United States
Department of the Interior
Geological Survey

7852

A RE-EVALUATION OF WATER-QUALITY INVESTIGATIONS, WESTERN DESERT, EGYPT, UAR

Prepared by the United States Geological Survey
in cooperation with the United Arab Republic
and the United States Agency for International Development Mission
to the United Arab Republic

Cairo, Egypt, UAR
July 1965

Administrative Report

A Re-evaluation of Water-Quality Investigations, Western Desert, Egypt, UAR

by

Herman R. Feltz

U. S. Geological Survey

Cairo, Egypt, UAR
July 1965

Frontispiece.--Hepus Temple, bearing the world's first water code, surrounded by a bountiful crop of irrigated wheat in Kharga Oasis.

Contents

Illustrations

A Re-evaluation of Water Quality Investigations, Western Desert, Egypt, UAR

by

Herman R. Feltz

Abstract

The small water quality laboratory in El Kharga at the time of the first evaluation 2 years ago, has been up-graded in both physical outlay and professional capability. Nevertheless, more improvements are needed. Several of the problems present at the time the laboratory was established remain, thus strong leadership and personal devotion of the local staff will be needed to overcome deficiencies.

New space specifically designed for laboratory use will soon be available in El Kharga and Cairo, but space alone does not ensure satisfactory completion of assignments. Capability must be broadened to include all major chemical constituents, and field techniques fully developed to obtain good deep-hole samples and measurement of unstable properties at well sites. Administrators of EGDDO must recognize, and participate in the positive resolution of problems encountered on the level at which personnel gather and interpret data. Improved transportation and mobile laboratories are urgently needed in order to complete assessment of water quality.

Chemistry has to a large measure been neglected, and therefore reduced the number of significant contributions to interdisciplinary data interpretation. The section has just reached the point of beginning to make a thorough appraisal of the quality of water from the oases.

Recommendations are made for continued strengthening of professional capability and overall efficient operation of the chemical department, leading to a definitive program of basic coverage in 18 months.

This report covers the period May 1963 to July 1965 based on six weeks contact (June-July 1965), and was sponsored by the U. S. Agency for International Development (USAID/UAR) in cooperation with the EGDDO, Cairo, UAR.

Acknowledgements

The professional and personal orientation and courtesies extended by personnel of the Water Resources Division, USAID/UAR, and the EGDDO is sincerely appreciated. Close cooperation and frank discussions with individuals of both organizations were a major aid in the evaluation. Without this confidence, the value of the present visit would have been reduced, and I am pleased to have been a party to such an atmosphere.

Introduction

Since its inception in 1959, the Egyptian General Desert Development Organization (EGDDO), an action agency of the Ministry of Agriculture and Agrarian Reform, has fostered the reclamation of over 40,000 feddans (1 acre = 1.038 feddans) in arid regions (written communication, Sobieh, 1965). Continued expansion of the EGDDO program, coupled with increased demand for basic data from reclaimed areas, is taxing the present capability of the chemistry section to describe the quality of ground water in the New Valley.

The purpose of this report is to re-evaluate the water-quality program of the EGDDO, and supplements an evaluation made by the author in May 1963.

Observation of laboratory practices, field work, report review, and planning were essential parts of the evaluation. Time was divided equally between laboratory and field operations.

Physical Facilities

The addition of laboratory facilities in Cairo at the Ministry of Agriculture is a significant advance. The author has contended from the time of the first evaluation that this office must be established where modern quarters, a central location to field operations, and involvement in the scientific community of the country can be realized. Two possible arrangements of the laboratory have been drawn and given to the chemistry department for consideration along with plans independently developed by that group. These plans are shown in figures 1 and 2 in order of the author's preference.

The alloted space of approximately 860 square feet is sufficient to accommodate six chemists if need be, but better serves the need of four. Unitized laboratory furniture (individual pieces or sections) is desirable for ease of arrangement and assembly. Advances in technology may require additional equipment and different arrangements of furniture.

