WATER SUPPLY OPTIONS TO UNIVERSITY CAMPUS SYSTEM: A CASE STUDY OF THE UNIVERSITY OF AGRICULTURE, ABEOKUTA.

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ABSTRACT

Water is one of the most valuable natural resources vital to the existence of any form of life and adequate supply of it plays a decisive role in the success of many activities to promote human welfare and economic prosperity.

Lack of water supply has always been identified as one of the immediate causes of disturbances in University campuses. Such shortages are often attributeable to inadequate design arising from faulty projections in respect of the population of the University community at the maturity stage of the University.

The University of agriculture, Abeokuta (UNAAB) represents the first set of specialised Universities in Nigeria and by the nature of its mandate, particularly as it affects crop irrigation and animal husbandry, water should not be allowed to be in short supply.

This paper attempts to highlight the factors relevant to adequate design of water schemes in a University campus system. The water supply potentials vis-a-vis the estimated demands are identified and options to adequate supply of the total water requirement proferred for UNAAB.

1.0 INTRODUCTION

The supply of potable water to any community is a social service expected to be provided by Government and in the absence of adequate supply, a large proportion of the citizenry satisfy their needs from sources that are in most cases a vehicle for the transmission of diseases.

Adequate supply of treated water is very expensive and most Universities, because of scarce financial resources, depend on the municipal supply that is usually inadequate for the communities served. Other sources of water are, therefore, often sought to supplement the supply from the municipal source. Figure 1 shows the University locations in Nigeria.

Inadequate supply of potable water is usually one of the reasons for student demonstrations in institutions of higher learning in Nigeria. These demonstrations start on a peaceful note but soon turns so violent that attempts by law enforcement agents to quell them usually lead to fighting sometimes resulting in the death of students and law enforcement agents alike.

For the sustenance of good health of the University Community and in the interest of peaceful development of these institutions in Nigeria, adequate supply of potable water to them should be given serious attention. This paper therefore attempts to highlight the water supply potentials of the University of Agriculture, Abeokuta, and suggests the options open to it for adequate supply of the water requirements of this institution.

2.0 LOCATION OF THE UNIVERSITY OF AGRICULTURE, ABEOKUTA (UNAAB)

The University of Agriculture, Abeokuta (UNAAB) is one of the two Universities of Agriculture established in the country in January 1988, by the Federal Government. It has a mandate to give academic direction and leadership to Nigeria's agricultural development programmes. The other University of Agriculture is sited at Makurdi. UNAAB is geographically located between longitudes 3° 21' and 3° 23' east and latitudes 7° 21' and 7° 18' north and covers an area of 9,700 hectares. The land is bounded partly by the Abeokuta-Opeji trunk B road, the Osiele-Alabata trunk B road and River Ogun. The headquarters of the Ogun/Oshun River Basin Development Authority (OORBDA) on Alabata Road shares a part of its boundary with UNAAB. Figures 2 is a sketch of the University site and other Abeokuta land uses.

The University site is compact and irregular in shape. It is located about 14km north-east of the Abeokuta city centre. The land is well drained by rivers and the annual rainfall in the area is 1400 millimetres. The topography is a rolling one with few highlands. The lowest elevations of 57 metres above sea level are found in the west where River Tigba/Ajigbayin enter the Ogun river after which the land rises rather irregularly eastwards to a peak of 180 metres above sea level. Vegetation changes gradually from the deciduous forest type in the east to the savannah type in the west.

3.0 POTENTIAL WATER DEMAND

Water is required for domestic and recreational needs of both residents and day-time population and also for agricultural purposes including irrigation of crops, animal husbandry, fisheries, parks and gardens, and in the operation of machinery.

3.1 Water Standard

It is important that water to be used in the home should be safe for drinking, free from colour and turbidity and should have no unpleasant odour or taste.

Although, most animals seem to be able to use water considerably poorer in quality than would be considered satisfactory for human beings, water to be used by stock is still subject to the quality limitations of the same type as those relating to the quality of drinking water for human consumption. Water for stock is, in this report, considered to be potable for the best growth and development of the animals.

The standards required for the water used for irrigation are less stringent than those of potable water. Untreated water from rivers, boreholes and or liquid effluent from the sewage treatment plant can be pumped into a separate pipe network to supply the irrigation water demand.

