVERSARE


قوة بوليس طرابلس الغرب
TRIPOLITANIA POLICE FORCE
انتظروا العلامة الخضراء
WAIT FOR THE GREEN
ASPETTARE AL VERDE


ارتدى لباسا ذو الوان فاتحه بالليل .
إستعمل فرملك دراجتك بدل الاعتماد على قوة السيامه
تحاشى الإستهتار في القياده
تأكد أن النور الأمامي والخلفي غير معطلين
سر بالدراجة بانفراد وليس أزواجا أو اكثر .
لاتسمح لغيرك بالركوب معك في الدراجه
تلافى الخطر واحكم دراجتك بتعقل .
سر بجانب الدراجه عند قطع الطريق في حالة ازدحام المرور
إشارات الدوران باليد
١ الدوران على الشمال
٢ الدوران على اليمين
٣ إشارة التوقف
تابع السير على اليمين من الطريق
قف قبل الدخول الى الطريق الرئيسيه
إمنح الطريق لمن بيمينك
إستعمل محطة الوقوف بعيدا عن الطريق
إستعمل ممسك الأسفل السروال .
إستعمل الجرس او البوق .
إستعمل حمالات خاصة للطرود والبضاعه
تأكد أن الفرامل في حاله جيده للإستعمال .
إحفظ الدراجه نظيفه .
احفظ العجلات منفوخة بالهواء بالضغط المطلوب
إحفظ البراغي والصامولات في حالة مشدوده .
إستعمل الشحم أو الزيت لأجزاء الدراجه .

PART III
REQUIREMENTS FOR CONTINUING ACTIVITIES

A. CURRENT NEED OF CONSTRUCTION

The most pressing need for highway construction is an accelerated program of resurfacing on the Federal Coast Road.

At the close of World War II and for several years thereafter this road was in a poor state of repair because of lack of maintenance and insufficient repairs of the damage caused by war time traffic.

Since 1955 American Assistance Funds have allocated by LARC for the restoration of this road and definite improvements have been made. Resurfacing is being done on the basis of priority and therefore at scattered locations between the Tunisian and Egyptian Borders. However, the rate of progress of the resurfacing program is not keeping pace with the rate of deterioration that is occurring now and can be expected to continue to occur.

The road has been in use for more than thirty years and in spite of neglect and adverse use, its condition is better than may be normally expected. However, this condition cannot be expected to endure indefinitely. At the present rate of progress of the resurfacing program it will take over ten years to resurface the entire Coast Road. By that time there will be many sections of pavement again requiring restoration.

To restore this road to an acceptable condition within a reasonable period of time, due consideration must be given to the problems of financing, limitations of contractors, equipment, capable equipment operators, engineers, etc. Probably the minimum time necessary to complete the resurfacing would be five years and for this reason a program is included in this report to do the resurfacing of the Coast Road within a period of five years.

It must be emphasized, however, that with a five year program of resurfacing, normal and effective maintenance will still be required continuously on this road.

A satisfactory program of highway construction for Libya needs to include little more than enough to bring the Coastal Highway up to a satisfactory standard. The economical way to reach such a standard is by placing a thin layer of bituminized surfacing over the existing pavement.

In the proposed current program the estimated cost, based on current contract prices, is $3,300 per kilometer. At this unit price a minimum resurfacing program for the 1951 kilometers of Coastal Highway would cost approximately $6,000,000.

A low cost bituminous surfacing of the type contemplated in this estimate has a service life of about fifteen years. Weather is the significant element in service life and in fact the pavement would endure longer with more traffic because the larger volume would tend to retard oxidation which causes the asphalt to become brittle and crack up.

Thus a six million dollar program of resurfacing if completed in five years, could produce a highway expected to serve another ten years with minimum maintenance.

To condition the Federal Coast Road to adequately serve the present and anticipated traffic, the following should be done:

1. Place a seal coat as a minimum, on all areas where the surfacing is cracked, raveled or otherwise showing signs of deterioration. A seal coat, consisting of a light application of cut-back asphalt such as RC-2, will seal the cracks, and delay the deterioration for several years. This is merely preventative maintenance and will do very little to improve the riding qualities of the road. Before placing this seal coat, however, all holes should be patched.

2. Resurface the entire road, not only to add new life to the pavement but also to obtain a smoother riding surface by eliminating the bumps, hollows, corrugations and other irregularities. Resurfacing should not be done in any section where the alignment will be corrected.

The existing subgrade and base course are supporting the traffic loads satisfactorily and it is not necessary to disturb them in resurfacing. The only new base course needed will be for new construction.

Neither is it necessary to disturb any existing pavements. In fact it is much better to use them just as they are now that the roadbed is well compacted. All that is required is smoothing the riding surface. This can be done economically by at least two methods either of which adds a light surfacing course over the existing pavement. First is the penetration method, already described, which was introduced during 1958 and used to resurface 117 kilometers. Second is the premix method which has not yet been introduced in Libya. The second method can be expected to give a much smoother riding surface. It also consists of spreading a thin layer of surfacing on the existing pavement.

The essential difference between these methods is that in the second method the aggregate and cutback are mixed before spreading. A small-sized aggregate and cutback are mixed before spreading. A small-sized aggregate or sand would be best for this because the layer needs to be about one inch thick (2.5 cms.) as a minimum. It would be spread over the existing pavement by means of a grader

(motor patrol) or paver. Using premixed aggregate makes it possible to smooth up the existing rough pavement by filling the depressions and cutting high spots. This new layer, therefore, would vary considerably in thickness and for this reason the minimum thickness of the layer is limited to the maximum size of the aggregate. In fact it will be desirable to put this surfacing down in two courses, or more, using the first courses to level up the existing pavement even if they do no more than fill holes and depressions. The essential idea is to compact each layer thoroughly. The asphalt should be a cut-back so that the pre-mixed aggregate can be manipulated and placed with a liquid bitumen not requiring heat to remain workable during the process.

Mixing of the aggregate and asphalt can be done in several ways; the most logical for the present would be using ordinary concrete mixers. Charging, or loading, the mixers can be done satisfactorily by hand labor using wheelbarrows. The mixers are already on hand and idle. Four or more mixers should be used together in a group. Each mixer requires five or six men and therefore the total labor force employed in such resurfacing operations would be significant.

Even with hand labor used this way the operation would be economical, costing about $3,000 to $3,500 per kilometer, but most significantly it affords the opportunity to obtain a smooth riding surface while taking maximum advantage of the existing pavement. The final riding surface will be as smooth as the skill of the grader (motor patrol) operator permits, and this is the critical detail of the whole operation. A skilled operator may be able to get better surfaces with a paver.

3. Finish reconstruction of the birdges. Particular locations are Km. 41, 71, 144, 512 and 558. A contract for the construction of a 24-meter three-span, reinforced concrete T-beam bridge at Km. 558 was awarded May 13, 1959. Another contract for a similar bridge at Km. 512 was awarded June, 1959. Design of the bridge at Km. 71 is under way now and will be awarded to contract for construction shortly.

4. Smooth out the alignment, particularly where sharp curves occur in otherwise high speed alignment. Most of these sharp curves can be corrected by lengthening the radius of the curve. Through open country, all curves with a radius of less than 600 meters should be reconstructed, and flattened. Quite often a curve can be reconstructed on new alignment cheaper than attempting to superelevate the roadway adequately on the existing alignment.

5. Control sand drifts, which cover the road in some places, especially in the Agedabia area. Much of this sand could be prevented from getting to the road if barriers were built on the windward side of the road from 50 to 100 meters from the road. Since it is not practical to grow trees, barriers erected with old bitumen barrels are quite satisfactory.

6. Recondition several more cantonieras to provide living quarters for workmen and engineers, particularly in isolated areas, where accommodations are extremely poor or non-existent. These places are needed for storing equipment and supplies used for maintenance and especially during resurfacing operations.

7. Purchase equipment needed for resurfacing; this is a continuing process since no pavement is really permanent. A limited amount of equipment is needed by the Government forces to do maintenance work. The contractors are buying their own equipment for the bulk of construction work. The equipment needed by the Government forces for maintenance work would include: rock crushers, motor graders, asphalt distributors, dump trucks, front end loaders and tools for repair shops.

After making a survey of the important Coastal Highway the Upham organization endeavored to change some of the conditions which seemed most in need of attention. Emphasis was placed on elimination of the use of "Soling" in base courses of pavements and in maintenance activities on the Fezzan Road. It was pointed out that subgrade conditions almost universally throughout Libya were ideal with the result that the heavy "Soling" base courses were unnecessary and needlessly expensive. Emphasis was placed on the use of local granular materials of a type which had been found both economical in cost and eminently satisfactory in results under traffic and climatic conditions in the United States much more severe than those involved in Libya. As was to be expected, resistance to changes in old established procedures was encountered.

An endeavor was made also to improve the methods being used in the making of surveys and the preparation of plans. Here considerable difficulty was experienced due to a scarcity of trained and competent personnel and to frequent turnover in personnel. Unfortunately practically all engineering personnel must be brought into Libya from foreign countries on short term contracts. The result is that the same training must be repeated again and again. Resistance was also encountered from sources which were unexpected and not too easily understandable. There are, however, indications that some of the recommendations have been accepted and are being belatedly adopted.

With respect to future operations, it is pertinent to reiterate the fact that portions of the Coastal Highway have been resurfaced since World War II, but are now found to be in such condition as to require more than normal routine maintenance. Only such resurfacing work as has been done within the last two or three years is in such satisfactory condition as not to require at least a seal coat. Due to the absence of sufficient traffic to keep the bituminous surface kneaded and compacted, there is a tendency for the surfaces to oxidize and crack up even before they show any tendency to wear out. This would indicate the desirability of experimenting with the use of softer SC types of (cut-back asphalts) which contain greater percentages of slow curing fractions which do not so rapidly oxidize. It would also appear possible that the cost of rehabilitation of Provincial roads may be greatly

diminished by reshaping them with low grade materials such as sand, clay, or coalina, and surface treating them with one of the slow curing asphaltic materials. This type of surface has been found ideal in the United States on "Farm to Market" roads even under climatic and subgrade conditions much less favorable than those in Libya.

