Greater Kano water supply

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GREATER KANO WATER SUPPLY

Kano, the largest city in Northern Nigeria, has enjoyed a dominant position as a commercial centre throughout the centuries. This important role was strengthened further with the creation of the States and with the improved road links to other parts of the Federation. The infrastructural development in the last twelve years has had a great impact on the industrial growth. However, although beneficial it has been, it has had its undesirable effects as well. The population growth rate seems to be far above the average and is further increased by migration from the rural areas to Kano, which is the only real urban and industrial centre in the State. Beside the actual spatial expansion of the town, the population density has also greatly increased in certain parts of Kano township and a seasonal fluctuation of the population can also be observed.

The first waterworks in Kano was built between 1928-31, with a capacity of 2 MGD (o.1 m^3/sec). This plant generally known as the "Old Waterworks", was later extended to a maximum capacity of 4 MGD (o.2 m^3/sec), and is still kept in servicable condition.

The first phase of the new waterworks was completed in 1968, with a design capacity of 5 MGD (o.25 m^3/sec); its extension to the present capacity of 2o MGD (1 m^3/sec) followed the commissioning of the first phase almost immediately and was put into operation in 1974.

This far-sighted planning secured an exceptional position for Kano, where no major water shortage has occured in the last 12-15 years. From the early 197o's up to the present, the reserve capacity and almost uninterrupted supply, together with

