Program of Ground Water Resources Investigations for the Helmand-Arghandab Valley Authority, Afghanistan

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Program of Ground Water Resources Investigations for the Helmand-Arghandab Valley Authority, Afghanistan

Introduction

Data available on the few wells which have been drilled in the region covered by Helmand-Arghandab Valley Authority (HAVA) in southwestern Afghanistan indicate that, at least locally, wells of low to moderate yield can be constructed and that possibilities exist for wells of large yield. In at least one area, water is confined under sufficient pressure to flow at land surface. Because at some places irrigation developments approach or even exceed the available supply of surface water, thought is being given to increasing water availability by supplemental use of ground water. In some areas the supply of ground water from karezes and springs is inadequate even for land presently irrigated. Water-table control and drainage by pumping from wells may at some places be more advantageous than by conventional drains.

Mere description of the occurrence of ground water or assessment of the ground-water situation at one particular point in time is not sufficient for areas where large pumpage or importation of water is projected to take place; an essential time dimension must be considered. Recharge and discharge must be estimated and the effects of secular changes predicted, whether rise or fall of water level or alteration of water quality with

time. Deep exploratory drilling, accompanied by test pumping, is needed to make such predictions and to guide later studies and development.

The effects of withdrawals of water or of application of water may be estimated crudely but cannot be predicted quantitatively, unless studies are made of the ground water and its environment. Likewise, predictions cannot be evaluated or modified in the absence of data from a proper program of monitoring.

Whether or not much water is withdrawn, a study is needed to determine the areal distribution of saline ground water in the region. It is quite possible that areas between rivers, for example between the Arghandab and Tarnak, may be similar to the doabs of the Punjab, where brackish to salty ground water is encountered at depth. In the Punjab careful studies and astute management of ground-water extraction have permitted both extension of irrigation in the doabs and reclamation of nonproductive lands. Such possibilities need to be assessed in the HAVA region.

This report contains recommendations for developing within HAVA a capability to study and to monitor ground-water resources of the HAVA region. It is based on field reconnaissance observations by a 3-man team of ground-water specialists from the U.S. Geological Survey (USGS) who worked in the HAVA region between May and December 1971. The team included J. R. Jones, team leader, E. A. Sammel and N. E. McClymonds. J. G. Blevins,

US AID well-drilling advisor assigned to work with the USGS team also provided technical expertise for HAVA drilling operations during this period. The program herein suggested is logically within the scope of the Fourth Five-Year Plan. The studies recommended here are for demonstration of and training in procedures and techniques of ground-water investigation but at the same time would yield information required for rational utilization of the water resources of the region.

It is recommended that the organization within HAVA to make such studies be a group within the Project Development Planning Division. In this report it will be referred to as the Ground Water Section. Unofficially, such a group now (1971) exists on a small scale to utilize the services of the USGS ground-water team presently in the HAVA region. This group has participated in reconnaissance studies on a modest scale. Appendix A contains recommendations for an interim program to be carried forward pending the start of the proposed Five-Year program.

General Purpose of Project

The purposes of the proposed project are to develop in the Ground Water Section an office and field capability for making investigations of ground-water resources within the geographic region provenant to the HAVA; for monitoring the ground-water resources; for providing information necessary to plan development of ground water, for design of ground-water facilities, and for guidance in ground-water utilization. Additionally, capability to drill test holes and record data therefrom is to be developed.

These aims should be accomplished through advising and training Afghan personnel at all levels of the Ground Water Section. Training should be through day-to-day contact on-the-job instruction in field techniques; appropriate in-house classroom instruction in office processing of data and preparation of reports; and academic and practical training abroad.

In the process of developing these capabilities, data will be collected to assist in short-term and long-range planning and in operation of ongoing irrigation schemes.

Functions of Ground Water Section

The duties of the Ground Water Section should include the following:

1. Plan areal and special ground-water investigations.

2. Make areal studies of the various irrigation units and other areas under HAVA.

3. Make special hydrologic studies of groundwater development schemes.

4. Advise all concerned, including private individuals, on ground-water resources.

5. Collect and compile pertinent hydrologic data on existing wells, karezes, and springs by field inventories, library studies, and correspondence.

6. Map surface geology and drill or contract for exploratory wells, piezometers, and observation wells where advisable to supplement existing data on lithology, water-bearing properties, and water quality.

7. Perform pumping tests on existing wells and on test wells to determine water-bearing character of the aquifers.

8. Monitor water levels and chemical quality of water with special emphasis on cause-and-effect relations in project areas, but also observe conditions in areas where natural conditions apply,

9. Observe well hydraulics to determine optimum well designs for various areas.

10. Design wells and well fields and suggest appropriate pumping schedules.

11. Present finding in appropriate reports.

12. Maintain liaison with other agencies as appropriate. Specifically full mutual exchange of technical data must be effected with both the HAVA Ground Water Section and the Hydrology Division of the Water and Soil Surveys Authority, Ministry of Agriculture.

Operations of Ground Water Section

A brief list of specific activities and types of data required to fulfill the functions as listed above, and numbered in accordance with that list, is as follows:

1. Assembly of available hydrologic and geologic data, maps, air photos, and reports; procurement and construction of necessary equipment and supplies; provision of necessary personnel and logistic support; training; analysis of problems; preparation of timetables; establishment of procedures, standards, and formats; preparation of forms, base maps, etc.

2. Inventory of existing wells; exploratory drilling; vertical and horizontal surveying; visual inspection and laboratory analyses of geologic formation samples; field tests of specific conductance and pH of water; laboratory analyses of samples for water quality (exclusive of organisms); pumping tests; monitoring of water levels and quality of water during the investigations; ascertain water budgets.

3. Same as 2, but in project area.

4. Participation in planning meetings, writing of commentaries, assistance in preparation of project plans, visits to field sites, extraction and compilation of data.

5. Measurements and interviews in the field, office visits, copying of records, library studies.

6. Geologic mapping; exploratory drilling and related activities; preparation of specifications.

7. Test pumping of existing wells and wells drilled for testing; computation and interpretation of results.

8. Measurement of depth to water, discharge, and specific conductance; operation of water level recording instruments; compilation of pumpage; sampling of water; establishment of network of observation stations.

