Reconnaissance Survey of

International Road Connections in the Baghdad Pact Area

July-November 1957

U. S. DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
for the
INTERNATIONAL COOPERATION ADMINISTRATION

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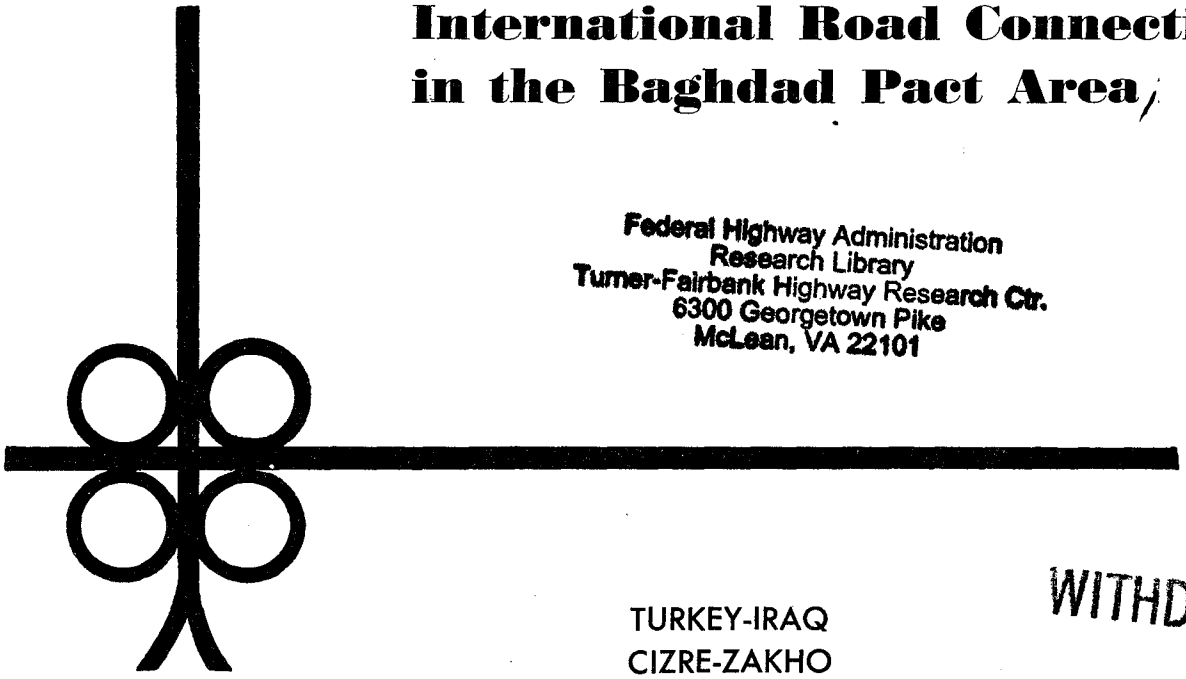

TURKEY-IRAQ
CIZRE-ZAKHO

TURKEY-IRAN
SIVELAN-BICIRGE-REZAIYEH-BIJAR-ZANJAN

July-November 1957

ACKNOWLEDGMENTS

It is impractical to make personal acknowledgment of all the persons who gave so freely of their time and knowledge and without whose assistance the reconnaissance work would have been much more difficult and time consuming.

Special acknowledgment is made of the assistance afforded in arranging travel facilities and interpreter services afforded by:

The Turkish General Directorate of Highways

The Iraqi Department of Public Works

The Iranian Ministry of Roads and Communications

Acknowledgment is made, also, of the assistance afforded by the United States Operating Missions in the three countries.

The survey group is particularly indebted to Mr. R. H. Baldock of the Edwards, Kelcey and Beck group in Iraq for his searching critique of design standards and traffic forecasts.

Mention should also be made of the assistance afforded by the division offices of the U. S. Bureau of Public Roads in Ankara and Tehran.

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I SCOPE OF WORK

The Project Agreements between the International Cooperation Administration (ICA) and the governments of Turkey, Iraq, and Iran provide for a reconnaissance survey of two routes: one from Cizre, Turkey, via Silopi to Zakho, Iraq; the other from Sivelan, Turkey, via Bicirge, Turkey, and Rezaiyeh, Iran, around the southern end of Lake Urmia to connect with the existing Tabriz-Tehran road.

The Service Agreement between the International Cooperation Administration and the U. S. Bureau of Public Roads sets forth the following objectives:

1. Provide a party of highway engineers to make a reconnaissance survey of the proposed highway connections taking into account any existing roads, and to propose construction or rehabilitation methods that will result in a highway in keeping with existing standards of the countries involved;

2. Propose design standards for use in planning and constructing the road;

3. Prepare a complete estimate of construction or rehabilitation, and a description of the recommended improvements, by countries and sections, divided into cost of small drainage structures, bridges, earthwork, and surfacing;

4. Prepare an estimate for on-the-job training, including recommended categories, and number of people, possible to train economically;

5. Prepare an estimate of cost of engineering services for surveys, design, and supervision of construction of the proposed highways, including on-the-job training of local engineering personnel;

6. Study and report on: the availability of local labor; housing; materials; equipment; camp and office sites proposed for the benefit of prospective engineers and construction contractors; and establish aggregate sources needed along the highway within reasonable haul distances;

7. Submit a list of engineering equipment necessary to adequately survey, design and supervise the proposed construction, taking into account available engineering equipment;

8. Submit a list of construction equipment necessary to construct the proposed highway, taking in account available construction equipment;

9. Prepare a report that shall include all the information listed above, and any additional information which the survey indicates may be of value, so that the report may be used as a basis for invitations of proposals from engineering and construction firms;

10. Make any other related studies that may be required in the immediate area or contiguous countries.

To gather the necessary information, three men were detailed by the Washington office to this work. They were assisted, as necessary and desirable, by members of the staffs of the existing division offices of the Bureau of Public Roads in Turkey and Iran. Mr. Prentice Julian arrived in Ankara, Turkey on July 19, 1957, to assume charge of the survey. Mr. Rudolph Roy arrived in Ankara on August 10 and Mr. Herman Gaines joined the group on September 16. Mr. F. H. MacElfresh was detailed from the Iran office of the Bureau of Public Roads and is largely responsible for the work in Iran.

Both of the routes were carefully reconnoitered in the field and contiguous roads were observed. Available air-photos were studied and supplemental information acquired from the Ministries of Public Works in the countries involved.

II GENERAL DESCRIPTION

The Baghdad Pact has been organized to bring the member countries in the Middle East closer together economically and culturally as well as to serve as a vehicle to deter aggression from without. Ready, suitable and easy communication among the several countries is essential to the proper development of economic and cultural ties.

Turkey-Iraq Route

At present there is no direct highway connection between Turkey and Iraq. The existing highway system in Turkey reaches only to Cizre. In the immediate vicinity of Cizre these existing roads are of low type but are being improved to higher standards as quickly as the available finances permit. The Iraq highway system reaches to Zakho with an intermediate type asphalt surfacing on a road of rather low geometric standards. Construction of the Cizre-Zakho section will effect a highway connection between the two countries.

It is not to be expected that much commercial usage of the connection will develop. The economies of the two countries are similar rather than complementary so there will be no great amount of export-import trade. Some movement of petroleum products from Iraq to Turkey may occur and there will probably be scheduled bus service over this route when the construction is complete. The Turkish port of Iskenderun is being developed as a free port. While it may attract some high-value commodities, its distance from the Iraqi border (some 715 kilometers) will serve to discourage very much highway shipment of bulk commodities.

The primary value of the road will be cultural and political. It will afford freer movement between the two countries and will, no doubt, attract some tourist traffic as the connecting roads in Turkey are brought to a higher standard. The route, when improved, will, of course, be available for military use should the occasion arise.

Turkey-Iran Route

Turkey and Iran are now connected by highway only at the Agri-Maku highway crossing near the northerly end of the border. This road is of rather low type construction. In southeast Turkey, the national highway system extends from Diyarbakir via Bitlis, Van and Baskale to Sivelan and Hakkari. Most of this road is gravel surfaced; much of it has relatively low geometric standards. Considerable improvement is currently being effected and eventually the entire route will be brought to national highway standards. Plans are being considered to extend the road southwesterly from Hakkari to a junction with the proposed Cizre-Zakho road east of Silopi. This route, when built, will shorten the distance from Sivelan to Iskenderun some 130 kilometers. From Sivelan a very low-type provincial road extends southeasterly some 40 kilometers to the town of Yuksekova; onward to the border near Bijirge there is only a pack trail.

On the Iranian side, a new road is under construction leading westerly from Rezaiyeh to a point about one kilometer from the border. This road is graded to a crown width of 8 meters and stabilized with a course of selected material (river gravel) from 15 to 20 cm thick. All excavation is being done by hand methods and no compaction is effected. At Rezaiyeh connection is made with the Iranian highway system. In this area, the national roads are all-weather gravel, but of very low type.

From Rezaiyeh on there are five alternate routes which could be used, three of which meet the expressed objective of passing south of Lake Rezaiyeh.

The control points for comparing alternate travel distances are Rezaiyeh and Zanjan.

A comparison of the distances follows:

Rezaiyeh-Shahpur-Sowfyan-Tabriz-Zanjan—637 Kilometers

This routing is via a newly built section between Shahpur and Sowfyan which was not traveled since the bridges had been washed out.

North of Rezaiyeh 64 kilometers there is a pass which rises rather percipitously on the north side with 12 to 14% grades to an elevation of 1,800 M.

Also, 38 kilometers south of Tabriz, Shebli Pass has 8 to 10% grades on the north side and rises to about 2,000 elevation.

There is some possibility of reducing the distance somewhat by missing Shahpur and go-

ing northeast from the end of the valley in which the pass is located. This saving might be 10 to 15 kilometers.

Rezaiyeh-Khoi-Tabriz-Zanjan—662 Kilometers

This routing is the longer of the two northern routings and it follows the established and regularly traveled roadway.

It has the disadvantage of using the two passes as well as increased distance.

The Tabriz-Khoi section and on to Maku near the Turkish border is a longtime objective of Iran for improvement. South of Tabriz much of the route is expected to be improved under present programs. Tabriz is the second largest city in Iran and a good road connection is desirable.

Rezaiyeh-Mahabad-Tabriz-Zanjan—716 Kilometers

This routing follows south of Lake Rezaiyeh and north to Tabriz and southeast again to Zanjan. It is the longest travel distance between the two control points even though 313 kilometers between Tabriz and Zanjan probably would not need to be built under the present project.

This route has the disadvantage of using Shebli Pass south of Tabriz and having a part of the distance out of direction by going north to Tabriz.

Rezaiyeh-Mahabad-Maragheh-Meyaneh-Zanjan—586 Kilometers

This routing is shorter than the previous routes but it follows the railroad location between Maragheh and Meyaneh for 177 kilometers. This section was not traversed by car as no road exists except remnants of the construction road.

From Meyaneh it was possible to go in 11 kilometers to the first railroad tunnel. The Maragheh side is more rolling and the first tunnel is about 27 kilometers from Maragheh. From the maps available and from interviews, the intervening section would not be feasible so far as grades and cost are concerned.

Rezaiyeh-Near Mahabad-Bukan-Saggez-Bijar-Zanjan—585.5 Kilometers

This route was selected as the most feasible for construction and it is the shortest route. All of the route was traversed except the cut-off section between Bukan and Mahabad.

This route is over flat and rolling country and the few grades traversed by the present road are reasonable (6 to 7%).

The route provides an outlet to the south and Tehran for the agricultural and manufactured products of the Rezaiyeh area. It also provides improvement for some of the route used by tank trucks to supply Rezaiyeh with petroleum products from refinery at Ahwaz.

Like Iraq, the economy of Iran is so similar to that of Turkey that not too much commercial usage can be expected. Some import of petroleum products into Turkey over this connection may be developed. When the road from Hakkari to Cizre and on to Iskenderun is improved to adequate standards there is a possibility that some transport from Iran destined for the free port of Iskenderun may build up. The principal products of the area around Lake Rezaiyeh are tobacco, wine, fruits, sugar and a possibility of cotton. The distance from Rezaiyeh to Iskenderun would be approximately 1,100 kilometers compared to about 1,325 kilometers to the Iranian port of Khorramshar. Iskenderun should afford more advantageous shipping rates, too, which would make its use more attractive. Despite these possibilities, it is seriously doubted that sufficient commercial traffic will develop to justify the construction of this connection. Justification will have to be found on cultural, political, and strategic grounds.

III RECOMMENDED DESIGN STANDARDS

Turkey and Iraq have developed geometric standards for highway construction comparable to, and in some features exceeding those used by most States in the U. S. A. Design standards based strictly on anticipated traffic volumes would probably not be acceptable from a strategic standpoint and would be low when one considers that these roads are parts of international routes which should eventually connect all the countries in this area.

At the recent meeting of the Subcommittee on Communications and Public Works of the Economic Committee, Baghdad Pact Organization, minimum design standards were developed and recommended for adoption for use on the international road system in the member countries. These standards are recommended for use on these roads, with the exception that on the canyon construction between Sivelan and the Kerem bridge the shoulder width be reduced to 1.5 meters. This option is permitted in very difficult mountain work.

It is recommended that only an interim surfacing be provided at this time. This surfacing should be composed of a 20 cm course of selected material subgrade stabilization and a 7.5 cm layer of crushed gravel (maximum size 1") surfacing, both courses to be placed full width of the roadway. Future surfacing to a dustless bituminous course should be deferred until traffic usage warrants its construction and until the connecting routes are further improved.

Salient features of the proposed minimum design standards are:

Pavement width: 7.0 Meters
Shoulder width: 2.5 Meters*

Topography:

	Flat	Rolling	Mountain
Design Speed, Km/hr ...	120	80	40
Min. Radius Curve, M...	320	210	80
Maximum grade, %	4	6	8

Surfacing: To provide and maintain a dustless, skid resistant surface adequate to the traffic to be served.

*May be reduced in very rough mountainous terrain.

The recommended cross section design is shown in Plate I.

