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Snell, Leonard J.
Hydrologist, USGS-ICA

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14. ABSTRACT

The purpose of this report is to summarize briefly the history of the Surface Water Research project since its inception in 1952, the work accomplished, and the problems encountered. In general, each topic is discussed under two periods of time: 1952-1963, when projects were confined to the Helmand River Valley and was entitled "Helmand Surface Water Investigations (306-12-021, 306-M-12-AD and 306-AC-12-AD5)," and 1963-1969 when activities were expanded to cover most of Afghanistan and title was changed to "Surface Water Research (306-11-190-002)".

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UNITED STATES OPERATIONS MISSION
TO AFGHANISTAN
INTERNATIONAL COOPERATION ADMINISTRATION
LASHKAR GAH, AFGHANISTAN

TERMINATION OF ASSIGNMENT REPORT

by

Leonard J. Snell
Hydrologist, USGS-ICA

January 1957

TERMINAL REPORT

Leonard J. Snell
Hydrologist
USGS-ICA, USOM/Afghanistan

GENERAL

As the writer was the first person to arrive, in 1952, for the Helmand Valley Project the first part of this report is a brief history of the project and some of the problems involved either as experienced by the writer, the hydrologic program, or the project in general.

Information on the area received in Washington before arrival in the valley was meagre and unreliable. The information as to housing accommodations was extremely poor. The recommendations were that adequate housing was available at the camp of the American contractor, or otherwise, but that furniture and other household goods were not available so should be shipped. Accordingly, the shipping allowance was twenty thousand pounds and the writer, and the then TCA Country Director, William J. Hayes, shipped approximately two-thirds of that allowable weight. Upon arrival it was found that family housing was not available at the contractor's camp and that only the local housing without water, sewage, etc., might be had. Two years later adequate housing became available and, in the meantime, house furnishings were supplied by the government so that the house-full brought out became a problem of disposal for the next few years.

The contractor, Morrison-Knudsen Afghanistan, Inc., furnished quarters in the Kandahar bachelor quarters for the writer, and the two other technicians who followed, until the end of January 1953. The quarters were modern and comfortable and practically all privileges afforded to M-KA personnel were afforded the TCA technicians. As the cost of living at those quarters was high ($2.00 per meal, which included quarters) a temporary quarters allowance of $1.50 per day was allowed by TCA.

Effective February 1, 1953, the 12-room Afghan government-owned hotel in Girishk, 80 miles West of Kandahar, was leased by TCA and the three technicians then in Kandahar moved into it with, also, some of the newly formed Helmand Valley Authority (HVA) officials as guests. The lease called for improvements to the building so that, within six months, the windows and doors were screened, the building wired and electricity furnished by diesel generators, bathrooms were remodelled, a well and pump provided, and an iron stove built into the mud walls of the kitchen to replace the mud stove and oven formerly used. As time went on the hotel was filled to capacity, the local sub-governor moved out of his offices to provide living quarters for two families, and the HVA constructed a duplex dwelling to accommodate another two families. Offices were in spare rooms in the hotel staff house until August 1953 when a government building built as a post-office was provided to TCA for use as its offices.

One of the unfortunate occurrances in early 1953 was the death of Mr. Nat Torbert, the newly arrived chief of the Helmand Valley TCA project. After less than three months in the country he suddenly became ill after a trip to Kabul and was flown by the American Embassy plane from Kandahar to Karachi where he passed away the same evening after only four days of illness.

Replacements for Mr. Torbert followed; however, due to the lack of administrative personnel during the first 2-year assignment the writer acted as administrative and operations officer and, as such, besides the regular stream-flow investigations and hydrologic program, carried on the duties of supervisor of the vehicle maintenance shop, procurement, receiving, staff house, and other general "housekeeping" duties during most of the 2-year tour of duty. As the first tour drew to a close the project personnel were arriving more rapdily and sections were becoming staffed so that additional duties were lessened.

The new Helmand Valley Authority headquarters city of Lashkar Gah, about 50 miles downstream from Girishk, on the Helmand River, first under construction in April 1953, slowly took shape. The evacuated M-KA camp at Chah-i-Anjir and the first residences at Lashkar Gah were occupied by January 31, 1955 and the Girishk hotel turned back to Afghan authorities. By the close of November 1955 all activities of the program were located at Lashkar Gah.

Upon arrival to the Helmand Valley it was learned that M-KA had carried on a stream-gaging program since 1947 and that some stream-flow stations had been established by engineers working directly for the Afghan government in 1946. In addition, M-KA had four climatological stations in operation, at their headquarters at Kandahar, the camp at Chah-i-Anjir, and at Arghandab and Kajakai dams. The Afghan Meteorological Service also had in operation, in the southern part of Afghanistan, weather stations at Ghazni, Kandahar, Girishk, and Farah. Stream-flow stations had been operated by M-KA for short periods outside the Helmand Valley, proper, on small streams in the Ghazni area and on the Kabul River, where proposed dams were considered for irrigation and/or power purposes.

During late 1952 and early 1953 the particulars for transferring the program from M-KA to the HVA, with supervision and aid furnished by the U.S. Geological Survey, through the TCA, was discussed and arrangements therefor made and the program transferred effective May 1, 1953. Trips were made to the various stream-flow stations during that interval with the M-KA engineers and their records studied and climatological data copied. Miscellaneous short reports were written during the period in reply to requests from the TCA Country Director on the proposed hydrologic program, proposed operation of reservoirs and irrigation systems, and other items. A visit was made

to the headquarters of the Afghan Meteorological Service, in Kabul, to learn about the program of that Service and to determine what cooperation could be obtained in the climatological program in the valley. During the time before assuming supervision over the program, various computations and graphs were made from existing available data such as temperature trends, drouth frequencies, runoff forecasts, and related studies.