In Kharga, where a new building for all Ground Water personnel assigned to the area is under construction, the chemistry section may occupy up to about 1,250 square feet on the second floor of the building. This space is ample provided the workload does not exceed 80 complete analyses per month. The proposal to designate one room to house basic data for interdiscipline use is excellent. A common data room affords opportunity for contact and professional discussions among chemists, engineers, and geologists working on the New Valley project. Indeed, supervisors should encourage free exchange of ideas within the framework of the overall objectives of the Ground Water Department in order to fully inform every employee of each section's role.

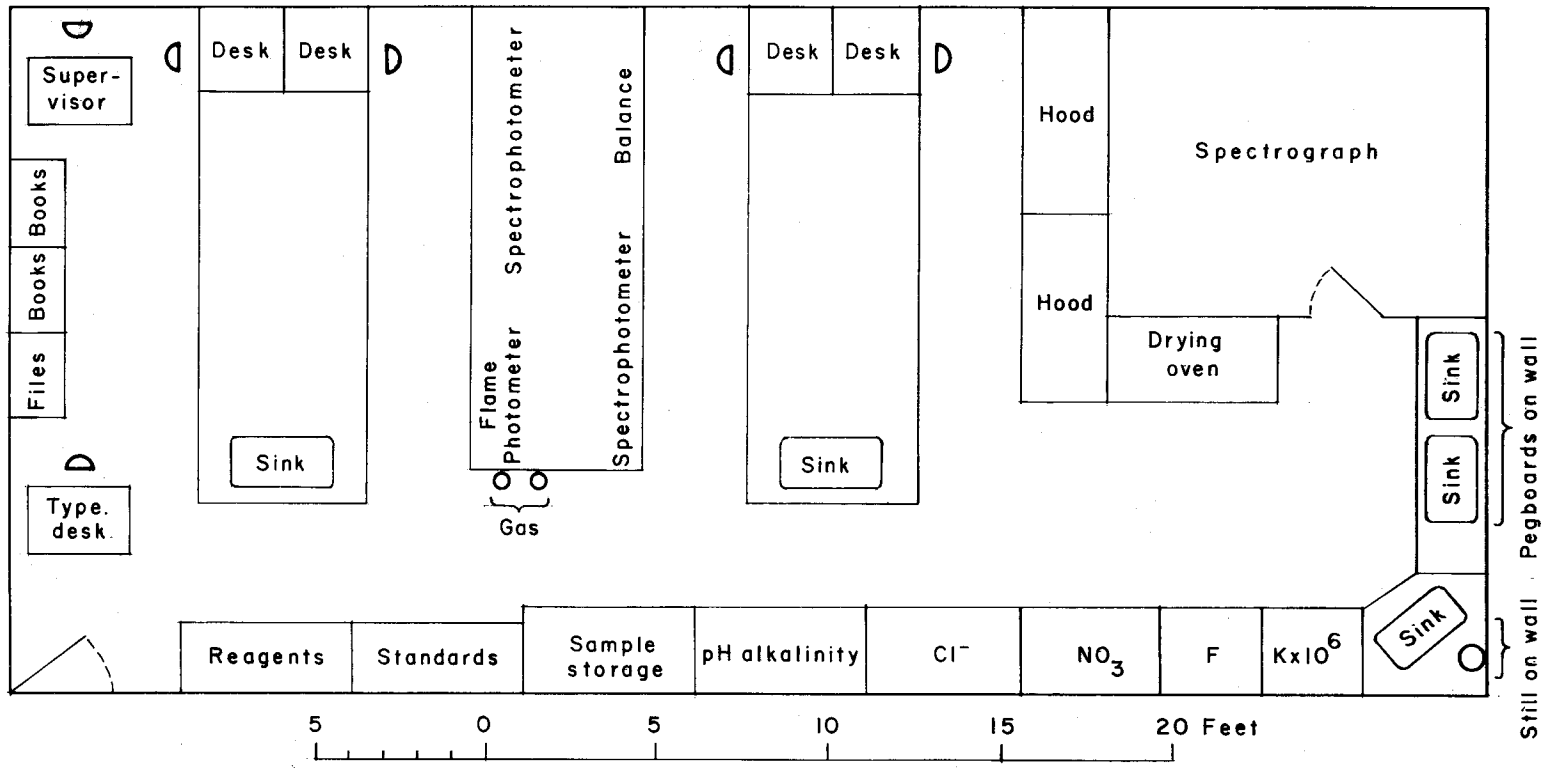

Figure 1.--A preferred plan for the Cairo water-quality laboratory.