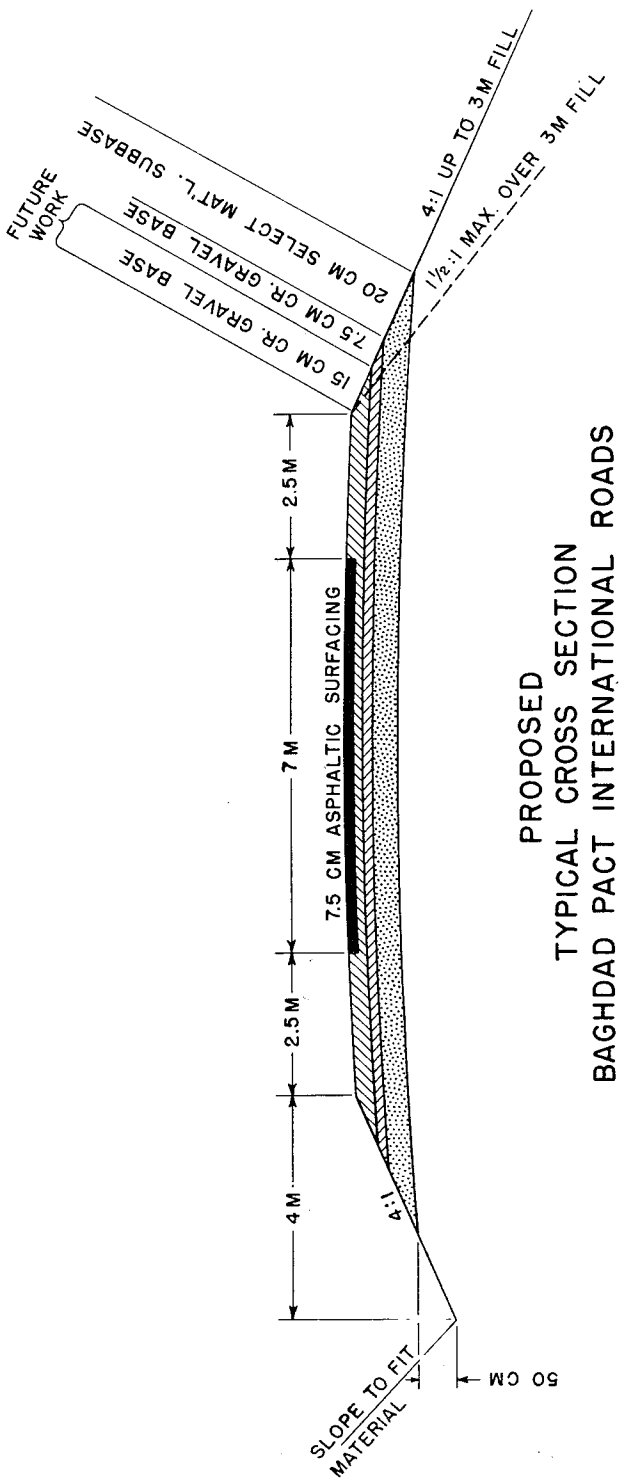


PLATE I

IV DETAILED DESCRIPTION, TURKEY-IRAQ ROUTE

A. Cizre-Iraq Border Section

1. Description

This section is considered as beginning at a point about one kilometer northwest of Cizre, where connection will be made with Turkish National Routes 69 and 10. Almost immediately it crosses the Tigris River on a high-level bridge and enters into sharply rolling country. Deep cuts and high fills will be required in the first 17 kilometers to afford acceptable grades and alinement. Some solid rock may be encountered in the deeper cuts but surface indications would seem to show that layers of rock from 0.2 to 1.5 meters thick interposed with earth and shale layers, 2 to 4 meters thick, may be expected. The next 20 kilometers to the Iraq border, is across a level to gently sloping terrace. Construction across this terrace will be very simple and inexpensive. The exact location of the border crossing will depend upon the choice of site for the international bridge. The choice of site will be discussed in detail in connection with the Iraq section. The total length of this section is approximately 47 kilometers.

2. Proposed Construction Procedure

It is fairly well established that the Turkish General Directorate of Highways will do the location work and construct this section with their own forces. Actually, location and design work is fairly well advanced and plans for several kilometers at the westerly end can be readied for construction in a very short while. An executed Project Proposal and Agreement between the ICA and the government of Turkey provides (US) $800,000 to procure construction equipment, materials and supplies for the construction of this section.

The existing ferry across the Tigris at Cizre will serve construction traffic. Almost any point along the route is reasonably accessible from the present track so work can be begun at as many points as may be thought desirable.

An analysis was made first of the working schedule and equipment needs to perform the grading work in one season as a "crash" program. This could be done but it would require some (US) $2.0 million for equipment and it is not thought that the urgency of the work is sufficient to justify this investment.

A more logical schedule would be to spread out the work over two seasons. This two-season schedule will require about $1,000,000 investment in equipment. The heavier cuts, particularly where considerable rock is encountered or where relatively long haul is involved can best be excavated by power shovel. One 1 1/2 C.Y. unit should be provided. In some of the cuts a relatively thin cap rock overlies earth and shale. There the rock can be drilled and shot, and loaded out by the tractor-shovel, leaving the underlying earth to be moved by carryall scrapers. Since the tractor-shovel will be needed later on to load selected material, its use in this excavation work is completely feasible. Much of the easterly 30 kilometers would seem to be suitable for excavation by elevating grader. It is understood that the Directorate of Highways has some elevating grader attachments adaptable to use with a heavy motor grader. It is suggested that one of these be used where the operation is suitable.

3. Local Resources

a. Labor: Unskilled labor and possibly some carpenters, masons and truck drivers should be available from Cizre and the villages along the way. Equipment operators and mechanics will probably have to be recruited from other parts of the country, supplemented by training of selected local personnel.

b. Housing: The engineers and workmen will have to be housed in construction camps. Suitable camp sites may be found in the vicinity of Kilometers 1, 17, 31, 40, and 47 (from Cizre). Other sites, suitable for "Fly" camps are available at frequent intervals, conforming with local practices.

c. Materials: Some investigation of possible local sources of materials was made--

i. Stone for masonry is not generally available in the immediate vicinity of the work. Some of the cap rock in the first 17 kilometers may be suitable for masonry work but generally it appears to be soft and of doubtful quality. Field stone is available about eight or ten kilometers west of the beginning of the project. No doubt suitable quarry sites can be located in the mountains which roughly parallel the easterly 30 kilometers of the road at a distance of 5 to 15 kilometers to the north.

ii. Concrete aggregate can be produced at the Tigris River near Cizre and at Kilometers 17, 32, 40, and 47.

iii. Selected Material for subgrade stabilization and for crushed gravel base and surfacing is readily available. Possible sources are Kilometers 1, 17, 32, 40, and 47. It is quite probable that in many sections of the easterly 30 kilometers the material underlying the top .20 to .30 cm of soil mantle will prove to be suitable select material for subgrade stabilization.

4. Cost Estimates

a. Engineering: Practically all the location and much of the design work has already been accomplished by the Directorate of Highways. To date their expenditures have been approximately TL 40,000 and they estimate that about TL 30,000 will be required to complete the location and design. Construction engineering is estimated at TL 500,000 although it is ordinarily difficult to accurately segregate construction and engineering costs on a force account work.

b. Construction: If the work were to be done by contract with a foreign construction firm the construction work is estimated to cost:

Earthwork	$2,800,000
Minor structures	950,000
Bridges	775,000
Interim surfacing	475,000
Subtotal	5,000,000
Ultimate surfacing	800,000
	5,800,000

An estimate was made using quantities estimated from the reconnaissance and unit costs from current comparable contract work. This estimate gives the cost as:

Earthwork	TL6,500,000
Minor drainage strs	TL2,500,000
Major drainage strs	TL2,500,000
Interim surfacing	TL1,700,000
Subtotal	13,200,000
Ultimate surfacing	2,500,000
Total	TL15,700,000

5. Equipment Needs

a. Engineering: The major items of engineering equipment needed for survey and construction are:

Transit	2	Chains	3
Level	2	Plumb bobs	8
Range Poles	6	Hand Levels	6
Level Rods	5	Axes, bags, stakes, etc.	

Since the engineering work will be done by the Turkish General Directorate of Highways, which is reasonably well equipped, no special purchase of engineering equipment is recommended.

b. Construction: The amount of construction equipment required has been predicated upon completing the bulk of the work in two construction seasons. Three grading groups are proposed as follows:

Power Shovel Group

1 1/2 C.Y. Power shovel	1
Heavy tractor w/angledozer	1
Air compressor, 600 CFM	1
Air compressor, 365 CFM	2
Jackhammers, No. 65	8
Rock Trucks, 6-8 C.Y.	4
Medium Tractor w/bulldozer	1
Medium Tractor (D-6 or equal)	1
Sheepfoot roller, dbl drum	1
Water truck 2,000 gal	1
Pump, water 3"	1

Scraper Group

Carrying scraper w/wheeled tractor, 12 C.Y.	3
Push tractor, heavy w/bulldozer	1
Medium tractor w/bulldozer	1
Medium tractor (D-6 or equal)	1
Sheepfoot roller, dbl drum	1
Motor patrol, 125 hp., 12'	1
Ripper, 3 tooth	1
Water truck, 2,000 gal	1
Pump, water 3"	1

Elevating Grader Group

Motor patrol, 125 hp., 12' blade	2
Elevating grader attachment	1
[1] Dump truck, 4 C.Y.	10
Medium tractor w/bulldozer	1
Medium tractor (D-6 or equal)	1
Sheepfoot roller, dbl drum	1
Water truck 2,000 gal	1
Water pump 3"	1

Surfacing Group

[2] Crushing plant, 50 T/hr	1
Truck-mounted shovel/dragline 3/4 C.Y.	1
Tractor-shovel 1 1/2 C.Y.	1
[1] Dump trucks, 4 C.Y.	10
[3] Motor patrol, 125 hp., 12' blade	1
Wheeled tractor, 45 hp.	1
Pneumatic Roller	1
Trucks, water 2,000 gal	2
Pump 3" water	1

See footnotes at end of tabulation.

Bridge Group

Aggregate Screening plant	1
Truck crane w/clamshell, 25 T	1
Concrete mixer, 16 S	3
[1] Dump Truck 4 C.Y.	4
Truck flatbed, 2 T	2
Aggregate scale	2
Pump, water 2"	2
Pump, water 3"	3
Pump, water 4"	2

Service and Miscellaneous

Truck flat bed, 2 ton	2
Pickup 1/2 ton	4
Mobile shop	1
Generator 5 KV	2
Generator 15 KV	1
Welder 300 Amp	1
Truck, fuel transport 2,500 gal.	2
Truck, service	2
Lubricator	2
Tanks, fuel storage 3,000 gal	2
Pump, water 2"	2

[1]Dump trucks to be shifted as necessary. Total of 20 to be provided.

[2]Since it is not expected that the selected material for stabilization will require crushing, a crushing plant of this size will be provided with only a few weeks work to crush out the proposed 7.5 cm layer of crushed gravel. If funds for equipment procurement are short, the topping material could probably be produced by using some of the small crushers from the existing equipment fleet.

[3]The timing of operations will probably permit use of one of the motor patrols from the grading groups.

This equipment is estimated to cost (US) $1,001,800 as shown on Plate II. The General Directorate of Highways has expressed a reluctance to commit any of their presently owned equipment to this work but apparently they will have to do this to contain purchases within the $800,000 set up in the project agreement. The elevating grader attachment is available and surplus to their needs. It probably would be well to have the accompanying motor patrol furnished from existing units. In the interest of maintaining an overall balanced fleet of equipment the logical additional contribution from existing equipment would be the three carrying scrapers and the rock trucks. Elimination of these units from the procurement list would bring the estimated cost into reasonable accord with the funds available.

The General Directorate of Highways has indicated that they will not expect to use any of the programed funds for materials and supplies.

It will be noted that no asphalting equipment has been included in the list of units required. The omission of this type of equipment is in line with the recommendation that only a stabilized surface be provided until such time as a pattern of road usage has been established to justify surfacing and until the connection roads within Turkey have been further improved.

6. On-the-job Training

a. Engineering: The location and design work is so far advanced that this job offers no attractive opportunity for on-the-job training. Furthermore, the personnel of the Turkish General Directorate of Highways are considered to be competent engineers and no on-the-job training in engineering is considered necessary.

b. Construction: The construction of this section of road would afford a very good opportunity for on-the-job training of equipment operators if such a program is considered desirable. The General Directorate of Highways have continuing training programs. They may, therefore, not consider any extension of those programs necessary or desirable.

If this project is set up as a field training area the minimum staff necessary would be:

1 Construction Superintendent
2 Tractor Operator-Instructors
1 Shovel Operator-Instructor
1 Motor Patrol Operator-Instructor
1 General Field Mechanic

If these men were to be recruited outside of Turkey, the cost of a two-year training program would be about $200,000 plus local costs for subsistence and local costs for trainees.

It is considered that over a period of two construction seasons adequate training to a journeyman grade could be provided as follows:

16 Shovel Operators
60 Tractor Operators
18 Motor Patrol Operators
12 Field Mechanics

By reducing the length of the training period reasonably adequate training could be afforded twice or even three times this number of men. Unless some adjustments are made in the prevailing wage scales it is doubtful that training to a journeyman grade is justified since fully trained men would probably leave the government service to take better paying jobs elsewhere.

Summary

Equipment Needs

CIZRE-IRAQ BORDER SECTION

Unit	No.	Unit Price	Cost
Power shovel, 1 1/2 C.Y.	1	$55,000	$55,000
Truck-mtd shovel/dragline 3/4 C.Y	1	45,000	45,000
Truck-mtd crane w/dragline 25 T	1	45,000	45,000
Tractor-shovel, 1 1/2 C.Y.	1	30,000	30,000
Tractor w/angledozer, heavy	1	30,000	30,000
Tractor w/bulldozer, medium	3	23,000	69,000
Tractor w/pushplate, heavy	1	28,000	28,000
Tractor, crawler, medium	3	21,000	63,000
Tractor, wheel, 45 H.P.	1	4,000	4,000
Motor Patrol, 12', 125 H.P	3	18,000	54,000
[1] Elevating Grader, attachment	1	6,000	6,000
Roller, sheepfoot dbl-drum	3	2,600	7,800
Roller, pneumatic	1	1,200	1,200
[2] Scraper w/wheel tractor	3	40,000	120,000
Ripper, 3 tooth	1	2,000	2,000
Compressor, air, 600 cfm	1	20,000	20,000
Compressor, air, 365 cfm	2	12,500	25,000
Air drills, No. 65	8	500	4,000
Hose, drill steel, etc		LS	5,000
[3] Truck, rock, 6-8 C.Y.	4	11,000	44,000
Truck, dump, 4 C.Y.	20	4,500	90,000
Truck, flatbed 2-ton	4	3,000	12,000
Truck, pickup, 1/2-ton	4	1,800	7,200
Truck, water tank, 2,000 gal	5	7,200	36,000
Truck, fuel tanker, 2,500 gal.	2	7,500	15,000
Truck, service	2	4,000	8,000
Pump, water, 2"	4	400	1,600
Pump, water, 3"	7	600	4,200
Pump, water, 4"	2	1,000	2,000
Crushing plant, 50 T/hr	1	75,000	75,000
Screening plant, aggregate	1	40,000	40,000
Mixer, concrete, 16 S	3	3,200	9,600
Scale, aggregate	2	500	1,000
Mobile Shop	1	21,000	21,000
Generator, 5 KV	2	1,500	3,000
Generator, 15 KV	1	6,000	6,000
Welder, 300 A	1	4,800	4,800
Lubricator	2	2,500	5,000
Tank, fuel storage, 3,000 gal.	2	800	1,600
Vibrator, gasoline powered	4	200	800
Total			1,001,800

[1]Should be available from present equipment.
[2]Might be supplied by the General Directorate of Highways.
[3]Could use Tournarockers, now owned by TCK.

PLATE II

B. International Bridge

At the point where the proposed route crosses the Turkey-Iraq border the international boundary is formed by the Haizil River. This river crossing will, therefore, be an international bridge. This structure, with some necessary protection work, is estimated to cost (US) $750,000. Its financing and construction will be subject to agreement between the two countries. Since there are no major structures nearby on the Turkey section it would seem logical for the construction of this bridge to be grouped with those on the Iraq section for contract purposes.

C. Turkey Border—Zakho Section

1. Description

This section begins at the Turkey-Iraq border and extends generally southeasterly to a connection with the Mosul-Zakho road immediately south of Zakho. The exact location of this section depends upon the crossing chosen as a bridge site for the international bridge on the boundary. Three possible sites were investigated: two on the Haizil River and one below the confluence of the Haizil and the Khabur.

The best bridge site is located about 500 meters below where the Haizil River emerges from the canyon. Here the river is still quite well confined between high banks. The eastern abutment would be protected by a stable bluff upstream and the westerly approach could be founded on high ground. This site would introduce some deviation from a direct alinement and the provision of a proper southeasterly approach from the bridge end to the top of the terrace would require careful location and a short stretch of relatively heavy earthwork.