It is pertinent to mention that one bitumen supplier is already prepared to make bulk deliveries of bituminous materials, and another will very soon be similarly equipped. Such being the case the purchasing of bitumens in drums for seal coat, resurfacing, or new construction work should be completely eliminated. Furthermore contractors and governmental highway organizations should provide themselves with the necessary facilities to use bitumens in bulk. Such a procedure should result in significant performance improvements and materially lower costs.

B. ADDITIONAL DESIRABLE CONSTRUCTION

The proposed current two-year program, which is also included in this report, does not mention construction of new roads because needs for new roads are not pressing. However, this does not mean that need for some re-construction does not exist. It merely means that salvaging the existing pavement is of first importance and is probably all that will be accomplished with funds likely to be made available.

Some minor construction that would improve the Coastal Highway and materially reduce presently existing traffic hazards consists of realigning, or flattening, excessively sharp horizontal curves. Several areas are specially in need of such construction, for example, between Misurate and Buerat there are at least a dozen sudden, sharp kinks in an otherwise straight alignment. Again between Derna and Ummer Zeim the present road is very crooked and in some places has both sharp horizontal and vertical curves occurring together. Alignment such as this adds up to more than 50 kilometers. Relocation and re-construction of these bad sections of new alignment would cost about $15,000 per kilometer.

Of a more costly nature is re-alignment between Tripoli and Homs. Here traffic is reaching a volume warranting consideration of constructing a modern highway. Major relocation would be necessary for most of the 100 kilometers as it is seldom practical to salvage an old road such as this with its crooked alignment, and choppy grades. Consequently this major construction can be expected to cost $30,000 per kilometer, or about $3,000,000.

Other than this, however, the need for new highways is not apparent. The Coastal Highway has been in existence for more than thirty years and still carries a meager volume of traffic. It does tie the vital parts of Libya together and therefore is important, but in itself has not, or cannot, do much to develop the vast areas of unproductive land. Inaccessibility is not a primary problem in Libya and new roads will not make the barren desert productive.

C. NEEDS FOR PROVINCIAL ROADS

The traffic potential to justify any new construction on Provincial roads does not exict at this time. Furthermore the provinces already have more road system than they can cope with and each kilometer of new road increases the maintenance obligation by that much more. An example is the Martuba-Lamluda road in Cyrenaica which has deteriorated to such a degree that major reconstruction will be needed to put it in serviceable condition again. As a war expedient to bypass Derna it was quite useful but now it serves very little traffic.

Moreover some roads, such as the Susa-Derna route, have never been fully completed. On this route there are some twenty-four bridge sites with various kinds of temporary streambed crossings, most of them serious death traps. These bridges should be built but it is a major project that will cost $1,250,000.

Nevertheless, in Cyrenaica, new construction has been started on the Tocra-Tolmeta route with the entire amount of available funds concentrated on this one route. The project should be completed now that it has been started. This means construction of the additional 30 kilometers of the route to the standard now started with 5-meter width of bituminous surfacing to cost about $450,000.

One area in Cyrenaica that may develop with new Provincial Roads is the rolling, open land between El Abiat and El Marj (Barce). Presently the road has been paved from Benina to El Abiat with a bituminous surfacing three meters wide. Beyond El Abiat to El Marj the present road is no more than a dry weather track, or series of tracks. The area is presently served by Cyrenaica's only railroad. However an all weather road would serve the local traffic better and more economically.

The area between Beida and Slonta or between Shahat (Cyrene) and El Faida would also benefit from farm to market roads.

The real needs for provincial roads are well indicated in the following selected reports:

Nalut - Ghadames (330 km.) Tripolitania Provincial

The consultant's engineers made a "Land Rover" inspection of the Nalut-Ghadames Road.

The road in general is the standard 3 m. width "Soling" on a road-bed averaging 5 to 6 m. in width. Except for short distances where the "Soling" is exposed there is a cover of smaller stone and/or fine material. The road-bed is structurally sound but extremely rough riding due to the heavy corrugations and exposed rock. The horizontal alignment is generally quite satisfactory although there is room for minor improvements. The vertical alignment is satisfactory except for

isolated humps and dips that should be eliminated. There are places, of course, where the grade is too low and should be raised. Wadi crossings are not a major problem. The existing crossings have no special protection, other than occasionally some extra "Soling", and they have not been badly washed. However, it should be noted that the rainfall was unusually light in this section this past winter.

For convenience the road is broken down into three natural and nearly equal sections, as follows:

Nalut - Sinaven, km. 0 to km. 114

From Nalut for a distance of four kilometers the road zig-zags along top of a ridge. It is unpaved but in excellent condition. For the next five kilometers it has a bituminous surface. The road descends the gebel into a wadi and back up the gebel on the other side. After that the first 60 Km. of the terrain is relatively flat and for the remaining 54 Km. to Sinouen it is gently rolling. The soil is mostly sand and small stone with some evidence of surface rock. The areas adjacent to the road are excellent for vehicular traffic and many vehicles ride here in preference to the road itself. There is excellent road building material all around. This is the roughest section of the road and in places is only 3 m. in width.

This section has had less maintenance in recent years than the other sections probably due to the good riding qualities of the surrounding desert. A motor grader and drag could be used to advantage here.

Sinauen - Derj km. 114 to km. 225

This section runs through rolling country covered with large stones which make it impossible to leave the road proper. The road is very rough riding and in many places the riding surface consists of exposed surface rock. Cover material should be placed on almost the entire length but will be difficult to get due to the large areas of exposed surface rock. The use of a motor grader for maintenance would be of doubtful value through this section but a drag would be helpful in smoothing out the corrugations in areas where the "Soling" or surface rock is not exposed.

Derj - Ghadames km. 225 to km. 330

This portion of the road has been recently improved. It runs through a sandy area. There is no visible evidence of "Soling". The surfacing is of tinn or similar material and has excellent riding qualities when kept reasonably smooth. The through road from Nalut to Ghadames by-passes Derj and is not often used.

This portion of road has "Soling" reasonably well covered throughout. The last 25 Km. shows recent maintenance work and is in good condition but fairly rough riding. For about 50 Km. (Km. 253 to 303) there are areas where sand drifts across the road and in some places the sand is sufficient to stall 2 wheel

drive vehicles. There were only two sand dunes encroaching on the road at the time of inspection to be by-passed. Fortunately most of the surrounding area is such that drifting sand and dunes can be by-passed without too much difficulty even by 2-wheel drive vehicles. Except for the two dunes, all areas of drifting sand on the road are caused by man-made sand-traps. In places the grade is too low and sand is trapped. In many other places the grade is satisfactory and high enough but sand and stones have been thrown up in mounds on each side of the road and form an artificial sand-trap. The maintenance method now used of hand shoveling drift sand to the sides gives only temporary relief and makes the next drifting worse.

A motor grader and drag could be used to advantage throughout this section for maintenance. A bulldozer could be used to advantage through the sand area for the initial improvements required.

The major problem on this road is maintaining a reasonably smooth riding surface. This is impossible with the crews presently employed and impracticable using only hand labor. Mechanized equipment must be used. Of course one big problem of maintenance of the surface is the almost complete lack of water in this area. There is also the problem of financing the maintenance and improvements, particularly as to the amount that can be warranted to be spent on this road. It is doubtful if the road carries as many as 2000 vehicles per year so any large expenditures could be warranted only as development roads for connecting different areas of the country and keeping open a good route of communications.

Recommendations

1. If this road is to be reasonably well maintained it is recommended that at least trucks and road drags be made available. Motor graders would be very valuable, especially on the Nalut-Sinauen and the Derj-Ghadames sections. The ideal solution would be to employ motor graders to shape the road and then leave them in the vicinity for permanent maintenance of this and other roads in the area. A bulldozer would be very helpful in getting the road originally shaped up, particularly in the sand area between Darj and Ghadames and the rocky area between Sinauen and Derj.

2. It would be of extreme value to the road program and to the area in general if it were possible to locate water along the route and to install permanent wells.

3. It is strongly recommended that direction signs be placed at the intersections of all roads in this area, and this should be done as soon as possible.

Nalut - Giado Road via Gaboa

This is the gebel road connecting Nalut and Ciado. Its major importance is that it is the only outlet to the north, east and west for the numbers of people living in the gebel in this area. The people are served by a weekly bus making the

run from Giado to Giosc to Nalut and back via Gaboa to Giado. As long as the Giado-Giosc-Nalut road is operational this road is essentially a local road and a feeder road to the south bound roads of very minor importance.

The road has the standard "Soling" covered with smaller stone and/or fine material. The road-bed varies in width from 3 to 7 m. but for most of its length is from 5 to 6 m. The road-bed is structurally sound but rough riding due to corrugations. The first 40 Km. from Nalut is in excellent condition but the remainder has fair and bad areas and needs maintenance work. The horizontal alignment is generally good but improvements could easily be made if warranted. The vertical alignment is satisfactory except for certain areas where it would be advantageous to raise the grade. Sand drifts across the road in certain areas and in some places get deep enough to stop the bus. These areas can be improved by raising the grade, eliminating the man made mounds on each side or by relocation. Throughout most of the distance relocation s no problem as excellent road building materials are plentiful all along this route.

The road crosses some 140 small water courses, 8 medium sized wadis and 2 bridged wadis on the Giado end. A number of the wadis have paved crossings in various stages of repair. The majority of the small wadis or water courses apparently have low volume at low velocity and can probably be ignored or crossed with small pipe.

Beginning at Nalut the first 4 km. zag-zag along the ridge top, are unpaved but in excellent condition. The next 5 km. are paved as the road climbs down the gebel into a wadi and back up again on the other side. At Km. 9 the pavement ends and the Giado road turns east off of the Nalut-Ghadames road. This report refers to that portion of the road from this intersection into Nalut.

