Date: 27 November 1987

Author: Dr. Stephen Foster, Regional Groundwater Advisor, CEPIS

Subject: Georgetown-Guyana Groundwater Resources: Evaluation and Management

1. GENERAL BACKGROUND

1.1 Georgetown, the Guyana capital, continues to be highly dependent upon groundwater for its municipal water-supply; GS & WC abstracting up to 11 mgd* (50 ml/d) from 8-12 production boreholes, which represents about 60% of the total dry-weather supply.

1.2 These production boreholes exploit two semi-independent and quite highly confined aquifers; the Lower A Sands (with 7 boreholes) encountered in Georgetown from depths of 500-600 ft (150-180 m) below MSL and the Lower 3 Sands (with 3 boreholes) from 750 ft (230 m) below MSL.

1.3 The abstraction of groundwater increased rapidly during the 1960s from an estimated 2 mgd (9 ml/d) in 1960 to about 10 mgd (45 ml/d) in 1970, but since then production has remained relatively constant.

1.4 Abstraction is highly concentrated within an area of about 4 sq miles (10 km²) in Georgetown itself and most production boreholes are less than 1.2 miles (2.0 km) from the Atlantic shore or from the Demerara River estuary.

1.5 In the main groundwater abstraction center, the GS & WC Shelter Salt site, groundwater levels are said to have fallen from being strongly artesian pre-1960 to 35 ft (11 m) and 50 ft (15 m) below MSL, respectively in the Lower A and 3 Sands aquifers.

---

* mgd = million Imperial (not US) gallons per day
1.5 At regional scale the aquifers of the Guyana coastal belt have large groundwater resources with potential recharge of more than 30 in/a (750 mm/a) in the very extensive "white sands area", which commences at a distance of some 15-18 miles (24-29 km) from the coast. This recharge rate is equivalent to 1.2 acq/sq ml (2.1 ml/l/km²).

1.7 The limiting factor in the availability of groundwater to production boreholes within Georgetown appears to be the fact that the groundwater hydraulic gradients developed are insufficient to allow recharge and transmission of these resources in the Lower Sands aquifers.

1.8 The depression of groundwater levels in Georgetown results in a very real risk of saline water intrusion into the aquifers as a result of either:

a. induced vertical leakage from the overlying Upper Sands formation which is said to contain brackish groundwater close to the coast and along the Demerara estuary,

b. lateral seawater encroachment.

1.9 There may also be some risk of land subsidence as a result of compaction of overlying unconsolidated argillaceous strata with high organic content.

1.10 Numerous groundwater specialists have commented upon the risk of rapid saline intrusion and urged that a detailed groundwater evaluation be undertaken (Worke, 1968; Arad, 1975; Nawarro, 1977; Dijon, 1978).

1.11 The Georgetown Water-Sector Master Plan prepared by ESI of Israel under instructions from UNDP and WHO-PHOS in 1975 was pessimistic about future groundwater prospects. It advocated phasing out of all production boreholes during 1987-93, unless proven otherwise by the detailed investigations recommended, on the assumption that increased capacity to obtain and to treat surface water would be developed by 1987.

2. CURRENT POSITION

2.1 Since no major initiative in respect of Georgetown water-supply has been taken since 1975, the city will remain highly dependent upon groundwater at least until 2000, and in the long-term if its exploitation can be put on a more secure and rational basis.

2.2 Abstraction has continued during 1975-97 at rates estimated generally to exceed 10 acq (45 ml/l) and despite continuously falling groundwater levels and problems with well deterioration, the supply system has survived, albeit precariously.
2.3 It is now clear that the two aquifers exploited in Georgetown show a high level of hydraulic independence, and although they are vulnerable to saline intrusion, the routes of ingress of saline water are subject to considerable resistance. The aquifers exhibit highly distinctive and contrasting natural groundwater chemistry:

a. Lower A Sands: pH = 6.0, Cl = 15-25 mg/l
   Fe = 1.0 - 5.0 mg/l, T = 26°C.

b. Lower B Sands: pH = 7.8, Cl = 120-160 mg/l
   Fe = 0.1 mg/l, T = 40°C.

2.4 In view of the continuing risk of saline intrusion and increased dependence upon the Georgetown aquifers, a detailed groundwater evaluation must be regarded as a very urgent requirement. The problem is to find a way that the necessary work program can be implemented, given that additional field data will almost certainly need to be collected, and that this is always a costly element.

3. PROPOSED PROGRAM

3.1 A strategy for the evaluation and management of the groundwater resources of the Georgetown aquifers is thus recommended. The likely outcome of the evaluation is that some redistribution of GS & WC abstraction will be required to reduce the risk of large-scale saline intrusion and loss of groundwater resources.

3.2 The program thus comprises the following phases:

a. compilation and analysis of all existing data, aided by a simple computerised numerical simulation model,

b. acquisition of field equipment and collection of any additional hydrogeological data, so as to allow improved calibration of the aquifer model, making use as far as feasible of existing facilities of GUYWA, HYDROMET and current operations of GS & WC,

c. use of the calibrated model to examine resource management options and guide progressive redistribution of GS & WC groundwater abstraction.

3.3 The final specification of the groundwater model must await the compilation of hydrogeological data, but the following general observations can, at this stage, be made:

Type of Model: 2-D/quasi 3-D transient finite difference package, such as PLAS-Prickett & Lonquist or MODFLOW-Yc

Aquifer: Lower A Sands only.
Area: Coast strip 50 km wide and 50-60 km depth centred on (and not bounded by) Demerara River, since this estuary is not a boundary to the confined aquifer.

Grid Size: 1 km sq in Georgetown and 2-5 km sq elsewhere.

Aquifer Characteristics: In view of very limited data, initially use k = 10-40 m/d, m = 40-70 m and b = 10^-4.

Aquifer Geometry: Estimate from existing geological sections, but model three options for seaward boundary:
(1) constant head at 5 km offshore
(11) constant head at 20 km offshore
(111) no-flow at 2 km offshore.

Recharge Regime: Direct recharge at up to 750 mm/a in "white sands area" plus possible induced leakage from Upper Sands in Georgetown area.

Discharge Regime: Known Georgetown pumping since 1910 or since 1960 with direct discharge to ocean and rejected recharge in white sands area as dictated by model, together with optional induced leakage to Lower B Sands aquifer.

3.4 Initial steady-state verification of the model will try to reproduce the known low hydraulic gradient between the Georgetown area and the white sands outcrop in the vicinity of Timehri airport, some 30 km south, varying the hydraulic characteristics and seaward boundary condition.

3.5 Subsequent first attempts at non-steady state calibration should try to simulate the fall in groundwater levels at the Shelter Belt site with the known abstraction since 1910 or since 1960, through further variation of the above parameter and of recharge scenarios.

3.6 It is probable that attempts at the calibration process will define the need for additional groundwater investigation and monitoring. In particular, the lateral extent of the cone of depression of the Georgetown abstraction, and whether changes in such abstraction affects groundwater levels in the Upper Sands are likely data needs, together with more tests to determine variations in aquifer transmissivity.

3.7 Equipment requirements for the supplementary monitoring program are likely to include such items as in-line flow meters, borehole salinity logger, groundwater level recorders, borehole depth sampler, EC, pH and 402 meters, etc., and possibly drilling spares.

3.9 Once calibrated the model can be used to examine the effects of redistribution of the abstraction regime, and to estimate approximately the rate of landward advance of seawater.