A Turkish location party has run a tentative line to a crossing of the Haizil River about 1.5 kilometers downstream from the crossing discussed above. This crossing would provide the most direct and shortest overall route. At this point the river plain between high banks is about three times as wide as at the upstream location. Local residents report, however, that they have never known this plain to be flooded by high water, which in their memory has always been limited to the primary channel. It might be possible, therefore, to cross the plain with an embankment, bridging only the main channel although it must be conceded that record floods would probably cover the river plain between high banks and might introduce hydraulic difficulties.

The third crossing investigated was about a kilometer downstream from the confluence of the Haizil and Khabur Rivers. This location would have the advantage of requiring only one river crossing rather than three. The river here, however, is braided with several channels in a riverbed more than a kilometer wide. It is quite evident that the main stream shifts from time to time and it would be quite expensive to provide a crossing here which would be safe from flood damage. Perpetual channel maintenance would be required to keep the river under any bridge that might be constructed. Aerial photographs indicate that possibly a narrower reach of this river exists than the one visited. The Iraqi engineers will investigate further, since, if an acceptable crossing is found below the confluence of the two rivers, only one bridge will be required instead of three.

The boundary connections will be decided by detailed location surveys and comparative estimates.

For the purpose of the reconnaissance estimate the route crossing the Haizil River has been used. Should a crossing downstream be located the length of highway in Iraq will be longer and more minor structures will be required but no major bridges. The cost of the international bridge will be increased somewhat but it is thought that the overall cost will remain reasonably constant.

On the route from the Haizil River crossing, the existing track crosses the Khabur River by two bridges within the town of Zakho, which is located partly on a river island. These bridges are through steel trusses with only a one-way roadway. The routing through Zakho is along very narrow village streets with sharp turns and poor sight distances. A suitable bridge site can be found about one kilometer below Zakho, which will permit bypassing the congested district and afford a connection with the Zakho-Mosul road near the southwest edge of Zakho.

A practically straight alinement can be had between the Haizil and Khabur crossings since the route will traverse a uniformly sloping terrace. One other bridge of appreciable size will be required to cross an intermittent stream which carries considerable water during rains. The total length of the route in Iraq will be approximately 12 kilometers.

2. Proposed Construction Procedure

The earthwork on this section presents no particular problem. It is easy grading work and can be accomplished fairly quickly. There is not enough work involved to make it attractive to a foreign contractor so it would seem to be proper to expect it to be done by an Iraqi contractor or by the Public Works Department as an administration project. A third possibility, that of arranging an intercountry agreement whereby the Turkish Directorate of Highways

would do the work as an extension to the work on their section, would probably be the most economical, overall.

If the international bridge were to be included with the two on the Iraq section a very attractive contract for bridge work could be offered. It would seem that including the international bridge with those on the Iraq section would be most logical since there are no major bridges nearby on the Turkey section.

3. Local Resources

a. Labor: Unskilled labor should be available in adequate supply at Zahko and the small villages along the route. Some masons, carpenters, truck drivers, etc., may also be available locally but the bulk of the skilled labor will have to be imported from elsewhere in Iraq or Turkey.

b. Housing: The local labor can probably live at home since the section extends only 12 kilometers from Zakho. Imported labor will have to be housed in camps and in accordance with local custom these will probably be tent camps. Suitable sites are available near the Khabur and Haizil Rivers and at least one point in between.

c. Materials: Sand, gravel and selected material are available in adequate quantities in the Khabur and Haizil Rivers and in a cross wash at approximately 3.5 kilometers from Zakho. It is quite possible that the material found underneath the top 0.25 to 0.50 Meter mantle throughout the route between the two rivers will prove to be satisfactory select material since the entire terrace appears to be a gravelly outwash. Stone for any masonry work will have to come from the mountains which are about one kilometer from the upper Haizil River crossing.

4. Cost Estimate

a. Engineering location work will be relatively easy and quickly accomplished even considering that there are three alternate lines to be run. A competent party should be able to accomplish the field work in about a month, including bridge data sheets. Roadway design will be easy and inexpensive. The greatest engineering cost will be the bridge design. Engineering costs are estimated at:

Location	$ 3,000
Design	30,000
Construction Engineering	20,000
Total	$53,000

b. Construction: The estimate of the cost of construction in US dollars is:

Earthwork	$170,000
Minor drainage structures	40,000
Major bridges	330,000
Interim surfacing	125,000
	665,000
Ultimate surfacing	285,000
Total	950,000

5. Equipment Needs

a. Engineering: Equipment sufficient to outfit one full engineering crew should suffice for both location and construction engineering. This would include:

1 Transit	@	$800	$800
1 Level	@	500	500
4 Range poles	@	10	40
4 Levelrods	@	50	200
2 Abney levels	@	40	80
2 100 M chains	@	15	30
Plumb bobs, tapes, axes			100
Total			1,750

b. Construction: The following major units of construction equipment will be required:

Earthwork

12 CY Carrying scrapers	3
Push Tractor (D-8 or equal)	1
Bulldozer (D-8 or equal)	1
Tractor, crawler (D-6 or equal)	1
Dbl-drum sheepfoot roller	1
Motor Patrol 12 ft., 125 HP	1
Water Truck, 1,500 gal	2
Water Pump, 3 inch	1

Surfacing

Crushing plant, 50T/hr	1
Dragline, 1/2 C.Y. Truck-mounted	1
Dump Truck, 4 C.Y	10
Motor Patrol, 125 HP, 12 ft	1
Water Truck, 1,500 gal	2
Water Pump, 3 inch	1
Roller, pneumatic	1
Tractor, wheeled 45 HP	1

Bridges

Truck crane, w/clamshell 25-ton	2
Concrete mixer, 16 S	4
Aggregate scale	3
Vibrator, gasoline powered	5
Dump Truck, 4 C.Y	4
Flat-bed truck 1 1/2 - 2 ton	2
Water pump, 2 inch	3
Water pump, 3 inch	2
Water pump, 4 inch	2
Washing and screening plant	1

(This list contemplates that the international bridge will be included in the Iraq section work)

Miscellaneous and Survey

Flat-bed truck, 1 1/2 - 2 ton	2
Pickups, 1/2 ton	2
Generator, 5 KV	2
Welder Arc, 300 A	1
Fuel truck, 2,500 gal	2
Lubricator	1
Service Truck	1
Fuel Tanks, 3,000 gal	2
Pump, water, 2 inch	2
Compressor, air 30 fpm	1

This equipment is estimated to cost $651,-700 as shown on Plate No. III. Since it is recommended that the present surfacing be limited to select material subbase and only enough graded crushed gravel for adequate maintenance this list does not include any asphalt equipment.

It is recognized that should the work be done by contract with a local firm this entire complement of equipment will probably not be supplied. If the grading work were to be done in connection with the Turkey section, the equipment list for this project could be reduced to that necessary for bridge construction and some service equipment; under that procedure the cost of equipment is estimated to be $170,-000.

6. On-the-job training

a. Engineering: This section is too small to afford much opportunity for on-the-job training. The roadway location and design will be so simple that not much training can be conducted. If the Edwards, Kelcey and Beck group could spare the time to supervise the work there would be a chance to demonstrate the preparation of a modern set of plans. If the International bridge is grouped with this section there would be enough bridge design work involved to merit an effort to provide some on-the-job training in that field. One competent bridge designer could provide about six months on-the-job training to some three or four bridge designers and six or eight detailers and squad leaders. The short time involved would probably make it unprofitable to provide a suitable person to direct this training unless there could be subsequent work for him in Iraq.

b. Construction: It is thought that the work will be of too short duration to justify any effort at formal on-the-job training unless construction superintendents, equipment operator-instructors, and mechanic-instructors are already available in the country.

Summary

Construction Equipment

HAIZIL RIVER-ZAKHO SECTION

Unit	No.	Unit Price	Cost
Scraper, motorized, 12 C.Y.	3	$40,000	$120,000
Tractor-Bulldozer, heavy	2	28,000	56,000
Tractor-crawler, medium	1	21,000	21,000
Tractor, wheeled, 45 HP	1	4,000	4,000
Roller, sheepfoot, dbl drum	1	2,600	2,600
Roller, pneumatic	1	1,200	1,200
Motor Patrol, 12', 125 HP	2	18,000	36,000
Truck-mtd. dragline, 1/2 C.Y.	1	45,000	45,000
Truck crane w/clamshell, 25 T	2	45,000	90,000
Truck, dump 4 C.Y.	14	4,500	63,000
Truck, flatbed, 2-ton	4	3,000	12,000
Truck, water tank, 1,500 gal	4	7,200	28,800
Truck, fuel tanker, 2,500 gal	2	7,500	15,000
Truck, Pickup, 1/2 ton	2	1,800	3,600
Truck, service	1	4,000	4,000
Pump, water, 2"	5	400	2,000
Pump, water, 3"	5	600	3,000
Pump, water, 4"	2	1,000	2,000
Crushing Plant 50 T/hr	1	75,000	75,000
Washing and Screening plant	1	40,000	40,000
Mixer, concrete 16 S	4	3,200	12,800
Scales, aggregate	3	500	1,500
Vibrator, gas powered	5	200	1,000
Generator, 5 KV	2	1,500	3,000
Welder, 300 A	1	4,800	4,800
Lubricator	1	2,500	2,500
Compressor, 30 CFM	1	300	300
Tanks, fuel 3,000 gal.	2	800	1,600
Total			651,700

(Includes equipment for international bridge)

PLATE III

Summary

Construction Cost Estimate

CIZRE-ZAKHO ROAD

Section	Length Kms.	Earthwork	Minor Structures	Major Structures	Interim[1] Surfacing	Subtotal	Ultimate[2] Surfacing	Total
Cizre-Haizil River	47.0	$2,800,000	$950,000	$775,000	$475,000	$5,000,000	$800,000	$5,800,000
Haizil River Bridge.....	0.4	100,000	.....	650,000	.....	750,000	.....	750,000
Haizil River-Zakho.....	12.6	170,000	40,000	330,000	125,000	665,000	285,000	950,000
Total.....	60.0	3,070,000	990,000	1,755,000	600,000	6,415,000	1,085,000	7,500,000

[1]Interim surfacing is proposed as subbase stabilization with selected material plus a 7.5 cm course of crushed gravel.

[2]Ultimate surfacing of gravel base with a 7.5 cm x 7.0 M bituminous surfacing to be provided when connecting roads in Turkey are further improved and when traffic demands will justify such surfacing.

V DETAILED DESCRIPTION, TURKEY-IRAN ROUTE

A. Sivelan-Bicirge Section

1. Description

This section begins at a junction with the Van-Hakkari road near Sivelan and immediately crosses the Zapsuku River. It follows in a generally southeasterly direction up the canyon of the Nahil Deresi. The first four kilometers are through a very tight canyon and will involve heavy bench work, practically all solid rock. After this, the canyon widens perceptibly and the work, while still practically all sidehill, will be considerably easier. At approximately 12.5 kilometers from the Sivelan junction a rock rib comes precipitiously down to the river's edge. This can best be penetrated by a short tunnel although a through cut could be used if the rock proves unsatisfactory for tunnel construction.

At Kilometer 21 (all measurements from Sivelan Junction) the route emerges into a wide valley and will skirt along the northerly edge with easy going until Yuksekova is reached at Kilometer 36. At Yuksekova the route will turn northeastward up the valley of the Dize Deresi. The next 12 kilometers will continue as valley floor construction. At Kilometer 48 the valley narrows and sidehill work in mixed earth, shale and some rock, with sustained grades somewhere near maximum will be required to reach the Delezi Pass at Kilometer 57.7. The elevation of this pass is approximately 2,225 meters. Even with an appreciable through cut at the pass (which is entirely feasible) some grade development will be needed descending easterly from the pass. A side draw to the left (northwest) should afford ample room to develop the necessary distance.

The route continues easterly down the Diri Deresi valley with moderately heavy sidehill work intermingled with construction across terraces to Kilometer 80.4 at the Turkey-Iran border near Bicirge.

2. Proposed Construction Procedure.

It is fairly well established that the Turkish General Directorate of Highways will do the location work and construct this road with their own forces: in fact the signed Project Agreement between Turkey and the ICA provides (US) $1,-200,000 to procure construction equipment for this purpose. The Directorate of Highways is considered competent to do this work.

Estimates of equipment needs have been based on completing the earthwork and most of the interim surfacing in two full construction seasons. Since location possibilities are rather rigidly prescribed by the canyon location and control points are well apparent it should not be necessary to locate and design the entire section before starting construction. It will be sufficient to have located and designed only the first 21 kilometers from Sivelan Junction to a point near the Kerem bridge to afford working space for three shovel spreads for the first season. The next 27 kilometers being valley floor location can be surveyed and designed quite rapidly and it should be possible to complete the field survey to the border well before the end of the first season. Survey and location work is now underway between Sivelan and Yuksekova and that section should be available for construction at the beginning of the 1958 season.

The Zapsuku River bridge at the beginning of the project will have to be built before the equipment can be delivered to the work site. It is understood that this bridge is already designed and the Directorate of Highways has indicated that its construction will be done promptly.

Grading work the first season may be limited to the canyon section from Kilometer 0 to Kilometer 21, where the heaviest work is encountered. Work at the tight canyon location in the first 4 kilometers will no doubt interfere considerably with traffic along the existing local road. It would be entirely feasible to delay work on those sections which cut the existing road until the winter season when the track is routinely closed to traffic because of snow. At as early a date as possible a bulldozer team should be assigned to rough out a service road from Yuksekova to Bicirge. This service road will facilitate the work of the locating party and will give access to structure locations for delivery of materials.

The second season the shovels can be moved ahead to work between Kilometers 48 and 80 and a scraper spread brought in to grade the valley section, Kilometers 21-48.

Structure construction will be a critical feature if the work is to be completed in two seasons. It will be necessary to work on several structures simultaneously to insure their completion in advance of the earth work.

Plate IV shows a possible work schedule for this section.

3. Local Resources.

a. Labor. Some unskilled labor will be available from Yuksekova and other villages in the vicinity but all the skilled labor and probably much of the unskilled labor will have to be recruited from other parts of the country.

b. Housing. The engineers and workmen will have to be housed in construction camps. Suitable camp sites may be found in the vicinity of Kilometers 10, 21, 27, 36, 39, 48, 58, 64, 75, and 79. In conformity to local practices tent camps will be used and intermediate camps will no doubt be established to bring the laborers closer to the scene of operations.

c. Materials. The only local materials available are:

i. Stone for masonry work is avialable at several locations along the route. In view of the scarcity, high cost and long haul of reinforcing steel and cement it may be expected that stone masonry will be used quite extensively in structure work.

ii. Concrete Aggregate can probably be produced near Kilometer 21 and in the vicinity of Yuksekova.

iii. Selected Materials may be obtained from the following possible sources:

Kilometer 4. Large talus slide of well decomposed rock
Kilometer 21. Gravel bar in Nehil Deresi
Kilometer 27. Gravel flat from side draw
Kilometer 36. River gravel bars
Kilometer 39. Gravel flat from side draw
Kilometer 62. Quarry site, will require crushing
Kilometer 75. Conglomerate and coarse gravel, will require crushing
Kilometer 79-80. Gravel flat, considerable oversize, will require crushing or wasteful scalping

4. Cost Estimates.

a. Engineering. If the engineering were to be let to contract an approximate estimate of the cost would be:

Surveys and Design	225,000
Construction Engineering	325,000

The Turkish Directorate of Highways is staffed and competent to perform this work with their own forces. Using unit costs as developed by them on similar work the estimated cost of engineering on this section will be:

Surveys and Design	TL200,000
Construction Engineering	TL500,000
Total--	

b. Construction. The cost of construction is estimated in dollars as follows:

Earthwork	$3,420,000
Rockwalls & Misc. str	200,000
Minor drainage strs	204,000
Major drainage strs	576,000
Interim surfacing	580,000
Subtotal	4,980,000
Contingencies 5%	249,000
	5,229,000
Say	5,230,000
Ultimate surfacing	1,350,000
Grand total	6,580,000

Conversion of these costs to local currency is complicated by fluctuating and multiple exchange rates. An independent analysis, using in most part unit cost supplied by the Directorate of Highways, was made to arrive at an estimate in local currency. This analysis produced the following estimated costs:

Earthwork	TL9,295,000
Rockwalls & Misc. Str	600,000
Minor drainage strs	800,000
Major drainage strs	1,350,000
Interim surfacing	2,150,000
Subtotal	TL14,195,000
Contingencies 5%	709,750
	TL14,904,750
Say	14,900,000
Ultimate surfacing	4,600,000
Grand total	TL19,500,000

5. Equipment Needs.

a. Engineering: The following list of engineering equipment will be needed in the location and construction engineering phases of the project.