Recommendations

This road is essentially a local road whose requirements are basically maintenance rather than capital improvements. The priority order of the work should be as follows:

1. Eliminate the sand drifts. This can be done by raising the grade and eliminating the side humps or by relocation.

2. Smooth the riding surface. This can be done by adding additional surfacing material where necessary, but blading or dragging will be sufficient in many areas.

3. Improve the wadi crossings. This could be planned over a long period of time so that no large expenditure need be required at any one time.

Giosc - Nalut Road

There are two roads connecting Giado and Nalut, both of which are important from the standpoint of serving the people located adjacent to them. Both roads have bus service once a week, the bus running from Giado to Giosc to Nalut and back by way of Cabao to Giado.

The Giado-Nalut road via Giosc is the more important of the two from the standpoint of developing a major highway network in this area. It offers a choice of three possible routes between Nalut and the coastal area. The most used route, and the longest to Tripoli, is via Giado to Rumia then via Garian and Azizia to Tripoli; an alternate route from Rumia is via Jefren to Azizia. A shorter route is to turn north near Giosc and joint the Coastal Road at Zuara. The shortest route to Tripoli is to turn off the Nalut-Giado Road near Scek Sciuk and proceed to Bir Aiad which is near the foot of the Gebel on the Jefren-Azizia Road. It should be noted that these last two routes by-pass the gebel by staying away from Giado, Jefren and Garian.

Immediately upon leaving Giado there is a very scenic descent of the gebel. The descent is paved but is very narrow and has inadequate retaining walls for safety. It is in effect a one-way road as far as trucks and buses are concerned. It is quite adequate for the present day traffic but would be very costly to develop into a major highway. The road is paved from Giado to within 3.5 km. of Giosc, some 36.5 Km. The pavement is 3 m. in width and in good condition. The road is complete for 26.5 Km. with all wadi crossings paved using dips. The next 10 Km. are paved but in this area there are some 18 wadi crossings that are unpaved. The last 3.5 Km. to Giosc are unpaved. The surveys are now under way and funds have been set aside to complete the paving and provide adequate wadi crossings up to the intersection of the road in to Giosc. Thus the first 40 Km. of the Giado-Giosc-Nalut Road will be paved.

Giosc - Nalut (76 km.)

The Giosc-Nalut Road runs generally parallel to the Gebel and therefore directly across the water shed area. As a result there are 118 wadi crossings, most of which are small but 28 could be classified as medium in size requiring culverts and two appear to carry a large volume of water. The present road is from 5 to 6 m. in width. There is the standard "Soling" covered by smaller stone and/or "tinn" in most places. The road is structurally sound but is extremely rough riding due to corrugations. It is covered by sand in some places that maks it impassable at times for 2 wheel drive vehicles. The last 3 Km. into Nalut are paved. This section climbs up the gebel. It is adequate for present day needs but too narrow for two-way traffic, and would be very costly to improve.

The alignment is satisfactory for most of the length. However, there are some 8 curves that should be flattened and 7 or 8 reverse curves that should be eliminated by relocation. A number of the single curves and reverse curves are adjacent to wadi crossings so relocatios will involve new wadi crossings.

Vertical alignment is generally poor due to the rolling, choppy grade, that could be easily eliminated. Like so many of the old roads the grade is too low for much of the distance and should be raised.

From Km. 22 to Km. 55 (Km. 0 to Giosc) there are heavy sand drifts that are at times capable of stopping 2 wheel drive vehicles. These drifts can be reduced or eliminated by raising the grade. Much of this section passes through an area of sand that is full of small grass covered hummocks. Through this area it may be best to relocate the road, using the present road to carry traffic during the new construction. There are other sections where the grade is low and driving sand is a maintenance problem but not a vehicular hazard. The grade should also be raised through these sections.

Recommendations

1. This road should be given a high construction priority in the Provincial Road Program. Between Tripoli and Ghadames this is the section most easily blocked by sand. In addition it forms a vital link in developing a major road system through this area.

2. As quickly as funds can be made available a survey of the road should be begun. The following order of procedure is suggested:

(a) Run center line traverse of old road, at same time spotting possible relocations and good wadi crossings.
(b) Plot traverse on continuous roll.
(c) Super-impose line revisions on plat.
(d) Check line revisions in field making any changes that are desirable.
(e) Make complete survey and plans.

3. Improve the wadi crossings. This could be planned over a long period of time so that no large expenditure need be required at any one time.

D. EQUIPMENT NEEDS

A realistic program calls for purchase of equipment of the most basic units rather than the more advanced and modern machines. For example a crushing and screening plant would be more useful in the type of resurfacing work contemplated, but there are no trained operators to manage such machinery. Furthermore, other auxiliary equipment is needed to make the crushing plant efficient and here again operators are needed.

But even more critical is the lack of adequate facilities to keep such equipment in operation condition. Repair shops with adequate tools and equipment to make repairs are just as important as the equipment. Here again, personnel trained in the use of equipment and its repair is essential.

Therefore, until a training program can be made effective and a nucleus of personnel established to handle such modern equipment the present system and methods of hand labor must continue to be used. Improvements can be introduced gradually, such as using pressure distributors to spread asphalt, instead of hand spraying. Recently, two contractors each bought a distributor and are pleased with the results. Obviously this kind of change-over will take a long time and considerable patience. Fortunately, a gradual shift to modern machine methods had the distinct advantage of innocuously disrupting the labor economics and allowing time for re-adjustments.

The selection of equipment and machinery has not resulted in the most suitable units for construction and maintenance of roads. The following comments are made for future guidance in procuring the most suitable equipment for the work to be done:

Truck Mounted Bitumen Distributors

The spray bar pressure pump, on the bitumen distributors used by the Federal Roads Department are powered by a power take-off on the truck transmission. This system does not give the best results in applying bituminous materials as the speed of the pressure is dependent on the speed of the truck. Accurate control of the bitumen applied by the spray bar is difficult to obtain. The distributors are not equipped with a trailing wheel tachometer and the speed of the truck must be determined by the use of the truck speedometer. Future specifications for the purchase of truck mounted bituminous distributors should include a separate power unit for the bitumen pump and a trailing fifth wheel tachometer calibrated in meters per minute.

Dump Trucks

The dump trucks purchased in the past have given satisfactory service. With a few exceptions, the trucks are powered by diesel engines. Future purchases of

dump trucks should be standardized on make, or at least on not more than two makes. This will enable the Department to simplify the procurement of spare parts, service and repairs.

Road Rollers

The road rollers are the three wheel type and have given good service, although a roller heavier than the 5 to 8 ton units now in use would be more suitable for obtaining the degree of compaction desired. There has been developed a large variety of pneumatic rollers of several weights that have done excellent compaction and should be considered when purchasing new equipment.

Bitumen Heaters

The bitumen heaters have been useful for preheating materials before loading into the bitumen distributor. However, these heaters are bulky, mounted on iron wheels and require the use of a low bed trailer when it is necessary to move them to a new location. A rubber tired unit or a bulk tank transporter would be more suitable for handling and heating bitumen.

Motor Graders

The motor graders have generally given good service, although these machines have been abused and damaged by using them for purposes for which they were not designed. Those graders are equipped with a bulldozer blade designed for leveling piles of loose materials. Damage has been done to these machines by using the bulldozer blade for digging out and moving rock and other hard material. Manufacturer's service bulletins were translated into the Arabic language and circulated to the Federal Roads Department personnel, which warned them of the possible damage that could be caused by misuse of the motor grader and attachments.

Maintenance Kettles

The maintenance kettles used by the Federal Roads Department, with the exception of two, are manufactured in Libya. The component parts such as the power units, pumps for fuel burners and bitumen, fuel burners, and other small parts and fittings are imported. The tank, frame, axles, wheels and some other parts and fittings are made in Libya from imported materials. These units are equipped with solid rubber tires and are not towable at high speed from one location to another. A maintenance kettle with pneumatic tires would be more practical and easier to move.

Recommendations

These recommendations were previously made by the Upham engineers to the various agencies of the government:

Federal Roads Department

Set up an equipment inventory and list all serial numbers and the information concerning each piece of equipment.

Install cardex or similar system for parts inventory.

Establish a class for training equipment operators and mechanics.

Equip a central repair shop in Tripoli, or other suitable location for heavy maintenance and repair of equipment.

Equip outlying shops for routine service and light maintenance and repair of equipment.

PROVINCE OF TRIPOLITANIA

Public Works Department

Repair and place in service equipment now in P.W.D. shop in Tripoli.

Purchase new equipment to replace old units which are not economical to repair and operate.

Purchase three heavy motor graders, 9 dump trucks and 3 small loaders for maintenance of Nalut Ghadames Road.

Establish spare parts stock for equipment.

PROVINCE OF FEZZAN

Nazirate of Communications

Repair and place in service units not in operation.

Order necessary spare parts to accomplish recommended repairs.

Set up shop equipment and wire shop for electrical outlets for power tools.

PROVINCE OF CYRENAICA

Nazirate of Communications

Repair and place in service units such as the motor grader purchased with LARC funds but which has never been effectively used.

E. PROPOSED PROGRAMS

Following are two construction programs: one showing the details of a realistic two-year program, the other summarizing a similar program needed to complete improvement of the Coastal Highway in five years.

The two-year program is based on the assumption of $1,000,000 being made available each fiscal year. It was intended to form the basis of a project agreement between ICA and the Libyan Government and accordingly shows considerable detail such as definitely limited projects and type of improvement proposed. Priority of construction is based on judgment of actual needs.

The five-year program contemplates a slightly stepped up program similar to the two-year programs which will complete the minimum improvements needed on the Coastal Highway within five years. This program refers only to the Coastal Highway and does not include a program for Provincial Roads.

This is a satisfactory program in that it is about the minimum that should be spent for construction on the Coastal Highway and at the same time it is about the maximum that the existing highway engineering facilities can handle.