9. Office and field studies.

10. Office studies, observation of results.

11. Preliminary reports, basic data reports, maps, graphs, final reports, letters and memoranda regarding ground water.

12. Field conferences, office conferences, correspondence, attendance at technical meetings.

Targets of Project

In order to establish procedures and develop local staff capabilities, field and office demonstrations and training proposed under this 5-year project should:

1. Establish procedures and standards for field studies of ground-water resources.

2. Establish procedures and patterns for monitoring ground water under natural conditions and under development.

3. Establish procedures and standards for drilling, sampling, and testing exploratory holes and water wells.

4. Develop capability for preparing specifications for and supervising test drilling and pumping test contracts.

5. Establish office procedures for processing, recording, filing, and disseminating data and reports.

6. Develop capability to plan and make areal and special studies and monitoring programs and all other functions and operations described in the sections above as being appropriate for the Ground Water Section.

7. Prepare preliminary, final, or periodic reports on specific studies.

Study Areas

The chief vehicle for training is study by demonstration of selected areas. Scope of training and potential usefulness of findings of the demonstration studies are key factors in assigning priorities to areas of study.

Locations of the areas are shown in figures 1 and 2. A schedule for studies of the areas selected and other activities is presented in figure 3.

Shamalan Area

First priority should go to the Shamalan area. Emphasis should be on studies of salt content and on establishing a monitoring system which will cover both the area presently developed and that soon to be irrigated. Although presumably the area will not depend on ground water for irrigation, the opportunity for obtaining information from numerous planned wells makes Shamalan the most useful area under HAVA for training in making ground-water studies. No test drilling is planned under the 5-year project.

Presumably by the time the ground-water project starts, the test drilling otherwise planned for the Shamalan project area will have been completed. Except where absolutely necessary for village supply, the test holes should be maintained as observation wells for at least a year so that a full seasonal cycle of water-level fluctuation can be observed. At least

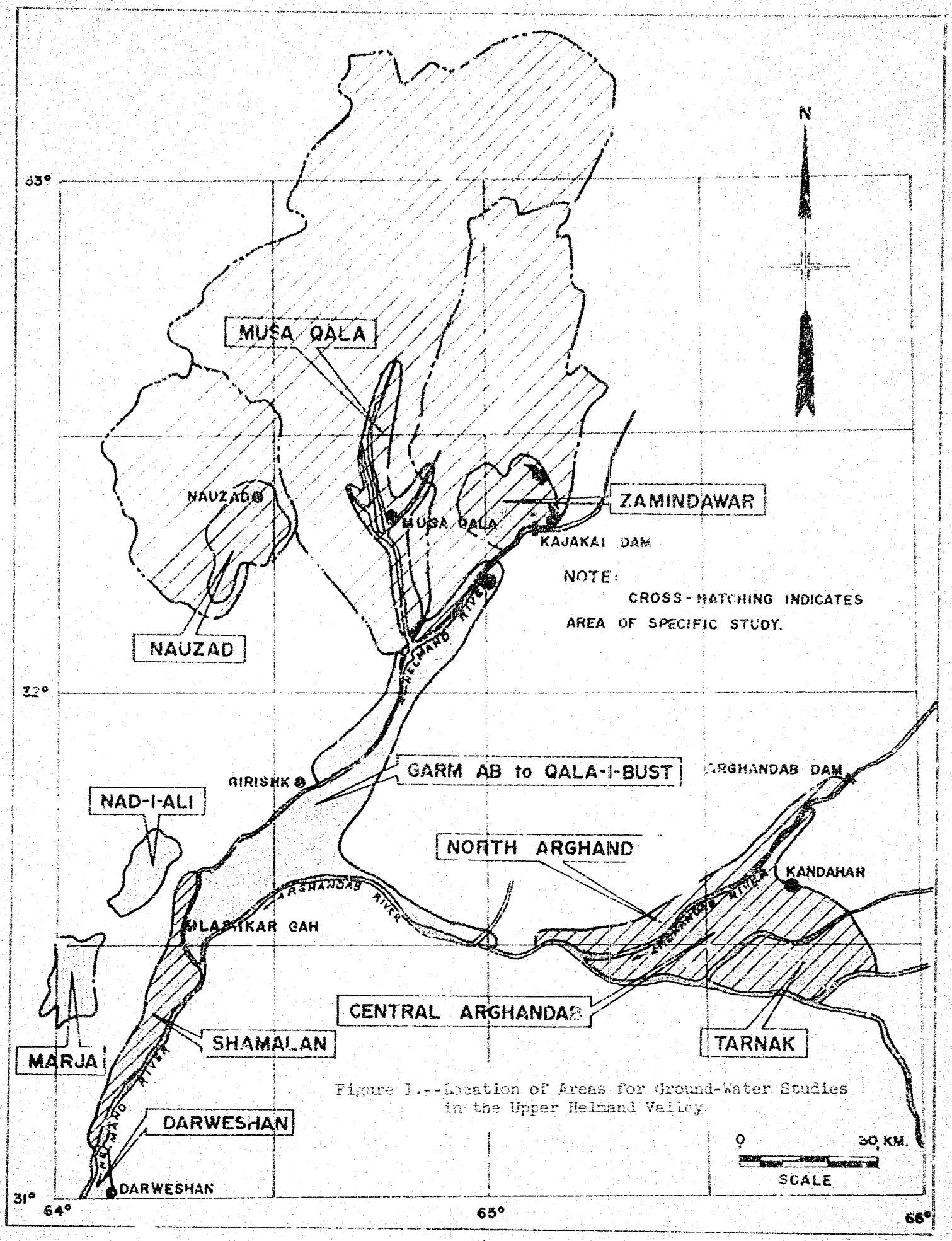


Figure 1.--Location of Areas for Ground-Water Studies in the Upper Helmand Valley