Transits	3	Plumb Bobs	12
Levels	3	Hand Levels	10
Range Poles	10	Axes, book bags,	
Level Rods	5	metallic tapes,	
Chains	4	etc.	

The Directorate of Highways which will perform the work is sufficiently equipped so no special purchase of engineering equipment for this project is contemplated.

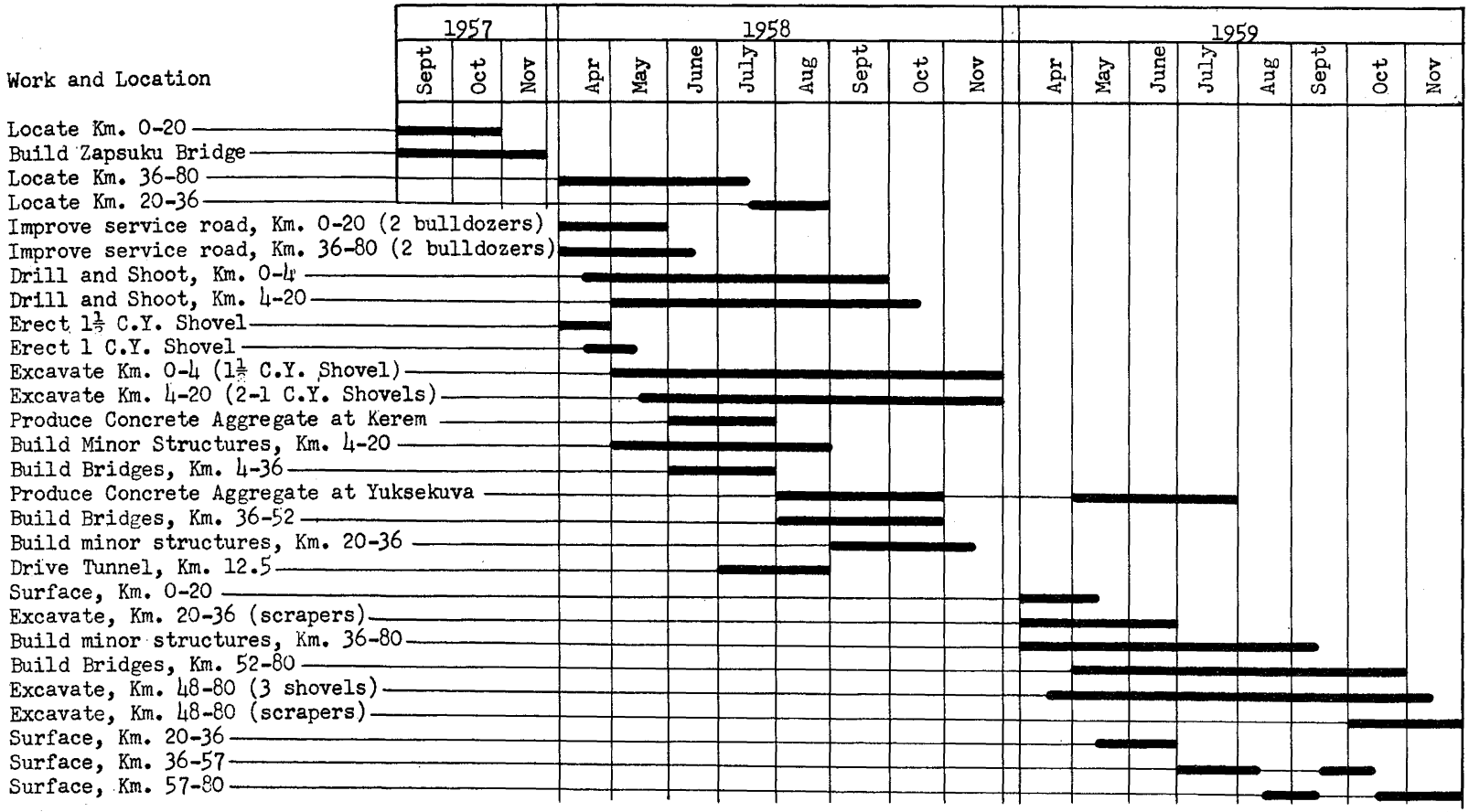
b. Construction: The construction work was analyzed to determine the major equipment required to perform the work in 2 or 2 1/2 years. The following groups of equipment will be necessary.

One Power Shovel Group

1 1/2 C.Y. Power Shovel	1
Heavy Bulldozer	1
Air Compressor 600 CFM	2

PLATE IV

SUGGESTED PLAN OF OPERATION
SIVELAN-BICIRGE SECTION



One Power Shovel Group—Con.

Air Compressor 365 CFM	1
Jackhammers 65#	8
Rock Trucks	2
Hose and Drill Steel	LS

Two Power Shovel Groups

I.C.Y. Power Shovel	2
Heavy Bulldozer	2
Air Compressor 600 CFM	2
Air Compressor 365 CFM	2
Jackhammers 65#	10
Rock Trucks	3
Hose and Drill Steel	LS

One Scraper Spread

Crawler Tractor (medium heavy)	4
Towed Scraper, 12 C.Y	4
Push Tractors (heavy)	2
Bulldozer (heavy)	1
Ripper, 3 tooth	1
Tractor, crawler (medium)	2
Dbl-drum Sheepfoot Roller	2
Motor Patrol, 125 HP	1
Water Truck, 1,500 gal	2
Water Pump, 3"	1

Surfacing

Crushing Plant, 50 T/hr	1
Front End Loader	1
Dragline 1/2 C.Y. Truck Mtd	1
Dump Trucks, 4 C. Y	12
Motor Patrol, 125 HP	1
Water Pump, 3"	1
Tractor, wheeled 45 HP	1
Roller, pneumatic	1

Bridges

Truck-crane, w/clamshell, 25 Ton	2
Concrete mixers 16 S	4
Aggregate Scales	2
Vibrators	4
Dump Truck, 4 C.Y	4
Flat bed Truck 1 1/2 - 2 T	2
Water Pump, 2"	3
Water Pump, 3"	4
Washing and Screening Plant	1

Miscellaneous and Service

Air Compressor, Tractair 125 CFM	1
Jackhammer	1
Hose and Drill Steel	LS
Tractor-truck	1
Lowboy Trailer, 20 T	1
Flatbed Truck, 1 1/2 - 2 T	4
Jeeps, 1/2 Ton	4
Pickup Trucks, 1/2 Ton	4
Mobile Shop	2
Generator, 15 KV	2
Generator, 5 KV	3
Welder, Arc 300 Amp	2
Fuel Trucks, 2,500 gal.	4
Lubricators	3
Service Trucks	3
Fuel Tanks, 2,500 gal	4
Pump, Water, 2"	2

This equipment is estimated to cost $1,303,-700 as shown on Plate No. V. While the Turkish Directorate of Highways has an appreciable amount of construction equipment, their current highway program is of such size that practically none of the units on hand can be considered available for this work.

Manufacturers' recommended list of spare parts, to the amount of 10 percent of the list price of the machines for all units subject to periodic repair, should be included in the procurement.

In recommending units of equipment consideration has been given to the difficulty in transporting the units to the job site. Some compromise has been made between the unit size or capacity and its maneuverablility. For example, larger power shovels would be more economical in the heavy going but would introduce complications in transporting them to and from the job sites.

6. On-the-job Training.

a. Engineering. The engineering work will be performed by the Turkish General Directorate of Highways and no formal on-the-job training program is recommended.

b. Construction. The General Directorate of Highways have continuing programs for training equipment operators. Because of the remoteness of the location this project is not thought to be very well adapted as an arena for field extension of the training programs.

Construction Equipment Needs

SIVELAN-BICIRAGE SECTION

Unit	No.	Unit Price	Total
Power shovel, 1 1/2 C.Y.	1	55,000	$55,000
Power shovel, 1 C.Y.	2	40,000	80,000
Truck-mtd, dragline 3/4 C.Y.	1	45,000	45,000
Truck, mtd. crane w/clamshell, 25 T	2	45,000	90,000
Tractor-shovel, 1 1/2 C.Y.	1	30,000	30,000
Tractor w/angledozer, heavy	4	30,000	120,000
Tractor w/push pad. heavy	2	28,000	56,000
Tractor, crawler, medium heavy	4	23,000	92,000
Tractor, crawler, medium	2	21,000	42,000
Tractor, wheeled, 45 HP	1	4,000	4,000
[1] Scraper, towed, 12 C.Y.	4	12,500	50,000
Ripper, 3-tooth	1	2,000	2,000
Roller, sheepfoot dbl-drum	2	2,600	5,200
Roller, pneumatic	1	1,200	1,200
Motor Patrol, 12', 125 HP	2	18,000	36,000
[2] Truck, rockdump 6-8 C.Y.	5	11,000	55,000
Truck, dump, 4 C.Y.	16	4,500	72,000
Truck, flatbed, 2 ton	6	3,000	18,000
Truck, water tank, 2,000 gal	2	7,200	14,400
Truck, service	3	4,000	12,000
Truck, fuel tanker, 2,500 gal	4	7,500	30,000
Truck, pickup 1/2-ton	4	1,800	7,200
Truck-tractor	1	10,000	10,000
Trailer, lowboy, 25 T	1	7,500	7,500
Jeep, 1/2-ton	4	1,800	7,200
Compressor, Air, 600 cfm	4	20,000	80,000
Compressor, Air, 365 cfm	3	12,500	37,500
Compressor, Tractair 125 cfm	1	6,000	6,000
Air Drill, 65#	19	500	9,500
Drill steel, hose, etc.		LS	15,000
Crushing Plant 50 T/hr	1	75,000	75,000
Washing and Screening Plant	1	40,000	40,000
Mixer, Conc. 16 S	4	3,200	12,800
Scales, Aggregate	2	500	1,000
Vibrator, gasoline powered	4	200	800
Pump, water 2"	5	400	2,000
Pump, water 3"	6	600	3,600
Mobile Shop	2	21,000	42,000
Generator, 15 KV	2	6,000	12,000
Generator, 5 KV	3	1,500	4,500
Welder, 300 Amp	2	4,800	9,600
Lubricator	3	2,500	7,500
Tank, fuel, 3,000 gal	4	800	3,200
Total			1,303,700

[1] Should be available from present equipment fleet.
[2] Could use Tournarockers from present fleet.

PLATE V

B. Turkey Border-Rezaiyeh-Mahabad-Bijar-Zanjan Section

1. Description

Turkish-Iran Border to Rezaiyeh—54.1 Kilometers

The proposed road begins at the mouth of a canyon on the Turkish side opening onto a wide flat valley approximately 9 kilometers across.

The river flowing from the Turkish side is called Nazloo Tchai in Iran and crosses the proposed road before the boundary is reached.

Tentative agreements are that a satisfactory crossing will be made in Turkey with the Iran side providing only one bridge at Kilometer 9 from the border.

The road grade has been established across the valley to within 1.5 kilometers of the border and is built on approximately a one-meter fill.

The Iranian Highway district headquartered in Rezaiyeh has been constructing a road between the border and Rezaiyeh for the past six years. Considering the limited equipment available, considerable progress has been made.

The standards for the present road are for an 8M roadway (berm to berm) with 1 1/2 to 1 slopes. These are some 6 percent and 7 percent grades on 24.6 kilometers of roadway which could be classed as mountainous.

Fills are standard construction with side borrow by hand methods and are without compaction. There are virtually no cuts so there is no balancing of material quantities, and fills are by end dump from the established grade line.

Curvature is reasonable and no particular improvement could be made without considerable relocation.

Some river gravel is beginning to be hauled onto the finished grade.

From Kilometer 9 the road rises to an elevation of 1,780 meters at Kilometer 28 and then down to 1,335 meters at Rezaiyeh.

The bridge at Kilometer 9 has not been built. There are three new structures to the summit. All are stone masonry arches. At Kilometer 15 there is a 3—6M span bridge, Kilometer 18.5 2—6M spans, Kilometer 19 1—6M span. All structures have an 8M roadway.

At Kilometer 36 a new structure is under contract 3—10M spans stone masonry arch. However, the river banks are 315M apart and it is expected that this bridge will wash out so a new bridge will probably be required in the near future.

At Kilometer 42 there is 4—4M span stone masonry arch with an 8M roadway.

The road joins the Khoi-Rezaiyeh road approximately 1.6 kilometers north of Rezaiyeh.

Within Rezaiyeh there is 2.5 kilometers of 20 to 22M width asphalt which should be patched and sealed.

Rezaiyeh-Mahabad—115.2 Kilometers

Rezaiyeh is the busy center of a rich, flat, agricultural area approximately 35 kilometers by 55 or 60 kilometers located west of the very salty lake of the same name. The climate is generally mild and the area is dotted with houses and small villages surrounded by cultivated fields.

The principal crops include grapes, melons, hay, tobacco, sugar beets, wheat, barley and other grains. Large new factories are being built to process tobacco and sugar beets. Brick is made for buildings and is in addition to the normal usage of sun-dried mud and straw bricks for house construction. Wine is made from several varieties of grapes and Rezaiyeh is considered one of Iran's best wine producing centers.

At Kilometer 68 from Rezaiyeh a road turns southeast to Khaneh which is an important truck transportation center serving eastern Iraq.

The existing road for this section south of Rezaiyeh is generally on the present ground level without fill and is surfaced with river gravel and lake shore sand and gravel. Unusually heavy corrugations are present in the 6 to 8M width of surface due to usual maintenance methods of shoveling side material to the center of the road by hand.

The road follows a somewhat indirect alinement for the first 30 kilometers from Rezaiyeh across the plain. The road then follows close to the lake for the next 40 kilometers due to the presence of foothills and rolling country near the lake shore.

Drainage to this point is across the road from the foothills on the west to the lake on the east. There are several knolls and shoulders coming down to the lake edge which will need higher road location and some cuts.

The road begins to leave the lake south of the Khaneh road junction crossing a slight elevation before dropping to the flat level plain at the south end of the lake.

North of Mahabad 9.8 kilometers on the present road is a location near a large brick factory which can be the turn off to the east across the plain. One crossing of the Mahabad river which empties into the lake will need to be made and will require a 50M bridge. The roadway should be on a fill to provide stability on account of the high water table.

The distance across this section is 2 kilometers to a connection with the east side road to Mahabad. Mahabad itself lies at the head of a canyon through which the Mahabad River

flows. The road serving the city from Rezaiyeh follows the west side of the canyon and the road northeast follows the east side of the canyon. Crossing of the Mahabad River is now made in the city by a stone masonry arch bridge of 5—8M spans with a concrete deck and a 7M roadway.