During the period February 1 to May 1, however, most of the time was spent on "housekeeping" duties such as getting the Girishk staff house in order, the vehicle repair shop and spare parts warehouse set up, helping to check on the wheat shipment to Afghanistan, handling routine office radio and letter correspondence with TCA/Kabul, and procurement and receiving with frequent trips to Kandahar and to Chaman, Pakistan, for goods and discussions with the newly engaged forwarding agent in Chaman.

The additional duties as above-mentioned continued throughout the first 2-year assignment to a variable degree but were reduced as an administrative assistant assumed some of the duties, a staff house manager was hired, and the new Helmand Valley project chief arrived. However, at the end of that assignment I still was the Operations officer and spent practically all time on general administrative duties. As a result, it is estimated that more than half of the total time of that 2-year assignment was spent in general administrative duties rather than concerned with the prime purpose of stream-flow investigations and hydrology. Although that time was spent on duties not directly a part of the job to which assigned, the general duties were necessary in order that the overall TCA Helmand Valley program could function as there did not exist an office staff for procurement and supply, vehicle maintenance, warehousing, and such others to carry on the varied functions necessary to keep the overall program operating.

Prior to leaving the United States, in 1952, a complete set of equipment and computation forms were ordered. Such equipment included three sets of stream-flow measuring equipment, forms to last two years, rain gages, a Dodge power-wagon, two portable radio transmitter-receivers, and small tools. All such equipment was received in late 1952. The radios were, however, not used as intended but used in the TCA/Kabul and Girishk offices for inter-office communications between them and with the M-KA offices. The small tools were practically all used and expended (or otherwise lost) by the vehicle maintenance shop and maintenance carpenter. All such original purchases were through the U. S. Geological Survey and non-expendable items accountable for to the Survey.

On the transfer of the stream-flow investigation program from M-KA to the MVA effective May 1, 1953, most of the M-KA equipment for that use was transferred to the MVA. In addition to measuring equipment such as meters, reels, reading rods, hand-lines, tag-lines, sounding weights, etc., it included the equipment installed in water-stage recording stations of which, aside from the fixed structures such as cableways across the

streams and the gage shelters and wells, were the eleven installed and one spare Stevens continuous water-stage recorders which are valued at about $400 each. Also transferred were a small stock of spare parts and miscellaneous equipment of no value due to damage or vandalism so no accounting was made on such items.

As the stream-flow project came entirely under the HVA the supply of equipment was adequate except for equipment for making high-water measurements from bridges and for surveying equipment for checking gages and for obtaining data for indirect determinations of flood flows and other uses. Such items were then obtained.

Difficulty in finding qualified Afghan employees for the program was met with immediately and continued to be one of the major problems throughout the four years. M-KA had operated, in 1952, with two American engineers in the program with a third man, although engaged for that purpose, used on another project. The locally trained Afghan hydrographers had varied somewhat and the most skilled had left the employment of M-KA the year before. As a result, only one experienced Afghan was transferred to the HVA for the program, plus a driver who was familiar with the field work though unable to read or write.

In December 1952, however, an Afghan who had worked for many years with the government as an engineering aide was employed in the section while others were given a trial but dropped due to inadequate familiarity with figures. In mid-1953 the hydrologic staff received a boost when three Afghans, young men who had returned after one year of engineering studies in Istanbul, Turkey, were added.

The turnover in personnel has been greater than desired but was caused, in addition to the sending of some of the men abroad, by the resignation of some who desired further education but were not recommended at the time so sought different employment where chances looked brighter or to study in Kabul and thereby avoid the army draft for a while longer.

The program of sending qualified men abroad to study caused a loss and the resulting difficulty in replacing such men. That loss is, however, temporary and the program in water investigations will gain considerably when the men return. The fact that no locally educated man are qualified and capable of supervising the program, and not even able to grasp the routine office computations satisfactorily, makes it necessary that some men must have an engineering education. It also means that technical aid must be supplied until one or two of such trained Afghans are on the job to assume responsibility. During the past four years there has been no local person available as a counterpart so that the section has acted largely as a part of the HVA and the writer as if a part of that organization, in many respects.

During all the time that the hydrologic program has been in operation it has been operated more as an independent unit as compared with other sections of the Helmand Valley ICA program. Vehicle maintenance, use of duplicating equipment, some procurement and supply, and some typing have been the extent of use of the administrative support section. The purpose behind such operation is that the Afghans in the section will not always have U. S. aid and assistance and the program will not always be a part of a larger, complete, organization for support purposes but must eventually be self-maintained as a section of, say, the Ministry of Public Works, Ministry of Mines, Ministry of Agriculture, or other Afghan government authority. The men must, therefore, learn to do more than just the field work in making stream-flow measurements, operating and maintaining stream-flow and climatological stations, computing daily and annual discharges, and such necessary functions, but must also, in the field, learn to erect cableways and recorder structures, mix concrete for anchors and footings, and other construction work. They must prepare the payroll, obtain the money from the HVA and/or the local bank, and pay the many watchmen, gage-readers, and laborers. In the office, besides the necessary computations such as the discharge measurements, daily mean gage heights, preparation of stage-discharge relation curves and tables, shift adjustments due to changing channel conditions, daily mean discharges, monthly and annual summaries, and other necessary or desirable data, other office practices and procedures directly or indirectly connected with the program must be learned. On the technical side are such necessary processes such as the use of a surveyor's level, determination of drainage areas by use of a planimeter and maps, use of mechanical adding and computing machines, slide rule, and maintenance of equipment such as temperature and humidity recorders, anemometers, psychrometer, and so on. Paper work, consisting of standardized station descriptions, station analysis (an explanation of the matters considered and the reasoning used in the computations), typing of such reports, completion of records and inking, the making of black and white prints with an electric printer or sun-frame, filing, and the folding of such records of monthly provisional data or final annual data and addressing them to the persons or activities on the distribution list. Such seemingly minor matters are, however, essential and provide the Afghan employees in the section with a rounded out conception of the entire program so that when the time comes that it is turned over completely to their supervision some persons will understand the routine matters and the section can operate quite independently without depending upon an administrative section which, in all likelihood, would be less efficient in such matters.