3.2 Domestic

This is water provided in households for sanitary and culinary purposes. The 1989 student population, 1245, is expected to increase to an optimum of 5,000 by the year 2000 at an annual growth rate of 15% approved for the University by the National Universities Commission (NUC). The projected population of the University community by the current NUC standards on student/staff ratio is given in Table 1.

As the NUC standards allow for 400 and 100 litres per capita per day for residents and day-time population respectively, the domestic water requirement at optimum population can be obtained as follows:

On-Campus population requirement = 4859 x 400

= 1,943,600 litres per day

Daytime population requirement

= 464,400 litres per day = 4644 x 100

Other requirements that may be considered under this category include:

Laboratory, Workshops and Sports Field -

400,000 litres per day

Swimming Poll (Water renewable once a week) -

45,000 litres per day

Water storage required for fire fighting which is 25,000 litres per minute for 4 hours, i.e. 600, 000 litres. This is to be provided in an elevated tank with separate network.

3.3 Animal Husbandry

There are plans to have 500 each of cattle, sheep, goats and rabbits, 250 pigs, 2,000 broilers and 5,000 layers. The total water requirement for this purpose can be obtained as follows:

Requirement of 500 herd of cattle at	
25 litres/day	= 12,500 litres/day
Requirement of 500 flock of sheep at	
10 litres/day	= 5,000 litres/day
Requirement of 500 goats at	
10 litres/day	= 5,000 litres/day
Requirement of 500 rabbits at	
1 litres/day	= 500 litres/day
Requirement of 250 pigs at	
12 litres/day	= 3,000 litres/day
Requirement of 2,000 Broilers at	
3 litres/day	= 6,000 litres/day
Requirement of 5,000 layers at	
2 litres/day	= 10,000 litres/day
Requirement per day for the Livestock	
Processing Unit including dairy houses	= 10,000 litres/day
TOTAL	52,000 litres/day

3.4 Irrigation

The University's Master Plan assigns 70 per cent of the total 9,700 hectare land for agricultural facilities and it is anticipated that about 20 per cent of this allocation will be utilised for irrigation cropping, nursery for horticulture and orchard. If 50,000 litres of water is required for irrigation per hectare per day of the dry months of the year (6 months), the water required to be stored during any raining season will be 12.2×10^9 litres.

3.5 Fisheries

It is anticipated that a 7.6 hectare fish farm complex consisting of nursery ponds, productive ponds, hatchery unit and a demonstration pond will be established. The reservoirs will be stocked with various species of fishes and will also serve for sport fishing. An estimated 80×10^6 litres of water will be required. This need not be specially provided for as water in the fish ponds can be obtained or renewed during the wet seasons.

3.6 Total Water Demand

From the above details, the estimated amount of potable water required for domestic use and for animal husbandry is 3.5×10^6 litres/day or 1240×10^6 litres/year, while the water required for irrigation in a year is 12.2×20^9 litres. Water required for fisheries, 80×10^6 litres, could be obtained during the wet seasons and need not be taken to be part of the water to be sought for storage.

4.0 WATER SUPPLY IN ABEOKUTA TOWNSHIP

River Ogun, through its tributary, the River Oyan, is the main source of raw water supply to Abeokuta and environs. A dam built across it by the OORBDA controls the downstream flow of water when necessary during the dry seasons.

Raw water is abstracted into a treatment plant from an intake structure located about 16 kilometres downstream of the dam site. Treated water goes into a clear water tank from where it is pumped into elevated storage reservoirs located on the Asaran hills at an elevation of 152.7 metres above sea level.

These storage reservoirs are two in number, each of 22.5 million litres capacity. The water supply system was completed by the Ogun State Water Corporation in 1988 and has a capacity of 162 million litres of potable water per day with provision for expansion to 216 million litres. Three booster stations are located at Adatan, Osiele and Aiyetoro road to pump water to specific areas of the town that cannot be serviced by gravity from these reservoirs. The booster stations are themselves fed through pipe connections from these reservoirs.

The Nigerian Institute of Social and Economic Research (NISER), Ibadan, estimated the population of Abeokuta to be 500,000 in 1988 and the amount of potable water in supply then was 43.5 million litres per day. Assuming a conservative annual growth factor of 5% and applying the World Health Organisation (WHO) water requirement standards of 100 litres per capita per day, the water demand for Abeokuta will be 90×10^6 litres per day by the year 2000.