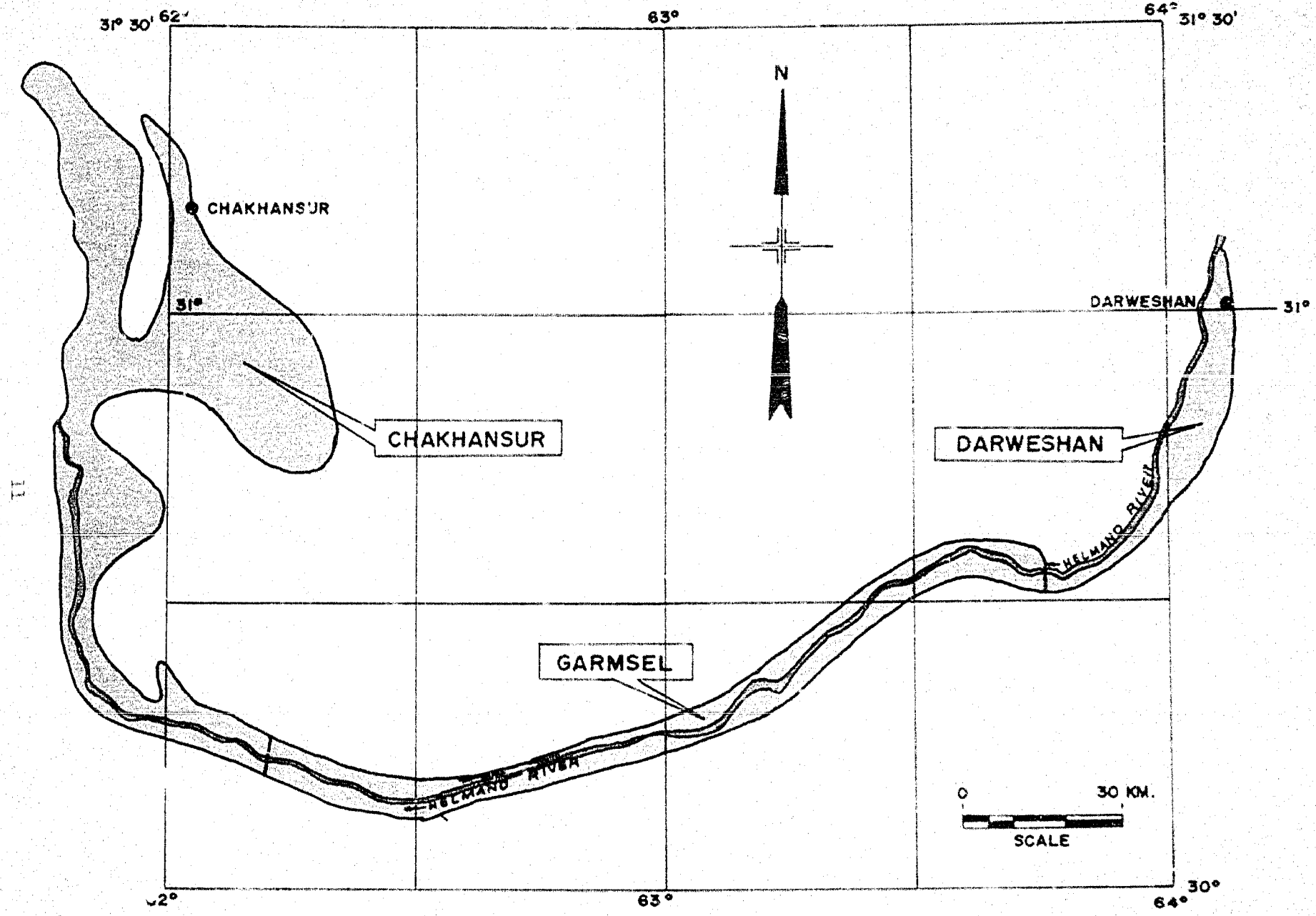
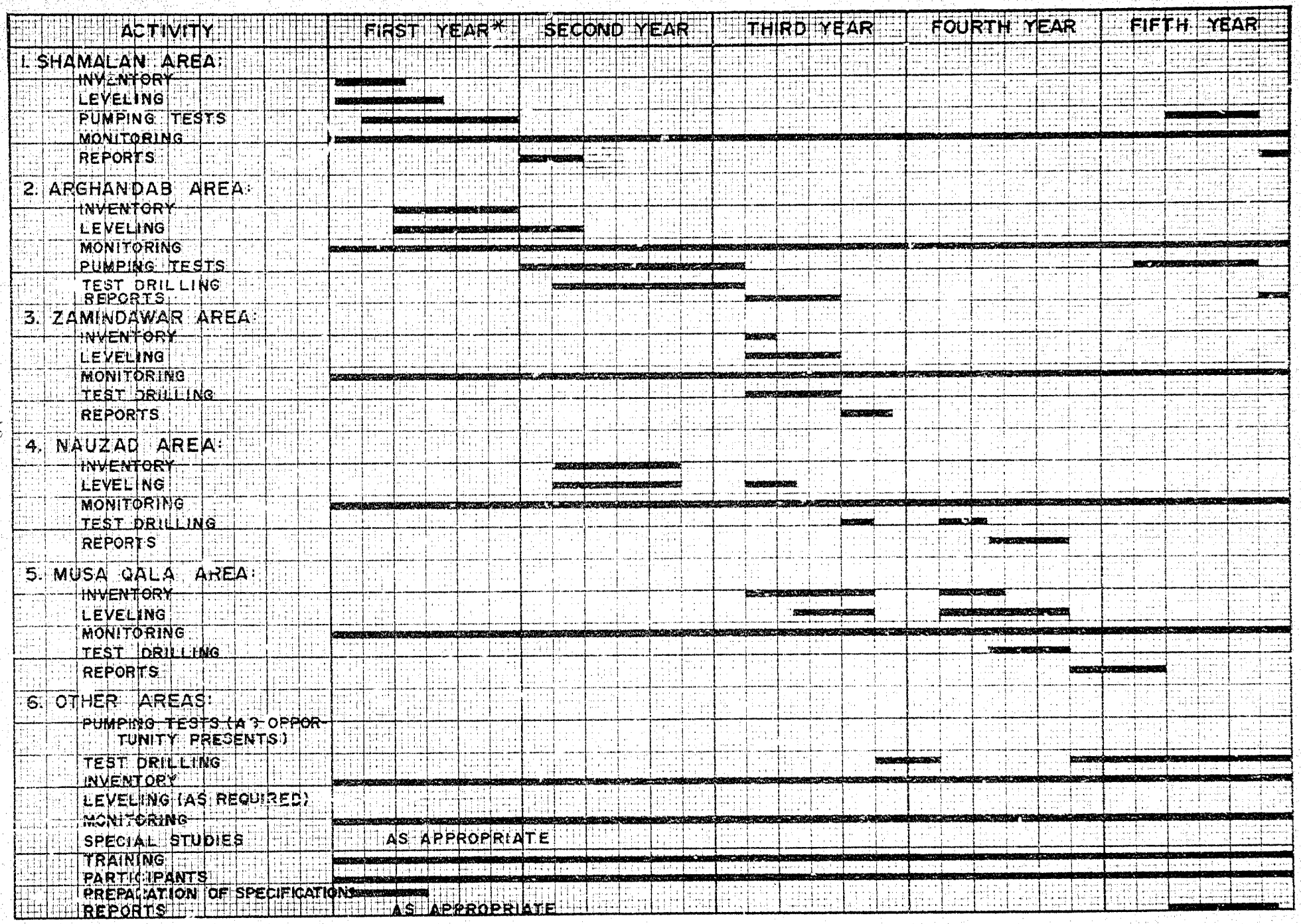


Figure 2.--Location of Areas for Ground-Water Studies in the Lower Helmand Valley



* CALENDAR YEAR FROM JANUARY 1 THROUGH DECEMBER 31.