The project called for one engineer to carry on the program of continuing the stream-flow investigations begun by M-K4, to train Afghans, and to expand the program as necessary. The detailed program is mentioned as follows:

Before the end of the first 2-year assignment of the writer it was found that, due to the considerable time spent on other project duties, the review of old records from 1947 to 1952 was not accomplished. Accordingly, it was agreed that the writer return for an additional one year

after home leave in order to review and complete such records and otherwise prepare them for publication. As a replacement, Mr. I. A. Heckmiller, also of the Water Resources Division of the U. S. Geological Survey, who was to succeed the writer after the 2-year assignment, was scheduled for his home leave five months after the scheduled termination of the one year assignment, which would cause a lengthy period without a project technician, it was agreed that the writer would remain until the return of Mr. Heckmiller or until the completion of a full 2-year tour of duty if so desired. Consequently, as less than two months remained between the return of Mr. Heckmiller and the end of the full assignment, it was decided the writer remain for the full two years at which time another assignment, either foreign or domestic, would be taken, as available and acceptable. As all back records are now completed it is assumed that one engineer is able to supervise the project as was originally planned and, also, he will soon be assisted by one experienced Afghan employee who should return from the United States in a few months.

PROGRAM

Description and Objectives of the Project (from project agreement):

"The primary objective in the hydrologic program is the surface-water investigation to obtain data that will permit a sound determination of the hydrologic regimen of the Helmand River system; the secondary, long-term objective, is to prepare Afghan personnel to carry on the investigation so as to assume ultimate responsibility. Specifically the services consist of assisting the HVA to:

a. Supervise and operate existing network of stream-gaging stations.

b. Establish and operate additional stream-flow stations; rate canals and other miscellaneous channels as required for canal operation.

c. Review, compile, and analyse stream-flow records for current and future technical use.

d. Establish climatological stations as required in the Helmand Valley.

e. Study rainfall-runoff correlations, canal losses, etc., forecasts; make analysis and corrective or supplemental recommendations.

f. Train Afghan personnel in both field and office functions.

g. Furnish advisory service to the HVA.

h. Aid in the development of an Afghan organization for the collection and analysis of hydrologic data and reports; ultimately, to work on a national scale.

The objectives, as stated, and the physical data form a necessary component in the overall Afghan program of developing and implementing a practical program of land and water utilization for agricultural and industrial development of the country and the Helmand Valley watershed in particular. Surface water control and utilization will aid measurably in planning means of increased agricultural production and industrial development by means of electrical power."

The end result of stream-flow investigations, climatological observations, and hydrologic studies is a compilation of records and data with which to more intelligently design and operate water-utilization projects whether for irrigation, power, or other use. The mass of data accumulated to date in the Helmand Valley, especially, cannot be included in a report of this kind. The greatest amount of data on stream flow is contained in a preliminary bulletin published by the U. S. Geological Survey entitled "Stream Flow Records, Helmand River Valley, Afghanistan, 1947-54 (with some record for 1955)". Other data which are computed and distributed at intervals are:

a. Monthly Hydrologic Summary. These summaries include current data of interest to the various activities operating in the Valley, such as the HVA, M-KA, ICA agriculturalists, reservoir operators, and some activities in Kabul. It carries comments on weather conditions, table of temperature, precipitation, evaporation, humidity, and wind data for various locations in the Valley and a table of reservoir operation data such as contents, inflow and outflow during the month, and reservoir elevation. Comments on runoff expectancy and suggestions for the operation of the reservoirs are also included.

b. Reservoir Operation Records. Operation records for both Arghandab and Kajakai reservoirs are prepared and distributed monthly. These records include detailed data such as daily inflow and outflow in cubic feet per second and in acre-feet, reservoir water elevation and contents as of 12 P.M. daily, daily change in reservoir contents, daily evaporation in acre-feet from the reservoir, and other data such as gate openings and/or changes, and seepage through dams as measured at weirs.

c. Final Annual Records of Stream-flow and Reservoir Contents. The final records, on a water-year basis, that is, from October 1 to September 30, with supporting data such as list of discharge measurements, curves and tables of the stage-discharge relation, and other data are duplicated and prints furnished the HVA and M-KA for their files and permanent records filed in this office and for publication.

d. Other computations and/or data and graphs such as flood and drouth frequencies, river water temperatures, rainfall, evaporation, temperature, and humidity graphs and tables and various other data were prepared and furnished interested activities or persons.

The original of all data above-mentioned are on file in the office of the Hydrologic Section of the HVA (this office) and copies are available upon request (except for the preliminary bulletin) so that figures are not made a part of this report; also, the most interested activities have been furnished such data currently.

The suggested form of report which is divided into the four headings of Developments and Achievements, Problems, Suggestions, and Plans, is not followed below as it may become unwieldy; instead, each of these items is included under each topic as listed under the "Project Objectives" given on page 6.

a. Supervise and operate existing stream-flow stations.