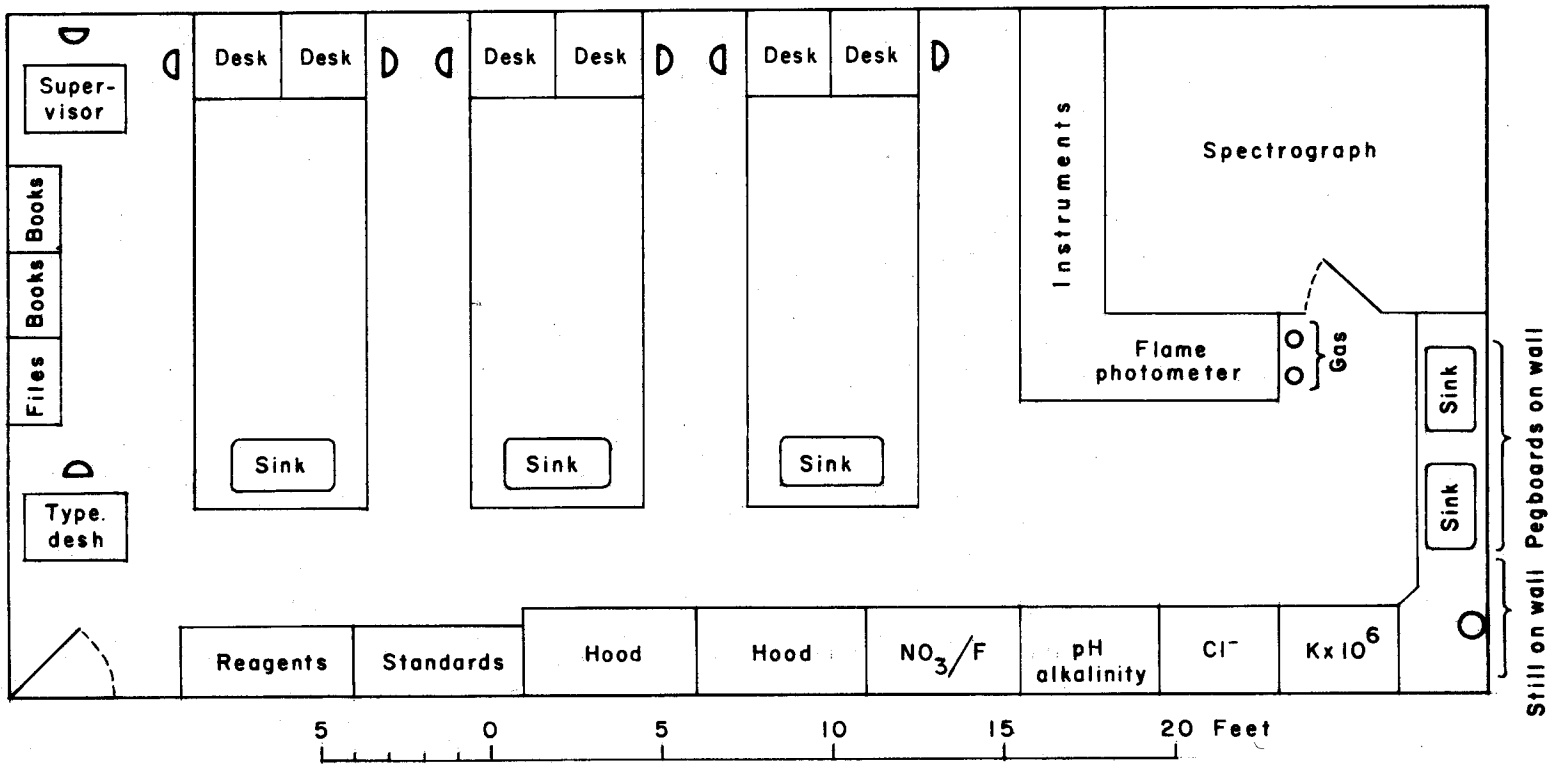

Figure 2.--Alternate plan for the Cairo water-quality laboratory.

Proper definition of water quality can best be made by utilizing field data from on-site measurements coupled with laboratory data. Mobile labs are essential to work in the oases and were recommended two years ago. They have not as yet been developed. Reliable transportation should be assigned exclusively to the chemistry section. The program is suffering from this deficiency to the extent of being two years behind other disciplines. A unit consisting of a truck and mobile lab is required for Kharga and Dakhla; a second unit will be required when work expands in Farafra and other oases. Unreliable data result from failure to provide equipment essential for field determinations.

The laboratories at Kharga and Cairo are not in urgent need of additional major outlays of equipment such as spectrophotometers, balances, furnaces, stills, and expensive singular items. They are short of lesser items such as glassware, certain chemicals, and small tools. More field equipment, particularly deep-hole samplers equal to or better than the one shown on page 9 are needed.

The repair of several pieces of existing equipment, particularly the two Model N pH meters, is of pressing importance. USAID/Cairo recognizes this need and will ship the instruments to the States for reconditioning. Leak proof polyethylene sample bottles are needed to retard loss of unstable constituents, and it is recommended that one gross be put into use immediately.

Figure 3.—Mohammed Shabaan, EGDDO, and the author preparing to sample a single water-bearing stratum, West Village well, Kharga Oasis.

Professional, Technical, and Clerical Staff

Several additions have recently been made to the chemistry staff. Expanded programs have created the need for more employees and have brought about vacancies from the bench-level chemist to administrative assistant. Personnel have been transferred from Kharga to Cairo and Farafra, and work outside the oases has brought about the hiring of additional chemists.