Figure 3.--Time Schedule of Activities

three of the test holes should be retained permanently as observation wells - one in or, less desirably, adjacent to the presently irrigated area; one in the area to be irrigated as a result of the expansion project; and one on the desert bench above the area to be irrigated. All these wells, and others if available, should be measured weekly for about a year, following which period records should be scrutinized with a view to reducing the frequency of measurements and possibly deleting some of the wells from the program. It is desirable that continuous water-level recorders be operated in each observation well for at least a month in order to learn the patterns of and reasons for fluctuations. During operation of the recorders, a recording barograph should also operate as nearly as is feasible.

Adjacent to each observation well, which should be providing data on deep aquifers, a shallow well or piezometer which taps the shallow water table should also be observed.

Measurements of specific conductance of both deep and shallow ground water must be part of the monitoring program. Wells in frequent use should be selected for the purpose. Water in the drains should be checked also, although if this is being done by others, the data should be obtained from them in order not to duplicate effort. Findings on both quality and level of well water should be supplied on a current basis to those responsible for drainage and as requested to others, such as O&M and Extension Service.

Establishment of the complete network must be preceded by and in part will accompany inventory of all wells, karezes, and springs in the Shamalan area. Wells selected as part of the interim program and test wells should, of course, be monitored prior to commencement of the specific Shamalan study. It is especially important to have an accurate leveling program to establish altitude of water surfaces.

Pumping tests should be made on as many wells as possible. As many as 250 drilled wells are planned for the construction project which should offer plenty of opportunity for testing.

Although basic data reports and interim reports may have been released prior to or during the study, an interpretive report should summarize the findings. The report should present opinions as to the suitability of the ground water and the aquifers for supplementing surface water for irrigation, if required in the future, and should include evaluation of the water for domestic use. This report should cover the studies which would be made during the first year of the 5-year project.

Near the end of the general 5-year ground-water project, performance tests should be repeated on as many wells as possible in order to determine whether specific capacity or yield has changed, and if so attempt to ascertain the reasons, such as corrosion, encrustation, failure of gravel pack, decline in pump efficiency, dewatering, higher water level, or incomplete development of the well. Comparisons with data from

earlier tests should include temperature and chemical quality of water. The information collected should be presented and analyzed in a special report which emphasizes changes.

Arghandab Area

Second priority should be given the Arghandab area. The area envisioned comprises the North Arghandab, Central Arghandab, and Tarnak projects of the HAVA (fig. 1). Already at several places more land has been prepared for irrigation than can be supplied from Arghandab Reservoir during normal years by the present distribution system, unless water is denied other previously established areas. During 1971 attempts have been made to save crops by tapping shallow ground water, and modest success has been achieved at some places. Because low aquifer permeability and saline water are encountered at places, preliminary information suggests that only locally would wells tapping shallow ground water support irrigation except during brief periods of emergency. Exploration for possible deep sources is essential. Even if findings indicate that little or no ground water is available for irrigation, studies are still required to determine the amount and distribution of saline water.

This large area is essentially unexplored for ground water. Geologically, it is almost certainly far more complex than would appear from the surface. It is likely that buried faults and ridges of the bedrock affect the occurrence and movement of ground water and perhaps its quality as well. Nothing is known

regarding recharge other than seepage from irrigation. The proposed study as part of the 5-year program would indicate the probability of successful large-scale pumping for irrigation water to supplement surface water, to drain areas not readily reached by conventional drains, or both. It would be in the nature of a pre-feasibility study.

It is suggested below that as part of the interim program as many as three deep test holes should be drilled in the Arghandab area, time and resources permitting, prior to commencement of the 5-year program. It is also strongly recommended that deep wells be test pumped as part of the interim program. Information from these activities, together with that collected by the USGS ground-water team during 1971, will provide a point of departure for the Arghandab study.

The study would begin during first year of the 5-year program and continue into the third year. Monitoring would extend over the 5 years and additional test pumping would be done during the fifth. The study should begin with inventory of all wells, karezes, and springs of the area, which activity should include re-examination of those points previously inventoried. Special effort should be made to obtain pumpage data, that is, the amount of water discharged over an irrigation season and/or a year. Establishment of altitudes of points on the ground-water surface(s) is vital. Shut-in pressures of artesian wells should be measured.

In all areas, but especially the Arghandab, inventory of new wells should be a continuing activity even after termination of the intensive inventory. Of particular interest are wells in areas where no information is available at all on deep drilled wells.

Concurrently monitoring should be done. It is usual that during the course of a ground-water study observations are made at many points, referred to as project observation wells or stations, relatively few of which are retained as permanent stations. A constant process of evaluation and culling of observation stations should be carried on, but most would be retained until after preparation of the main interpretative report. A necessary aspect of the study is determination of recharge rates. If conditions similar to those in other regions of south Asia apply, loss of water from the distribution system will be found to be the major source of recharge. Accurate measurements of flow in the distribution system must be made. Moisture profile studies are recommended, as are detailed water-budget studies in small, well-defined areas. Required for successful studies are precise data on timing and quantity of diversions. The hydrogeologists would need cooperation and assistance from several sections of HAVA.

In the Arghandab area where ground water is to be considered for possible irrigation use, it is essential to determine the capability of the aquifers to transmit and store water and the

chemical quality of the water. In order to make such determinations deep tests are necessary.

When the new drilling equipment arrives, it should be used in the Arghandab area for a year to drill deep test holes. If line pipe can be obtained and rigs made available prior to arrival of the new equipment, test drilling should begin as soon as possible.

In addition to the information obtained from the deep tests by measuring water levels, logging lithology, and analyzing water, it is necessary to determine aquifer parameters by means of pumping tests. The data are required to predict potential yields of wells and, probably more important, long-term response of water levels and changes in quality of water under heavy pumping.