Near the junction of the 2 kilometers cutoff and the east side Mahabad road is a junction with an old Russian-built road to Bukan. The choice of the routing from this point on is either to go northeast via Meyanduab and then south to Bukan, a distance of approximately 100 kilometers or go directly on the old road for a distance of 50.5 kilometers. The latter routing was chosen.

Mahabad-Bukan—50.5 Kilometers

This section of road was not traversed by the reconnaissance party but both termini were checked. The country is generally rolling and can be characterized as having a few mountain peaks with broad valleys.

Local inquiry regarding the section revealed that the old bridges were either not in existence or not usable. The old grade was plainly visible and it is very probable that improvements could be made in alinement.

One major bridge would be required immediately west of Bukan of approximately 500M length. Four moderate structures would be required for cross drainage totaling an estimated length of 80M for the 4.

Bukan is a small agricultural market center for the valley in which it is located. Grains, grapes and melons seem to be the principal crops.

Bukan-Bijar Jct.—154.2 Kilometers

From Bukan south the proposed road would follow approximately the present road with only such relocation as would be necessary to take advantage of the long sections of new grade which has been constructed but not used.

Generally the present road is 7 to 8 meters wide, river gravel surface, without minor culverts and side ditches and usually corrugated.

The present road for approximately 61 kilometers south from Bukan is on a new grade, usually from 0.5 to 1M fill and is 8M wide. The road passes through a wide valley until about 13 kilometers north of Saggez.

For this 13 kilometers there is sidehill cut which will need widening.

Saggez village square is to the right of the road which is on the north side of the village. The Saggez River, 0.5 kilometer from the village, is crossed on steel girder bridge with a concrete deck with 7—30M spans, a 5 1/2M roadway with two 3/4M sidewalks. The bridge is quite new and would be left in place.

Similarly at Kilometer 54.2 there is a shorter bridge (3-30M spans) of the same type and standard providing a crossing of the Zarnineh River, which may be left in place.

From Kilometer 54.2 to a few kilometers beyond the village of Miranshah (Kilometer 94) the country is quite rolling with a number of short pitches for rise and fall. There is frequent evidence of washes across the road from the side hills. Within this section is a bridge over the Khurkhureh River at Kilometer 72.9 3—22M plate girder spans with 5 1/2M roadway, to be left in place.

From about Kilometer 96 to the village of Dyvandarch, Kilometer 138, there is a new road grade with most of the bridges in place, which has not been used. The grade was evidently built several years ago and is on good alinement. An 8M width standard was used with some minor drainage structures or concrete pipe in place. This section will need completion and widening.

The country is open and slightly rolling and on a high plateau.

The section between the village of Dyvandarch and Bijar junction, a distance of 16.2 kilometers, changes from a plateau down a canyon to a river crossing at Kilometer 145.7 on a 7—15M span concrete arch bridge with an 8M roadway.

Beyond the river crossing the road continues on a side hill section, with the river on the right, to a junction with the Bijar road. The road ahead goes to Sanandaj with the Bijar road turning abruptly left at Kilometer 154.2 from Bukan.

Bijar Junction-Bijar—59.6 Kilometers

The proposed routing leaves the Saggez-Sanandaj road at a junction where there is no village or habitation in the area. The present road is a one-lane trail with little or no surface material. The alinement could be considerably improved. There are no ditches, minor culverts or bridges on the present road so nothing would be lost by complete construction on good alinement.

The country is gently rolling on a plateau occasionally cut by transverse canyons.

The present road passes through three or four villages and serves probably a dozen in the area. Each village appears rather self-sufficient with agriculture and livestock as the main interests.

While the plateau and ridges followed by the present road present a minimum of drainage problems, bridges are needed at canyons, some of which have running water in the dry season. From Bijar Jct. towards Bijar, the following

bridges are needed: Kilometer 17.6, 18M; Kilometer 26.7, 18M; Kilometer 32.4, 12M; Kilometer 34.2, 20M; Kilometer 41.4, 30M.

At Kilometer 50.4 the plateau ends in a small elevation and the road descends gradually into a long curving valley in which the village of Bijar is located.

Local inquiry at Bijar concerning alternate routes disclosed that on the opposite side of the valley from the road there was a trail which led eventually to Meyanduab. The section north from Bijar was passable by wheeled vehicles for some distance since the road served some villages. Beyond that it was described as an impassable trail without bridges and passing through mountainous country.

Bijar is a prosperous semi-isolated community whose commercial interests center largely in grain and livestock. The area around the village has the appearance of dry land grain farms.

There is a road maintenance unit located here whose responsibility is the care of the main transportation link, which is the road to Hamadan. Bijar is 173 kilometers from Hamadan and there appears to be more than adequate bus and truck service. There is shipment of sheep by double decking on trucks. The trip to Hamadan can be made in four or five hours.

Bijar-Zanjan—152.3 Kilometers

The proposed road from Bijar follows an east-west valley and a 12M bridge is needed to cross the drainage approximately 2.8 kilometers out. In general the country is rolling with wide plateaus.

There are three passes, Kilometer 40.8, elevation 1,750M; Kilometer 99.5, elevation 1,800M; and Kilometer 127.3, elevation 2,153M., of generally north-south mountains which are crossed with approximately six to seven percent grades.

There are few people in the area. The present road passes through three or four villages and there are not more than twice this many in valleys away from the road.

The present road for the first 30 kilometers is one lane, without drainage structures, having a scattering of river gravel for surfacing and on alinement which could be considerably improved.

On the next 40 kilometers a new road is under construction. The alinement is good and the width is 8 meters berm to berm. In general, the minor drainage structures remain to be built but the grading is completed. The grading has been done by hand methods using side borrow to make the uncompacted road fill. A minimum of cut has been made.

SUMMARY OF ROAD SECTIONS

Kms.	Road Section	Type of Work	Standard Applicable
54.1	Turkish-Iran Border-Rezaiyeh (Includes 2.5 Kms. of 22M asphalt in Rezaiyeh)	Compaction Widening Base Surfacing	24.6 Kms. Mts. 27.0 Kms. flat
115.2	Rezaiyeh—Mahabad (9.8 Kms. north of Mahabad cutoff across the river for 2.0 Kms.)	Complete construction	Flat
50.5	Mahabad-Bukan	Complete construction on new line	Rolling
153.8	Bukan-Bijar Jct. (16.2 Kms. Dyvandarch to Bijar Jct.)	Compaction Widening Base Surfacing Bridges	Rolling
59.6	Bijar Jct.-Bijar	Complete construction	Rolling
152.3	Bijar-Zanjan (0.7 Kms. 10M asphalt in Zanjan)	70 Kms. construction 51.6 Kms. compaction Widening Base Surfacing Bridges	Rolling
585.5			

The remaining 82 kilometers of road to Zanjan has been completed to the 8 meter width standard and on most of this a river gravel surfacing has been placed. This construction has been handled from the District Office in Zanjan and has been in progress for six years. The road sections have been done by coolie labor and the bridges by contract work.

At Kilometer 151.4 just outside of Zanjan is the only railroad crossing on the route. The present crossing is at grade over one track.

From Kilometer 151.6 to Kilometer 152.3 10M asphalt street in Zanjan will need sealing. Connection is made at this point in Zanjan with the Tehran-Tabriz road.

In addition to the bridges already constructed which will be left in place, two new structures are needed. A 12M bridge is required at Kilometer 2.8 and there is a 100M wash at Kilometer 81.6 which will require an 80M bridge.

The bridges in place are as follows:

Km. 31.1	4-15M spans, stone arch 8M roadway.	No approach fills
Km. 55.7	4-8M spans, reinforced concrete slab.	No approach fills
Km. 67.6	5-15M spans, stone arch 8M roadway, Jazelazan River.	No approach fills
Km. 70.1	5-10M spans, stone arch 8M roadway.	In use
Km. 103.2	2-10M spans, stone arch 8M roadway, Haga River.	In use
Km. 150.9	3-10M spans, stone arch 8M roadway, Zanjan River.	In use

2. Proposed Construction Procedure

While none of the recently constructed sections will meet the recommended design standards, particularly with regard to roadway width, it is considered that they will adequately serve the traffic that may be developed in the next few years. It is recommended that the construction schedule, in the initial stages, be concentrated on the impassable sections with only such betterment work on the more recently constructed section as is required to serve the present traffic. In accordance with this recommendation the following initial work is suggested.

a. Turkey Border-Rezaiyeh

1. Build section from end of present grade to the boundary.
2. Provide structures, where missing.
3. Complete subgrade stabilization.
4. Provide light course of crushed gravel surfacing which can be maintained.

b. Rezaiyeh-Mahabad. Complete reconstruction should be provided since the existing road is very low type.

c. Mahabad-Bukan. Complete construction (with subgrade stabilization and maintenance gravel) is required. This section should be undertaken first.

d. Bukan-Bijar Junction. Retain, without immediate widening, such sections of the new grade that fit in with the ultimate location. Provide subgrade stabilization and maintenance gravel.

e. Bijar Junction-Bijar. Complete construction through subgrade stabilization and maintenance gravel. This section might be undertaken concurrent with the Mahabad-Bukan section, or immediately following the completion of that section.

f. Bijar-Zanjan. Complete construction with subgrade stabilization and maintenance gravel, first 30 kilometers.

Provide drainage structures, subgrade stabilization and maintenance gravel, next 40 kilometers.

Provide maintenance gravel remaining 82 kilometers.

The work on the Boundary-Rezaiyeh section can be done by the existing contractor, with bridges advertised as a new contract.

Predicating the procedure plans on retaining much of the newer work, unwidened, for the time being, two complete construction crews could be used to good advantage. One crew should build the Mahabad-Bukan section first, then move on to the Rezaiyeh-Mahabad section. The other crew would enter at Bijar, concentrate on the 30 kilometers easterly toward Zanjan and afterward work on the Bijar Junction-Bijar section. A third "flying" crew could do such reshaping work as is necessary on the grades which are to be retained in preparation for subgrade stabilization and maintenance gravel application, working first on the Zanjan-Bijar section and moving northward.

3. Local Resources

a. Labor. Unskilled labor is available in adequate supply in the area through which the route traverses. Some seasonal fluctuation may be expected depending upon agricultural demands. Stone cutters and stone masons should also be available locally. A limited number of truck drivers may be found but the level of their skill and efficiency is very low.

Equipment operators and mechanics are nonexistent, locally, and indeed cannot be found in sufficient numbers or with sufficient skills in the entire country. Operators from outside will have to be brought in to staff the work initially.

b. Housing. Job-site camps will be required. Engineers and supervisory personnel should be provided with house trailers and water treatment facilities will be needed. Operators and local labor can probably be accommodated in tents.

If headquarters and design work are maintained in Tehran, as would seem logical, housing suitable for American occupancy will be readily available at a monthly rental of from 10,000 to 15,000 rials (U. S. $130 to $150).

c. Materials.

Materials for construction of all elements required for the completion of the road are available in Iran although reinforcing steel as well as structural steel is imported from Europe. The supply is adequate and prices are very reasonable. Contract prices for reinforcing steel and structural steel on a recent project were $0.13 and $0.12 per pound, respectively.

Stone for base construction, concrete, asphaltic concrete and stone masonry is available in unlimited quantities from local sources situated along the roadside. Sand is also available from local river deposits but will, of course, have to be washed and screened. Stone will also have to be crushed and screened in local plants by the contractor.

Cement is manufactured here in Iran in sufficient quantities to fulfill the needs for this project and is of recognized quality as established by standard tests for portland cement. The factories are in the Tehran area and haul would be of some significance. The price at present is 110 rials per 50 kilo bag, which is equivalent to $1.43 in American dollars for 110 pounds.

Asphalt is produced in Iran in sufficient quantities to provide adequate supplies for the requirements of this work. Again as in the case of the cement the refineries are some distance from the project and haul would be a factor in this case also. Asphalt in Tehran costs from 3,700 to 4,200 rials per metric ton or $48.10 to $54.60 American.

d. Camp Sites.

As previously noted it is recommended that all field parties, both engineering and contract, be housed on the project in camps. The location of camp sites will be largely dependent on a reasonable supply of water and accessibility to a source of food supplies. Both of the latter items are readily available at a number of points along the proposed route. The locations listed below were noted in the course of an on the ground reconnaissance of the route as presenting very good possible camp sites. There are no doubt many others which may be found more suitable when more study and time in selecting sites can be spent than was at all possible in the short period which was available to the reconnaissance group.

The following sites where camping facilities appeared to be particularly suitable were observed in the course of the reconnaissance survey:

Km. 19.5 S.W. of Zanjan, River bottom
Km. 42.5 S.W. of Zanjan, near village and water
Km. 44.5 S.W. of Zanjan, River valley
Km. 62.4 S.W. of Zanjan, River valley
Km. 96.5 S.W. of Zanjan, River valley
Km. 122.2 S.W. of Zanjan, River valley
Km. 23.8 S.W. of Bijar, village and water
Km. 41.4 S.W. of Bijar, village and water
Km. 5.1 N.W. of Bijar-Bukan Road Junction, springs in area
Km. 8.5 N.W. of Bijar-Bukan Road Junction, River valley
Km. 58.6 N.W. of Bijar-Bukan Road Junction, River valley, village
Km. 81.3 N.W. of Bijar-Bukan Road Junction, River valley
Km. 100.0 N.W. of Bijar-Bukan Road Junction, River valley
Km. 126.6 N.W. of Bijar-Bukan Road Junction, River town of Saggez
Km. 17.8 N.W. of Saggez
Km. 36.6 N.W. of Saggez, near town of Bukan
Km 68.8 N.W. of Saggez, in vicinity of town of Meyanduab
Km. 7.3 N.W. of Mahabad, River valley
Km. 31.6 N.W. of Mahabad, River valley
Km. 69.0 N.W. of Mahabad, near village and water
Km. 78.7 N.W. of Mahabad, near village and water
Km. 103.4 N.W. of Mahabad, near village and water
Km. 16.0 N.W. of Rezaiyeh, near village and river valley
Km. 33.0 N.W. of Rezaiyeh, good springs and valley

In addition to providing camp site facilities, each location is also near a source of stone for base course, asphaltic concrete and concrete aggregate consisting of river gravel as well as sand to be properly processed for the use intended.

These materials have been employed in their natural state, because of the lack of crushing and screening equipment, in the surfacing and maintenance of the existing roads in this area and have given satisfactory service except for their obvious lack of proper gradation. They will, without doubt, meet the required AASHO tests for their particular use on the projects.

Because of the distances involved it will be almost imperative to utilize the available local materials of this type.

e. Equipment. Construction equipment of the type and quantity considered necessary to construct this project within a reasonable time is not available locally in Iran for employment on this project. The Iran Plan Organization in conjunction with two consulting engineering firms from Europe have inaugurated a system of importing road construction equipment in the past two years for sale to local contractors for the construction of roads but this equipment is very limited and is committed to projects under supervision of the consultants.

Local contractors at present rely almost entirely on hand labor methods, with one or two trucks at the most in the line of equipment.

In view of these conditions and facts, it is considered that the equipment required for construction of this route should be supplied entirely from outside sources and the equipment needs have been so established in the report.

4. Cost Estimate

a. Engineering

COST OF LOCATION PARTY

Engineering services including on job training of local engineering personnel. Estimated cost of engineering for location party for one year.

Salaries per party--Annual

Chief of party (1)	$12,000.00
Transitman (2)	18,000.00
Levelman (1)	9,000.00
Rodman (6)	36,000.00
Chainmen (2)	12,000.00
Note keeper (1)	10,000.00
Laborers (Axemen) (6) (Local)	3,000.00
	100,000.00

Subsistence per man $90 per month, 13 men $1,170.00 per month, per party = $14,000.00.