PROPOSED HIGHWAY PROGRAM, FEDERAL & PROVINCIAL ROADS

1959 and 1960 Fiscal Years
(All amounts in dollars)

FISCAL YEAR 1959

I. FEDERAL COAST ROAD

(a) Resurfacing & Seal Coats

PRIORITY		LOCATION	LENGTH KMS.	TYPE OF WORK	TOTAL COST
1.	T	Between Sirte & Marble Arch (km 609 to km 620)	11	Seal & Resurface	$ 36,500
2.	T	Between Sirte & Marble Arch (km 464 to km 520) (km 464 to Km 484)	56 20	Seal) Resurface)	91,000
3.	C	Between Agheila & Marble Arch (km 280 to km 300)	20	Seal & Resurface	66,000
4.	C	Between Derna & Tmimi (km 300 to km 375) (km 348 to km 368)	75 20	Seal) Resurface)	105,200
5.	C	Between Tmimi & Gadabi (km 394 to km 412) (km 404 to km 408)	18 4	Seal) Resurface)	23,000
6.	C	Between Barce & El Aweila (km 100 to km 116)	16	Seal & Reserface	52,500
7.	T	Between Tripoli & Sabratha (km 6 to km 67)	61	Seal	42,500
8.	C	Between Gambut & Bir Lashab (km 530 to km 540)	10	Resurface	26,000
9.	T	Between Zliten & Misurata (km 157 to km 182)	25	Seal	17,500
10.	C	Between Benghazi & Ghimines (km 4 to km 40) (Portions)	36 15	Seal) Resurface)	64,200
11.	T	Between Sirte & Marble Arch (km 536 to km 572)	36	Resurface	93,600
		Sub-Total Federal Roads Seal Coat & Resurfacing 1959			$618,000

I. FEDERAL COAST ROAD (cont.)

(b) Bridges

	LOCATION	DESCRIPTION	TOTAL COST
1.	Bridges, km 41 East of Tripoli	Construct 5-span slab deck existing railroad bridge and 3 km. of approach road	$ 35,000
2.	Bridge, km. 91 East of Tripoli	Construct box culvert and 0.5 km. approach road	21,000
	Sub-Total Federal Coast Bridges FY 1959		$ 56,000

II. PROVINCIAL ROADS

Tocra-Tolmeta	km. 15+ to km. 20 Construction of Route	$ 77,000
Tripoli - Ben Gashir Road	km. 0 to km. 10 Widen Base & Surfacing	80,000
Sub-Total Item II. Provincial Roads FY 1959		$157,000

III. EQUIPMENT FOR FEDERAL ROADS DEPARTMENT AND NAZARATES

(a) Federal Roads

NUMBER AND TYPE OF EQUIPMENT

Two	6 to 8-ton 3-wheel rollers	$ 16,000
One	1,000-gallon water-tank truck - (Fezzman)	7,000
Two	225-gallon asphalt kettles	3,200
One	Front-end rubber-tired loader	16,800
Two	Dump trucks	9,000
One	Motor Grader	18,000
One	1,000-gallon asphalt distributor, truck-mounted	12,500
Sub-Total E uipment Federal Roads FY 1959		$ 82,500
	Say	$ 82,000

III. EQUIPMENT FOR FEDERAL ROADS DEPARTMENT AND NAZARATES (cont.)

(b) Provincial Roads

NUMBER AND TYPE OF EQUIPMENT	TOTAL COST
One Motor Grader	$ 18,000
Two Dump Trucks	9,000
Two Asphalt Kettles	4,000
Sub-Total Equipment Provincial Roads FY 1959	$ 31,000

IV. ENGINEERING PERSONNEL

Three Field and Office Leaders	$ 20,800 ≠
Six Engineering Aids	28,800 ≠
Four Junior Engineers	6,400 ≠
Total Cost Engineering Personnel FY 1959	$ 56,000

≠ Cost includes Recruitment, Subsistence and Repatriation.

FISCAL YEAR 1960

I. FEDERAL COAST ROAD

(a) Resurfacing and Seal Coat

PRIORITY			LENGTH KMS.	TYPE OF WORK	TOTAL COST
1.	T	Between Sirte & Marble Arch (km 572 to km 587)	15	Resurface	$ 39,000
2.	C	Between Tmimi & Tobruk (km 412 to km 462)	50	Seal	
		(km 435 to km 445)	10	Resurface)	61,000
3.	C	Between Tmimi & Gadabia (km 375 to km 394)	19	Seal	13,600
4.	T	Between Misurata & Tauorga (km 237 to km 262)	25	Seal & Resurface	82,000
5.	C	Between Giourba & Derna (km 252 to km 266)	14	Subdrains, Surfacing	56,000
6.	T	Between Gasr Garabulli & Homs (km 90 to km 120)	30	Seal & Resurface	99,000
7.	T	Between Misurata & Tauorga (km 211 to km 237)	26	Seal	18,200
8.	T	Between Zliten & Misurata (km 182 to km 211)	29	Seal	
		(km 182 to km 197)	15	Resurface)	59,300
9.	C	Between Chimines & Agedabia (km 53 to km 106)	53	Seal	
		) Portions	14	Resurfacing)	84,000
10.	C	Between Farzouga & Barce (km 75 to km 92)	17	Resurfacing	56,100
11.	C	Between Giourba & Derna (km 266 to km 300)	34	Seal	
		) Portions	10	Resurface)	49,800
		Sub-Total Federal Roads Seal Costs & Resurfacing FY 1960			$618,000

(b) Bridges

1.	T	Wadi Caam (km 144)	Construct bridge, drainage - structures and approx. 3 km. of approach roads	$ 56,000

II. PROVINCIAL ROADS

LOCATION	DESCRIPTION	TOTAL COST
Tocra-Tolmeta, continue construction	km 20 to km 25	$ 79,000
Tripoli-Beng Gashier	km 10.00 to km 24, 14 base, widen surface	78,000
Sub-Total Provincial Roads FY 1960		$157,000

III. EQUIPMENT

(a) Federal Roads

NUMBER OF UNITS AND TYPE OF EQUIPMENT

	Non-Shop equipment	$ 8,000
Three	Front-end rubber-tired loaders	25,200
Four	Dump Trucks	18,000
One	Motor Grader	18,000
	Equip various shops with servicing equipment and tools	12,800
	Sub-Total Federal Roads Equipment FY 1960	$ 82,000

(b) Provincial Nazirates Equipment

One	Motor Grader	$ 18,000
Three	Dump Trucks	13,500
	Sub-Total Provincial Nazirates Equipment FY 1960	$ 31,500

IV.	ENGINEERING PERSONNEL	TOTAL COST
Three	Field and Office Leaders	$ 20,800 ≠
Six	Engineering Aids	28,800 ≠
Four	Junior Engineers	6,400 ≠
	Total Cost Engineering Personnel FY 1960	$ 56,000

≠ Cost included Recruitment, Subsistence, Repatration.

ADDITIONAL PROJECTS REQUIRED ON FEDERAL COAST ROAD IF MORE FUNDS

BECOME AVAILABLE ON ESTIMATES IN EXCESS OF AMOUNTS BID BY CONTRACTORS

I. FEDERAL ROADS

PRIORITY		LOCATION	LENGTH KMS.	TYPE OF WORK	TOTAL COST
1.	C	Between Ghimines & Agedabia (km 106 to km 159) 3 Portions totalling 36 kms.	36	Seal	$ 25,200
2.	T	Between Zavia & Sabrata (km 53 to km 61)	8	Resurface	20,800
3.	T	Between Garabulli & Homs (km 80 to km 90)	10	Seal & Resurface	33,000
4.	C	Between Beida & Cyrene Jct. (km 200 to km 214)	14	Seal & Resurface	46,200
5.	T	Between Garabulli & Homs (km 70 to km 80)	10	Seal & Resurface	33,000
6.	T	Between Garabulli & Homs (km 61 to km 70)	9	Seal & Resurface	29,700
7.	C	Between Cyrene Jct. & Cicurba (km 214 to km 252)	38	Seal	26,600
8.	T	Between Sirte & Marble Arch (km 484 to km 520)	36	Resurfacing	93,600
9.	T	Between Sirte & Marble Arch (km 520 to km 536)	16	Resurfacing	41,600
10.	C	Between Un R Resem & Tmini (km 358 to km 375)	17	Resurfacing	44,200
		Sub-Total Seal & Resurfacing Project FY 1960			$393,400

PROPOSED FIVE YEAR PROGRAM

for

FEDERAL COAST ROAD

	1960	1961	1962	1963	1964
Resurfacing	$1,200,000	$1,200,000	$1,200,000	$1,200,000	$1,200,000
Bridges	56,000				
Repairing Cantonerias	25,000	25,000			
Purchasing Equipment	82,000	30,000	30,000	20,000	20,000
Correcting Alignment	150,000	150,000	150,000	150,000	150,000
Sub-Total	$1,513,000	$1,405,000	$1,380,000	$1,370,000	$1,370,000
Maintenance	600,000	600,000	600,000	600,000	600,000
TOTAL	$2,113,000	$2,005,000	$1,980,000	$1,970,000	$1,970,000

F. ORGANIZATION NEEDED

To carry out this, or any other program, an appropriate organization is of first importance. There is now a Federal Roads Department which is working, but it is neither complete nor well integrated.

The primary need to integrate an appropriate organization is an experienced and capable Director. He must have the authority to hire personnel needed to make the organization complete. While it is desirable that some Civil Service control be applied, he should be allowed considerable freedom of action without petty interference from higher authority.

In this matter, the Minister of Communications necessarily retains control but this should be exercised through control of the budget. Details of engineering and administration should be left to the responsibility of the Director.

The Director, if he is a qualified engineer, will have definite ideas about creating an efficient organization and he must have authority to put these ideas into action. No doubt he will want to develop his department along two lines: first in administration, and second in engineering.

Administration presently is incomplete in a number of ways; for one, in the lack of an effective annual budget and corresponding fiscal control. Cost accounting is presently lacking and cost records scanty or incomplete.

Engineering also in incomplete; for example, there is no laboratory equipment available to test materials and no technician to make tests. Consequently control of types and quality of materials going into construction is haphazard, to say the least.