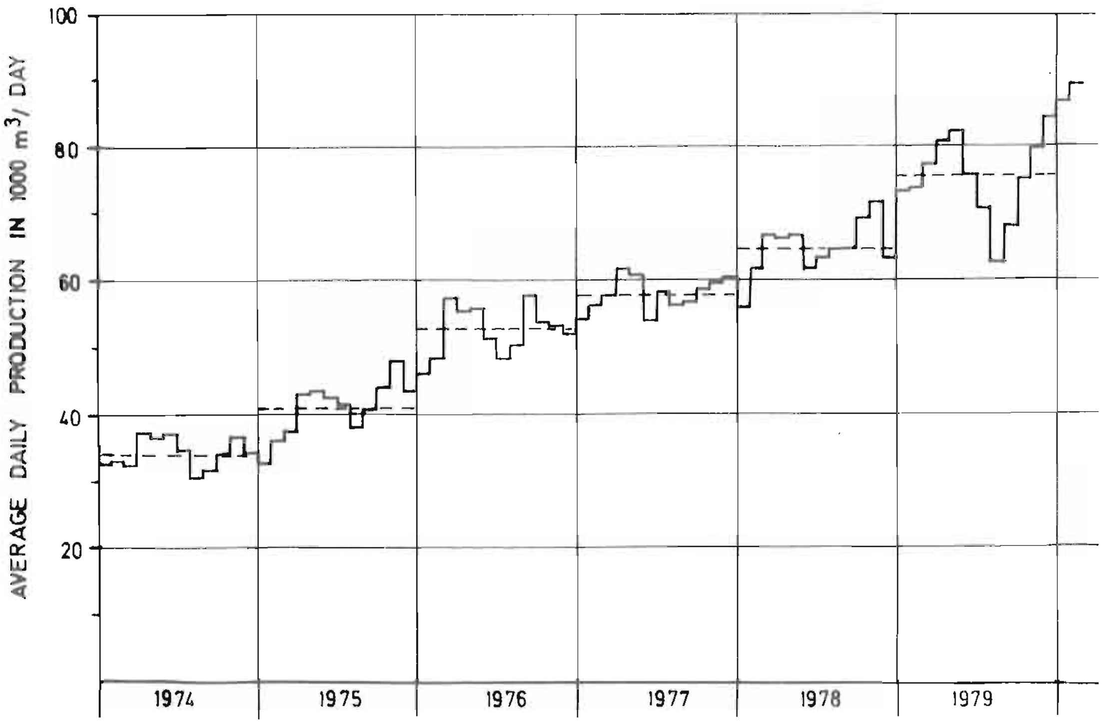

Fig. 1. Average daily production between 1974-1979

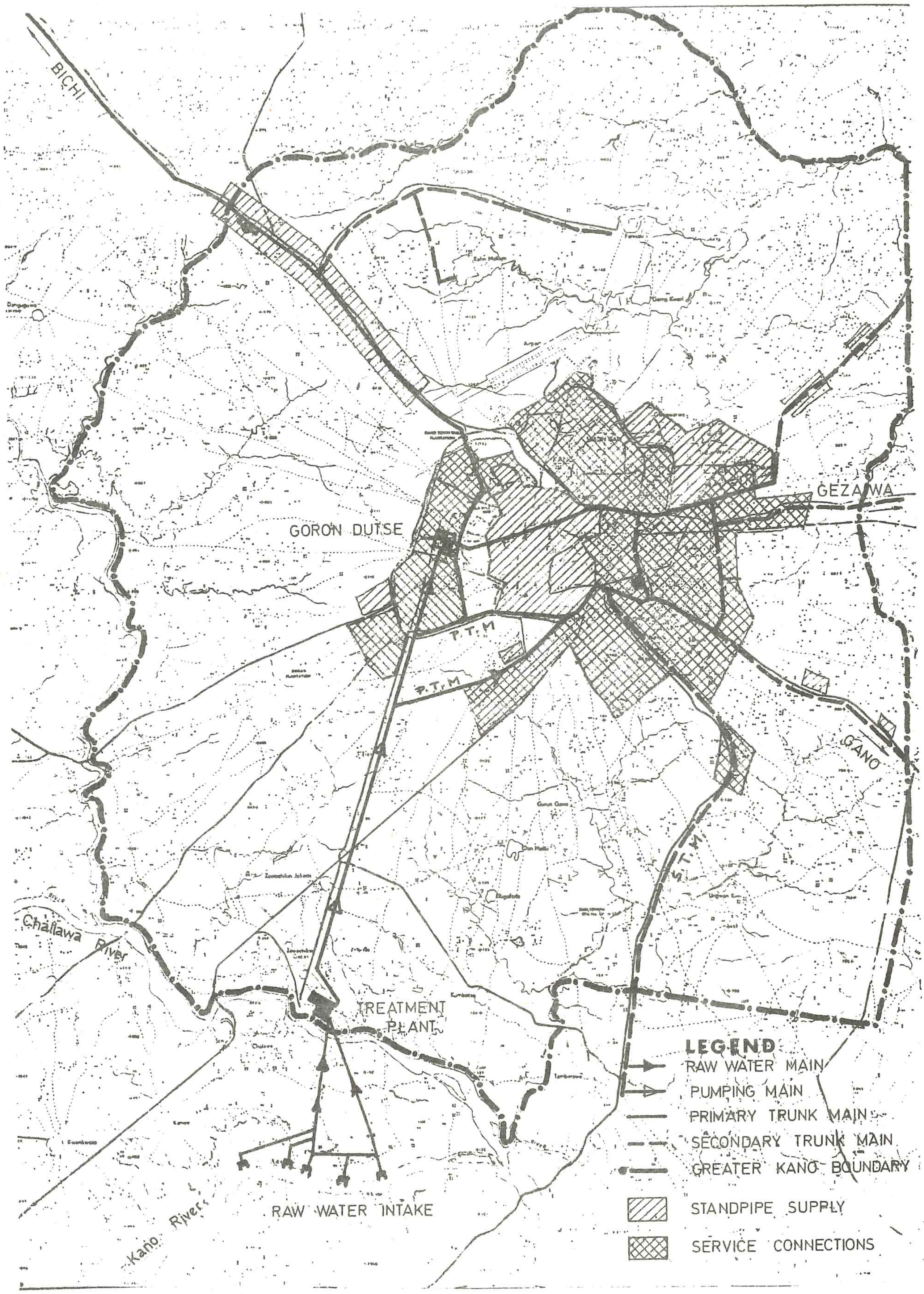

Fig. 2. General layout of the present water supply scheme of Kano. (Scale approximately 1:125ooo)

the other infrastructural development, attracted a rapid influx of industry.

With the production of water secured, in the late seventies more weight was given to the extension of the distribution network, the total length of which exceeds now 1ooo km and half of this was laid between 1975 and 198o. The diagram on Fig.1. shows the average daily production in the last six years.

Fig. 2. shows the simplified layout of the water supply system in Kano, indicating also the level of services in the areas supplied. The quality of the water has been maintained to the requirements of International Standards.