Camp equipment, house trailers, towing vehicles, and all pertinent equipment to live out on the project:

5 House trailers & trucks	@	$7,000.00 =	$35,000.00
2 Jeeps	@	2,000.00 =	4,000.00
1 Carryall	@	3,000.00 =	3,000.00
1 Pickup truck	@	2,000.00 =	2,000.00

Camp lighting equipment, cooking utensils, bedding and water purification equipment and fuel--lump sum $10,000.00.

SUMMARY

Salaries	$100,000.00
Subsistence	14,000.00
Camp and necessary transportation equipment	54,000.00
Total	168,000.00

(per year--per party)

Total for 3 parties for one year $168,000.00 x 3 = $504,000.00.

Cost of trainees--8 engineers @ 5,000 rials a month plus living allowances of 70 rials per day or say 2,500 rials per month = 7,500 rials per month or say $100.00.

For 8 trainees, cost $800.00 per month on each party or $7,200.00 a year per party or say $25,000.00 for the year for trainees assigned to all three location parties.

Summary of cost of engineering for location, including cost of trainees:

Engineering party salaries	$100,000.00
Subsistence	14,000.00
Camp equipment	54,000.00
Per party	168,000.00

3 parties @ $168,000.00 = $504,000.00 per year
Say 510,000.00

Trainees--8 per party @	800.00	per month
8 per party	7,200.00	per year
3 parties	25,000.00	per year
Interpreters 4 per party	30,000.00	per year

Total for 3 parties including cost of trainees--$565,000.00 per year

Engineer personnel and equipment for surveys.

Ave. 5 Km. per week

$\frac{585}{5}$ = 117 weeks

$\frac{117}{3}$ = 39 weeks (say 40 weeks)

Party Composition:

Chief of party	1	$12,000.00	Abney level
Transitman	2	9,000.00	Transit
Rodman	6	6,000.00	Range poles 4
Chainmen	2	6,000.00	Chains 4
Laborers (axemen)	6 (Local)	40.00	Axes & brush hooks
Levelman	1	9,000.00	Level
Note keeper	1	10,000.00	

13 Men (Americans)

3 Parties..... 39 Men (Americans)

8 Iranian trainees to be assigned to each party and a minimum of 4 interpreters to each party.

COST OF CONSTRUCTION ENGINEERING PARTY

Salaries of one party per year including on-the-job training for this type of personnel.

Project Engineer (Resident engineer)	1	$15,000.00
Instrument man	1	10,000.00
Level man	1	9,000.00
Rodman @ ($6,000.00)	4	24,000.00
Inspectors (structures)	3	24,000.00
Inspectors (roadway)	4	32,000.00
Inspectors (crushing plant)	2	18,000.00
Laborers (porters)	4	2,000.00
Total Salaries		134,000.00 per year

Subsistence per man $90 month 16 =
$1,440.00 x 12 =
$17,300.00 per year

Camp equipment to house the construction party and transportation vehicles for on-the-job transportation.

[1] 5 House trailers and trucks			
[2] 10 Jeeps for inspectors, etc.	8 @	$2,000.00	$16,000.00
[1] 1 Carryall			
[3] 2 Pickups	1 @	2,000.00	2,000.00
[1] Camp lighting equipment, cooking utensils, water purification equipment, etc.			
			18,000.00
3 parties			54,000.00

[1]These items will be transferred from the survey crews.

[2]2 Jeeps will be transferred from the survey crews.

[3]1 Pickup will be transferred from the survey crews.

Cost of trainees—11 assigned to each party
11 @ $750.00 rials per month or $100.00 American including expenses
11 @ 100.00 = $1,100.00 per month
12 x 1100.00 = 13,100.00 per year

Summary of engineering costs for construction supervision including cost of trainees based on four years operations by the field parties.

Three Parties for Four Years	(4 years)
Salaries 3 @ $134,000.00 = $402,000.00 for one year	$1,608,000.00
Subsistence, etc., 3 @ 17,300.00 = 51,900.00 for one year	207,600.00
Camp equipment and transportation vehicles 3 @ $18,000	54,000.00
Contingency items for camp and transportation and repairs and replacements to camp equipment	100,000.00
	1,969,600.00
Trainee expenses, salaries and subsistence, 3 @ $13,200.00 = $39,600.00 per year 4 years	$158,400.00
Total Engineering Costs for Construction	2,128,000.00

Engineering Construction Party

1 Project (Resident Engineer)
1 Instrument man
1 Levelman
4 Rodmen
3 Structure inspectors
4 Roadway inspectors
2 Crushing and asphalt plant inspectors

Iranian

2 Laborers (Porters)
2 Chauffeurs

Complete camp equipment to house and feed these men on the job site

4 House trailers with towing truck for living quarters
1 Trailer for office and laboratory use
1 Mess tent

Trainees--

1 Project Engineer
1 Instrument man
1 Levelman
6 Inspectors
2 Rodmen

COST OF HEADQUARTERS DESIGN

Engineer costs for Central and Design Office, Tehran, based on a period of 4 years duration.

			Salaries	4 Years
Chief Engineer	1	@	$25,000.00	$100,000.00
Asst. Chief Engineer	1	@	20,000.00	80,000.00
Design Engineers Roadway	3	@	12,000.00	144,000.00
Design Engineers Bridge	2	@	12,000.00	96,000.00
Materials Engineer	1	@	15,000.00	60,000.00
Location and Hydrographic	1	@	15,000.00	60,000.00
Specifications writer	1	@	12,000.00	48,000.00
Draftsman	10	@	8,000.00	320,000.00
Steno-Clerks	3	@	6,000.00	72,000.00
Total Engineering Salaries				980,000.00

House and Utilities Allowance
Per employee $200.00 per month = $2,400.00 per year
23 employees @ $2,400.00
$9,600.00 4/yrs. x 23 = ... 220,000.00

Office rental 80,000 Rials/Mo.
= Say $1,100.00/Mo./48 Mo. = ... 52,800.00

5 Jeep station wagons	15,000.00
2 Conventional station wagons	8,000.00
Operational expenses for above (gas/oil/etc.)	30,000.00

Salaries Iranian help:

Interpreters (3) $600.00 per mo. for 48 mo.	28,800.00
Chauffeurs (7) $280.00 per mo. for 48 mo.	13,440.00
Porters (2) $75.00 per mo. for 48 mo.	3,600.00
Office equipment and incidentals	10,000.00
Total Engineering Costs for Chief Engineer's Office, Tehran	1,361,640.00

Cost of trainees assigned to Tehran office:
12 Engineer trainees @ $100.00 per mo. =
$1,200.00 per mo. for 48 mo. 57,600.00

Engineering Headquarters Tehran

1 Chief Engineer	$25,000.00
1 Assistant Chief Engineer	20,000.00
3 Design Engineers (Roadway)	12,000.00
2 Design Engineers (Bridges)	12,000.00
1 Materials Engineer	15,000.00
1 Location Engineer (Chief-Hydrographic also)	15,000.00
1 Specifications writer	12,000.00
10 Draftsman	8,000.00
3 Steno-Clerks	6,000.00

Iranian

3 Interpreters	15,000 Rials
7 Chauffeurs	3,000 Rials
2 Porters	1,500 Rials

Trainees

5 Design engineers, two roadway and three bridge
1 Specifications writer
5 Draftsmen
1 Materials engineer

SUMMARY OF ENGINEERING COSTS

Cost of engineering services for surveys, design and supervision of construction including on-the-job training of local personnel.

Location, 3 parties—one year	$ 565,000.00
Construction, 3 parties—four years	2,128,000.00
Design and Administrative—four years	1,419,240.00
Total	4,112,240.00

b. Construction.

Construction costs have been computed based on construction in two stages. The first stage will retain the existing grades on the newer sections without widening, adding only select material as necessary and a 7.5 cm course of crushed gravel to serve traffic. Sections requiring construction or full reconstruction will be graded full width, initially, but will have only subbase stabilization and 7.5 cm of crushed gravel surfacing. It is recommended that widening, where necessary, and the ultimate gravel base and bituminous surfacing work be deferred until the connecting roads are further improved and until traffic demands warrant a better surface.

The estimated costs, by section and by item, are shown on Plate VI.

Summary

Construction Cost Estimate

TURKEY-IRAN BORDER TO ZANJAN

Section	Kilometers	Earthwork	Minor Structures	Major Structures	Interim[1] Surfacing	Subtotal	Widening and Ult. Sur.[2]	Total
Turkey Border-Rezaiyeh	54.1	$36,000	$1,600	$562,400	$110,000	$710,000	$1,400,000	$2,110,000
Rezaiyeh-Near Mahabad.....	113.2	3,875,000	125,000	360,000	875,000	5,235,000	1,860,000	7,095,000
Near Mahabad-Bukan.....	52.5	1,200,000	100,000	950,000	410,000	2,660,000	850,000	3,510,000
Bukan-Bijar Junction	153.8	2,375,000	120,000	150,000	1,315,000	3,960,000	2,840,000	6,800,000
Bijar Junction-Bijar.....	59.6	1,100,000	120,000	150,000	500,000	1,870,000	960,000	2,830,000
Bijar-Zanjan	152.3	750,000	10,000	150,000	850,000	1,760,000	3,200,000	4,960,000
Total.....	585.5	9,336,000	476,600	2,322,400	4,060,000	16,195,000	11,110,000	27,305,000

[1] Interim surfacing includes only subbase stabilization and a 7.5 cm course of crushed gravel.

[2] Includes widening to 12 M crown width, gravel base and 7.5 cm x 7 meter asphaltic surfacing. This work to be deferred until justified by traffic demands.

PLATE VI

5. Equipment Needs

a. Engineering. Engineering equipment required to adequately survey, design, and supervise construction (4 years) of the project would include the following:

Engineers' transits	7	@	$800	$5,600
Engineers' levels	7	@	500	3,500
Abney levels	6	@	40	240
Hand levels	50	@	14	700
Chains	20	@	15	300
Metallic tapes	60	@	5	300
Level rods	24	@	50	1,200
Range poles	60	@	10	600
Plumb bobs	24	@	2.50	60
Calculators, hand operated	10	@	400	4,000
Calculators, electric	5	@	800	4,000
Adding machines	5	@	300	1,500
Drafting instruments, etc.		LS		5,000
Subtotal				27,000
House trailers and trucks	15	@	7,000	105,000
Jeeps	30	@	2,000	60,000
Carryalls	3	@	3,000	9,000
Jeep station wagon	5	@	3,000	15,000
Station wagon	2	@	4,000	8,000
Carryall	3	@	3,000	9,000
Camp equipment	3	@	10,000	30,000
Subtotal				236,000
Total				263,000

This equipment list has been predicted on a survey period of one year and a construction period of four years, with the equipment being shifted from location survey to construction engineering as the location work is completed.

b. Construction. The construction equipment needs have been estimated on the basis of providing two major grading crews, one mobile grading crew, two surfacing crews, two bridge crews, and two culvert crews. Asphalting equipment has not been included since deferment of this operation is being recommended. The major units considered necessary are:

Major Grading Unit (2 required)

- 4 12 C.Y. carrying scraper w/prime mover
- 2 Tractor-bulldozer, heavy
- 1 1 1/2 C.Y. power shovel w/dragline
- 2 Ripper, 3-tooth
- 6 Trucks, rock 6-8 C.Y.
- 2 Tractor w/push plate and PCU, heavy
- 2 Sheepfoot roller, dbl-drum
- 4 Tractor/bulldozer, medium
- 2 Motor graders, 12', 125 HP
- 2 Truck, water, 2,000 gal.
- 1 Pump, water, 3"

Mobile Grading Unit (1 required)

- 2 12 C.Y. carrying scraper w/prime mover
- 1 Tractor/bulldozer, heavy
- 1 Tractor w/push plate and PCU, heavy
- 1 Ripper, 3-tooth
- 1 Tractor/bulldozer, medium
- 1 Sheepfoot roller, dbl-drum
- 1 Motor grader, 12", 125 HP
- 1 Water truck, 2,000 gal.
- 1 Pump, water, 3"

Surfacing Unit (2 required)

- 1 Crushing plant, mobile 75 T/hr
- 1 Truck-mounted dragline 3/4 C.Y.
- 1 Power shovel 1 C.Y.
- 1 Tractor shovel 1 1/2 C.Y.
- 2 Hopper bins, 50 T.
- 1 Belt conveyor, self-powered, crusher to stockpile
- 1 Belt conveyor, self-powered, swinging feed
- 1 Medium tractor/bulldozer
- 4 Trucks, dump, 6-8 C.Y.
- 20 Trucks, dump, 4 C.Y.
- 2 Pneumatic Roller
- 2 Tractors, industrial wheeled 60 HP

Surfacing Unit (2 required)— Con.

2	Motor Patrol, 12", 125 HP
1	Water truck, 2,000 gal.
1	Water pump, 3"

Drilling Unit (2 required)

1	Compressor, 600 cfm
1	Compressor, 365 cfm
2	Wagon drills
4	Air hammers, 65 #
1	Blasting machine
1	Line tester
1	Jack bit reconditioner, complete
LS	Drill steel, hose, bits, etc.

Bridge Crew (2 required)

1	Screening and washing plant 25 T/hr.
3	Truck mtd. crane w/clamshell 25 T.
3	Concrete mixers 16 S
2	Aggregate scales
3	Vibrators, gasoline powered
2	Concrete buckets, 3/4 C.Y.
8	Concrete buggies
4	Trucks, dump 4 C.Y.
2	Trucks, flatbed 2-Ton
2	Pump, water, 2"
2	Pump, water, 3"
2	Pump, water, 4"
2	Truck, water tank, 2,000 gal.

Culvert Unit (2 required)

2	Truck-mtd. crane w/dragline, 25 T.
1	Air compressor, self-propelled, 125 cfm
2	Mechanical tampers, 90 #
3	Jackhammers, 65 #
2	Trucks, dump, 4 C.Y.
2	Trucks, flatbed, 2-Ton
1	Mixer, concrete, 16 S
1	Compressor, air 365 cfm
1	Blasting machine
1	Line tester

Culvert Unit (2 required)—Con.

LS	Drill steel, hose, bits, etc.
1	Scale, aggregate

Service Units (3 required)

1	Mobile shop
1	Hydraulic press, 60 T.
1	Generator 15 KV
2	Generators, 5 KV
2	Welder, 300 A.
2	Acetylene welding and cutting unit
3	Lubricators
2	Service trucks
4	Trucks, flatbed, 2 T.
2	Tractor trucks, 15 T.
2	Lowboy trailers, 25 T.
3	Tilt-top trailers, 10 T.
8	Jeeps
8	Pickups
1	Blacksmith outfit, complete
5	Sets mechanics heavy-duty tools
1	Air compressor, 30 cfm
1	Well drill (only one for all three units)
1	Radio, receiving and sending (plus one central station)
5	Mobile vehicle radios, sending and receiving 12 V. 55 Watt
1	Office trailer, 30 ft.
4	Fuel tanks, 3,000 gal.
2	Fuel pumps, metering
LS	Hand tools
3	Pump, water, 2"

This equipment is estimated to cost $3,647,-700 as shown on Plate VII. No asphalting equipment has been included since it is recommended that the ultimate surfacing be deferred for some time. Supplies and spare parts to the amount of ten percent of the cost of the units should be provided to keep the units in operation for the first year.