The Director must have authority to hire a few qualified men for the key positions. Such trained and experienced engineers are not yet available in Libya and he must look elsewhere for them.

The most basic need in the highway program of Libya is a complete and well integrated highway organization at both the Federal and Provincial levels. At the present time, no such complete organization exists at either Federal or Provincial level, nor is there uniformity as to jurisdiction. The Federal Roads Department is a branch of the Ministry of Communications and in Cyrenaica and Fezzan, highway matters are in the Nazirate of Communications, while the Tripolitania highway matters are under the Nazarite of Public Works. There is perhaps some justification for this allocation, but it would seem that uniformity is highly desirable and should be established. Consideration might also be given to the possible formation of a highway organization which would have full and complete jurisdiction over both Federal and Provincial roads. This would enable such an organization to set up a

coordinated system of primary, secondary, and tertiary highways for the country as a whole. It would also have the great advantage of permitting the employment and utilization of competent personnel available for the country as a whole, while there is possible inadequate warrant for the employment of such personnel at the Provincial or Municipal level.

One of the most serious phases of the personnel problem in Libya is the complete absence of competent technically trained Libyan personnel. The result is that all skilled personnel are of necessity recruited from foreign sources on short term contracts. The result is a highly undesirable turn-over in personnel. Serious consideration must also be given to an upward revision in salary scales in order to attract and hold more desirable personnel. At the same time, however, it is absolutely essential that some steps be taken to provide for the education and training of Libyan nationals who may take over and become responsible for the future construction, maintenance, and operation of the countries' highway facilities. Only in this way can Libya be assured of a permanent highway organization composed of career men who are dedicated to the task of providing for their countries' transportation problems.

As soon as possible, the Federal Road Department should be properly organized and districted with divisions set up which are responsible for:

1. Administration
2. Survey, Design, and Plans
3. Bridges and other Drainage
4. Construction
5. Maintenance
6. Equipment together with necessary shop facilities for proper maintenance and repair
7. Materials including an adequate Laboratory

Some of these divisions may possibly be combined, but this factor is one of detailed consideration. There is also the possibility that it may be economical and practically sound to provide for cooperation between the Federal Roads Department and the Provincial organizations in some cases, notably in the case of shop and laboratory facilities although previous attempts at obtaining such cooperative activity have been unsuccessful.

At the present time there is an almost complete lack of even a rudimentary inspection force to supervise and keep proper records on work performed under contract. Without an adequate and competent inspection force, the most carefully prepared specifications are without meaning. It has been remarked on several occasions that contractors do not read the specifications.

There is no means for testing materials for either physical or chemical conformity with specifications. The result is that the purchaser is compelled to rely on the certification of the seller, a procedure which is open to several objections. Experience shows that even with the best of intentions material can fail to comply with requirements for various reasons. If properly tested and approved before use both seller and buyer are protected. There should, therefore, be established, equipped, and staffed a Testing Laboratory Such a laboratory should be primarily a highway laboratory but could be made available for service to all branches and at all levels of government.

One of the most valuable assets of any organization is an "esprit de corps". Without the unquestioned loyalty and cooperation of every member of the organization it is impossible to produce the best results. It is, therefore, imperative that any member of the organization who is disloyal, dishonest, or obstructive, be compelled to mend his ways or be forthwith separated from service.

Need of Maintenance Organization

There is no point in creating a major highway construction organization either within the government or in the construction industry for the reason that no major highway construction program is likely to be put in effect in Libya. But there is a definite need to develop an adequate highway maintenance organization.

Maintenance is a continuing obligation of good government and, therefore, the highway maintenance organization must be permanent if Libya is to develop as a nation. Adequate highway transportation is a critical element of good government, and depends more upon good maintenance than upon new construction.

This means stabilizing the key jobs in the highway department so that a few Libyan engineers and practical assistants may feel justified to attempt a career of highway engineering. The Director of Highways must have considerable authority with freedom to act without petty interference from his Minister. He must have security of position if he is to make long term plans to purchase and use equipment efficiently. He must always plan for the future in preparing budgets, which are the mainstays of good management.

The point stressed here is the importance of permanency and security of policy. This is needed to induce Libyans to carry on the highway work. Presently extremely few Libyans are fully aware of the requirements of highway maintenance or recognize the opportunities to be developed in meeting those requirements.

Unfortunately there have been no qualified candidates for the highway engineering jobs, at least none came forward during the life of this contract. This is not to say of the Libyans that they are not ambitious or anxious to learn, but merely that those candidates who did come forward lacked the requisite basic training and

education. The training and education needed in Libya is more basic and elementary than contemplated in this contract, and will take more time than has been granted.

This condition is revealed in the fact that all highway engineers directing the work in Libya are foreign nationals, mostly Palestinians. Since they are working under a one or two year employment contract, there is little feeling of permanency. The condition cannot be changed either much or quickly.

G. LEGISLATION NEEDED

Presently each Province has a highway department separate and apart from the Federal Roads Department. None of the four is a complete organization and each is staffed to do only the bare essentials, primarily maintenance. The whole network of roads in Libya, including Provincial and Federal roads, is small and would hardly warrant a complete highway organization, but still one large highway department could be better staffed than the four small ones.

The principal advantage of one highway department is economy and efficiency, both in personnel and in equipment. One Highway Director could just as well manage all of the road work in Libya and probably better than could four separate ones. In the matter of salary, Libya could afford to pay a salary sufficient to attract one well experienced Director and still save something over the salaries of four separate ones.

This same principle applies to the assistant positions where one or two engineers could very well handle all of the engineering. A very real advantage there is that such specialized jobs as bridge and structure design, field surveys, road design, and construction engineering could be greatly improved for all road work. It would then be feasible to introduce testing and establish materials control.

Better use of equipment could be realized if it can be shifted around as needed. Specialized equipment, such as an asphalt distributor, is liable to be idle considerable time unless there is a big surfacing program. Similarly, repair shops can also afford specialized machines if there is sufficient work to warrant their cost.

Legislation to acquire and control right-of-way for highways will be needed in ever closer defined terms. At present the ownership of lands is not always clear which, of course, also applies to the road. On the Tocra-Tolmeta project, for example, no one seems to know what the width of right of way is or whether a particular house, which is too close, is actually encroaching. Is the present occupant required to move it; is he entitled to damages, and how much? Who has the authority to decide?

Similarly, the question of rights to materials, such as rock for the crusher and land from which to take material for embankments. Who owns them and who is to pay for the material, and how much? Judicial procedure to decide these and other similar questions will need to be developed.

Permanent records are a part of such judicial procedure and for highway purposes a set of plans becomes a useful record. Roads are prominent land marks and with a good set of survey notes and plans can be used for public records. Land surveys and subdivisions are scarce and therefore the road, especially if it has a surveyed center line can be used for reference.

Police authority is becoming more essential and stricter control of highway traffic is inevitable. In addition to the normal function of regulating traffic flow and controlling speed, the police authority will need to control size and weight of trucks. Aside from the traffic hazard created by an out-sized truck is the potential and actual damage to the highway itself. Bridges may be designed for, say an H20-S16 loading and be seriously damaged by loadings greater than this, which in fact are already using the road. But in addition to this, the road bed, too, is damaged by excessively heavy loads and creates an expensive maintenance job.

Improve Civil Service and personnel policies.

H. FINANCING

At the present time, much of the necessary financing of highway activities originates in aid from the United States and other countries and, in theory at least, is only available for capital expenditures such as construction or reconstruction. It is therefore important that some definite provisions be made for adequately financing proper maintenance and operation activities at the Federal, Provincial, and Municipal levels.

Experience indicates that it is absolutely essential that accurate and complete fiscal records be kept, complete and regular reports made, and expenditures made only after proper authority has been received for such expenditures. There are numberous examples of the lack of proper fiscal control in Libyan highway matters which could be cited. In addition, the lack of proper records has made extremely difficult the preparation of reports on accomplishments.

The Libyan Federal Government budget for 1959 together with reports of the status of LARC funds and the ICA allocations to LARC follows:

FEDERAL BUDGET

of the

LIBYAN GOVERNMENT

for

FISCAL YEAR 1959 - 1960

Allocations to:

a.	Federal Government Ministries	LL 5,016,955
b.	Province of Tripolitania	2,883,500
c.	Province of Cyrenaica	2,578,500
d.	Province of Fezzan	705.750
e.	Development and Stabilization	1,040,000
f.	L.A.R.C.	1,156,725
	TOTAL BUDGET	LL 13,381,430

(An increase of LL 1,252,808 over 1958/59)

SUMMARY

of

ALLOCATIONS AND EXPENDITURES

from the

LIBYAN GOVERNMENT BUDGET

to the

FEDERAL ROADS DEPARTMENT

BUDGET	ALLOCATIONS	EXPENDITURES	BALANCES
1955/1956	LL 177,100.000	LL 169,323.047	LL 7,776.953
1956/1957	158,105.000	136,165.154	21,939.846
1957/1958	146,433.000	128,973.077	17,459.923
1958/1959	160,925.000	120,527.980≠	40,397.020≠

≠ As of 1.31.59

STATUS OF LARC FUNDS

AS OF MARCH 31, 1959

	PROJECT	LL EARMARKED	LL ALLOTTED	LL TRANSFERRED	LL ALLOT. BAL.	LL EXPENDITURES
E 2L	Fezzan Road	377,065	377,065	350,065	27,000	324,216
E 3L	Federal Coast Road	1,427,633	1,427,633	1,388,156	39,477	1,261,061
E 7L	Federal Coast Road Bridges	71,400	71,400	57,900	13,500	48,400
E20T	Prov. Roads (Tripolitania)	210,321.428	210,321.428	129,800	80,521.428	136,500
E20C	Prov. Roads (Cyrenaica)	220,321.429	220,321.429	165,000	55,321,429	139,764
	TOTAL	LL 2,306,740.857	LL 2,306,740.857	LL 2,090,921	LL 215,819,857	LL 1,909,941