1. All stream-flow stations operated in the Helmand Valley upon the transfer to the HVA have been continued in operation. Although in the Helmand Valley, proper, the stations operated on the Ghaani, Paltu, and Sardeh Rivers were transferred by M-KA to the Ministry of Public Works early in 1952 and thereby discontinued. The same fate met the stations on the Kabul River near Sarobi and Darunta although the Siemans Company of Germany has obtained some data near Sarobi in the course of construction of the hydroelectric dam at that location. Existing stations taken over were as follows (the dates indicate the period of available record; the (R) designates an automatic recording station and the (N) designates a non-recording station):

Helmand River near Dehraout	(R)	Oct 1952 -
Tirin River at Dehraout	(R)	Mar 1952 -
Kajakai Reservoir	(R)	Jan 1953 -
Helmand River below Kajakai dam	(R)	Oct 1946 -
Musa Qala River at Musa Qala	(N)	Apr 1952 -
Seraj Canal at Sangin	(N)	Oct 1952 -
Arghandab River above Arghandab Reservoir	(R)	Oct 1951 -
Arghandab Reservoir	(R)	Feb 1952 -
Arghandab River below Arghandab dam	(R)	Oct 1947 -
Arghastan River near Kandahar	(R)	Oct 1952 - Sept 1953; Oct 1954
Arghandab River near Qala Bist	(R)	Oct 1947 -
Helmand River near Chahar Burjak	(R)	Oct 1946 -
Khash River near Dilaram	(R)	Oct 1952

Note: Listing is in downstream order and indentations indicate intervening tributaries.

2. The existing stations were improved somewhat by the addition of another intake pipe to stilling wells and installation of graduated tapes to replace the cable drive on floats for better operation by simplified reading of the inside stages. That station maintenance was done largely by Mr. Heckmiller.

3. Problems in the operation of the gages were the usual ones in any area with the necessary reinstallation of cableway structures and recorder shelters and wells as floods or changing channels destroyed them.

b. Establish and operate additional stream-flow stations; rate canals and other miscellaneous channels as required for canal operation.

1. Additional stations established since the assumption of the project are as follows:

Boghra Canal above Girishk	(N)	Oct 1954 -
Shamalan Canal near Chah-i-Anjir	(N)	Oct 1954 -
Helmand River at Darweshan	(R)	Oct 1956 -
Shila Charkh near Kala-i-Kang	(N)	Aug 1955 -
Farah River near Farah	(N)	Apr 1953 -

2. The above include the main canal stations at the head of the Boghra canal and head of the Shamalan canal. In addition, the turnouts from the Boghra canal were first readied for rating in December 1952 with one of the M-K engineers with the installation of weirs on some ditches and staff gages on all, with metric gages painted on most canal structures such as check structures for use of the canal operation's employees although such were not rated as regular stations.

3. The staff gages were often stolen and all Boghra canal turnouts again equipped with staff gages by the Operation and Maintenance section in 1954 and 1955. The laterals were again rated and curves given to the O&M section. The laterals were not measured at regular intervals largely due to the shortage of personnel in the Hydrologic section to do the work. In that regard, the O&M section desired to train men to do such work within its section; however, to obtain equipment and hire and train men for duplicate duties when men were so badly needed for the overall stream-flow program was not practical at the time. At some future date it may be desirable for the O&M section to have in its employ one hydrographer to check ditch flows and ratings and, preferably, that such a man be one trained in the Hydrologic section for this purpose so that data will be standardized.

4. In addition to the above, over a hundred discharge measurements were made of the flow in existing, old, irrigation ditches in the Arghandab and Shamalan areas. Such data furnished information for planning purposes.

5. Other main stream-flow stations have been, and still are, desirable. The principal one, and one which has been discussed often with the General President of the HVA, is a station on the so-called "Common River" (the Helmand River below the Rud-i-Sieston, which forms the boundary between Afghanistan and Iran for a few miles). It is believed that a joint Afghan-Iranian established and operated station is most desirable at that location so that the records for that stream will be accepted without prejudice by both countries. The joint station has been suggested often to HVA officials with the suggestion that arrangements be made by them, through the Foreign Office, with Iran; however, to my knowledge it has not yet been done.

6. Records on stream flow on other streams have been requested by M-KA, either verbally or by letter; however, such have not yet been established. The streams involved are the Tarnak and Dori Rivers near Kandahar and the Andraskan River near Shindand or Jija. The HVA has not requested such stations be established. Actually, the Andraskan River is inaccessible during most of the period when it carries water as the Khash and Farah Rivers must be forded. As the latter two rivers are expected to be bridged by 1958 the station should, perhaps, be established in the next year. The Tarnak and Dori River near Kandahar could be established as equipment and materials are available for automatic stage recorders and cableways on these relatively small but flashy streams.

7. The formerly operated stream-flow stations in the Ghazni area might well be re-established if the dams on the Paltu and Sardeh Rivers are some day to be constructed (the two dams were begun about 1958 on those small streams but reached only some 10% and 20% of completion, respectively, before abandonment).

c. Review, compile, and analyse stream-flow records for current and future use.

1. Records computed, beginning with October 1952, have been computed to the standards of the U.S. Geological Survey. One of the reasons for the assignment of USGS personnel was to assure that the records would be to accepted standards in view of possible international complications in the division of waters between Afghanistan and its neighbors.

2. Records prior to October 1952, obtained and computed by M-KA, have been reviewed and, where necessary, completed according to the regular practices.

3. All records have then been edited, prepared for publication and again reviewed by the Section of Reports, in Washington, in the same manner as the regular USGS "Water Supply Papers". The preliminary publication "Stream Flow Records, Helmand River Valley, Afghanistan", as mentioned above, was issued by the USGS, Washington, and provides in

convenient form the stream-flow records since 1947 for use in present and future planning. Additions to that publication on an annual or biennial basis should be printed by the HVA or other activity to continue to make records available for reference. It was hoped that the offset press ordered in 1954, but which arrived in a badly damaged condition, could be used for such publication; however, it may still be a year before the press is in operation.

d. Establish climatological stations as required in the Helmand Valley.

