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Water Production Potentials of Present Enugu Water Supply Facilities

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Abstract

Enugu metropolis has been growling under acute scarcity of water supply for many decades. Majority of the residence rely solely on water vendors who source their water at 9th Mile Corner, about 8km away from Enugu using water tankers. This study found out that the three functional water production facilities of Ajali water scheme, Oji River and Iva valley schemes are working at `15% installed capacity, having a combined production of 20,000m^3/day of water. The rehabilitation of Ajali, Oji River and Iva valley water schemes to work at 100% installed capacity and the revival of "crash programme borehole" water scheme, Amechi Awkunanaw water project, Ajali Phase 2 and Iyioku water scheme would provide a combined capacity of 281,500m^3/day which is sufficient to take care of the future demand of 228,760m^3/day in 2041.

1.0. Introduction

Adequate water supply is central to life and human development, and of the five basic human needs (water, food, health, education, peace) water is a common factor to the other four [1] [2]. Water is a very important factor in settlement development and determines population growth as well as influences world health and living conditions [3] [4]. Nigeria is blessed with abundant water resources estimated at 226 billion m^3 of surface water and about 40 billion m^3 of ground water. However, Federal Ministry of Water Resources noted that out of the 85 million people living in urban and semi-urban areas in Nigeria, less than half have sufficient water supply [5]. It is worth noting that despite the fact that Nigeria is one of the signatories to the United Nations International Drinking Water Supply and Sanitation Decade whose objective was to supply water to all citizens of the country between 1981 and 1990, and in spite of the efforts of various Governments at all levels, the water supply coverage in the country appears to be decreasing and deteriorating [6]. One of the reasons for this deterioration according to [7] is the enormous socioeconomic rate of development which far outstrips the level of water supply development. Other reasons include low investment level in operation and maintenance which accounts for frequent breakdown of the production facilities, and lack of proper management of the nation's water resources. [8] [9] [10]. This research, therefore, investigates the possibility of providing adequate water supply for the future population of Enugu metropolis up to the year 2041 from the existing water schemes.

2.0. Methodology

Enugu city encompasses three Local Government Areas (LGAs), namely; Enugu East, Enugu North and Enugu South. Enugu North lies wholly within the metropolis while sections of both Enugu East LGA and Enugu South LGA stretch beyond the built-up confines of the city.

Data collection for this project started with a site tour of the existing water supply and production facilities in Enugu metropolis in the company of representatives of the Ministry of Water Resources, Enugu State Water Corporation and other parties involved in the project. The following schemes were visited.

i. Ajali Water Treatment Plant
ii. Oji River Artesian Boreholes Water Supply Scheme
iii. Crash Programme Borehole Scheme at Ninth Mile
iv. Iva Valley Water Supply Scheme
v. Amechi Awkunanaw Water Supply Scheme, and
vi. Ekulu Pottery Water Supply Scheme

At each scheme, the following data were noted, where available:

1. Type of plant
2. Geographic (GPS) location of the scheme
3. Design production capacity
4. Current production capacity
5. Current production status and constraint
6.

2.2. Demographic and Water Demand Studies

Population data for Enugu collected from various sources all based on the 2006 National Population Census, show by projection that the population of Enugu is about 930,000. This projection is based on normal statistical projection of annual population growth rate of 3 percent per annum. However, a general overview of the population growth trend in Enugu seems to suggest that recent events in the country have given rise to massive movement of people into the city, a fact that becomes evident from the rate of expansion of development of residential accommodation in the city particularly on the outskirts to the north and east flanks of the city. It was therefore considered that some amount of demographic studies was necessary in order to obtain more reliable data to be used in carrying out hydraulic design calculations on this project.