TOTAL AMOUNT EARMARKED BY LARC

FOR ROADS AS OF MARCH 31, 1959

E 2L	Fezzan Road	LL 377,065	
E 3L	Federal Coast Road	1,427,633	
E 7L	Federal Coast Road Bridges	71,400	
E20T	Prov. Roads (Tripolitania)	210,321.428	
E20C	Prov. Roads (Cyrenaica)	220,321.429	
		LL 2,306,740.857 =	$6,458,874

ICA FUNDS TRANSFERRED TO LARC FOR ROADS

1955	F.Y.	$ 650,720/	
1956	F.Y.	812,000//	
1957	F.Y.	907,200	
1958	F.Y.	1,300,000	
			$3,669,920

DISTRIBUTION OF ICA FUNDS BY LARC

1955 F.Y.

E 2L	Fezzan Road	$ 56,000	
E 3L	Federal Coast Road	588,000	
E 7L	Federal Coast Road Bridges	6,720	
	TOTAL 1955 F.Y.		$ 650,720

1956 F.Y. (Project Agreement No. 1)

E20T	Prov. Roads (Tripolitania)	$ 392,000	
E20C	Prov. Roads (Cyrenaica)	420,000	
	TOTAL 1956 F.Y.		$ 812,000

1957 F.Y. (Project Agreement No. 70-31-222)

E 2L	Fezzan Road	$ 112,000	
E 3L	Federal Coast Road	459,200	
E 7L	Federal Coast Road Bridges	112,000	
E20T	Prov. Roads (Tripolitania)	112,000	
E20C	Prov. Roads (Cyrenaica)	112,000	
	TOTAL 1957 F.Y.		$ 907,200

≠ Proportion made by LARC to Roads from original $3,000,000 grant.
≠≠ All allocated to Provincial Roads.

1958 F.Y. (Project Agreement 70-31-012)

	E 2L	Fezzan Roads	$ 352,800	
≠	E 3L	Federal Coast Road	697,200	
	E 7L	Federal Coast Road Bridges	49,000	
≠≠	E20C	Prov. Roads (Cyrenaica)	100,500	
≠≠	E20T	Prov. Roads (Tripolitania) F.Y.	100,500	
		TOTAL 1958 F.Y.		$1,300,000
		TOTAL ALL ICA FUNDS AS OF NOVEMBER 30, 1958		$3,669,920

≠ Includes $42,000 Local Commodities
≠≠ Includes $15,600 Local Commodities

DISTRIBUTION BY LARC TO ROADS BASED ON LARC FISCAL YEARS

		EARMARKED		
1955-56 F.Y.				
E 2L	Fezzan Road	LL 20,000		
E 3L	Federal Coast Road	210,000		
E 7L	Federal Coast Road Bridges	2,400		
			LL	232,400
1956-57 F.Y.				
E 2L	Fezzan Road	LL 150,000		
E 3L	Federal Coast Road	400,000		
E 7L	Federal Coast Road Bridges	40,000		
E20T	Prov. Roads (Tripolitania)	140,000		
E20C	Prov. Roads (Cyrenaica)	150,000		
			LL	880,000
1957-58 F.Y.				
E 2L	Fezzan Road	LL 84,065		
E 3L	Federal Coast Road	486,347		
E 7L	Federal Coast Road Bridges	- 0 -		
E20T	Prov. Roads (Tripolitania)	40,000		
E20C	Prov. Roads (Cyrenaica)	40,000		
			LL	650,412
April 1958 - December 31, 1958				
E 2L	Fezzan Road	LL 126,000		
E 3L	Federal Coast Road	339,786		
E 2L	Federal Coast Road Bridges	17,500		
E20T	Prov. Roads (Tripolitania)	30,321.428		
E20C	Prov. Roads (Cyrenaica)	30,321.429		
			LL	543,928.857
	TOTAL		LL	2,306,740.857

I. SPECIAL RECOMMENDATIONS TO LARC

The compilation of this report has brought forth some suggestions for improving the financial control of expenditures. These suggestions arise out of the difficulties encountered in collecting details of expenditures needed to determine actual costs of individual projects. It has been difficult even to determine what projects are involved and still more difficult to find details of what was accomplished.

Part of the difficulty is in the filing system. This can be corrected by expanding the present system, which otherwise need not be disturbed. That is to say that E 3 L, for example, can still continue to mean Federal Coast Roads. It is merely necessary to divide or separate the material filed under E 3 L into different categories of titles. Filing by projects heading is particularly useful since a project usually has a rather definite beginning and ending, especially if it is a contract. Highway construction and maintenance is a continuing process and therefore the project should be given a number immediately when some action is started and this number continues to identify that activity thereafter. This number is to be added to the existing file number, thusly: to illustrate a bridge project in design stage for Federal Coast Road might be known as E 7 L - 10, indicating it is the tenth activity (or project) on Federal Coast Road Bridges.

This file number also can be used to identify accounts if all expenditures and costs are properly distributed or charged to their applicable project.

The ability to make such a plan effective is available to LARC in the transferring of funds. LARC (or any contributing agency) may retain authority and control over actual expenditures, by transferring funds on a reimbursement basis, instead of in advance. Transfer of funds should be made on detailed estimates approved by an engineering section backed up by actual physical inspections of the project during construction and upon completion.

Again such a plan depends upon personnel to do the actual inspection. Most of the present difficulties come from the lack of proper inspection reports in the LARC files. The lack also exists in the action agency, but this would be corrected if LARC insisted upon having supporting data before transferring funds. When transfer of funds is really dependent upon realistic cost reports such reports will be furnished.

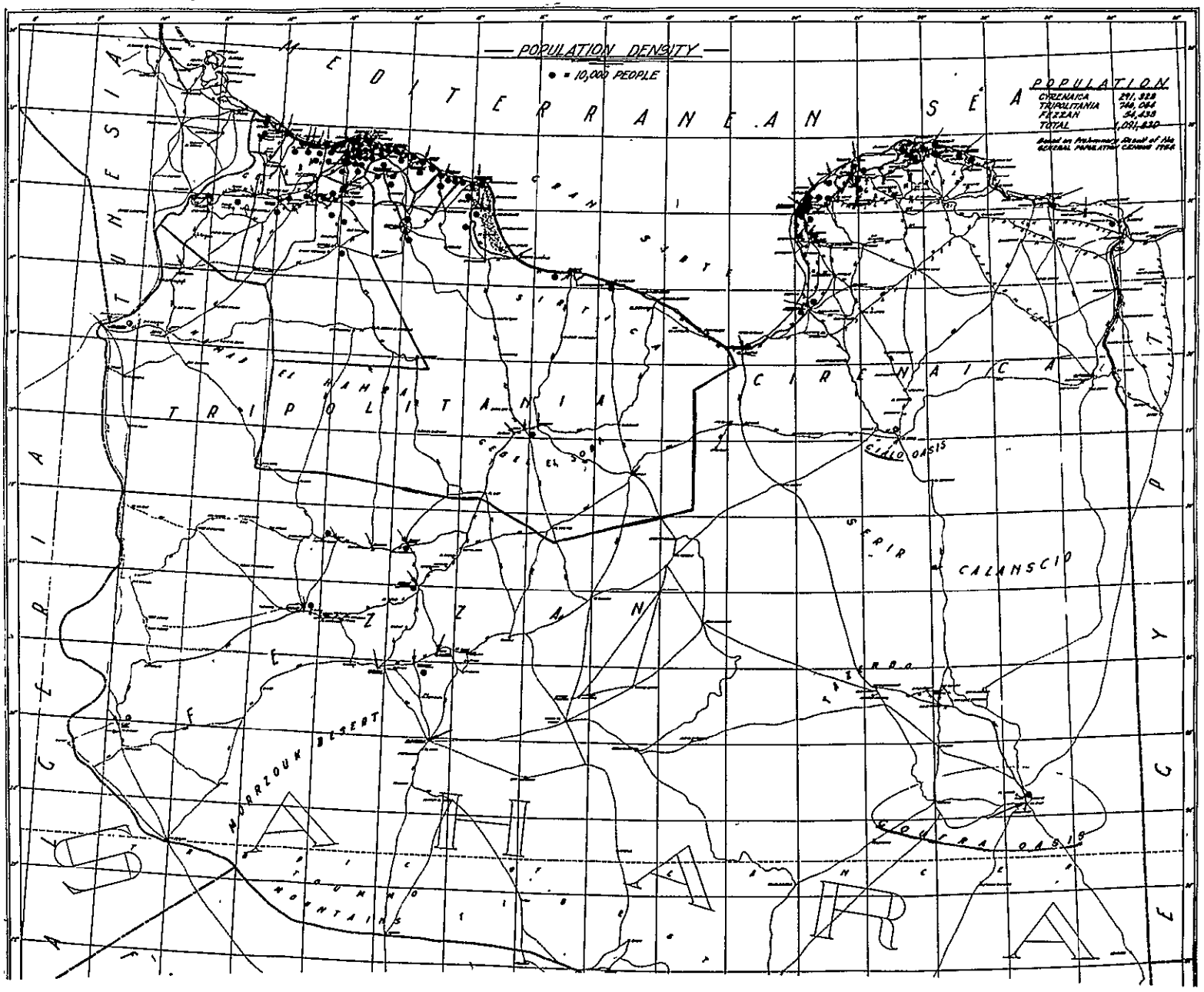
Also needed to round out this procedure is a perpetual program of proposed projects. Such a program would show at all times the new projects planned and the amount of money likely to be available to do them.

Thus financing and planning would be on the basis of individual projects, each project controlled in three stages: first, in the stage of the engineer's estimate of cost; second, in the bidding and contract (or force account) stage; and third, in the final estimate and final payment.