Construction Equipment Needs

TURKEY BORDER-ZANJAN

Unit	No.	Unit Cost	Total Cost
Power shovel, 1 1/2 C.Y.	2	$55,000	$110,000
Power shovel, 1 C.Y.	2	40,000	80,000
Truck-mtd. shovel/dragline 3/4 C.Y.	2	45,000	90,000
Truck-mtd. crane w/clamshell 25-ton	6	45,000	270,000
Truck-mtd. crane w/dragline 25-ton	4	45,000	180,000
Tractor shovel, 1 1/2 C.Y.	2	30,000	60,000
Crushing and screening plant 75 T/hr	2	80,000	160,000
Washing and screening plant 25 T/hr	2	40,000	80,000
Carrying scraper w/prime mover	10	40,000	400,000
Tractor w/bulldozer, heavy	5	28,000	140,000
Tractor w/bulldozer, medium	11	23,000	253,000
Tractor w/push plate and PCU, heavy	5	28,000	140,000
Ripper, 3-tooth	5	2,000	10,000
Roller, sheepfoot, dbl-drum	5	2,600	13,000
Roller, pneumatic	4	1,200	4,800
Tractor, wheeled industrial 60 HP	4	4,000	16,000
Motor patrol, 12', 125 HP	9	18,000	162,000
Truck, rock, dump, 6-8 C.Y.	20	11,000	220,000
Truck, dump, 4 C.Y.	52	4,500	234,000
Truck, watertank, 2,000 gal	11	7,200	79,200
Truck, flatbed, 2-ton	20	3,000	60,000
Truck, tractor, 10-ton	6	10,000	60,000
Trailer, lowboy, 25-ton	6	7,500	45,000
Trailer, tilt-top, towed, 15-ton	9	3,000	27,000
Truck, service	6	4,000	24,000
Truck, pickup, 1/2-ton	24	1,800	43,200
Jeep, 1/2-ton, FWD	24	1,800	43,200
Pump, water, 2"	13	400	5,200
Pump, water, 3"	8	600	4,800
Pump, water, 4"	4	1,000	4,000
Compressor, air, 600 cfm	2	20,000	40,000
Compressor, air, 365 cfm	4	12,500	50,000
Compressor, self-propelled, 125 cfm	2	6,000	12,000
Compressor, air, electric, 30 cfm	3	1,300	3,900
Drill, wagon, air, 1 3/4"	4	4,500	18,000
Drill, air hammer, No. 65	14	500	7,000
Tamper, air, No. 90	4	300	1,200
Drill steel, hose, bits, etc		LS	30,000
Jackbit reconditioner, complete	2	5,100	10,200
Blasting machine	4	250	1,000
Line tester	4	100	400
Hopper bin, 50-ton	4	4,500	18,000
Belt conveyor, crusher to stockpile	2	4,800	9,600
Belt conveyor, swinging feed	2	6,000	12,000
Mixer, concrete, 16 S	5	3,200	16,000
Scale, aggregate, portable	6	500	3,000
Vibrator, gasoline powered	6	200	1,200
Concrete bucket, 3/4 C.Y.	4	500	2,000
Concrete buggies	16	150	2,400
Mobile shop	6	21,000	126,000
Hydraulic press, 60-ton	3	8,100	24,300
Generator, 15 KV	3	6,000	18,000
Generator, 5 KV	6	1,500	9,000
Welder, 300 A. electric	6	4,800	28,800
Welder, acetylene	6	200	1,200
Lubricator	9	2,500	22,500
Blacksmith outfit, complete	3	800	2,400
Mechanics heavy-duty tool set	15	200	3,000
Well drill, 6"	1	10,500	10,500
Radio, receiving and sending, 60 W	4	15,000	60,000
Radio, receiving and sending, mobile for vehicle mtg. 12 V. 15 W.	15	500	7,500
Office trailer, 30'	6	3,000	18,000
Fuel tanks, 3,000 gal	12	800	9,600
Fuel pumps, metering	6	100	600
Tire recapping and rebuilding unit, up to 24"	1	45,000	45,000
Hand tools		LS	5,000
Total			3,647,700

6. On-the-job Training

a. Engineering. On-the-job training for engineers has been discussed, briefly, in connection with the cost of engineering services. It is considered feasible to assign eight engineer-trainees to each of the three location parties, which will provide one year's training to twenty-four engineers.

Similarly, it is thought possible to assign eleven trainees to each of the three construction engineering crews. These eleven-man crews can be composed of three engineers and eight inspectors, each, thus affording training to nine engineers and twenty-four inspectors per year. Over a four-year construction span reasonably adequate training could be afforded to thirty-six engineers and ninety-six inspectors.

In the headquarters design office twelve trainees per year can be accommodated. These trainees can be distributed as follows:

3 roadway design engineers
2 bridge design engineers
1 materials engineer
1 specifications writer
5 draftsmen

Two-year training assignments are recommended so two sets of trainees can be handled.

Summarizing the training possibilities the following categories of training can be provided:

3 location engineers (chief-of-party)
9 transitmen
9 levelmen
3 office engineers (location)
24 project engineers (construction)
12 field materials engineers
96 inspectors
6 roadway design engineers
4 bridge design engineers
2 materials engineers
2 specification writers
10 draftsmen

Training of this number of men will, of course, depend to a large extent upon the availability of suitable candidates.

If the supply of potential trainees is too limited it might be possible to reduce the construction engineering costs appreciably by reducing the number of foreign engineers during the last two years of the construction season, turning over much of the work to the trained Iranian personnel.

b. Construction. The Iranian Government is setting up a training school for equipment operators and mechanics at Tehran. This school, when in operation, can give more suitable training than could be expected from a construction contractor. The government of Iran may, therefore, not wish to include any training phase in the contract for this project.

If the school is in operation before the contract work begins, as it should be, one attractive possibility would be to use this project as a sort of post-graduate course to the school. Under this scheme of operation it should be possible to reduce the number of foreign operators and mechanics required and to afford more extensive training to Iranian nationals. During the four-year construction period it would be possible to give rather comprehensive field training to the following categories of skilled workmen:

48 shovel operators
16 crusher operators
40 scraper operators
80 tractor operators
50 motor patrol operators
48 field mechanics
200 truck drivers
10 powdermen
70 drillers

The salaries of these trainees can be offset by reduction in the number of men necessary to recruit from outside. The cost of the training program would lie, principally, in the reduction of efficiency of operation. This reduction is difficult to estimate but it is thought that ten percent would be a reasonable overall figure. On that basis the training program is estimated at approximately $1,250,000.

VI SUMMARY AND GENERAL RECOMMENDATIONS

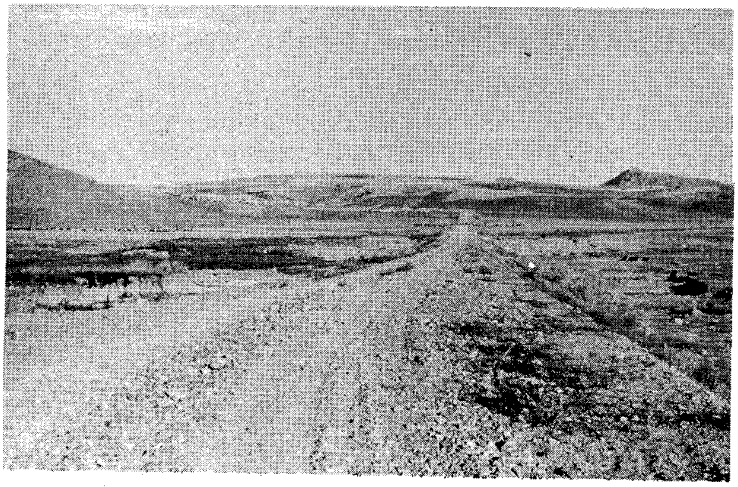
The Cizre-Zakho road when completed (and after the presently programed work on connecting routes in Turkey is finished) will provide a usable land connection between Iraq and Turkey. It may attract some commercial traffic, mainly the transport of products from northern Iraq to the port of Iskanderun. Some tourist traffic may be expected, principally vacation travel from Iraq to the Black Sea resorts and to Europe. The total road usage in the near future is not expected to reach a figure that would justify construction costs on the basis of economics. The desirability of the road from a political and cultural standpoint is sufficient to indicate an early start on the work.

The Turkey-Iran connection can be opened to traffic by the construction of the Sivelan-Bicirge section in Turkey and the completion of the Rezaiyeh-Bicirge section in Iran. Full use of the route cannot be had, however, until the connecting links in Iran have been improved and, in Turkey, either the Bitlis-Van road is reconstructed or the Sivelan-Hakkari-Cizre route is constructed.

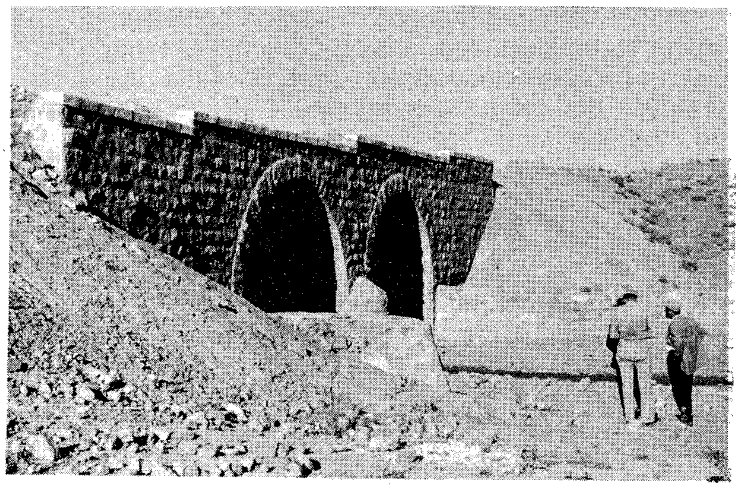
This route will no doubt attract some commercial traffic in connection with the export of products from northern Iran to the Mediterranean seaports and to Europe. This commercial usage will be on a very modest scale, since commodities available for export are limited in amount. The route is of enough importance politically and culturally to justify its construction.

Both routes are feasible of construction. The Turkish General Directorate of Highways has indicated that they are prepared to construct the section within their country with the assistance from ICA provided in current PPA's covering equipment procurement. Financing of the sections in Iraq and Iran has not been accomplished.

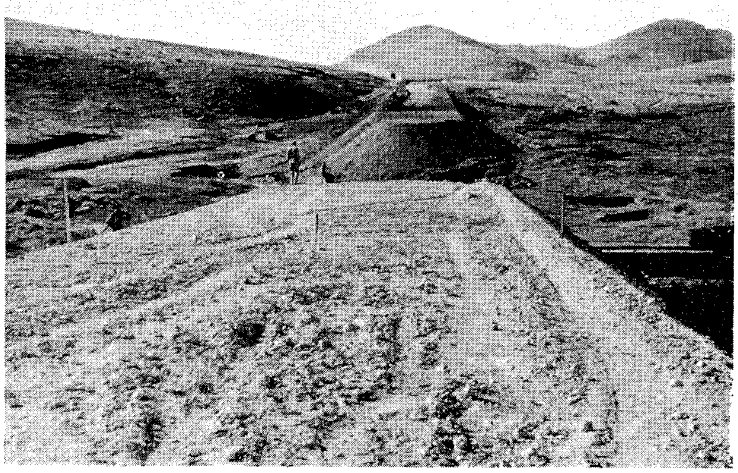
It is recommended that any new construction on these routes follow the geometric standards recommended by the Economic Subcommittee for Communications and Public Works of the Baghdad Pact Organization. Stage construction is recommended, with only subbase stabilization and light maintenance gravel to be provided until such time as traffic demands justify a higher type surface.



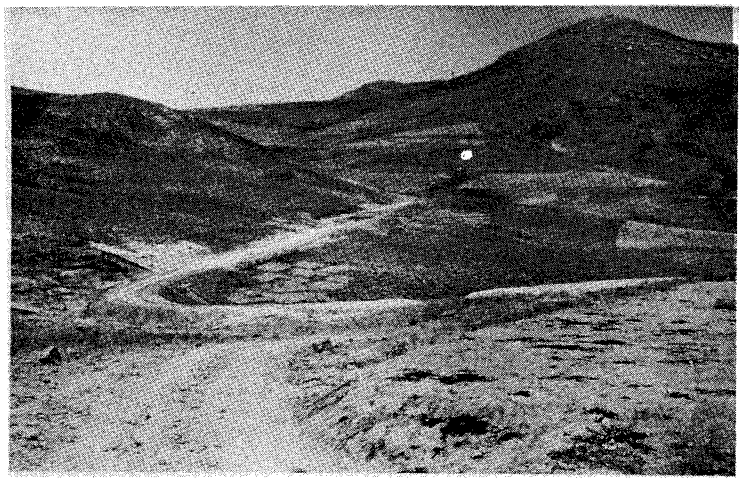
Kilometer 41 west of Rezaiyeh, view to east showing newly constructed roadway.



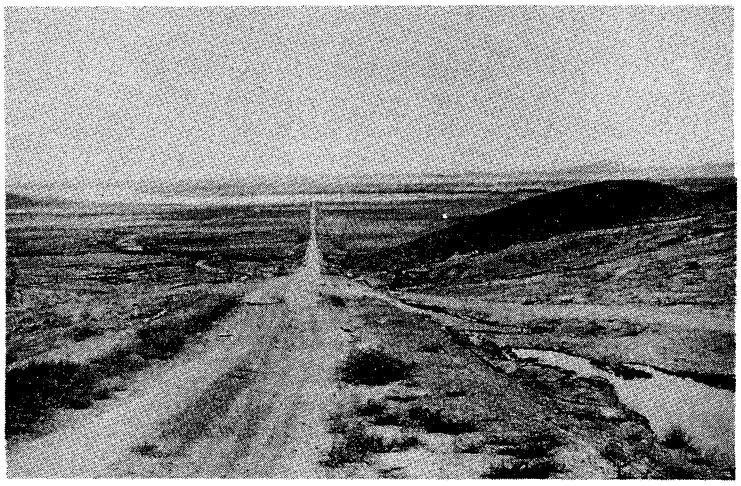
Kilometer 31.5 west of Rezaiyeh. Two 6-meter stone arch spans, new construction 8-meter roadway width.



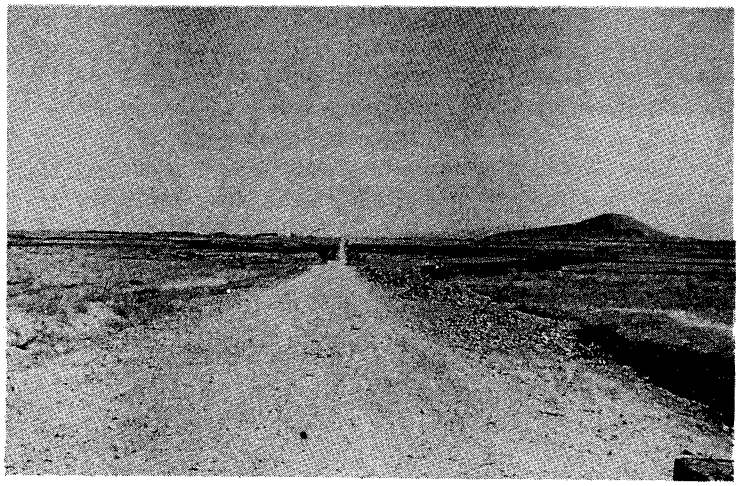
Kilometer 25 west of Rezaiyeh. New fill being built by end-dump methods. Borrow pits excavated by hand can be seen on right.