Pumping tests should be made a part of the interim program, and during the 5-year study every effort should be made to test as many wells as possible, all exploratory holes should be tested. Additionally, at the end of the program, wells should again be tested and yield and specific capacity compared with those originally measured; the reasons for any change should be sought. The findings should be presented in a special report.

If prospects for large-scale ground-water development seem favorable, recommendations should be made for further studies. Preparation of a general plan of study, including geologic studies, deep test drilling, test pumping, and seismic studies

would be within the purview of this project, but would require time additional to that shown in the time schedule of activities.

Preparation of a detailed plan and specifications for the necessary studies should be a separate activity, perhaps appropriate to a private consultant. Certainly the detailed studies would be beyond the present capability of Afghan groundwater personnel and should be made by a consulting firm experienced in major ground-water investigations.

Zamin Dawar Area

Work in the Zamin Dawar area (fig. 1) would consist chiefly of study of hydrogeology of deep aquifers by means of test holes. The chief hope for additional water supplies for irrigation is from deep aquifers, although it would be possible to command part of the area from Kajakai Reservoir at least part of the year subsequent to raising the spillway.

In this area of presumably small recharge, pumping even moderate quantities of water will lower water levels, thereby reducing or even stopping the flow from karezes. Initially, it is suggested that no wells for irrigation be drilled closer than 2 kilometers from any kareze mother well until pumping tests are made which permit prediction of drawdown effects.

In Zamin Dawar area the work by the USGS team during 1971 is the point of departure for additional study. No information was

gathered on possible deep aquifers. Monitoring of water levels, discharge, and quality of water which is to be done as part of the interim program should be carried on from inception of the 5-year program. As test drilling is done during the third year, the monitoring system should be expanded to include at least one well tapping aquifers beneath the uppermost one.

Following updating of inventory, test drilling, leveling, and concurrent monitoring during the third year of the program, a final report should be prepared. The only residual activity proposed is monitoring.

Nauzad Area

During the second year of the 5-year project work on the Nauzad area should begin. The work should start with inventory of karezes, springs, and wells, accompanied by leveling and monitoring, the last to be continued through the fifth year. Test drilling is scheduled to begin late in the third year, be interrupted during the winter months, and resume during the fourth year. The work should proceed along the lines of the Zamin Lawar study, but because little information will be available prior to the study, considerably more time is planned for inventory than at Zamin Dawar.

Musa Qala Area

Work in the Musa Qala area (fig. 1) is scheduled to begin during the summer of the third year of the 5-year program. Procedures are expected to be as for the Zamin Dawar and Nauzad areas, with probably more emphasis on spring and stream flow. In this connection, it is essential that the gaging station on Musa Qala Rud be properly operated.

Inventory and leveling should start in the summer of the third year and, following a winter recess, be completed during the fourth year. Test drilling is planned for the fourth year.

Other Areas

Usually studies of ground water in small areas, which do not include some regional reconnaissance, are inadequate to some degree. HAVA is potentially responsible for large areas outside those described above. (See figures 1 and 2.) In order to provide information needed for planning and for understanding the regional hydrogeologic framework, as many data as time and opportunity permit should be collected from other areas.

Scattered dug wells, karezes and springs should be inventoried, as should all drilled wells. Appropriate data should be assembled on stream discharge and precipitation. Necessary leveling should be done.

Periodic measurements of water level, discharge, and specific conductance should be made at selected wells, karezes, springs, and stream stations.

Test holes should be drilled in scattered areas to provide information on deep aquifers and water quality. It is suggested that some of these test holes be drilled during the winter of the third year and the rest after tests in the Musa Qala area are completed.

General Activities

Special studies, not presently identified, almost certainly will be made by the Ground Water Section. Some will be spot studies of specific areas, most small, and others may be of some special hydrologic variable, for example, time lag between precipitation or irrigation and recharge; bank storage; or quality of water. No advance scheduling can now be made of such activities.

Reports, except those on major activities, also will be required at times and on subjects not now predictable. When periodic reports are considered together with those on major areas and special studies, report writing may be considered in the nature of continuing activity.

Likewise, training and monitoring are to be considered as continuing activities.

Training

Training should be the major task for the U.S. staff. Most of the training would be performed on the job. Selected HAVA personnel should be closely associated on nearly full-time basis with the U.S. staff. The hydrogeologist especially should have close, frequent contact with the Chief of the Project Development Planning Division, the head of the Ground Water Section, and the geologists and engineers of the section. On-the-job training should be the most productive instructional tool. The U.S. staff should demonstrate, instruct, and guide, but should see that most of the work is done by Afghans, under close supervision. As competence grows, more of the work should be performed by local personnel. Appropriate classroom instruction should also be given.

In addition to on-the-job and other in-service training to be given by U.S. personnel, it is recommended that out-of-country (participant) training to be given to qualified individuals. A recommended schedule of participant training with estimated costs is presented below in the section on "Budget." The participant training should consist of on-the-job and academic training in the U.S., for example in a USGS office engaged in ground-water investigations coupled with test drilling. Planning, sampling, sample examination, logging, well testing, compilation, reporting, and relation of work to comprehensive studies should be included in the training. Provision is made for 5 man-years of training programs in table 1.

Training should be a conscious activity over the entire period of the 5-year project. In addition to training provided by the project, academic training should be encouraged and whenever possible, assisted administratively and financially by HAVA. Attendance and participation in technical meetings, where possible, also should be encouraged.

Personnel

It is recommended that one U.S. hydrogeologist and one well-drilling advisor be provided to guide training and study area activities. Their main task, however, is to be training.

The hydrogeologist will be the party chief. Although he should have free access to all appropriate officials of HAVA from the president down, most of his association will be with the head of the Project Development Planning Division and the head of the Ground Water Section. He will work with them on all aspects of ground-water studies, particularly planning and reporting. Early in the project he will advise and assist in preparation of specifications for commodities. He will be the U.S. official responsible at appropriate level for all planning and administration required for proper management of that part of the loan used for ground-water studies and training. He will, on the U.S. side, be responsible also for training and will participate in field and office work. He will, however, be an advisor, not a line officer of HAVA, working within established USAID guidelines.

The well-drilling advisor will be responsible for training of drillers and support personnel, and for timely preparation of specifications and orders for rigs, auxiliary equipment, and supplies. He will operate drilling rigs and perform related tasks such as repair work and welding only as required for purposes of instruction or in case of emergency. Whenever time permits, the well-drilling advisor should assist Helmand-Arghandab

Construction Unit (HACU) in its drilling work. He would be primarily an advisor and is not to be considered an employee of HAVA. He must, however, exert every effort to accomplish the objectives of HAVA.