The Abeokuta water supply scheme is therefore capable of producing almost double the amount of potable water that would be required in the year 2000. However, although there is adequate water to satisfy all needs in Abeokuta, some areas at present experience shortages due to inadequate distribution networks.

5.0 WATER RESOURCES POTENTIALS OF THE UNIVERSITY SITE

Streams, rivers and groundwater are the potential sources of water at the University site.

The rivers that drain the site include Ofu, Papa and Oshun which join to form a single river before leaving the site to discharge into Rivers Ogun, Ajigbatun and Alakata which also join before flowing out of site, Pala, Oshinko and Arakanga. Figure 3 shows the rivers/streams on the site. Some streams have no appellations and have been identified in this figure as A, B, C, D, E, and F. All the rivers/streams, except Arakanga, have their sources within the site. Arakanga has part of its catchment area outside the university land and also flows into the headworks of the Abeokuta Water Supply Scheme.

5.1 Rainfall

There is no rainfall data for the site and for this reason, data from the Headquarters of the OORBDA has been assumed in this report to be representative of the rainfall pattern of the site as the two sites are contiguous to one another. Table 2 below is the rainfall data for the Headquarters of the OORBDA.

Quantity of run-off depends upon a number of factors including the amount and intensity of rainfall, climate and vegetation and the geological, geographical and topographical features of the area under consideration. It usually varies from about 20% in arid and sandy areas where the rainfall is scarce to more than 50% in rocky regions where rainfall is heavy. Of the remaining portion of rainfall, some of the water percolates into the ground and the rest is lost by evaporation, transpiration and absorption. Groundwater is that portion of the surface water which has percolated into the earth to form underground deposits called aquifers.

5.2 Groundwater Prospecting

Of all sources of water, groundwater is usually the most practical and safe, although it is often high in mineral content.

The University site is on a Basement Complex and the dominant rock types are igneous and metamorphic. Large scale groundwater development would, therefore, require extensive geophysical studies to locate water bearing aquifers.

The nearest borehole to the site was sunk in 1981 at the Headquarters of the OORBDA. The borehole is 37 metres deep and has a yield of 4,500 litres/hour. Another borehole sunk in 1983 at the Federal College of Education, Osiele (See Figure 2) has no record of depth and yield.

5.3 Surface Water Development

It is possible to impound water in all the streams that flow on the site for the total or partial water requirement of the University. Normally, the amount of water reaching a reservoir site depends on the amount of rainfall, the size of the catchment area and the proportion of rainwater which runs off the ground as distinct from that which soaks in or which is returned to the air in evaporation. Many methods are often used for the determination of run-off. However, because of inavailability of required data, only the daily variation of rainfall intensity have been studied and 40% rainfall used to determine the quantity of water that could be reserved by a dam on that site.

Also, the determination of a dam site requires considerable topographical and geological studies, most of which are not readily available. Non-geological factors are therefore considered in the preliminary assessment of the different rivers/streams for purposes of this report. These factors include distance from the area to be served, altitude, area of catchment and amount of rainfall earlier indicated. Geological investigations such as the proportion of the runoff and percolation of the catchment areas, dangers of leakage of reservoir and foundation of the dam will be required when the dam sites are being finally determined. Some information about the rivers at the site are given in Table 3.

The construction of a dam is a very expensive project. If the total water requirement of the University were to be met from only one dam on account of cost, the approximate reservoir capacity would be about 17×10^9 litres, estimated as follows:

Total Water Requirement =	13.44×10^9 litres
Assume 15% as reservoir dead storage =	2.02×10^9 litres
Totak =	15.46×10^9 litres
Assume 10% evaporation =	1.546×10^9 litres
Total reservoir capacity to guarantee required water =	17×10^9 litres

The nearest dam to the University is at the Headquarters of the OORBDA. The multi-purpose earth dam which was completed in 1982 has a catchment area of 180 hectares and a storage capacity of $.630 \times 10^9$ litres. This is a small capacity dam as far as the water requirement of the University is concerned.