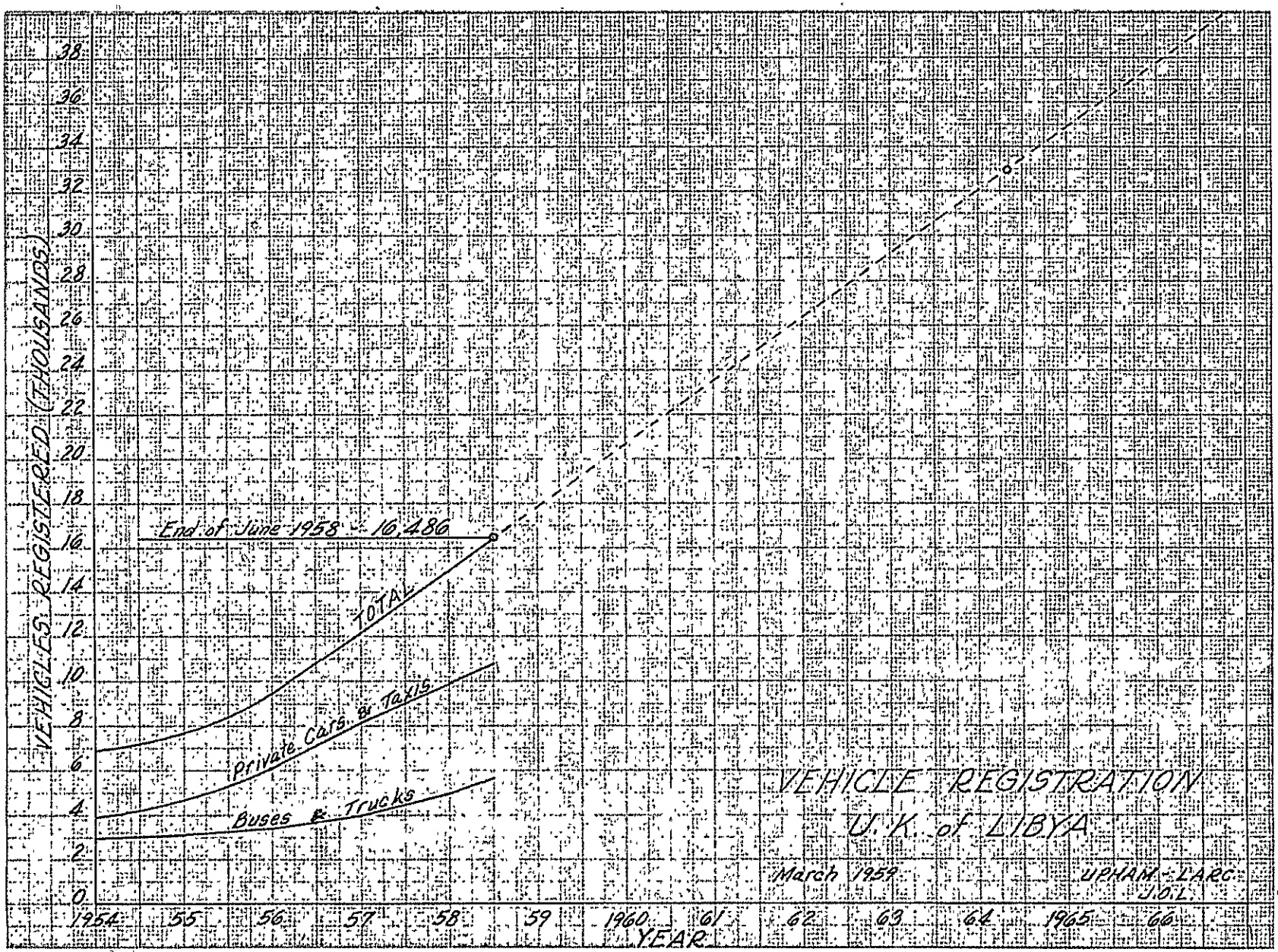
All this means that considerably more responsibility would be placed on the Action Agency to provide programs, plans, estimates, and reports. It would also require LARC to provide adequate engineering inspection as well as a strengthened audit section. The effort would provide data to show what is happening to the Assistance Funds.