1. The purpose of the stations is to obtain data for use by the agricultural sections and, in a few instances, to obtain data for runoff forecasts. Existing stations, operated by the Afghan Meteorological Service in the Valley, are at Ghazni, Kandahar, Girishk, and Farah but past records are very incomplete. M-KA has operated stations at Kandahar, Arghandab dam, and Kajakai dam since work began at those locations and at Chah-i-Anjir and Marja for shorter periods; the period of record is from 2 to 6 years, depending on the location. The M-KA records are reliable; however, the record at the Pakistan (formerly British) Consulate at Kandahar extends back to 1939 and is, therefore, the most valuable for so long a period of record.

2. To fill in some of the gaps in distance, and to obtain records at places where intensive agricultural development was to take place a fairly complete station was established in 1954 at Nad-i-Ali, on the Boghra project, and included the collection of data on maximum and minimum temperature, precipitation, evaporation, humidity, and wind velocity; a hygrothermograph furnishes a continuous record of temperature and humidity in addition to the temperature record obtained from the maximum and minimum-reading thermometers. A similar station was in use at Chah-i-Anjir for less than a year when it was then moved to Lashkar Gah, the HVA headquarters. Another similar station was established at Kala-i-kang, in the Chakansur area, to obtain data in that basin for possible future planning. The stations have operated quite successfully. The debunking of the "120-day wind with 80 mile per hour daily averages" story about the Chakansur has been a by-product. The highest daily average in one and a half years is 25 miles per hour and the highest monthly mean only 10 miles per hour at any of the stations.

3. Other, lesser-class, stations have not been successful. A station for precipitation and temperature data was established at Panjao (Daimangi) in the upper reaches of the Helmand River drainage. In the more than two years since establishment only one month of record has been received due to variously reported reasons such as that the observer had not been paid, that the observer had sent data to the Kabul office of the Afghan Meteorological Service, and so on. The fact that it is 375 miles away, by road, has kept the visits to the station down to only one each year. Another similar station was begun at Dehraout, above Kajakai reservoir, but was undependable so was moved to Croggan (Qaleh-i-Kuzami Kadem) but again was unsuccessful to the

extent of the theft of the rain gage from the government official's yard. A third similar station was set up at Nukur, in the army post compound, but records undependable due to lack of interest of army observers.

4. During October 1956 new equipment, including rain gages, maximum and minimum thermometers, and psychrometers were received for the expansion of the program. Such instruments are planned to be used to continue the station at Marja as the MVA takes over after M-KA leaves that project headquarters in January 1957 to move to Darweshan, to establish a station at Dilaram, and to again set up the station at Orosgan.

5. The Afghan Meteorological Service has been in operation for about 15 years but appeared to have been deteriorating for lack of experienced personnel and funds so that its stations have not been properly maintained. It was endeavored to receive some cooperation with the MVA from that Service; however, although the willingness to cooperate was expressed it did not materialize. After a trip through the high central part of the country from Herat to Kabul, in July 1955, when it was desired to find a location for a station which might be used for runoff forecast purposes and Panjao was decided upon, the Meteorological Service was again visited. It was found that a supply of excellent new equipment was in its storerooms but that it was not assigned even one vehicle for travel to stations. All station reports were made monthly with only the original, in pen and ink, which was sent to Kabul and data could only be acquired by copying from that original record. The Service has, in 1956, been strengthened by the addition of European technicians. It is expected that within about two years the Service will be greatly improved and, with the expansion of air service in the country, that the weather information will become essential. It may be that as the Service becomes more able to carry on its duties that the climatological stations established in the Helmand Valley may be transferred and integrated with the country-wide weather service and such data sent to the MVA periodically for information and for runoff forecast purposes.

e. Study rainfall-runoff correlations, canal losses, forecasts; make analysis and corrective or supplemental recommendations.

1. The periods of runoff record is rather short with only five years upon arrival in the country and only nine years at present on two streams. A review of available climatological data indicated that only the Kandahar rainfall record was complete and, apparently, reliable and extended back to 1952. Precipitation data for more desirable stations such as Ghazni and Kabul, which are at higher elevations and receive greater precipitation, proved to be too incomplete and unreliable for use in the studies. As previously mentioned, the stations established at Panjao, Nukur, and Orosgan have not so far been successful.

2. For the past three years the rainfall-runoff relationships based on Kandahar precipitation have been used. While the straight-line rainfall-runoff relation, without the introduction of antecedent precipitation or of temperature, is the crudest of the forecast methods it has given fair results in the Helmand River forecasts of total yearly runoff based on the December to March rainfall. All eight years fall within 12% of the straight-line relationship. Arghandab River forecasts have been much less successful. The river discharge from mid-June to January 1 may be forecast within about 10% as recession curves are quite regular, except that during an exceptional year, as 1956 when monsoon rains occurred July for the first time in about a generation, the regular pattern of eight years duration was greatly diverted from. As the years of runoff and precipitation records become greater the correlations can be improved. Also, if records can be successfully obtained at higher elevations such data should furnish closer correlation.

3. Snow-moisture surveys have often been discussed and have been tried along the road from Mukur to Kabul but with little success. Snow-moisture determinations were made in January and February of 1954, 1955, and 1956 near Mukur, near Nashaki, and near Ghazni at elevations about 5000 to 7000 feet. Snowfall was not great except in 1954 (when we were snowbound for four days and nights) and the three years of record as yet of no use. After another two years of data it may be that the introduction of that data into statistical multiple correlation computations will indicate the effect in combination with low level rainfall data. Although it has been suggested by some parties that snow moisture data should be collected in the mountains where heavy snow is usual, the plan is felt to be not feasible at the present stage of development. The time and cost of such surveys in attempting to travel off the main roads would be excessive when even the main roads cannot be travelled for days and sometimes for weeks. It was hoped that the snow data obtained at Panjao, Mukur, and Orosgan could be utilized but to-date the records are either missing or too unreliable. One of the obstacles in obtaining data is the difficulty in locating a person who can read and write and then the unreliability in the readings or observations due to the inability to read a graduated rule, thermometer, or other instrument correctly and write the figure correctly, or perhaps to faked "readings" which are prevalent everywhere and not peculiar here. Although some expense was involved, the climatological observer for the complete station at Kala-i-Kang was brought into this office for about three weeks to gain experience in readings and caring for the instruments with the result that about a year and a half of reliable data are now available for that station.