From figure 3 and Table 3, it is obvious that Oshinko, Ola/Alakata, Pala, A/F, B, C, D and E have relatively small catchment area and could only service localised irrigation/fisheries projects. Arakanga has its source and hence part of its catchment area outside the University site. Control and pollution are therefore possible although the stream has the

best location for reservoir citing in terms of the topography and also has a large dam surface area estimated at about 650 hectares. Although Tigba/Ajigbatun appears to have an advantage over Papa/Ofu/Oshun because of (a) its larger catchment area, (b) its being on a generally higher elevation and (c) its nearness to the southern boundary line of the University along which pipeline could be laid to the campus core, the two rivers have to be further investigated to ensure that the one to be selected for dam construction.;

(a) has enough water to fill the reservoir.

(b) can store the maximum quantity possible with the smallest dam practicable

(c) has suitable dam location where it will have a sound foundation and an impervious reservoir and where good construction materials are available

(d) has suitable dam location where the water stored can be put to the best use.

6.0 WATER SOURCES OPTIONS TO UNAAB

The present Abeokuta Water Supply Scheme produces 162 x 10^6 litres of potable water per day and is expandable to 216 x 10^6 litres. Also, the projected potable water requirement of Abeokuta for the year 2000 has earlier been estimated to be 90 x 10^6 litres per day. The Abeokuta scheme should readily meet the University's total water requirement of 13.44 x 10^9 litres per year except that it would be economically wasteful to use potable water for irrigation purposes. The scheme could therefore be considered for the supply of the potable water component, 3.5 x 10^6 litres/day, to the University. Figure 4 shows the location of the University land, the Abeokuta Water Supply Headworks and the Asero Booster Station. The intake structures of the present Abeokuta Water Supply Scheme is built at the river bank and house the trash racks, band screens and 4 No low-lift pumps capable of lifting 2 x 10^6 litres of water per hour to a manometric head of 35 metres. Water is then pumped through a 1000mm diameter raw water main into the treatment plant. Considering the elevation of the headworks relative to those at the University, it is possible to lift raw or treated water from the headworks straight to the central core of the University.

The other options for water supply to the University are through boreholes, construction of dams and any combinations of these options.

6.1 Supply of Treated Water From The Municipal Source

It is unfortunate that despite the availability of sufficient treated water for supply to Abeokuta, there are scattered shortages of water in the municipality because of inadequate reticulation system. In the circumstances and to ensure adequate and reliable supply to the University, it is important to ensure that the trunk mains to be used are laid along the route that will pose minimum difficulties to the realisation of the University's objective. As can be see in figure 4, two routes are feasible; the Abeokuta-Ibadan trunk A road route and the Abeokuta-Opeji trunk B road route.

6.1.1 Supply Through Abeokuta-Ibadan Trunk A Road Route

Two water supply pipelines 350mm and 150mm diameters exist on the Abeokuta-Ibadan trunk A road between Adatan and Osiele. A booster station located at Adatan pumps 392m^3 of treated water per hour through a head of 128 metres to Osiele; 10 kilometres away from Adatan. This booster station is fed through pipe connections from the reservoirs on the Asaran hills located about 4 kilometres away. To service the University through this route, a new 6.5 kilometre pipeline to the campus core would have to be laid through the Alabata road and connected at the junction of Alabata and Ibadan roads to the existing pipelines on the Abeokuta - Ibadan road.. The estimate for the installation of a 300mm diameter pipeline including the construction of a 250,000 litres reservoir is 5.6 million. However,

(a) the actual number of consumers along this route is uncertain and for this reason, the true demand on the booster station is unknown. The amount of water that would be available to the University cannot, therefore, be ascertained particularly as water will get to the University only after all other consumers along the route from the booster station to the point of connection to the University would have had their needs.

(b) the potable water demand of the University, i.e, 3.5 x 10^6 litres per day is more than the total production of the booster station, i.e. 2.3 x 10^6 litres/day.

(c) the maintenance of the 14 kilometre pipeline from the Asaran hill reservoirs through the booster station to the connection point at Osiele/Alabata junction will constitute a difficulty because of the high vehicular traffic along the Abeokuta-Ibadan trunk A road.

It is possible to ensure that the water requirement of the University gets to it through this route if a separate 14 kilometres pipeline is laid for the University and a new booster station constructed. The estimate for the pipe-work and the construction of a 250,000 litre reservoir alone is 11.0 million naira. Another 1.5m naira is required for a new booster station. However, the difficulty of maintaining 14 kilometre pipeline in a heavily trafficked road remains.