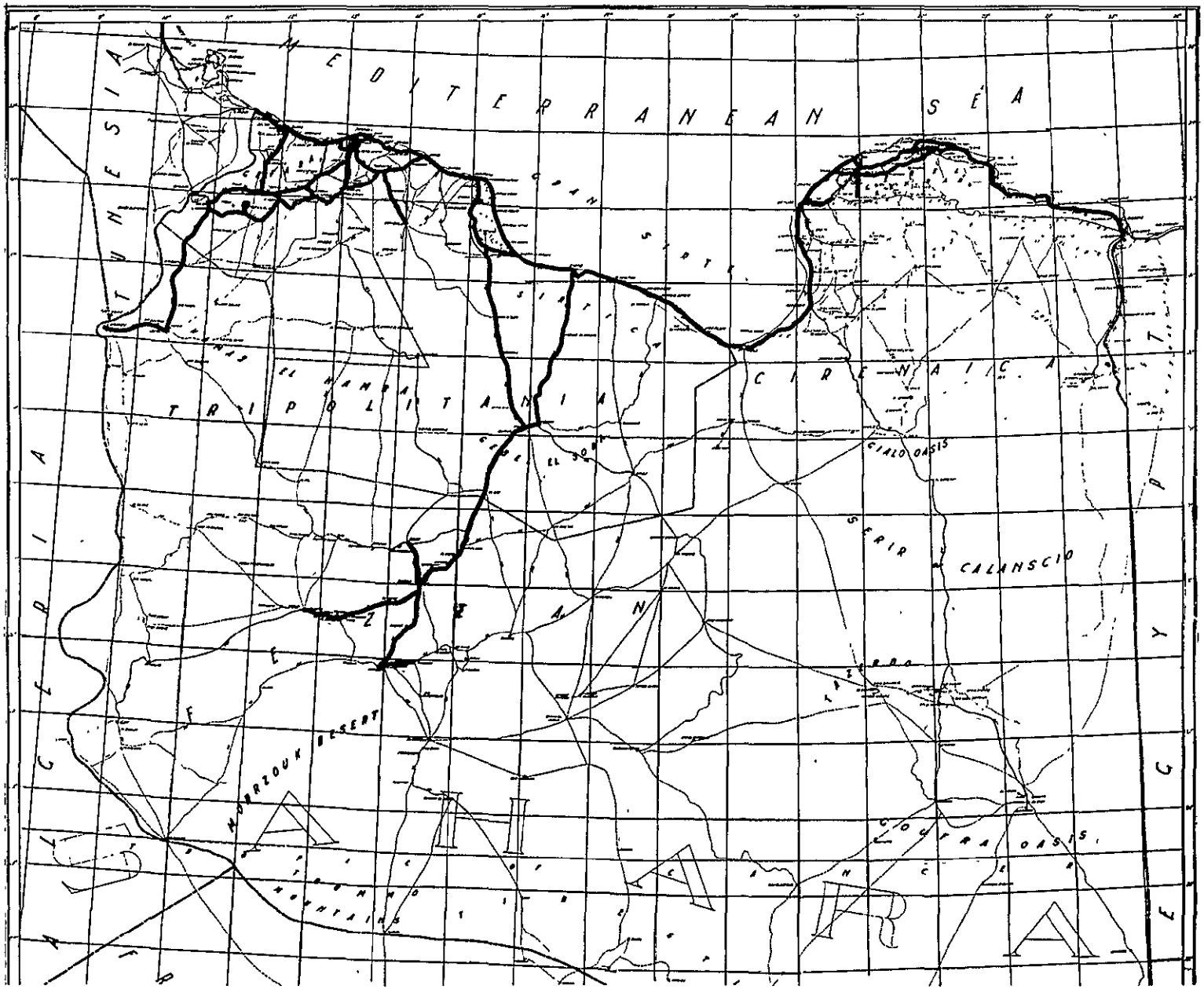
PART IV

APPENDIX

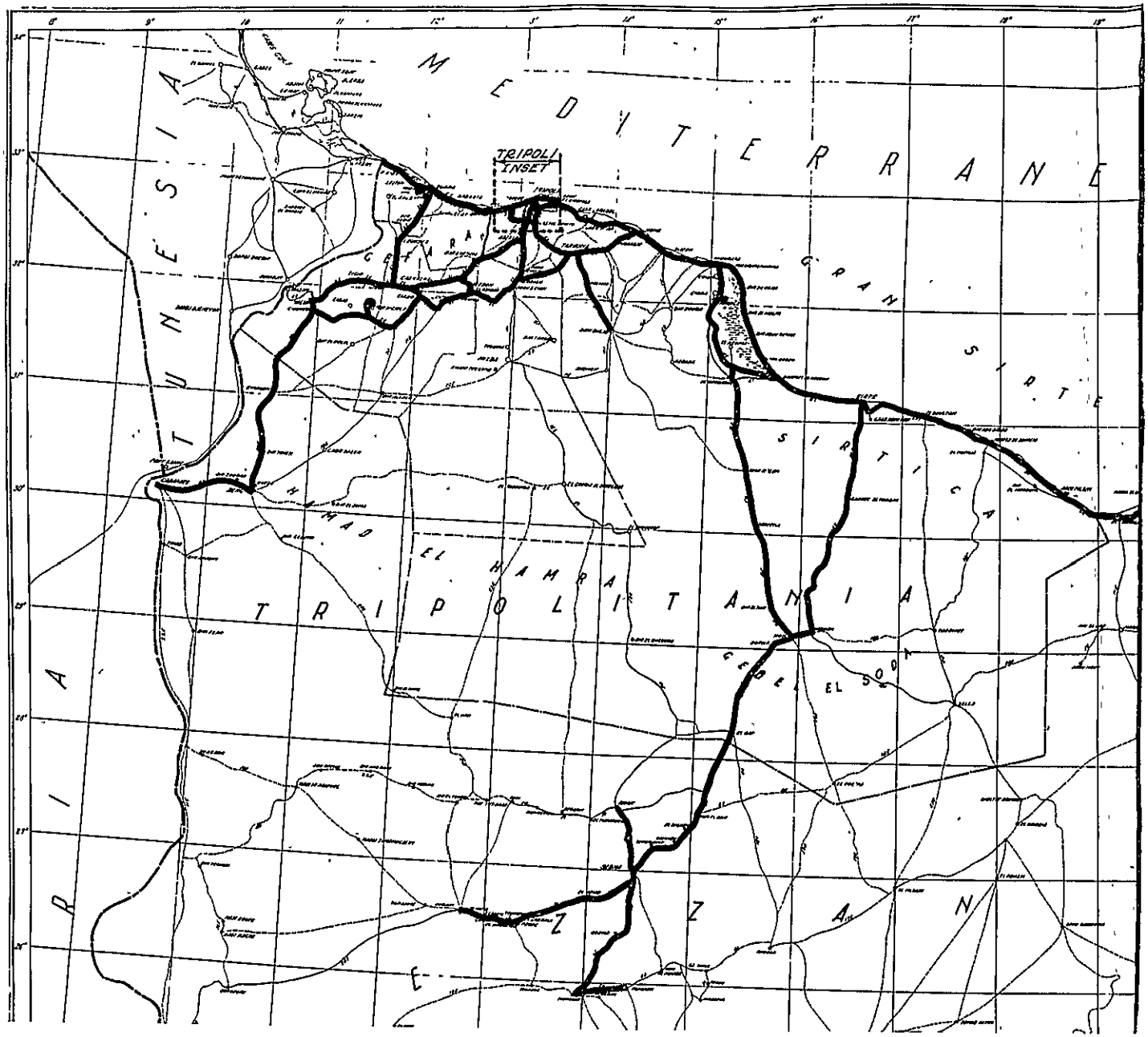


MAP SHOWING POPULATION DENSITIES IN LIBYA

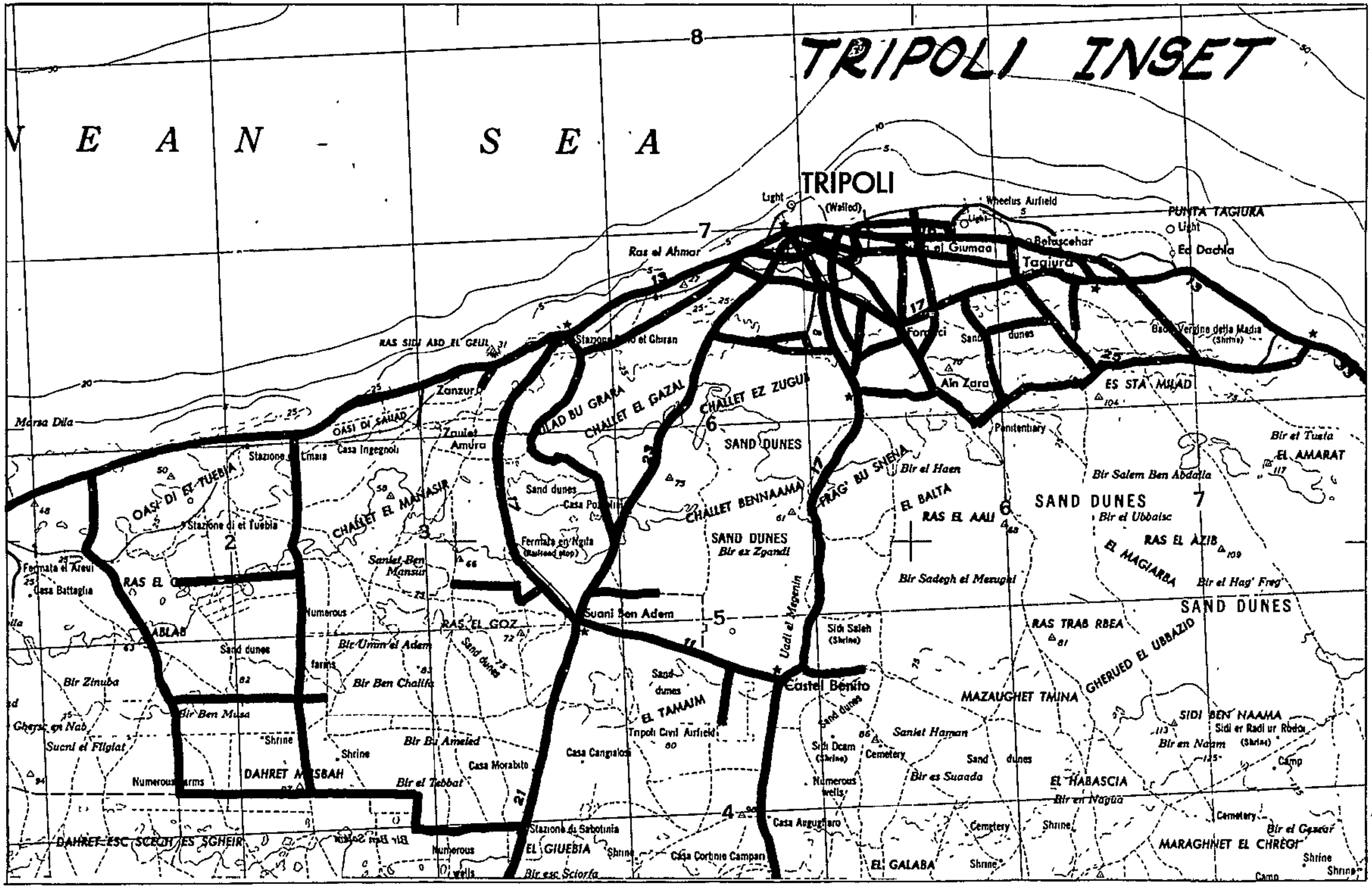

VEHICLES REGISTERED (THOUSANDS)
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
End of June 1958 - 16,486
TOTAL
Private Cars & Taxis
Buses & Trucks
1954
55
56
57
58
59
1960
61
62
63
64
1965
66
YEAR
VEHICLE REGISTRATION
U.K. of LIBYA
March 1959
UPHAM - LARC
J.O.L.



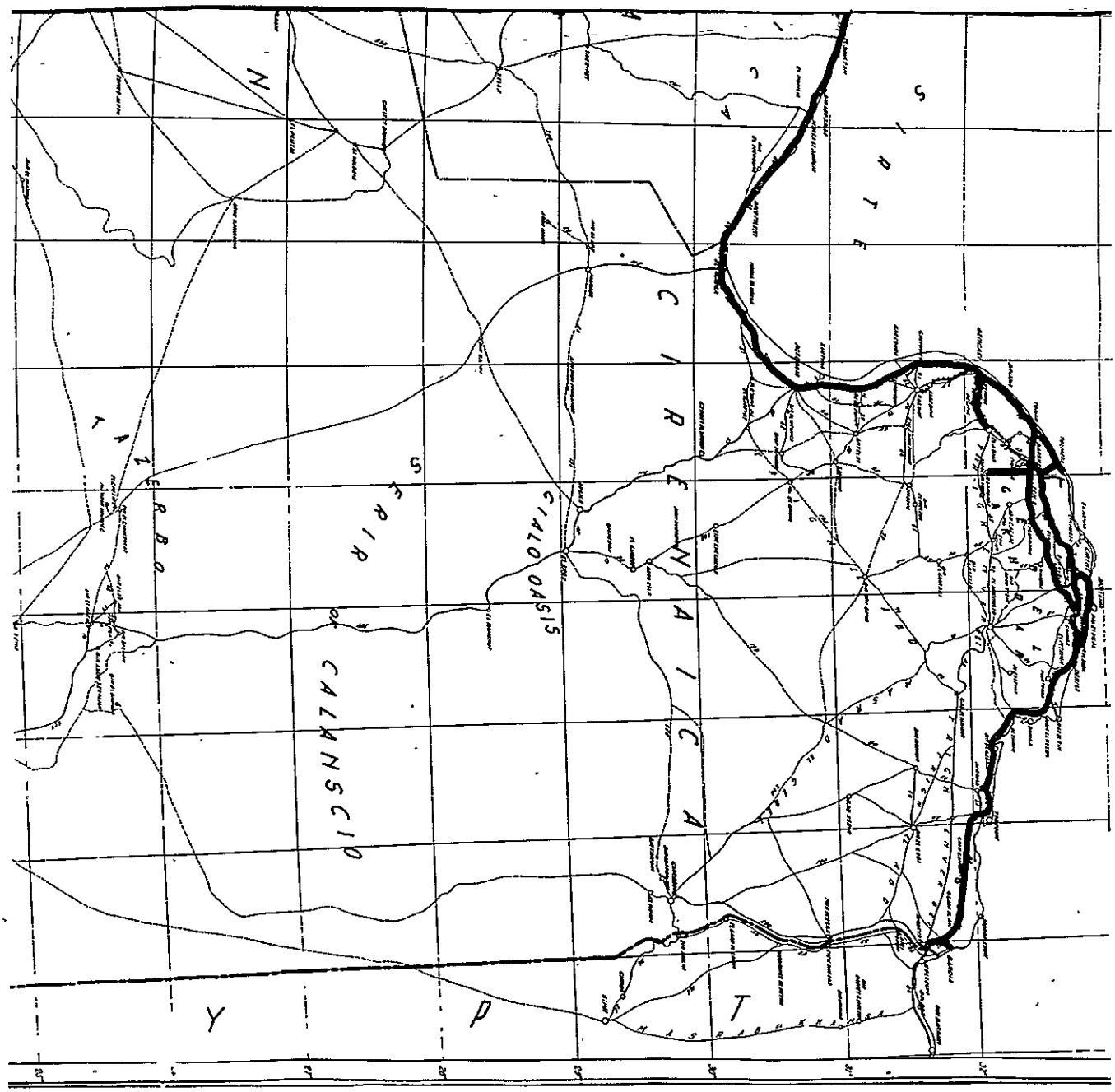
LIBYA'S FEDERAL AND PROVINCIAL ROAD SYSTEMS



FEDERAL AND PROVINCIAL ROAD SYSTEMS
IN PROVINCE OF TRIPOLITANIA



ROAD SYSTEM IN THE TRIPOLI AREA



FEDERAL AND PROVINCIAL ROAD SYSTEMS
IN THE PROVINCE OF CYRENAICA