The raw water supply to the Old Waterworks was based originally on the Challawa river, while the intake of the new waterworks was situated on the River Kano. In the early stages the intake consisted of wells and tube-wells sunk into the alluvial river deposits. The specific yield of the intake was limited in the Challawa river, due to the fine, silty deposits. The much coarser sand in the Kano river ensured better specific yields. Extensive investigations and studies were carried out in the mid 196o's which proved that the seasonal recharge of the Kano river sand would not provide sufficient source for the new waterworks extension. The recognition of this led to the construction of the first major impounding reservoir, the Bagauda dam, built on a tributary of the Kano river. The carefully monitored release of water from this reservoir, providing a perennial flow between the outlet works and the waterworks'intake, ensured the necessary recharge of the river-bed deposits, with an approximate 15% loss along the river stretch. The same reservoir served as the source of water for the Kadawa Pilot Irrigation Scheme. In the future a small regional scheme can be based on this source.

With the construction of the Tiga Dam, impounded in 1974, the Kano-Hadejia-Yobe rivers have been transformed into a perennial river system which provides a virtually unlimited raw source for the Kano water supply system.

This solid base for the improvement and extension of the water supply services in Kano and the fact that the production has almost approached the design capacity of the plant made it imperative to find quick and economic solution for future expansion. The work was begun with the study of population and demand growth. This included the survey and study of

a/ present population densities in the various areas and districts;

b/ population growth in the specified areas;

c/ the spatial development of the town (planned and forecast - controlled and uncontrolled);

d/ extension of the distribution network to areas still without services;

e/ present and future levels of supply.

The discussion here is focused an Greater Kano, but planners and designers obviously face the same or similar problems elsewhere.

The national census undertaken in 1963 revealed a population of 467,5oo in the total Kano metropolitan area and 294,45o in the actual urban area. Present population estimates can be based either on the hypothetical figures of national growth factors, (2.5 percent as an average and 8 to 9 percent in the high density urban areas). Another approach is to carry out a physical population survey on selected sampling areas.

Such a survey was carried out within the scope of the Kano sewerage and drainage project by the Consultants G. HOLFELDER LTD., sponsored by the UNDP and the Kano State Government.

14 sample areas were selected where the population densities and sanitary conditions were recorded. The data, used together with the plans showing the present and projected (planned) future land use were compared with previous studies (Trevallian report, 1963; Chr. Becker, 1967; Traffic Analysis, 1973) and the actual population increases within given areas were evaluated. These results already include the migration factor.

The figures thus obtained show a population of 892,ooo for the total metropolitan area and 643,ooo for the urban area, and an average growth factor of approximately 5%.

Based on the Urban Development Plan, the most probable population density figures and the future land use maps, combined with the desirable level of services were used to prepare the water demand growth curve (Fig. 3.). The demand curve based on the UNDP report has been slightly modified taking two more factors into account:

a/ The rapidly growing, partially uncontrolled, ribbon type development along an approximately N-S axis, while the controlled development shows a more definite trend along an E-W axis;

b/ The water demands in other major settlements outside the metropolitan area but supplied from the Greater Kano Water Supply scheme. These settlements were not part of the sewerage and Drainage Project's study.