Whereas this report is primarily concerned with the New Valley project, the overall operation of the chemical department is affected for the reasons cited. There is then created an abnormal strain at the moment during a training period, then continuing as new positions are filled all along a line of succession. New chemists and new leaders will need a period of adjustment in which job experience is being gained.

The staff at Kharga will soon be short at least four persons with the transfer of George Tawfik and Salah Gad. The office is short another chemist, two technicians, a good laboratory aid, and a clerk. Duties of employees at all levels was discussed in the prior report. Particular effort should be made for hiring and training technicians and a good aid.

Following this staffing problem, the Cairo laboratory will need attention since the building to house it will soon be completed. It is not now too early to start selection of personnel and initiate training even in the cramped space at the present location. New employees could learn simple techniques and orientation sessions

held to familiarize the new employee with his role in the organization as related to the objectives of the overall program of the EGDDO.

Methods and Techniques

Analytical coverage is still not complete. Specifically lacking are F and NO_3. However, several reagents have been supplied by USAID/Cairo and as soon as solutions can be prepared and the methods understood, the number of properties measured can be increased to include all major cations and anions. Reagents were also delivered for measuring SiO_2, B, and the heavy metals.

The determinations that have been made and values recorded are good results when considering the handicaps under which the chemists labor. This does not mean the results are of an acceptable level, however. Overall error is about 5 to 15 percent, and the goal should be as low as 2 percent for the range of total dissolved solids found in waters of the New Valley.