4. Sediment discharge investigations were begun on the Arghandab River above Arghandab reservoir and on the Helmand and Tirin Rivers above Kajakai reservoir in October 1955. Over 1,200 samples were taken during the 1956 water-year at intervals of as many as three per day during high flows to one per week during periods of low flows and low concentration. Samples were analyzed by U.S.M. for sediment concentration and, in a few samples, for size distribution. The silt

discharge into the reservoirs will be computed on an annual basis. Water passing the dams had remained clear since storage began; however, during the flash rises in July 1953 from the heavy monsoon rains heavy density currents carried considerable silt through the reservoirs. As samples had not been taken below the dams on a regular basis, only a few crude samples were obtained from which to estimate the silt passing through the gates.

f. Train Afghan personnel in both field and office functions.

1. The principal work is that of surface water investigations. To carry on such investigations and compile the data requires that personnel have sufficient education to understand what is to be done and sufficient training in mathematics to make the necessary arithmetical computations with an overall sense of the need for accuracy throughout. The desirable employee, then, should be at least a graduate of the Afghan Institute of Technology, in Kabul, or of the twelfth grade in another school which carries a good course of study, especially in mathematics. Such men can be trained to do the field work and, with supervision, do much of the office computations. It is essential, however, that at least one man be a graduate engineer familiar with all the phases of the work.

2. In the four years since 1952 ten Afghans have been employed in the section on a permanent basis for periods sufficient to learn many of the duties. Following is a list of such personnel with approximate dates of employment and other data:

Abdul Khaliq: December 1952 to present. Well experienced and with 14 years experience as engineering aide in the Afghan civil service.

Sher Ahmad Sekander: May 1953 to present. Two years prior to 1953 in surface water investigations with M-KA. Since September 1955 in the United States for additional training and education under the U. S. Geological Survey district office, in Lincoln, Nebraska.

Abdul Wahab Jaji: August 1953 to September 1954. One year at Roberts College, Istanbul, Turkey. Resigned to accept employment with United Nations mission in Kabul.

Abdul Ali Gulbahari: August 1953 to February 1954. One year at Roberts College, in Turkey. Resigned to enter medical faculty, in Kabul.

Abdul Ghaffar Sharja: October 1953 to present. One year at Roberts College, Istanbul, Turkey. Since September 1955 at American University of Beirut to study engineering.

Hasan Ali Tayeb:	June 1954 to present. A.I.T. graduate. September 1955 to June 1956 at University of Wyoming in engineering studies; since that time at University of Nebraska and U. S. Geological Survey district office, Lincoln, Nebraska, to further his experience and engineering education.
Ghulam Rasul:	July 1955 to present. A.I.T.
Aziz Ahmad:	July 1955 to present. A.I.T.
Bahaudin:	July 1955 to present. A.I.T.
Abdul Ghafoor Arafi:	August 1955 to present. A.I.T. graduate. August 1956 to present at American University of Beirut attending preparatory school for electrical engineering studies.

3. All men receive training and experience in performing and computing, primarily, stream-flow discharge measurements. The work is identical to that in the United States with U.S. equipment used throughout. Measurements are made by wading, from cableways, and from bridges, with current meters calibrated by the U. S. Bureau of Standards; depths and areas are obtained by wading rod or by sounding reels and weights. The time required to become satisfactorily proficient in discharge measurements varies with the individual and with his attitude toward the performance of good work and takes from at least nine months to two years. Maintenance of equipment is also variable and consists of the care of the various instruments used in the field and of the care of the automatic water-stage recorders installed at most stream-flow stations. After two years, if a man has had an interest in his work, his routine field work should be reliable. Other necessary field work, such as rebuilding of structures, etc., must be largely learned as time goes on through experience. Besides the personal instruction given the men, there are available a number of reference books and U.S.G.S publications and standards for study. Some training and practice in field and office work in the determination of flood flows by indirect methods from field is also given.

4. Office computations consist mainly of the computation of the annual stream flow for the various stations plus data for monthly reports and other data such as the monthly reservoir operation reports and annual reservoir records. The office work requires constant supervision and checking and is where the lack of sufficient basic education and the sense of accuracy is noted. The men are trained to perform the following steps in the many computations and to follow certain standardized procedures:

a. Compute mean daily gage heights from gage readings and from automatic water-stage recorders and to make necessary time and/or pen corrections.

b. List discharge measurements and supporting data.

c. Plot discharge measurements on cross-section paper and draw stage-discharge relation curves.

d. Prepare tables of discharge, "rating tables", from the above curves.

e. Compute "shifts", or adjustments for changing channel characteristics, and variation, in percent, of individual discharge measurements from the rating table.

f. List mean daily gage heights on standard computation form.

g. Apply and distribute the "shifts", computed above, with their knowledge of probable causes for changing conditions.

h. Apply mean daily discharges by use of the mean daily gage heights, shifts, and the rating table.

i. Compute monthly and annual mean daily discharges, monthly and annual total flow in acre-feet, maximum and minimum discharges, etc.

j. Plot hydrographs of daily discharge for quick reference, and other final data.

k. Make prints, by machine or sun-frame, of the records for distribution.

l. Compute monthly and annual climatological summaries.