2.3. Field Work

The methodology used for the estimation of the population comprises the following;

i. Delineation of border between the different urban communities

The following urban communities as listed hereunder were physically surveyed and their borders with each other delineated. It is note-worthy to mention that information obtained from Enugu North Local Government Town Planning Authority assisted us tremendously during the delineation of these boundaries between communities. The identified communities are as follows:

a. Independence Layout
b. GRA
c. Ogui
d. New Layout
e. Achara Layout
f. Uwani
g. Coal Camp
h. New Haven
i. Trans Ekulu
j. Awkunanaw
k. Maryland
l. Asata
m. Abakpa
n. Emene
o. Ibagwa Nike
p. Amorji Nike

ii. Classification of Buildings

Three different types of buildings in different areas were sampled randomly in order to determine an average estimated population of persons per building. After sampling, it was observed that this average estimated population varied from community to community. Then all different types of buildings within Enugu metropolis were counted and data obtained were used to estimate the population accordingly.

The buildings were classified thus;

i. Bungalows in rooms, flats and self contained.
ii. Storey building in rooms, flats and self contained.
iii. 2 Storey building in rooms, flats etc
iv. 3 Storey building in rooms flats etc
v. Above 3 storey building in rooms, flats etc
vi. Shops
vii. Churches
viii. Mosque
ix. Hospitals
x. Schools
xi. Barracks

2.4. Water Demand Calculations

Enugu Metropolis is a well developed urban settlement and the estimation for water demand will be derived from the population that has now been established from site survey in accordance with the National Water Supply and Sanitation Policy as set out by the Federal Ministry of Water Resources in the year 2000. The recommendations of this policy are as shown in Table 1.

Table 1: Categories of Water Consumption Rates

Category	**Population**	**Water Demand (lpcd)**
Rural Areas	Up to 5,000	30
Semi-Urban Areas	5,000 – 20,000	60
Urban Areas	20,000 and above	120

NB: lpcd = litres per capita per day

Enugu being an urban settlement, the water consumption rate of 120 lpcd is used for estimation of water demand. However, a look at Table 2 will reveal that some structures like shops, banks, shopping plazas and schools are included in the list of occupied structures. The water demand pattern in these structures differs significantly from the recommended rates in Table 1 since water is used here for lesser chores such as drinking, washing of hands and flushing of toilets and, therefore, water usage is much less than in a residential building where water usage includes bathing, car wash, cooking etc. A spreadsheet was used to calculate the resulting total water demand. Table 2 shows the range of values used in the population and water consumption estimates.

Table 2: Population Occupancy Used in Survey Results

S/No	Structure Type	Occupancy Range	Consumption (lpcd)
1	Bungalow	5 to 7	As in Table 3.3
2	Two Storey Building	10 to 15	ditto
3	Three storey Building	16 to 20	ditto
4	Above three storey Building	20 to 25	ditto
5	Hotels	20 to 50	ditto
6	Shops	3	10
7	Banks	50	10
8	Shopping Plaza	20 to 50	10
9	Schools	500	10
10	Churches/Mosques	10 t0 20	10 - 20

Notes:

1. Occupancy in churches/mosques is taken as permanent resident persons in the premises (excluding worshippers)
2. Water consumption in shops, nanks, schools and commercial places is estimated at 10 litres per capita per day (lpcd) to cover basic needs for drinking and personal hygiene during the day

3.0. Results and Discussion

The existing operational water production facilities include the following:

1. Ajali Water Treatment Plant (77,000 m^3 per day)
2. Oji River Artesian Scheme (50,000 m^3 per day)
3. Iva Valley Scheme (4,500 m^3 per day)

These plants have a combined design capacity of 131,500 m^3/day. However, the present total combined actual production capacity of these plants is about 20,000m^3/day representing only 15% capacity utilization. Various reasons have been given for this state of affairs, among which are Broken down pumping equipment, lack of adequate public power supply and high cost of diesel which has negated effective usage of available stand-by power generating sets. [11] [12][13].

In addition to the above water production facilities, the following three plants are potential sources to augment water supply to the city:

i. "Crash Programme" Borehole Scheme at Ninth Mile (18,000 m^3/day). This scheme was once operational but it has been vandalised over the years. In its full design state, this facility consisted of twelve (12) boreholes, a pump house and a generator house. The scheme is in a prolific aquifer zone but its main handicap is the ever present threat of vandalism that has continued to scuttle its viability.

ii. Amechi Awkunanaw Scheme (25,000 m^3/day**).** This scheme is under construction (funded by the Federal Government through Anambra-Imo River Basin Development Authority). Construction activities had been halted at the time of carrying out these studies reportedly due to funding constraints.

