Historical Review of the International Water-Resources Program of the U.S. Geological Survey 1940-70

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the U.S. bilateral program to provide the services of a specialist in limestone geohydrology to evaluate the potential of the Cenomanian-Turonian aquifer of central Israel with respect to further development as well as for underground storage. Robert Schneider, USGS hydrogeologist, was assigned to the work between April and June 1962. During his stay and in concert with Israeli colleagues, Mr. Schneider studied available data on the geologic environment of the Upper Cretaceous Cenomanian-Turonian limestone aquifer, the development of permeability, the flow regime of the aquifer, the storage characteristics and sources of pumped water, the use of the aquifer for underground storage, and temperature distribution in the aquifer system. Based on his studies, Mr. Schneider recommended additional test drilling to define the boundaries of the aquifer, statistical evaluations of aquifer porosity, pumping tests, three-dimensional scale models for study of ground-water flow in parts of the aquifer system, and an electrical analog model of the entire system. The technical findings of Mr. Schneider were described in USGS Water-Supply Paper 1608–F.

Between 1962 and 1970, five USGS specialists in various aspects of hydrology visited Israel for short-term advisory assignments under technical-assistance programs of United Nations agencies. The scope and nature of these activities are described elsewhere in this report under "Multilateral Activities."

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JAPAN

Japan, foremost modern industrial power in the Far East, occupies a 3,200-km arc of 4 principal and 3,300 smaller islands off the coast of East Asia. Although the U.S. has never provided formal technical assistance to Japan, the USGS furnished technical consultation on water-supply problems for installations of U.S. Forces in Japan on several occasions since World War II, including a general review of ground-water problems in Japan for the U.S. Forces. Most of this work has not been recorded in available form. Where documentation exists, however, for the work of USGS hydrologists in Japan, it is described in the following paragraphs.

During January–March 1951, M. L. Brashears, USGS hydrogeologist, was assigned to evaluate ground-water problems for the General Headquarters, Supreme Commander for the Allied Powers, and to make general recommendations with respect to institutional needs for ground-water investigations in Japan. Mr. Brashears' report of May 1951 pointed out the high level of ground-water use for irrigation, industrial processing, public-water supply, and domestic use; the deleterious effects of over pumping in the Osaka, Nagoya, and Tokyo areas, resulting in reduced artesian flow, increased pumping lifts, salt-water encroachment and land subsidence; possibilities for artificial recharge of aquifers to check these problems and to recover wasted surface water; and the need for upgrading ground-water technology, surveillance, and management. He also outlined a broad program of investigations to achieve these objectives.

At the request of the U.S. Air Force, J. T. Callahan, USGS hydrogeologist, was assigned in October 1964 to make a brief evaluation of ground-water development problems at Misawa Air Base in Aomori Prefecture near the north end of Honshu Island. Mr. Callahan pointed out that the base lies in an artesian basin underlain by alluvial deposits of water-bearing sand and gravel separated by layers of clay and silt and that successful water wells have been drilled to depths of 200 to 400 m to the north, south, and west of the base. He concluded that construction of one or more production wells was feasible in the base area, but, because of the high vertical and lateral variability of the alluvial aquifers, "slim holes" should be put down at all proposed production well sites to determine the position and lithology of water-bearing zones for proper emplacement of casings and screens of production wells.

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JORDAN

Jordan, centrally located among the Arab nations, sustained a steady economic growth for the 15 years prior to 1970. An important base for this growth has been U.S. economic aid, which aggregated more than $€40 million during 1955–70. Moreover, this aid has emphasized water-resources development, notably

construction of storage and diversion dams, canals, and shallow (less than 100 m deep) wells for irrigation in the Jordan Valley and drilling of deep wells for irrigation in other more arid parts of the country. As an adjunct to this work and as part of U.S. bilateral aid to the Government of Jordan, the USGS provided technical advisors on several occasions during the 12 years prior to 1970, all of whom have directed efforts toward assisting the investigation, development, and management of Jordan's water resources.

Perhaps the first appraisal of the water resources of Jordan by a USGS scientist was that of V. E. McKelvey, who was assigned under the auspices of US ICA during October–November 1958 to evaluate the country's mineral resources with particular emphasis on the development potential of phosphate deposits. In his open-file report of 1959, he also included a description of the hydrologic regimen of the Jordan Valley–Dead Sea Basin and prepared quantitative estimates of Jordan's perennial annual water supply, surface runoff, water use, potential usable supply from replenishable sources and nonrenewable ground-water storage.