5. The training abroad of some of the Afghan employees has caused some difficulty due to the loss of such more experienced men; however, over a period of years, the program should gain materially. Names of men who have been sent, under the participant training program, are given on pages 14 and 15 along with the names of the places to which

sent. Three of the four men are scheduled to return to the Hydrologic section to eventually supervise it. One, however, is to prepare himself as an electrical engineer to be assigned to the hydroelectric plants at Kajakai or Arghandab dams. The experience obtained in stream-flow should be of value to him in his future work. As previously stated, it is necessary that aid be provided until one or more of the men now abroad returns to assume the supervision and responsibility for the program.

g. Furnish advisory service to the HVA.

1. The principal advice has been in the operation of Kajakai and Arghandab reservoirs. Kajakai reservoir capacity is less than one-third of the average annual discharge of the Helmand River and Arghandab reservoir capacity is less than one-half of the average annual flow in the Arghandab River. The greatest difficulty has been in releasing sufficient water from Kajakai reservoir to provide a greater amount of flood control. Although a minimum operational elevation will be necessary when power plants are in operation at some later date, there is now no need to save water so that the reservoir could be drawn down to within 10% of capacity and thereby avoid early spillway overflow while flash floods from rainfall are probable. Although an additional half-million acre-feet would be filled in less than ten days during the high runoff from snow-melt the period of probable heavy rains would be over and a full reservoir would nevertheless be assured. In 1955-55 the reservoirs were operated almost entirely on advice from the Hydrology section; however, in 1956 the authority to change gate releases moved up to ministerial level and became cumbersome.

2. The operation of Arghandab reservoir is not so simple; a season of low precipitation might result in the reservoir not being filled as was the case in 1955. The precipitation early in the season, from mid-December to mid-February, must be used as an indicator of the probable runoff and the operation guided thereby and by the late autumn base flow, which varies considerably.

3. The record of past water use has been used as a guide to requirements and the releases have been based on that figure rather than on crop requirements based on agricultural studies. For the Arghandab River the requirement is determined by the difference in the flow below Arghandab dam and near Qala Bist. On the Helmand River it is based not on requirements but on uniform releases to stabilize water levels as the water supply is more than twice the water requirements so that a steady flow advantageous to the water users is recommended while wasting the excess water.

4. Other advisory services have been in the furnishing of data on what would have happened in former years under different systems of operation, such as full gate releases, closed gates, and various other operations. Without the power outlets in use the gate releases

are quite limited -- total gate capacity of Kajakai dam is 7,800 cfs and that of Arghandab dam is 1,800 cfs at spillway elevation. Water control is lost when inflow exceeds those amounts except for the effect of reservoir detention on sharp rises. Other, quite usual, questions about water, such as frequencies, low flows, stages, and others, are answered verbally or by exchange of notes.

h. Aid in the development of an Afghan organization for the collection and analysis of hydrologic data and reports; ultimately, to work on a national scale.

1. As far as the HVA is concerned the organization should develop as time goes on and the men now undergoing studies abroad return to assume the supervision. Equipment and trained hydrographers will be on hand and only the change in supervision, from U. S. technical aid to Afghan supervision, will be made.

2. It is desirable that the hydrologic program, or water investigations program, be on a national scale under one of the cabinet ministers. The participant training abroad is based on such eventual accomplishment so that a main headquarters could be, perhaps, in Kabul with sub-offices at, perhaps, Lashker Gah and in the Baghlan or Mazar-i-sharif areas.

3. In February 1956 a visit was made to the Minister of Public Works, in Kabul, to discuss the expansion of the stream-flow investigations into the Ghazni area where stations had been abandoned after M-K had transferred them to Public Works, which was in no position to carry on the program. Although in the Helmand River drainage the HVA was not much concerned in that area whereas the FOA/Kabul office was interested in 1953-54 in beginning some developments in the Ghazni and Mukur plains. The Minister did not appear interested in the water investigations but only in the water developments.

4. Early in 1956 the irrigation specialists in the United Nations mission to Afghanistan requested, verbally, during two visits that stream-flow data be obtained in the northern part of the country in the Baghlan-Kunduz area. As it was our plan to ultimately have the program on a national scale it was agreed that the training of men for that expansion and reconnaissance for location of desirable sites would be made if the U.N. and ICA received the approval of one of the Ministries as a cooperating agency. Such approval was not obtained as of mid-August when last discussed.

In December 1956 it was learned that the Ministry of Mines was establishing a Geological Survey within its organization and an invitation extended to visit with Ministry officials in January. A visit was made by the writer and Mr. MacMillan to the Ministry on January 12, 1957 and the plan discussed with Dr. S. Ahmad Popal, assistant Minister. Dr. Popal was very desirous of receiving aid in the establishment of a

surface water branch and it is believed that such cooperation should become real early in fiscal year 1958. The ministry will send Afghan trainees to the Helmand Valley for training and the exchange of personnel should be beneficial to both agencies. (The Geologic and the Ground Water branches of the new Geological Survey will be under the technical supervision of United Nations geologists, who, at this time, are Swiss and German, respectively.)

The program on a national scale may, and should, become real and effective as water is a valuable resource throughout the country. It is, however, true that at the present time the HVA is in a better position to operate than are the Ministries so that the Valley program must be a training and pilot program until the program on a national scale is operational.