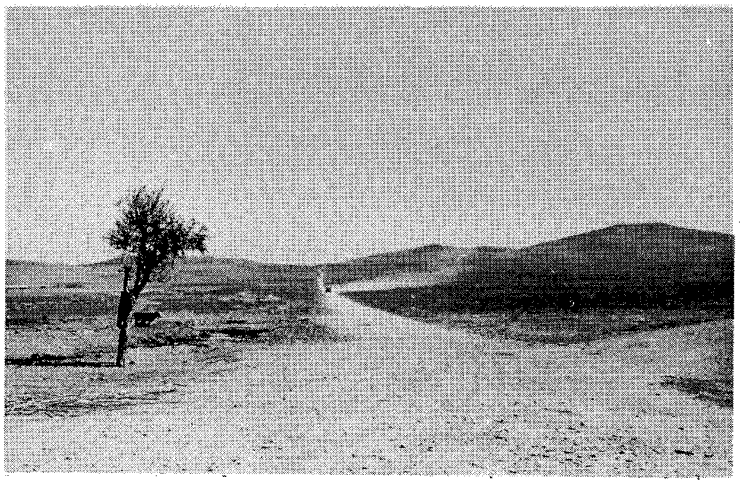
Kilometer 23.7 west of Rezaiyeh, showing new road descending to west from pass.



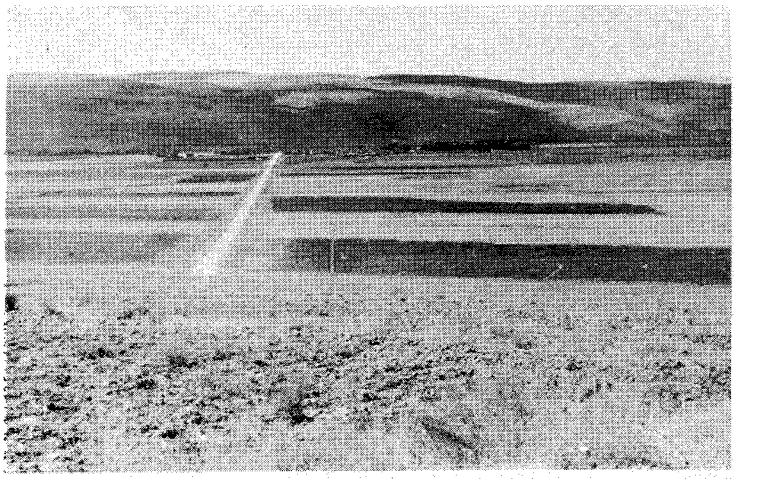
Kilometer 20.3 west of Rezaiyeh, view of road looking toward Rezaiyeh.



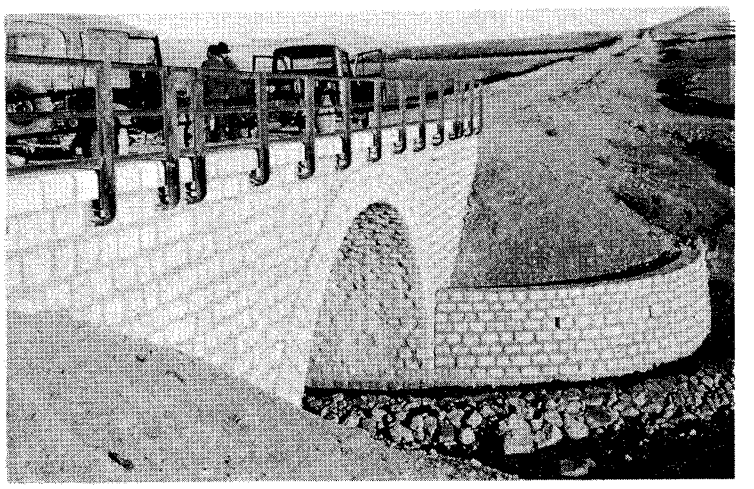
Kilometer 12.8 west of Rezaiyeh. Selected material is dumped in piles on one side of roadbed and gradually spread by hand. Virtually one-way traffic is required for months by this operation.



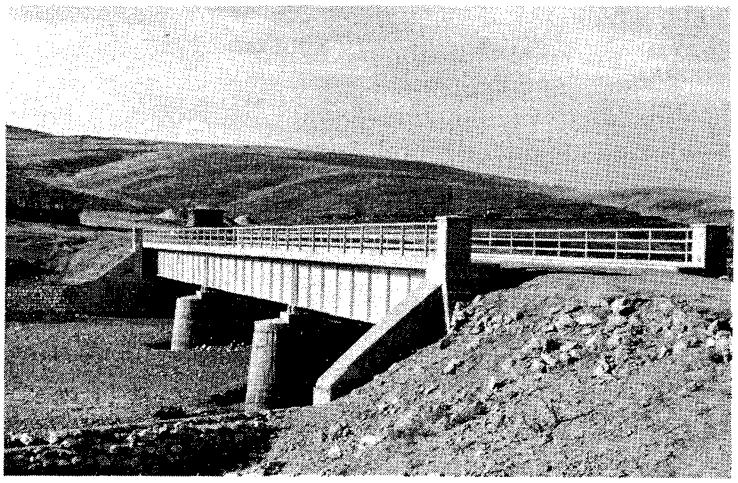
Kilometer 59.6 northwest of Mahabad. View typical of existing low-type road on this section.



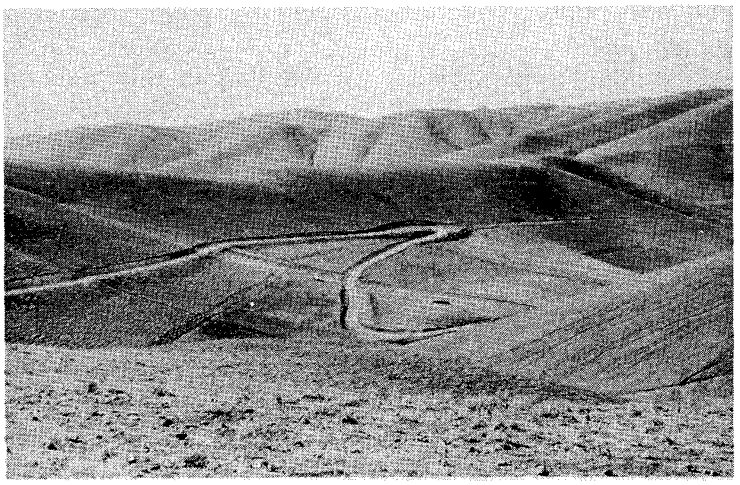
Kilometer 70.4 northwest of Mahabad. Low narrow fill across river flat.



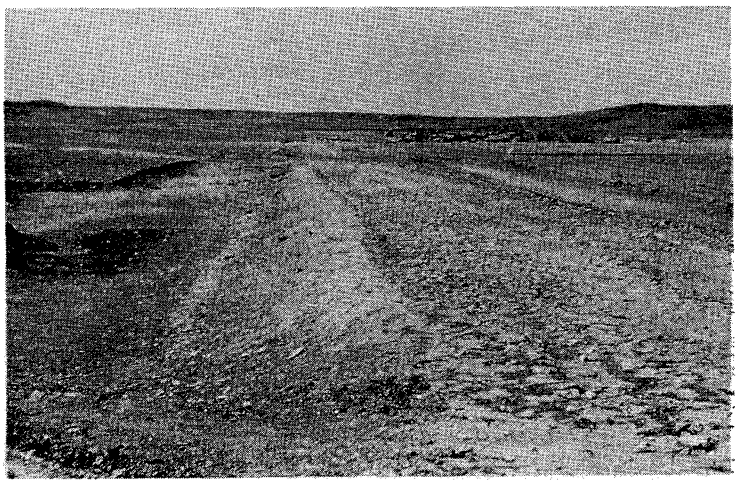
Kilometer 125.6 north of Bijar Junction. Newly constructed stone masonry bridge 15-meter span, 7-meter roadway, light handrails.



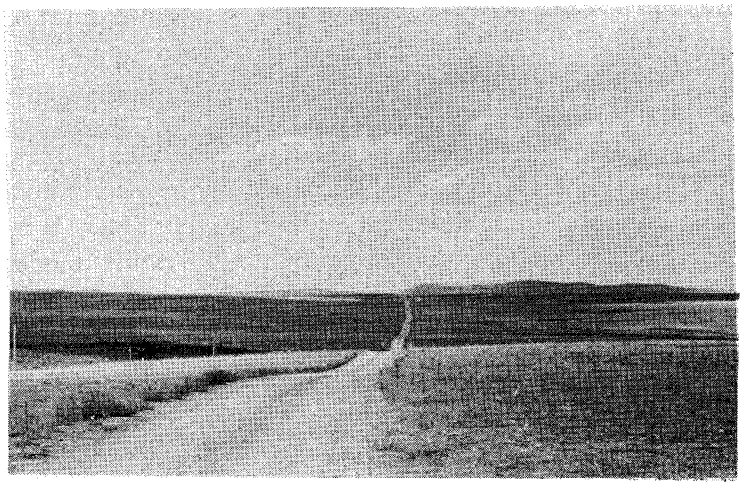
Kilometer 81.3 north of Bijar Junction. Newly constructed steel plate girder bridge with concrete deck. Three 22-meter spans, 5.5-meter roadway with two 0.75-meter sidewalks.



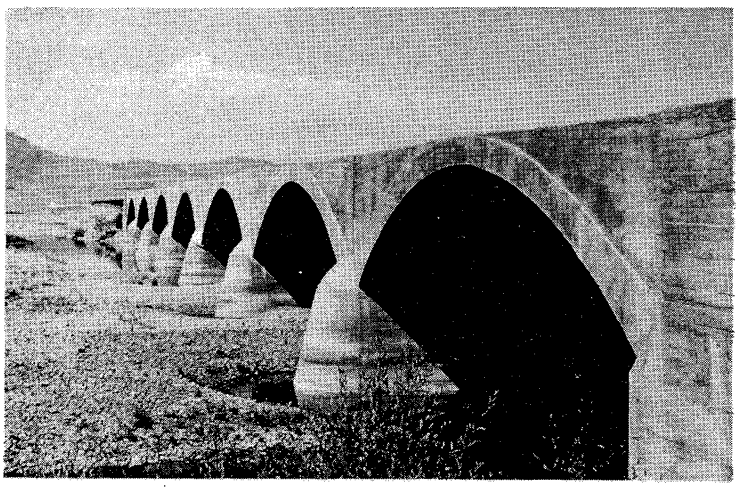
Kilometer 66.4 north of Bijar Junction. View showing alinement in sharply rolling terrain.



Kilometer 37.4 north of Bijar Junction. Finished grade of new roadway, not yet in use.

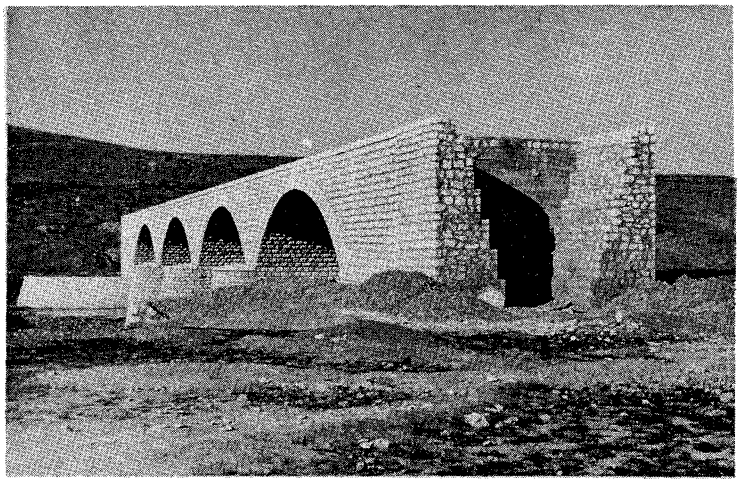


Kilometer 21.5 north of Bijar Junction. Existing low type road across plateau.

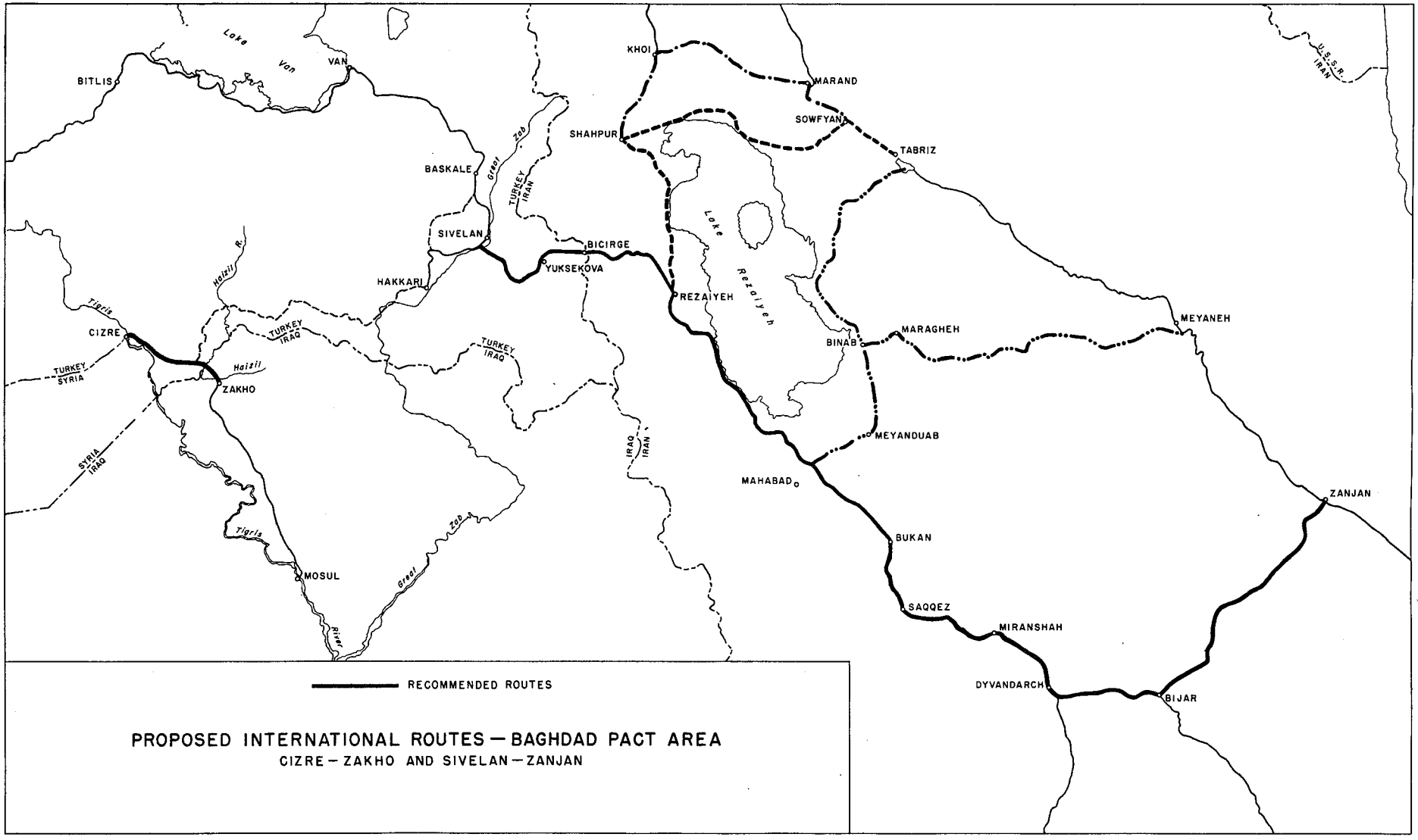


Kilometer 8.5 north of Bijar Junction. Bridge of seven 15-meter concrete arch spans with 8-meter roadway width. Note absence of handrails.

Kilometer 51.3 west of Bijar. Existing low type road across rolling plateau.



Kilometer 120 west of Zanjan. New stone arch bridge of four 15-meter spans, 8-meter roadway. Approach fills have not yet been constructed.



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