The Ground Water Section should provide a minimum of three geologists and one engineer, or two in each category, in addition to the Section Chief for work and training. Necessary additional personnel required for surveying, drafting, typing, interpretation and translation, driving, mechanical work, etc., will be provided by HAVA. At least one driller, three helpers, and necessary watchmen will be provided for each drilling rig to be operated.

HAVA Support

In addition to supplying personnel to be trained, HAVA should provide office space, equipment, furnishings and supplies; maps and air photos; stores; stenographic, secretarial, translation and interpreting, drafting, mechanical, and transportation services, including drivers if needed. In this last respect, one pickup truck of those to be purchased under the project should be assigned to each U. S. technician.

Budget

The fiscal estimates herein (table 1) are based on requirements for supporting only the program described herein and do not include local currency costs of HAVA. The estimated total for the 5-year project is $685,000.

Below are presented in tabular form cost estimates for commodities (table 2) required to support a 2-man U.S. input.

Table 1.--Summary of Estimated Dollar Budget

Item	Year 1	2	3	4	5	Total
Personnel, U.S. (2 men)	$ 80,000	$80,000	$80,000	$80,000	$80,000	$400,000
Participant Training (5 man-years)	9,000	9,000	9,000	9,000	9,000	45,000
Commodities						
Drilling Equipment	(112,900)	-	(42,850)	-	-	(155,750)
Scientific Equipment	(11,135)	-	(600)	(500)	-	(12,235)
Vehicles (excluding Rig Truck)	(51,200)	-	(2,000)	(9,500)	-	(62,700)
Office Equipment and Supplies	(200)	-	(100)	-	-	(300)
Miscellaneous	(1,000)	(500)	(700)	(500)	(500)	(3,200)
Commodities Subtotal	176,435	500	46,250	10,500	500	234,185
Contingency					5,815	5,815
Total	$265,435	$89,500	$135,250	$99,500	$95,315	$685,000

Table 2.--Schedule of Commodities

Item	Year 1	2	3	4	5	Total
Drilling Equipment and Supplies						
Drilling Rig, percussion truck-mounted (Speedstar 72 or equivalent), equipped for drilling to 400 m, plus drilling and fishing tools	$ 50,000					$ 50,000
Spares			$ 10,000			$ 10,000
Electric generator, 2500 W, 115/230 V with 12 V Battery Charger	750					750
Electric Welder	1,800					1,800
Cutting and Welding Torch	250					250
Air Compressor (LeRoi 50 SDS or equal) with spare parts for 2,000 hrs. of operation	7,000					7,000
Centrifugal Pump (gasoline)	350		350			700
Deepwell Turbine Pump and Diesel Engine	9,000					9,000
Pipe, 2-inch 2,700 ft @ 2	(4,000)					
4-inch 1,470 ft @ 3	(4,400)		(1,400)			
Line Pipe, 6-5/8-inch OD 4,000 ft @$4/ft	(16,000)		(16,000)			
Line Pipe, 8-5/8-inch OD 4,000 ft @$5/ft	(10,000)		(10,000)			

Table 2 (continued)

Item	Year 1	2	3	4	5	Total
Line Pipe, 10-3/4-inch, OD 300 ft @$6.50 ft.	(2,600)		(2,600)			
Pipe, subtotal	$ 37,000		$ 30,000			$ 67,000
Well Screens, 1 1/2-inch x 5 ft, 50 ft @$35/ft	1,750					1,750
4-inch x 10 ft continuous slot wire wrap, 30 ft @150/	3,000		1,500			4,500
Mechanic's and Hand Tools	2,000		1,000			3,000
Drilling Equipment and Supplies, Subtotal	$112,900		$ 42,850			$155,750

Table 2 (continued)

Item	Year 1	2	3	4	5	Total
Scientific Equipment and Supplies						
Water-Level Recorder (Leupold & Stevens FM or equal), 1.5 V Battery Driven Clock, 6@$ $350/each	$ 2,100					$ 2,100
Spares	400		250			650
Portable pH/Eh Meter (Analytical Measurements 707-MV or equal) Battery Operated w/Carrying Case and Spare Electrode, 2 @$250/each	500					500
Conductivity Meter (Solubridge RB 3 or equal) with 1X and 10X probes plus 2 spare Batteries and 1X Probe, 2 @ 350/each	700					
Recording Rain Gage	400					400
Microbaragraph, Weekly	300					300
Microbaragraph, Monthly	300					300
Spares	50					50
Tapes and Reels						
Deep well exploration reel (USGS W28101) w/1,500 ft of cable, ready to operate	(900)					
Deep Well Current Meter, other accessories, spares	(300)					
Electric Tape, 92 m 2 @ 110	(220)					
Spares	(60)					

Table 2 (continued)

Item	Year 1	2	3	4	5	Total
Tapes and Reels						
500 ft	(180)					
Spares	(50)					
Refill	(145)					
300 ft, 2 a$150/each	(300)					
Refill, 2 @$110/each	(220)					
100 ft, 3 @$30/each	(90)					
Refill, 3 @$20/each	(60)					
50 ft (in case), 6 @$20/each	(120)					
Refill, 4 @$12.50/each	(50)					
Folding Rule, Engineers, 6 @$4/each	(24)					
Level/Square/Tape, 2 m 6 @$.30/each	(18)					
Tape Repair Kit	(45)					
Tape Mending Tool	(25)					
Miscellaneous	(23)					
Tapes, subtotal	$ 2,780					$ 2,780
Dumpy Level	650					650
Surveyors Rod, 2 @$60/each	120					120
Level Field Books, 10 @$4/each	40					40
Altimeter, Surveying, 2 @$400/each	800					800
Pocket Transit (Brunton), 4 @$60/each	240					240
Leather Belt Loop Case, 4 @$7.50/each	30					30
Hand Level, 2 @$12.50/each	25					25
Tally Register, 2 @$6/each	12					12

Table 2 (continued)