CONCLUSION

The breakdown of progress in the various objectives of the program covers the program of the past four years, it is believed, quite fully. In many instances, as noted above, the plans did not work out as hoped. The main drawback in the overall program has been the continuing one of the lack of Afghan men to train. With sufficient personnel a slow expansion could be carried on as men are able to carry on the necessary field and office work satisfactorily. The field work is costly in time and in vehicle operation and wear and tear so that a new trainee can always be taken on such trips at negligible additional cost. Also, on almost all field trips it is necessary that two men travel together as vehicle breakdowns due to poor roads, gasoline, and maintenance are frequent. On the Chakansur trips it is necessary for two 4-wheel-drive vehicles to make the three or four day trip as insurance in crossing the uninhabited desert and to pull each other through sand or irrigation ditches. One has doubts, therefore, if the program would be continued long after foreign assistance is discontinued unless persons who appreciate the need for adequate data for planning are provided by the expansion of educational benefits in the Country.

The above discussion covers the items of developments and achievements and, to some extent, the problems. The suggestions and plans are combined below as a conclusion.

1. At the present time at least six Afghans should be in the section and all should be at least A.I.T. or other twelfth grade graduates. Such number could keep the field and office work going without the delays now met with, as, with only four men, the time off due to illness, vacations, and holidays result in postponement of trips and computations. Six men, or more, could as easily be trained as a lesser number and the section made even more self-sufficient than at present with only policy and other matters, such as procurement and supply and other support services, needed.

2. The expansion of the program to cover the entire country should always be the goal so that data for future planning may be obtained as early as possible. Such expansion should be in cooperation with a cabinet Ministry, now expected to be the Ministry of Mines, and completed by the time the men now abroad return in about three years.

3. Although Afghan supervision and services are not capable at present to assume overall control it appears desirable that the HVA assume more and more the responsibilities for operation and maintenance of everything from cost of labor and materials for repair of field structures (which is done now) to operational costs of vehicles and other equipment. Such maintenance and operational factors are part of the overall program and may also be called "training". Even if the money must be turned over to the HVA for such use it will aid in teaching such responsibilities.

4. A ground-water investigation program should be started in the near future. The use of wells for domestic use is self-evident and pumping for irrigation may be feasible after power is obtained from the completed dams; drainage by pumping may also be valuable in areas now undergoing development or in areas proposed for development. Mechanization, generally, is believed still many years away although it may, also, arrive rapidly if some of the resources, other than water, are developed. In that regard, there is again the absence of local personnel with whom to work so that a man, perhaps from the Valley project, should be sent abroad to study ground water geology.

5. Salaries paid to Afghan employees, whether in the Hydrologic section or elsewhere, are low and do not provide the incentive for improvement. Even the cost of the gasoline consumed on a field trip is alone five or ten times the wages of the hydrographer.

6. Education is the greatest need in the country. Great strides have been made in the past few years and will, in all probability, be continued. An increasing number of persons are being sent abroad for advanced education and will help to fill the need however, on the expanding local educational program, from the compulsory primary education such as begun this year at Lashkar Gah to the opening of the engineering and agricultural faculties, in Kabul, must rest much of the future of the Country whether in water utilization or other developments.

7. Much could be said about the administrative and/or support branches of both the ICA and HVA. The need of both is not to continue to add more inexperienced personnel who add little to the success of the project but mainly to the overhead but to employ persons who will operate more efficiently. The HVA has improved appreciably in 1955 so that the Hydrology payroll, cash for materials and labor, work orders to M-KA, and other necessary services which were slow have recently been rapidly expedited as compared to two and three years ago.

DIVISION OF WORK AND COOPERATION

The majority of the stream-flow stations in operation were established by M-KA prior to October 1952 and records were obtained and computed by that organization. The stations were well located and constructed, considering the extremely poor travel conditions encountered. The records computed were satisfactory for the immediate needs and necessitated only a review in order to complete and/or revise the records

where data was missing on the basis of later acquired data and to complete and compile them for publication.

As the writer returned after the first 2-year assignment especially in order to review the past records the supervision of the field work was largely with Mr. I. A. Mackmillan since that time, including the rehabilitation and improvement of the stations.

The HVA has paid the salaries of all Afghan employees, including hydrographers, gage readers, watchmen, and laborers; also, much of the costs of local materials or materials available from M-HA.

The ICA (formerly TCA and FOA) has furnished the vehicles, vehicle maintenance, gasoline, and directly or indirectly, the furnishing of all equipment, instruments and specialized materials for the program, plus office space, procurement, and other support services.

The U.S.G.S., during 1952-54, handled much of the procurement and supply of equipment, and special instruments and forms, and since that time, only the standardized items as ordered through ICA. Final review of all records was by the Reports Section and chemical analysis of six river water samples were made by the Quality of Water laboratory in Washington.

The interest in the surface water and hydrologic investigations and data by certain persons and activities has been appreciated and aided in providing an incentive to the Afghan trainees in a field of engineering quite unfamiliar in Afghanistan. Appreciation is especially offered to His Excellency Abdullah Malikyar, General President of the HVA, who has shown the greatest interest and with whom I have worked the longest and most closely, to Sayed Wahdat Shah, chief engineer in 1953 and 1954, and to Mr. Karl Kohler, chief advisor to His Excellency; to the various chief engineers of M-HA, Messrs. Wm. Mohlweg, George Gavin, and Dale Shockley, and the chief agronomist, Dr. Claude Fly; and to Wm. J. Hayes, TCA, country director 1952-54, and Paul Von der Lippe and DuVal Stoaks of the Helmand Valley Project; and to others; without whose keen interest the program would not have been nearly so successful.

It would be interesting to return to Afghanistan and the Helmand River Valley a few years from now to review the progress made. There is no doubt that the Country will develop and prosper not only from the utilization of its water resources for agriculture and power but from the development of its other natural resources, such as fuels and metals, and its human resources, which so far have not been developed; however, a few years will elapse before that stage is accomplished.

Leonard J. Snell
Hydrologist, USGS-ICA

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