The author has reviewed an appreciable amount of recorded data during this evaluation period, and it appears reasonably certain that HCO_3 and pH data are quite erroneous. This leads to the suspicion that Ca + Mg values may be low due to loss of CO_2. In company with EGDDO personnel, the author spent considerable time making field determinations for pH, HCO_3, CO_2, and $Kx10^6$ on both discharge and deep-hole samples. The lower pH and CO_2 values for samples from deep water-bearing zones as compared to discharge samples, strongly indicates that CO_2 is bound at depth and field determinations are absolutely essential. Discharge samples should also be analyzed at the well site for unstable properties because it is obvious from naked eye observation that gases are being dislodged from the water

for quite some distance down a flume from the point of discharge. There is no container capable of preserving these unstable constituents for laboratory examination at a later date.

The decision to change the method for measuring SO_4 from the turbidimetric to thorin should improve the quality of determinations, primarily because of less interferences and elimination of critical timing. The author delivered a magnetic titration assembly and thorin to the department, and it is anticipated that the new procedure can be readily employed. The laboratory has received the Model B spectrophotometer it sorely needed, thus accuracy and reproducibility are possible.

Carbon dioxide must be determined at the well with more regularity. Many analyses in the file contain a single entry for this constituent. The "closed titrating system" consisting of an Erlenmeyer flask fitted with a rubber stopper and 10 ml buret should be used.

Conductivity measurements have not been made routinely. The receipt of several meters from a British manufacturer will now allow the determination. Field values are almost non existent and can be made at each well site with the British crank powered unit or the Industrial RB-2-338. Conductivity is the easiest and most economical means of detecting range and change in water quality, thus it should be done at each well on a definite schedule.

Alkalinity and pH measurements must be made in the field to achieve accurate values. No data, with the exception of those

collected during July 1965 are on file. HCO_3 concentration and pH at well sites must be recorded on the analysis notes and statement card to inform those interpreting data of the correct concentration of these properties. In all studies true values are imperative. Laboratory determinations are for use in determining validity of analyses at time of analysis; the values may or may not be in agreement with field data.

Calcium and magnesium, subject to precipitation with loss of HCO_3, must be collected routinely in a separate bottle (150 ml) as is done for the heavy metals, acidified with several drops of HCl, and measured concentrations recorded and compared to solution values. If there is no difference, one can safely assume both alkalinity and alkaline earths represent the quality at time of collection. If not, then acidified values of Ca + Mg should be reported along with field values of alkalinity.

Fe has not been consistently determined, but certainly should be. Reagents which were unavailable locally have been delivered to permit the measurement routinely. Samples collected in separate containers and acidified with HCl are proper.

Al, Mn, Cu, Pb, and Zn should be measured in a reconnaissance study. The results should be evaluated as soon as possible following the survey. It is of interest to know whether these elements are present in New Valley water, but a lengthy detailed program is not needed. The metals will probably be found in trace quantities only; a single report in this case will suffice.

Boron data should be gathered in a reconnaissance study to supplement major constituent reporting. The element may be present in certain areas in concentrations high enough to affect production of certain crops. Only if significant quantities are discovered should a large-scale program be launched. A section of Water-Supply Paper 1473 is devoted to a discussion of the significance of the property as studied by the U. S. Department of Agriculture Salinity Laboratory (Hem, 1959).

Spectrographic analyses for trace quantities of water properties are of secondary importance to basic data. Such a program should not be undertaken until the basic data, properly evaluated, is published. The author feels trace properties are not critical to reclamation efforts.

Fundamental studies should be a part of the overall program and considered when time permits. Carbon-14 dating, proposed as a supplemental source of information leading to a determination of the direction of water flow in and recharge to the Nubian series should be postponed until basic data are gathered. Reported dates ranging from 25,000 to 80,000 years, even if in error 10 percent or more, point up that recharge is of little significance to such a vast reservoir.

Investigational Program

The water-quality program for the New Valley project has reached the point where intensive efforts should be made to complete the basic data report for Kharga and Dakhla areas as quickly as possible.