This scheme derives its source from a concrete dam on Inyama River situated high up in the Udi Hills and is designed to produce and send water to consumers by gravity (without any mechanical pumping requirement). If and when completed, this scheme promises to be a reliable source of water supply to the southern parts of Enugu Metropolis.

iii. Ekulu Pottery Water Treatment Plant

This plant is defunct. Its location is approximately at (E329234, N714745). It is a treatment plant designed to source water from Ekulu River via a River Intake Pumping Station. The raw water is delivered to a treatment works located about 700 metres away. [14]. All the mechanical and electrical components of the plant have long disappeared leaving only the civil structures which surprisingly appear to be in very good condition. Some of the civil components inspected were aeration tank, inlet chambers and clarifiers. The plant is said to have been abandoned after the building and commissioning of Ajali Water Treatment Plant [15]. Pertinent records in the form of drawings and design data for the plant were not available as at the time of this study.

Table 3 – Existing Water Production Facilities for Enugu

S/N	Scheme	Design Capacity (m^3/day)	Present Operating Capacity (m^3/day)	Comment
1	Ajali Water Scheme	77,000	7,000	
2	Oji River Scheme	50,000	11,000	
3	Iva Valley Scheme	4,500	2,000	
4	Crash Programme Scheme at Ninth Mile	18,000	0	Totally Vandalised
5	Amechi Awkunanaw Water Supply Scheme	25,000	0	New project started in 2007 under construction by Anambra-Imo River Basin Dev. Authority. Construction on hold due to funding constraint.
6	Ekulu Pottery Water Supply Scheme	Not known	0	Dilapidated plant. The plant has been stripped bare of all mechanical, electrical components and pipe work.
	TOTAL	**174,500**	**20,000**	

3.1. Population Growth and Water Demand

The results from the population survey and water demand calculations show that the present and future population/water demand status using linear population projection method of 3% growth rate for duration of 25 years is as follows:

$P_1=P_0\ (1+\gamma)^t$

Where; P_1= Projected population, P_0= Base population or the starting point of estimation γ = Growth rate, t = time interval.

Table 4: Population Survey Results and Water Demand Calculations

												2016		2041	
'NO	POPULATION CENTER	Bungalows	2 Storey Bldg	3 Storey Bldg	Above 3 Storey Bldg	Shops	Hotels	Banks	Shopping Plaza	School	Church/ Mosque	Total Population	Water Demand (m3/day)	Population	Demand (m3/day)
1	Independence Layout	991	1,071	79	41	37	23	6	9	25	11	32,425	2,546	67,891	5,331
2	GRA	708	713	49	19	228	5	25	13	26	13	27,828	1,755	58,266	3,675
3	Ogui	745	331	127	28	126	6	25	13	6	6	18,488	1,711	38,710	3,582
4	New Layout/Obiagwu	1,297	739	287	42	484	3	2	3	11	18	34,306	3,389	71,829	7,097
5	Achara Layout	290	430	1,036	374	266	5	10	1	24	37	52,338	4,936	109,584	10,334
6	Uwani	1,018	1,174	399	66	346	1	3	1	16	13	43,724	4,314	91,548	9,033
7	Coal Camp	2,548	746	351	132	566	2	7	3	15	21	49,204	4,923	103,022	10,307
8	New Haven	1,618	1,576	784	212	469	17	2	15	17	18	66,773	6,964	139,808	14,581
9	Trans Ekulu	4,434	4,637	578	190	1,665	20	4	23	34	53	140,488	14,537	294,151	30,436
10	Awkunanaw	7,260	2,173	1,841	1,417	2,687	6	2	1	68	147	199,431	19,632	417,564	41,105
11	Maryland	550	608	680	245	520	3	0	2	5	16	37,015	4,016	77,501	8,408
12	Asata	471	231	59	33	158	5	8	13	3	9	11,591	1,116	24,269	2,337
13	Abakpa	8,920	4,655	2,667	604	4,646	13	2	11	118	146	275,683	25,614	577,219	53,629
14	Emene	6,196	2,892	864	31	2,023	4	2	5	40	89	132,046	13,156	276,475	27,546
15	Ibagwa Nike	564	57	26	0	20	0	0	0	1	0	5,883	649	12,318	1,360
	TOTAL	**37,610**	**22,033**	**9,827**	**3,434**	**14,241**	**113**	**98**	**113**	**409**	**597**	**1,127,223**	**109,257**	**2,360,155**	**228,760**
RESENT STATUS (2016)															
	Population	259,872	321,575	196,028	85,550	42,723	3,000	4,900	2,920	204,500	6,155	1,127,223			
	Consumption Rate (lpcd)	120	120	120	120	10	120	10	10	20	120				
	Demand (m^3/day)	31,184.64	38,589.00	23,523.36	10,266.00	427.23	360.00	49.00	29.20	4,090.00	738.60	109,257.03			
ROJECTED STATUS (2041) - 25 YEARS															
	Population Growth Rate at 3 % per annum														
	Population	544,114	673,307	410,439	179,123	89,452	6,281	10,260	6,114	428,178	12,887	2,360,155			
	Consumption Rate (lpcd)	120	120	120	120	10	120	10	10	20	120				
	Demand (m^3/day)	65,293.71	80,796.80	49,252.69	21,494.72	894.52	753.76	102.60	61.14	8,563.55	1,546.46	228,760			