Item	Year 1	2	3	4	5	Total
Drafting Supplies						
Lettering Set (11 templates)	$ 175					$ 175
Spares				$ 50		50
Drawing instruments						
Proportional Dividers, 8-inch	45					45
Detail Pen	15					15
Drawing Set	60					60
Adjustable Triangle	8					8
Adjustable Curve Rule, 2 @$4/each	8					8
Map Measurer	8					8
Polar Planimeter	60					60
Drop-bow Pen, 2 @$10/each	20					20
Drafting Film (36-in by 50 yd), 2 @$75/roll	75			75		150
Tracing Paper (36-in x 50 yd), 4 @$15/roll	30			30		60
(42-in x 50 yd), 4 @$18/roll	36			36		72
Copying Machine (3M 107 - Model 76) and Paper	700		$ 250	250		1,200
Stop Watch, 5 @$30/each	150					150
Miscellaneous	298		100	59		457
Scientific Equipment & Supplies Subtotal	$ 11,135		$ 600	$ 500		$ 12,235

Table 2 (continued)

Item		Year 1	2	3	4	5	Total
Vehicles							
Truck, 5-ton, 4WD		(9,800)					
Truck, 3-ton, 4WD		(6,000)					
Pickup, 3/4-ton, 4WD	(2)	(8,400)					
Pickup, 1/2-ton, 4WD	(8)	(22,000)			(7,500)		
Spares		(5,000)		(2,000)	(2,000)		
Vehicle, subtotal		$ 51,200		$ 2,000	$ 9,500		$ 62,700
Office Supplies & Equipment		200		100			300
Miscellaneous		1,000	$ 500	700	500	500	3,200
Commodities Total		$176,435	$ 500	$ 46,250	$ 10,500	$ 500	$234,185

Appendix A

Interim Program

Because it would probably take from 1 to 2 years to implement the proposed project, certain activities are suggested to be carried out by the Ground Water Section of HAVA prior to arrival of U.S. personnel. It is envisioned that members of the USGS team which worked with HAVA during the summer of 1971 will make occasional visits to review and advise on the work or problems which arise.

Inventory: Inventory of wells, karezes and springs should be conducted on a continuing basis. Specific conductance of water should be measured wherever possible and water from a number of wells analyzed. Arrangements should be made so that all new wells drilled in the entire area of HAVA responsibility will be visited and measured between completion of drilling and installation of pumps. Additionally several existing wells should be inventoried in each of the HAVA areas or units considered for development or assistance. Scattered wells elsewhere should be inventoried. The data are needed for background when the project is implemented and will save considerable time then. Additionally, the data will in part serve as a beginning of monitoring studies. Some of the data will serve more immediate needs of development planning, and therefore, the priority of needs of the various areas should be considered. However, sufficient geographic coverage is necessary to serve as a reconnaissance base of at least shallow ground-water conditions over the entire HAVA region.

Inventory now underway in the Zamin Dawar area should be carried to completion. That is all active and recently active karezes, wells, and springs should be inventoried, including history and other details, with emphasis on flow and conductance measurements and establishment of altitudes of water surfaces. Similar information should be collected for the Shamalan area where emphasi will be on well inventory. This inventory could be accomplished between trips to Zamin Dawar and during inclement weather. Next concentration should be on the Arghandab area, where over-expansion of land to be irrigated will probably require more water than is available from surface sources during most years. The more than 100 new well listed by HAVA Extension Officers during the summer of 1971 should be precisely located and accurate data on well performance should be added. The Nauzad and Musa Qala areas also should receive early consideration. The reconnaissance effort should include wells, karezes, and springs along the north and south of the Kandahar-Girishk highway.

Pumping Tests: Pumping tests of wells should be made at every opportunity. Every effort should be made to carry out drawdown and recovery tests of drilled wells. This should not be difficult for new wells if planned in conjunction with their inventory. Wherever possible, the Ground Water Section should persuade the driller, or person who installs the pump, to provide

a protected entry port through which water levels can be measured during pumping tests and subsequently as required. If necessary, the Ground Water Section should install the measuring ports.

Efforts are being made by US AID to obtain a 2-inch centrifugal pump to be used by the Ground water Section for testing dug wells. This pump should be used exclusively for testing wells and springs, not for filling tanks, dewatering pits, or supplying juis, even in emergency. First priority should go to privately dug wells in the Kandahar area as a means of selecting suitable pumps for the wells.

Test Drilling: The Ground Water Section should activate the Speedstar 71 drilling rig now in Lashkar Gah, which US AID has rehabilitated and supplied with drilling tools. A left-lay drilling cable ordered from Pakistan has not yet (December 1971) arrived; the rig should not be used until the presently installed right-lay cable is replaced unless special drilling procedures are followed.

A driller must be obtained to operate the rig and train HAVA personnel in its use. It is recommended that a skilled driller or drilling supervisor be borrowed from the Ground Water Division, Water and Soils Survey Authority, Ministry of Agriculture, for this purpose. An engineer, unless he has had long personal experience in actually drilling wells, would not suffice for drilling and training. The operation should be under the general supervison of a man who has experience with operation of heavy equipment and with conduct of field investigations.

Additional support equipment is required to operate the drilling rig efficiently. A truck to bring water needed in the drilling operation is required. A truck is needed also to move pipe and other supplies. One truck, judiciously used, could in a pinch, perform both functions. In addition, a pickup truck for running errands, carrying personnel, etc. should be assigned to support the rig. Camping equipment and tents are reported to be available now in HAVA stores. A necessary item is 6- and 8-inch casing additional to the 200 feet of each now on hand. Procurement of 2,200 feet of 6-inch casing (also called line pipe) and 800 feet of 8-inch would support a minimal program, but more should be procured if possible.

Needed for full success of the program is a test pump. This could be either a 4-inch deep-well turbine (preferably water-lubricated) or a 4-inch deep-well submersible pump. A power source would be required for either. Horse power requirement would be from 12.5 to 15.

If it is within the capability of the rig, each hole should be drilled to bedrock. Unless the bedrock shows unexpected permeability, penetration should be limited to 3 meters, ordinarily sufficient to establish that the formation is continuous, not just a boulder.

Samples should be collected every 2 meters and at every change of formation. Probable aquifers should be tested by bailing and if but little drawndown by bailing, by power pump.

Tests shall be conducted by a technician who will measure discharge and recovery. Water samples should be collected from each aquifer. Depth to water should be measured daily and at the start of each drilling shift. Written notes should be made on materials, fluid loss or gain, caving, rate of penetration, down time, etc. In the event performance is better than anticipated or the period before the proposed project is longer than expected, 12 sites for test holes are suggested in a proposed order of priority, although until proficiency is gained by the drilling crew, probably 4 to 8 weeks will be required for each hole, with depth averaging 150 meters, although at Kandahar test holes will probably be deeper. It should be noted that these sites exclude the Shamalan area, which is to be explored by a contract driller.