6.1.2 Supply Through Abeokuta-Opeji Trunk B Road Route

The supply of treated water to UNAAB is possible directly from the gravity and pressure mains of the 2 No 22.5 million litre capacity reservoirs on the Asaran hills. The reservoirs are located 4.5 kilometres away from the northern boundary of the University on the Abeokuta-Opeji trunk B road. The topography is such that water could flow from the reservoir to the campus core by gravity. As there is no supply pipeline existing along this route beyond the location of the reservoirs, a 16.5 kilometer pipeline, 12 kilometres of which fall within the University will be required (see figure 4). The estimate for the pipe work including a 250,000 litre reservoir is 13.2 million naira. However, the few communities along this road between the location of the reservoirs and the University are likely to request to be serviced from the pipeline and this may lead to loss of pressure and possible inadequacy of supply to the University. To avoid this development therefore, a parallel pipeline could be laid to service these communities. The 4.5km length of pipeline is estimated to cost 3.3 million naira.

6.2 Supply of Independent Treated Water With Source Outside the University Land

The commissioning of the Oyan Dam made possible the availability of raw water all year round in River Ogun from where water is already being extracted by the Ogun State Water

Corporation for the Abeokuta Water Supply Scheme. The University could also have an intake structure and a treatment plant by the river bank and transport treated water through the pipeline envisaged to be laid on the Abeokuta-Opeji trunk B road for the municipal supply (see figure 4). The problems envisaged however are as follows:

(a) acquisition of land for the intake structure at the river bank

(b) security of intake structure, pump and treatment plants

(c) illegal connections to the pipeline outside the University land.

Apart from the disadvantages enumerated, this option is easy to manage because the pumping and the treatment works are located at the same site.

The estimate is as follows

	Naira
Intake Structure	2.2m
Treatment Plant (250,000 litres/hr)	12.8m
Stand-by Power Plant	1.3m
18.5 kilometre pipeline	13.5m
	29.8m

If this option is to be supplementary to the municipal supply, only 2 kilometre extension pipeline to the intake structure will be required and the revised estimate is 17.8m naira.

6.3 Supply of Untreated Water

Raw water obtained from River Ogun could be transported to the University for treatment through Opeji road. Although the supply of treated water from the municipal source along the route has been discussed above, the same pipeline cannot supply both treated and untreated water for health reasons. Hence, another pipeline has to be laid. Raw water could also be diverted from this pipeline within the University land to service irrigation projects. The problems anticipated are:

(a) acquisition of land for the intake structure at the river bank

(b) security of intake structure

(c) increase in number of personnel to man the pumping station outsider the University and the treatment works within the University

(d) communication between the pumping and the treatment works.

The estimate for this option is as follows:

	Naira
Intake Structure	2.2m
Treatment Plant (250,000 litres/hr)	12.8m
Stand-by Power Plant (2No)	2.0m
18.5km pipeline	13.5m
Total	30.5m

It is possible to convert the pipeline meant for the supply of treated water to transport raw water to the University. Two kilometre pipe length would be required for the desired connection from the trunk main to the intake structure. The estimate for this alteration is as follows:

	Naira
Intake Structure	2.2m
Treatment Plant (250,000 litres/hr)	12.8m
Stand-by Power Plant (2No)	2.0m
Pipeline	1.4m
Total	18.4m

6.4 Water Supply from Borehole

It is anticipated that like at the OORBDA, boreholes with a yield of 4,500 litres/hour can be sunk at the site. One hundred and twenty such boreholes operating for 8 hours a day would be required to satisfy the treated water requirement o 3.5×10^6 litres for domestic use and for animal husbandry only. An allowance of 25% has been made for resting pumps alternatively to prevent over-pumping and also to take care of losses and wastes.

Inter-connectable borehole fields are desirable and the distance between two boreholes should not be less than the circle of influence. If 2 borehole fields are assumed and boreholes are sunk at least 50 metres apart, a minimum land area of 24 hectares would be required for the fields.