Table 5: Population Growth and Water Demand Trend

Year	Population	Water Demand
2016 (present)	1,127,223	109,257
2041 (25 yrs)	2,360,155	228,760

It would be recalled that the existing water production facilities at Ajali, Oji River and Iva Valley have a total design production capacity of 131,500 m^3 per day. This shows that the existing three functioning water schemes have the potential capacity to satisfy present day (2016) water demand in Enugu metropolis. However, the capacity utilization of these plants have degenerated to an extent of producing only 20,000m^3 per day representing about 15% of the present total water demand. Thus, the total rehabilitation of the three Water Supply schemes at Ajali, Oji River and Iva Valley will produce enough potable water to satisfy the present water demand in Enugu metropolis for some years to come.

Table 2 above shows that the water demand in Enugu will double by 2041 (i.e. in 25 years time) to 228,760m^3 per day. It is therefore necessary to upgrade and/ or augment the existing plants in order to meet with projected demands.

In this regard, it is worthy to note as follows:

(a) Two potential sources of water, namely Crash Programme Scheme at Ninth Mile and the Awkunanaw Water Supply Project can together produce additional 43,000m3 of water daily raising the total production potential to 174,500 m^3 per day.

(b) The design of Ajali Water Treatment Plant includes a second phase of development to double the plant capacity with additional 77,000m^3 per day.

(c) There is a proposed Iyioku Water Supply Project which is expected to contribute 30,000 m^3 per day to the water needs of Enugu metropolis.

The above additional sources of water, when exploited, will contribute additional 150,000 m^3 per day, thus bringing the total potential water supply capacity to 281,000 m^3 per day. This amount of water will be sufficient to meet the water demand in 25 years (2041) and much beyond.

Table 6: Water Production Potentials in Enugu Metropolis

Water Source	**Design Capacity (m3/day)**	**Present Operating Capacity (m3/day)**
Operational Plants		
1. Ajali Water scheme	77,000	7,000
2 Oji River Scheme	50,000	11,000
3. Iva valley Scheme	4,500	2,000
Total	131,500	20,000
Potential Additional Plants		
4. Crash Programme scheme at Ninth Mile	18,000	0
5. Ajali Water Scheme (Phase 2)	77,000	0
6. Amechi-Awkunanaw Water Scheme	25,000	0
7. Iyioku Water Scheme	30,000	0
Total	150,000	0
Ultimate Total	281,500	0

4.0. Conclusion

The existing and functional water production schemes would have met the present water demand of Enugu metropolis if they were functioning at optimum capacity. Unfortunately, these facilities are working at 15% installed capacity. There is a huge potential to meet up with the future water demand of 228,760m^3/day in year 2041 when the existing schemes are rehabilitated to work at 100% installed capacity in addition to the revival of other abandoned water production facilities. A total of 281,500m^3/day will be available to the consumers which is more than the projected demand of 228,760m^3/day.

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