The sites suggested are:

1. Site selected for possible municipal well for Lashkar Gah. The hole should be drilled as deeply as possible, at least to 100 meters. This test hole could be converted to a production well provided the casing used is replaced. The advantage of drilling at this site first is ease of access, and proximity to headquarters, desirable for this operation by an untrained crew.

2. Nahre Seraj area, vicinity of Wakil Abdullahkhan Kalay--near lat 31°43' N.; long 64°32' E. Purpose is to determine quality of water, depth to water, and character and thickness of aquifers in area between Helmand and Arghandab Rivers.

3. Zamin Dawar area, vicinity of Khola Abad, 1 kilometer (km) west of Gulmesh Mandeh, about 2.5 km west of bridge over Helmand River at Kajakai. Site should be above low flood plain, but on generally low land near lat 32°19'30" No.; long 65°04'30" E. Purpose is to determine character of materials, find possible deep water-bearing gravel layers, and ascertain quality of water at depth in the area of lower Gulmesh Mandeh.

4. Zamin Dawar area, vicinity about 3 km southwest of Albelagh (about 7 km south of Deh Baba village) on west side of valley, but as far down slope towards flood plain as practicable -- near lat 32°19' N.; long 64°56' E. Purpose is to determine character of materials and quality of water of deep aquifers in the lower part of the Baghni alluvial fan.

5. Zamin Dawar area, vicinity about 3 km north of the abandoned village of Joy Daraz (about 7 km south of the abandoned village of Rosharabad) wherever drilling rig has easy access near lat 32°29' N.; long 64°53' E. Purpose is to determine character of materials and quality of water of aquifers in the upper part of the Baghni alluvial fan.

6. Nazud area, vicinity of Nauzad village, preferably east of village center, as near as possible to axis of valley near lat 32°24' N.; long 64°29' E. Purpose is to determine whether the valley contains deep alluvium with permeable aquifers and to test quality of water.

7. Musa Qala area, vicinity of 6 km to northwest of Musa Qala town, west of Musa Qala Rud near lat 32°22' N.; long 64°43' E. possibly off the terrace, near flood plain of Farhad Rud. Purpose is to determine the character of materials and the quality of water of the aquifers in the central part of the Musa Qala Rud valley.

8. Central Arghandab area, south of village of Walakhan, along loop road about 10 km southwest of Kandahar near lat 31°31' N.; long 65°38' E. Purpose is to explore for deep aquifers in supposed axis of valley and to determine variations of quality with depth.

9. North Arghandab area, approximately 45 km west of Kandahar, south of Herat Road, vicinity of Mya village near lat 31°32' N.; long 65°10' E. Purpose is to explore depth of alluvium, test for water quality in area heavily dependent on kareze flow; no previous deep exploration.

10. Zare Dast area, approximately 35 km west of Kandahar, and 5 km north of Herat Road lat 31°36' N.; long 65°19' E. Purpose is to explore broad alluvial valley for deep alluvial aquifers and quality of water in area where no groundwater is currently being exploited.

11. North Tarnak area, approximately 20 km southwest of Kandahar, vicinity of Nakwadak, Gurgan, or Dehe Rajab (depending upon access) near lat 31°28' N.; long 65°36' E. Purpose is to determine depth of alluvium and water quality in area dependent on kareze flow.

12. Vicinity of Khushkawa (Helmand) near lat 31°39' N.; long 64°32' E. Purpose is to determine quality of deep water, character and thickness of deep aquifers in area of saline shallow water.

In addition to logging test wells drilled under their supervision, personnel of the Ground Water Section should have responsibility for obtaining logs and drilling reports on all production wells drilled by HACU, HAVA, and other agencies. Under present conditions, checking during construction will have to be done by Ground Water Section personnel either on a continuous basis or by frequent visits to drilling sites.

Monitoring: A program of measuring water levels and specific conductances periodically should be instituted. Discharge of selected karezes also should be measured. In general, monthly measurements of these parameters will be sufficient, but wherever possible weekly measurements should be made following the first heavy rain and continued until the readings clearly indicate the effects of recharge; subsequently the frequency may again be reduced to monthly. Immediate attention should be given to this program, especially as water levels are now exceptionally low. It is desirable to observe water levels in wells which are not ordinarily used. Such wells will be scarce. Ideally, wells would be drilled or dug for the purpose; indeed it is hoped that some such wells will be provided by the test-drilling program. In absence of unused wells, measurements should be made in wells before daily withdrawals are made. For example, wells could be

measured at 0600 hours Saturday morning. Probably the most satisfactory method of getting such measurements would be to select protected wells, such as those at a mosque or in a compound, and hire a local observer, say the mullah, a school teacher, or a member of the family in whose compound the well is situated. to make the measurements. It is recommended that wells to be measured by local observers be measured on a weekly schedule on a permanent basis even though monthly measurements would satisfy technical requirements.

Ideally, depths to water should be measured by steel tape and carpenters chalk. If absolutely necessary, in interest of economy, local observers who measure dug wells could be equipped with woven tapes and observe the depth at which the tape contacts the water surface. Measuring points must be clearly marked.

Specific conductance measurements should, where possible, be made on water from wells that are frequently used, such as the Kandahar municipal wells and irrigation wells. Generally, reading specific conductance is sufficient for monitoring ground-water quality; only occasionally or in the event of marked change should it be necessary to make chemical analyses of the purpose. Conductance readings should be made of kareze water on the same schedule as discharge measurements. Experience should permit reduction of frequency of measurement after 2 or 3 years.

In the Arghandab area water levels should be measured in capped drilled wells. Measuring ports with plugs or caps that require a wrench for removal should be installed. Additional

dug wells for weekly or monthly measurement can easily be selected to extend the network of observation points for many of the newly dug wells will not have pumps installed because of low yield. Wells measured by Mr. Sammel should be included. Effort should be made to have wide geographic coverage rather than merely a large number of wells. If tapes are provided, extension agents of HAVA could make many of the measurements.

Data Storage: It is essential that data obtained in this program be as complete, accurate, and accessible as possible. Standard forms, including those already devised by USGS, should be provided for well and kareze inventory, water-level records, drilling logs, test pumping records, and water quality records. Location of all wells, test holes, and sampling sites should be plotted in a standardized manner on large scale maps, and the records should be indexed by area for easy retrieval. Water level records obtained periodically in wells and karezes should be compiled in graphs.

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