The preliminary estimate for a 40 metre deep borehole using UPVC casing together with pump and 40,000 litre capacity ground storage tank is 150,000 naira. Total preliminary estimates are:

	Naira
120 Nos Borehole and associated pipe work	18.2m
Treatment Plant	12.8m
Stand-by Plant	1.3m
Total	32.3m

6.5 Construction of A Dam

The total yearly water requirement of the University is 13.44×10^9 litres and from Table 3, only River Tigba and its tributary, Ajigbatun, can meet this demand. As earlier indicated, however, two other rivers, Ofu/Papa/Oshun which can provide an estimated 9×10^9 litres of water and Arakanga which can provide an estimated 12×10^9 litres should join Tigba for further investigations for the selection of the best dam location.

The preliminary estimate for this option is as follows:

	Naira
Dam and intake works	18.8m
Treatment Plant	12.8m
Stand-by Power Plant	2.0m
Pipeline (average)	9.0m
Total	42.6m

The choice of the dam site will affect the total length of pipe work that would be required for water to get to the core of the University.

7.0 CONCLUSION

Supply of treated water to the University from the municipal source offers the least expensive option since treatment works will not be required. Although the estimate for the provision of water through the Opeji route (16.5m naira) is higher than the estimate through the Ibadan route (12.5m naira) supply from the Opeji route will be more reliable since water will get to the University by gravity directly from the reservoirs that service the whole Abeokuta township. The University may be short of water either when the valve is deliberately shut off or if there is no water in the reservoirs. However, although the pipe laid will be for the exclusive use of the University, illegal connections are possible but will in this case be limited to the 4.5km stretch laid in predominantly rural setting outside the University land.

The experiences of many Universities that depend or have depended on the municipal water supply suggest that total reliance should not be placed on this source because of the usually low efficiency of the Public Water Boards sometimes attributable to management problems and or insufficient government funding. The supply from the municipal source should therefore be for a short time or should at least be supplementary to another source that would be completely controlled by the University. This control is necessary to ensure that water estimated for actually gets to the University, in quantity and quality.

Supply from borehole fields is not advisable because of possible inadequacy of supply and the high unit cost of production. Also, there is the difficulty of high operational and maintenance skill and cost. Furthermore, extensive geophysical studies are still required to ascertain the quantity and quality of water that would be generated from this source.

The construction of an all-purpose dam is the most reliable option to ensure the delivery of the total water requirement of the University. The construction cannot be realised immediately even if funds are readily available because of the design studies that would need to be carried out. Measures that would lead to the construction of a dam should therefore commence immediately. If, however, the University cannot finance the construction of a dam, the most feasible alternative for achieving the total water requirement of the University is to pump raw water from an intake structure on River Ogun for treatment at the University.

ACKNOWLEDGEMENT

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TABLE 1 POPULATION PROJECTION FOR THE UNIVERSITY (UNAAB) COMMUNITY

	1989/90	1990/91	1991/92	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/200
Students Population	1245	1431	1646	1893	2178	2504	2880	3312	3808	4380	5000
Academic Staff	125	144	165	190	218	251	288	332	381	438	500
Senior Admin Staff	25	29	33	38	44	51	58	67	77	88	100
Senior Tech Staff	42	48	55	64	73	84	96	111	127	146	167
Junior Staff	249	287	330	379	436	501	576	663	762	876	1000
Senior Staff accommodated on campus	64	74	85	98	112	129	148	170	195	224	256
Junior Staff accommodated on campus	50	58	66	76	88	101	116	133	153	176	200
Students Accommodated on campus	415	477	549	631	726	835	960	1104	1270	1460	1667
Average Family size						7					
On-campus population	1213	1401	1606	1849	2126	2445	2808	3225	3706	4260	4859
Transient Population	1157	1330	1529	1759	2023	2326	2674	3078	3437	4068	4644

TABLE 2 OORBDA HEADQUARTERS RAINFALL

YEAR	MONTHLY TOTAL (mm)												ANNUAL RAINFALL (mm)
	J	F	M	A	M	J	J	A	S	O	N	D	
1986	2.1	67.6	71.3	97.1	166.4	175.3	295.8	31.2	181.5	116.5	5.9	0	1210.7
1987	0	34.4	68.2	37.4	127.7	100.5	212.1	289.6	256.2	96.5	0	1.9	1224.5
1988	1.3	40.2	72.1	214.2	216.5	298.4	201.3	102.1	301.6	76.1	43.6	8.7	1576.1
1989	0	0	94.5	206.5	164.1	212.6	179.6	128.8	96.9	117.2	22.4	0	1222.6
1990	0	4.9	5.2	128.4	146.2	226.4	338.5	74.9	187.1	101.5	10.7	112.3	1336.1
1991	6.3	111.1	109.3	118.2	170.4	81.3	273.5	127.5					
											Average		1314