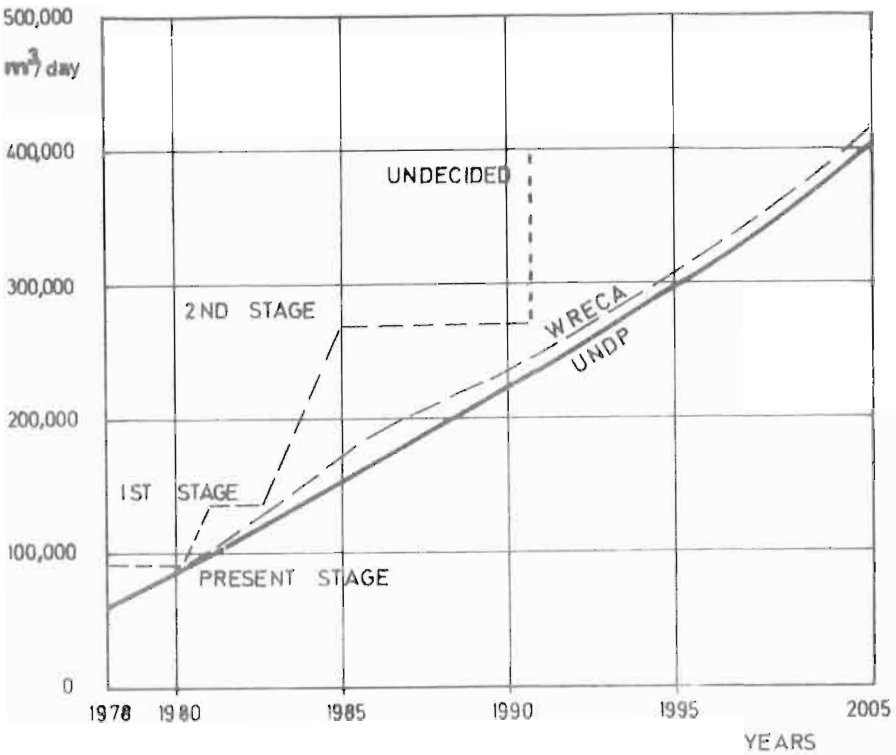

Fig. 3. Estimated water demand growth (net).

The per capita consumption in low density housing areas was suspected to be too high. Measurements were carried out in a sample area and it was found that consumption went beyond the looo l/capita/day figure. This is obviously unacceptable both at present and for future planning and specific measures will have to be taken to improve the metering, tariff-system and revenue collection in order to reduce the exorbitant consumption rates.

The present design capacity of the treatment plant, according to our analysis, can be uprated with minor modifications, almost to 3o MGD (1.5 m^3/sec) which is also the upper limit of the available pumping plant and transmission mains (including the new looo mm diameter main presently under construction).

The treatment plant is a traditional Paterson-Candy design, consisting of 24 No. hopper-bottom type vertical flow sedimentation tanks (clarifiers), 16 No. rapid gravity filters, 1 million gallon (45oo m) capacity clear water storage and adjoining pumping plant. The first stage of uprating will include the introduction of flocculant aids and the more proper admixing of chemicals (aluminium-sulphate and lime) to the raw water.

In the second uprating stage we intend to improve the flocculation process simultaneously with the clarification. To this end, one of the settling tanks will be modified and used as a 1:1 scale model.

Laboratory test results show that the use of coagulant aid (nonionic polymer) will greatly improve the settling properties of the floc, but adequate slow mixing and detention time is needed to improve the flocculation process. This is, naturally, in accordance with the findings and results of extensive research work and worldwide experience in this field.

The simple sludge blanket upflow clarifiers, though widely accepted and incorporated in a number of new treatment plants in Nigeria and elsewhere, are nonetheless considered in many quarters to be oldfashioned. Their advantage is that they are not too sensitive to fluctuations in flow (below their design capacity) and raw water quality. Thus, their operation is simple and does not require highly qualified staff.

With this statement we arrive at a very interesting and important question: what degree of sophistication is advisable and acceptable in the developing countries and specifically in Nigeria? Conditions may vary from place to place, but in author's opinion, the young generation of Nigerian engineers provides now a good and rapidly improving base to allow the application of new and more sensitive technologies. On the other hand, high degree of automation of plants for automation sake must be viewed circumspectly. It is not the more complicated or sensitive process, but the more complicated equipment that should be regarded with caution. The inflow of spare-parts and expertise needed for this equipment may cause more problems than a treatment technology more sensitive to fluctuating factors, but less dependent on automated processes would do.

The aim of this conference is not just to discuss treatment technologies in detail. However, it is well known that in the last one and a half decades a rapid development has taken place in the clarification process technology. Two basic concepts seem to compete: the ballasted flocs settling basins and the lamellar settling basins. Without discussing the advantages of these methods in this forum, I should like to call attention to the possibility of the wider application of the lamellar settlers - both in new plants and in the uprating of existing treatment works.

In the not very distant past, the meagre operational records and the difficulty of obtaining physical and chemical analyses did not provide sufficient base for the designer to choose the more efficient technology; the lack of local experience and the almost sole use of foreign designer consultants equally contributed to the "safe design" principle - resulting in indisputably well functioning, but very costly plants, as the investment cost to capacity ratio and construction time are concerned.

This is exactly the situation in the Kano waterworks. The rapidly growing demand must be met; the available time and funds are limited; the present treatment plant is of a rather conservative design.

Experience has shown that many plants can be uprated by the use of more advanced engineering technology. With carefully designed modifications, plant output can be increased manifold at minimum cost and with minimum disruption of the continuous operation.

In order to increase capacity the plant first must be hydraulically capable of handling a greater throughput. The relevant study, carried out by UMARU ABDULAZIZ, has shown that the conveyance capacity of the raw- and settled-water channels must be increased; the necessary modification is at present in the design stage, but - as anticipated - this creates actually more difficulties than the alterations in the treatment process itself.

