WATER QUALITY IN THE HASOUNA WELLFIELDS, WESTERN JAMAHIRYA SYSTEM, GREAT MAN MADE RIVER PROJECT (GMRP)

by

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I, Naser Sahli, do declare that this project is my own work, and that to the best of my knowledge and belief, all the references and sources of information have been acknowledged.

Naser. IM. SAHLI

Production Note:
Signature removed prior to publication.

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I would like to dedicate this work to the soul of my Mother who died during the preparation of this work and also to my daughter Alla who has been suffering from a brain tumour for the past 5 years and I wish her a speedy recovery from this disease.

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ABSTRACT

The Hasouna Wellfields, comprising 484 wells designed to produce 2.5million m^3/day of water, are part of the Libyan Great Man Made River Project (GMRP). They are located about 700 km south of Tripoli, in an area of stony desert and sand dunes, forming a rolling topography of low to moderate relief. The water will be conveyed by pipeline for water supply and irrigation to the coastal regions west of Tripoli.

Geologically, the study area forms the northern edge of the Murzuq Basin and comprises rock formations ranging in age from Pre-Cambrian to Upper Cretaceous. There are two aquifers: the Cambro-Ordovician (CO) Hasouna Formation (the main aquifer), and the overlying Zimam Formation. The Zimam Formation, which contains saline water, is absent over the part of the field area where the freshwater-bearing, Hasouna aquifer is unconfined. The CO aquifer is major regional aquifer with a transmissivity range between 1500 to 2000 m^2/day and a storativity range from 2.2×10^{-5} to 6.4×10^{-2} between the confined and unconfined areas of the Wellfields. Pumping tests have shown that the CO aquifer is leaky-confined type over part of the study area.

Water quality is good with average total dissolved solids (TDS) of 1039 mg/l, average chloride content of 600 mg/l and a positive redox-potential, indicating an oxidizing environment. However, the concentration of dissolved CO_2 ranges from 3.7 to 97 mg/l and nitrate ranges from 0.0 mg/l to 133 mg/l. These two constituents can result in wellfield operational and consumer health problems respectively.

The main objective of this study was to make a complete investigation of the water quality, hydrochemical processes and all the physical and chemical properties of these Wellfields.

Special attention was focussed on the problem of corrosion due to the CO_2 and the nitrate. This research used various methods, including the classification of water type, analysis of field data, study of major and minor cations, anions and trace elements, and the determination of water aggressivity supported by field study of corrosion coupons, hydrochemical processes, water quality for potable uses and isotopic analysis.

The calculated saturation and corrosion indices indicated that the Hasouna water is corrosive. The field study using corrosion coupons demonstrated that the corrosive properties of the water can change under short term non-pumping conditions to be scaling in character. Although the GMRP has addressed the problem of CO_2 by stripping it in degassing towers before it enters the pipeline, the results of this research will assist the process by identifying areas of high and low CO_2 concentration. A similar approach of blending low and high nitrate water can be used for the nitrate problem.

The origin of high nitrate levels in the Hasouna water is problematic. Similar high levels occur in Sirt and Kufra basins in Libya, (Edmunds and Wright, (1979)). The isotopic analysis of $\delta^{15}N$ (31 samples) and $\delta^{18}O$ (6 samples) from nitrate for the Hasouna water suggested the source could be precipitation and soil nitrate ($\delta^{15}N$ and $\delta^{18}O$). The $\delta^{15}N$ signature is similar to NH4, NO_3, N_2 and effluent/manure. These sources imply a more humid climatic environment than the present. The stable isotope data indicate a meteoric origin for the groundwater, and the radiocarbon age is > 8 ka, which suggests that the Hasouna water is likely to have a late-Pleistocene or very early Holocene origin. At that time the climate was more humid than the present day arid conditions.

The water in Hasouna is classified to be class C3, for salinity hazard (High) and class S1/S2, for Sodium Hazard. This indicates that the blended water is suitable for irrigation with special management to control salinity.

The analysis of the speciation properties of the ionic composition of the water indicates undersaturation with all of the plausible mineral species. The hydrochemical processes, which control the composition of the Hasouna water are mixing, ion exchange and dissolution of gypsum and dolomite.