Ground-Water Investigations, 1959–60, 1962, 1966

After termination of U.S. bilateral technical assistance in Iraq, Edward Bradley, USGS hydrogeologist, was assigned from May 1959 to June 1960 to US ICA/Amman as technical advisor in ground-water geology to the Jordan Development Board's (DNB) Water Resources Department, which was absorbed in 1960 in a new Central Water Authority (CWA). During his stay in Jordan, Mr. Bradley (1) trained several geologists and engineers of the JDB in the basic methods of ground-water field studies, (2) completed in collaboration with the United Nations Food and Agriculture Organization (FAO) and Jordanian hydrogeologists, a countrywide inventory of recently constructed wells and an administrative report summarizing hydrogeologic data in Jordan, and (3) made 22 special site studies for test drilling and ground-water development, chiefly near Amman and in the West Bank area of Jordan.

In early 1962 the Government of Jordan requested US AID/Amman to provide the short-term services of a hydrogeologist to advise the Ground Water Division of the CWA on requirements for continuing ground-water investigations, use of ground-water data, coordination of technical activities with related functions of other government agencies, and training of Jordanian technical personnel—chiefly directed toward improved management and legal control of ground-water development in the Jordan River Valley. C. R. Murray, USGS hydrogeologist, was assigned to this mission from March to August 1962. For the guidance of the CWA and other agencies, his administrative report of October 1962 presented recommendations for general studies needed in the Jordan Valley and elsewhere in the country in areal and subsurface geology, ground-water recharge and discharge, water-level observations, water-table contours, water-quality analyses, test drilling, aquifer tests, ground-water law, and technical training of Jordanians. He also initiated ground-water studies near Jericho and South Shuneh, both in the Jordan Valley, that were subsequently carried to completion during 1962–64 by Jordanian hydrogeologists and ground-water engineers of the CWA.

In the early 1960's a threat to continuance of irrigation from wells had resulted from overpumping, water-level declines, and water-quality deterioration near Jericho in the West Bank area. To evaluate the problem and recommend solutions the Central Water Authority in late 1965 requested US AID/Amman to provide the short-term services of a USGS specialist. E. S. Davidson, USGS hydrogeologist, was assigned to the mission between January and March 1966. In his unpublished report of March 1966, he described the hydrogeology of the aquifer system near Jericho and the interrelations of saline- and fresh-water zones. He also presented detailed recommendations for increasing the fresh-water supply, stabilizing fresh-water levels, and arresting saline-water intrusion by pumping from new wells west of the Main Rift fault and by recharging the principal dolomitic limestone aquifer in the Cretaceous Belqa Group through ponds, existing wells or temporary dikes across the Wadi Qilt. Although the CWA had begun action to carry out Mr. Davidson's recommendations, this work was suspended in June 1967.

Surface-Water Investigations, 1962

Beginning in October 1961, Jordan undertook the building of a new National Hydrologic Service under the direction of the Hydrology Division of the Central Water Authority (CWA) with technical assistance provided by the FAO and a British consultant firm. Problems encountered during this buildup led the CWA in early 1962 to request US AID/Amman for the short-term services of a USGS surface-water hydrologist to review the program of the National Hydrologic Service and to recommend measures for improvement of operations and the hydrologic network. F. F. LeFever was assigned to this mission during March–May 1962. His administrative report

of September 1962 presented a general description of the surface-water hydrology (fig. 46) of Jordan; the work accomplished; and detailed evaluations of and recommendations for improvement of National Hydrologic Service's field procedures in stream gaging, office practices, hydrologic basic-data networks, reports, organization, personnel training, equipment, instrumentation, and gaging-station structures. Since Mr. LeFever's mission the National Hydrologic Service has attained a high level of viability.

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KOREA

The Republic of Korea (South Korea) occupies the southern part of a mountainous peninsula projecting 960 km southeast from Manchuria and the mainland of East Asia. Since 1953 the Republic of Korea (ROK) has been a major recipient of U.S. bilateral military and economic aid, including a large input of technical assistance. Between 1946 and 1968, U.S. economic aid alone to South Korea amounted to $4.7 billion. The USGS participated in the water-resources sector of the U.S. bilateral technical assistance program in South Korea first in 1963, again in 1964 and 1965, and continuously between February 1966 and February 1971. The scope, objectives, and accomplishments of these activities are described in following sections.

Ground-Water Reconnaissance, 1963, 1964

A severe drought in 1962 resulting in a loss of 20 percent of South Korea's cereal crop focused atten-

FIGURE 46.—Yarmouk River, the principal tributary of the Jordan River. View looking upstream from the Maqarin stream-gaging station.