The author recognizes that the preparation of adequate laboratory facilities and training of personnel has consumed a large amount of time the past several years. However, with a few instrument repairs and familiarization with methods for measuring the several properties not presently determined, the work may proceed at an acceptable level of competence and in sufficient quantity so as to complete the major portion of the Kharga and Dakhla investigations within 18 months. The word "complete" is taken to mean collection and analysis of samples, data tabulation, and interpretive publications.

The following approach is proposed:

1. Sample each of the EGDDO wells in both Kharga and Dakhla at the top of the screen open to the lowest producing zone and at the discharge.
2. Where it is impossible to sample at depth, collect a discharge sample only.
3. Sample a reasonable number of shallow and/or native wells in the two oases.
4. Make field determinations for conductivity, pH, alkalinity, CO_2, fix a sample for H_2S and record temperature.
5. Using the maximum/minimum thermometer or Halliburton recorder, collect at least one value from the lowest producing zone of each well or run a profile survey.

6. The wells should be sampled twice, once as soon as possible, again 6 months later. If there are no significant changes, sampling should be discontinued, data tabulated, and a report prepared.

7. With an estimated loss of 2 months work time when moving into the new laboratory at Kharga and some time to fabricate a mobile unit (trailer or modified jeep), the basic program should not extend beyond 18 months. Specifically, 12 months to finish basic data collection, and the next 6 months for evaluation and reporting data in a written report.

8. A reconnaissance for minor elements should be considered near the end of major cation and anion reporting. The data should include phosphate, boron, and the heavy metals. This survey would complete the basic water-quality investigation. Special studies of complex problems will no doubt be undertaken later, and personnel would be able to perform functions of a higher caliber as a result of their experience. Requests for chemical quality work should be viewed with an intent toward interdisciplinary resolution of hydrologic problems.

9. Continued effort to upgrade the individual capability of each chemist and technician must be expended. New personnel and re-assignment of seasoned, experienced personnel makes this aspect of operating the chemical department all the more imperative.

10. Laboratory equipment, field equipment, and vehicles must be kept in first-class condition if data are to be obtained with reasonable effort. Chemists should not be unduly burdened with malfunctioning items. The laboratory supervisor must, therefore, assert himself much more than he has in the past.

11. Special projects can best be served from the laboratory at Cairo where more elaborate equipment, a stable power supply, freedom from airborne matter, and opportunity for university and colleague consultation are available.

12. The lab at El Kharga should be kept open indefinitely, but with a reduced staff, to satisfy needs of the local water plant and to analyze samples from newly constructed wells if additional drilling is done.

Summary

Progress in making the El Kharga laboratory an acceptable facility and realization of a departmental laboratory in Cairo deserves commendation. The chemical department will soon have the physical accommodations it has needed. Personnel may soon direct full attention to matters scientific and begin in earnest to describe the quality of water in the New Valley.

Presented below are the principal recommendations drawn from detailed discussions:

1. Set a goal of 18 months in which to complete the basic program in Kharga and Dakhla.
2. Assign a vehicle to the laboratory for full-time use.
3. Provide one mobile lab unit as soon as possible, and outfit a second unit based on experience with the first.
4. Expand laboratory capability to allow immediate measurement of SiO_2, F, NO_3, and conductivity. Measurement of the heavy metals may be added later.
5. Improve individual chemists' analytical techniques.
6. Begin re-sampling program, complete, and repeat in six months.
7. Collect field data including conductivity, pH, alkalinity and/or acidity, CO_2, fixation of H_2S, and temperature.
8. Tabulate and interpret data in internal and external reports.
9. Continue to evaluate the water-quality programs, making changes dictated by experience and responsibility to overall programs of the EGDDO.

References

Hem, J. D., 1959, Study and interpretation of the chemical characteristics of natural water: U. S. Geol. Survey Water-Supply Paper 1473, 269 p.

Sobieh, Hassan M., Board Chairman, EGDDO, 1965, in Al-Goumhouria newspaper, June 12, p. 7.