The uprating of the rapid gravity filters is likewise possible, though it also means some changes in the piping system. Filter backwash at the present rate of flow takes place in 18-24 hours, based on the increased headloss in the filter media. Deterioration of the filtrate quality has not occured so far. The conservative filtration rate can easily be increased even three-fold, especially if the planned improvement of the settling-clarification process ensures that there would not be high floc "carryover" to the filters.

Extension of the treated water balancing tanks and new pumping plant cannot be avoided, but a gradual increase of the treatment capacity will be of great help to meet the growing demands within the limited time and funds available.

Last, but not least, the extension and reconstruction of the trunk-main and distribution systems including the storage capacity should be mentioned.

Fig. 4. shows the average daily fluctuation in the consumption. This curve was arrived at using actual flow measurements data at the treatment plant, below Goron-Dutse reservoir and at the only direct cross-connection from the high pressure pumping main to the system, supplemented with the water level fluctuation data in the storage tanks.

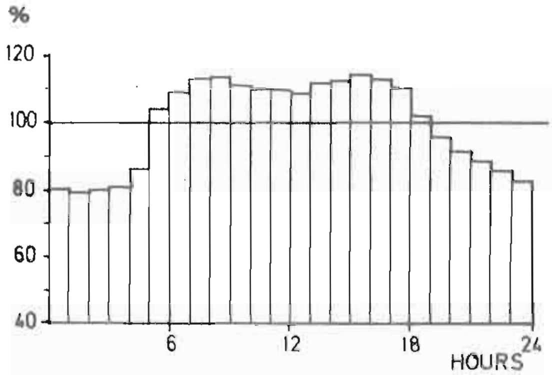

Fig. 4. Average daily fluctuation of consumption

This curve shows a remarkable character: the level of consumption was shown to be far more even than anticipated. Consequently, less than 4o% of the storage capacity has been utilized, except on a few occasions when pumping was interrupted due to the failure of power supply. The pump operators can follow the demand fluctuations very closely, based on the telemetric recordings of prevailing water levels in the storage tanks.

The total storage capacity in the distribution system is lo MG (45ooo m³); i.e. cca. 5o% of the daily total production. This capacity at present can be regarded as more than sufficient, but the question is, what should be the total daily consumption/storage ratio in the future.

The topographycal situation does not allow the further extension of the high level Goron-Dutse tank. The previous planning made allowance for a large low level tank at the bottom of Goron-Dutse and another pumping station to lift the total amount of water to the hilltop tanks, from where the whole system was supposed to be gravity fed. Detailed network study was completed for this concept, demanding very large diameter ring and radial maine in the network, in order to maintain the required pressure in the entire system.

Another study is under way now, in which the reliability of the power supply versus total storage is going to be looked into, as the basic question. With the present and future pumping stations at the waterworks, the demand fluctuation can be closely followed. The more reliable the power supply from the national grid, the less total storage and standby capacity is required. The previous concept would require two standby stations - at the waterwork and at Goron-Dutse. Changing the philosophy of the supply, /1/ pumping directly into the system at 2 or more points, /2/ using the existing storage facilities entirely as balancing tank, /3/ one standby generating station at the waterwork and /4/ the possible reduction of the ringmains diameter seem to result in less capital costs, even with the construction of more elevated water tanks at strategic points in the distribution system.

The surprisingly even consumption pattern in 24 hours may be contributed to two causes (high losses [waste] in the distribution network and a large total capacity of storage facilities in the industrial and domestic consumer sector). The provision of extra storage in the industrial sector should be further encouraged, thus reducing the requirement of storage in system, the usual domestic tanks on the other hand, can always be a source of pollution at the consumers' taps and should be avoided as much as possible from the public health point of view.

The greater Kano water supply system will ultimately cover an area of 3o km radius and additional other towns and villages even beyond this distance. It should be regarded as a sizeable regional water supply scheme, providing water to a large suburban and rural area as well. In a long-term programme this system can be connected to neighbouring water schemes based on other sources, like the new dam-reservoirs along the GWARZO Rd, the WATARI Dam near Bagwai and Bichi and a wholly integrated system can be developed. However, individual, smaller water supply schemes can be built in the north-eastern part of Kano State, based on the aquifers of the Lake Chad formation.