SOURCE: Headquarters, OORBDA

TABLE 3 RIVERS/STREAMS ON UNIVERSITY LAND

Name of River/Stream	Catchment Area Km^2	Elevation At Source (Metre above sea level)	Elevation At Exit from University land (Metre above sea level)	Estimate of water that could be impounded ($\times 10^9$ litres)
Ofu/Papa/Oshun	18.5	99	52	9.1
Tigba (with Tributaries including Ajigbatun	38.3	143	57	19.5
Ajigbatun	5.6	128	75	2.6
D	5.0	103	64	2.6
Pala	3.2	96	64	1.6
Oshinko	5.3	148	84	2.7
B	3.2	108	61	1.6
A	4.0	120	62	2.0
F	3.6	160	94	1.8
Arakanga	23.6	134	103	12.0
Ole	8.8	157	105	4.5
Alakata	3.2	135	107	1.6
E	2.6	109	67	1.3

FIG:1 UNIVERSITY LOCATIONS IN NIGERIA

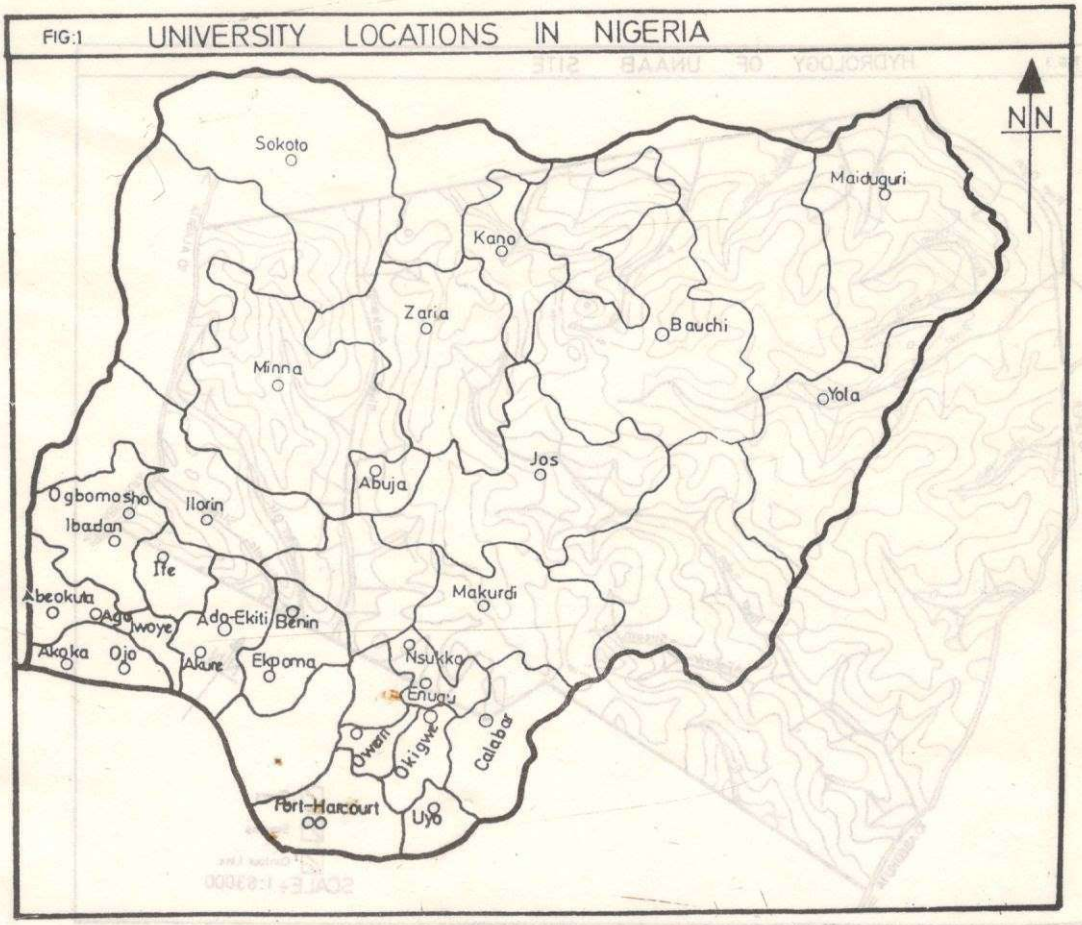


FIG: 2 THE SITE AND OTHER ABEOKUTA LAND USES

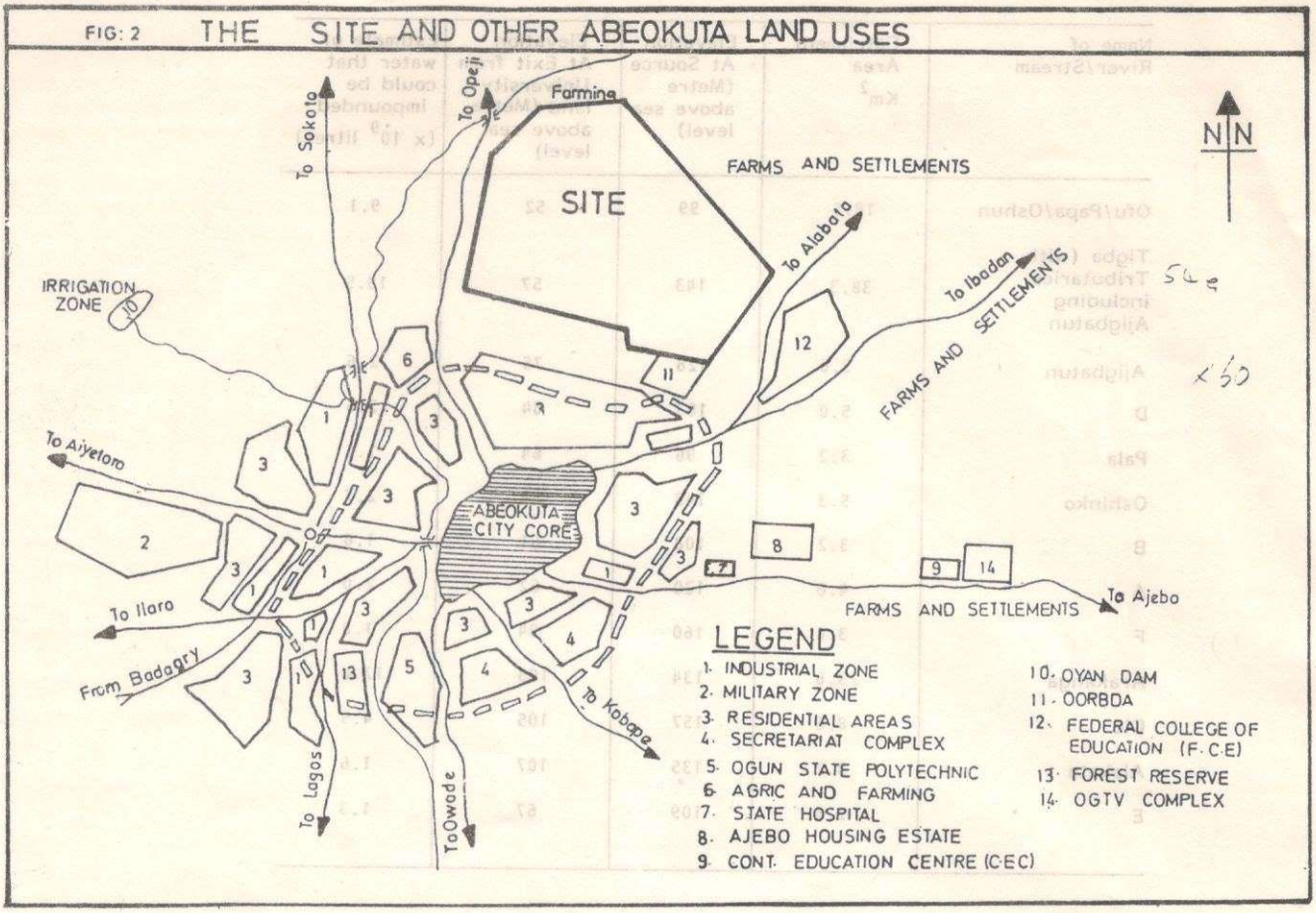
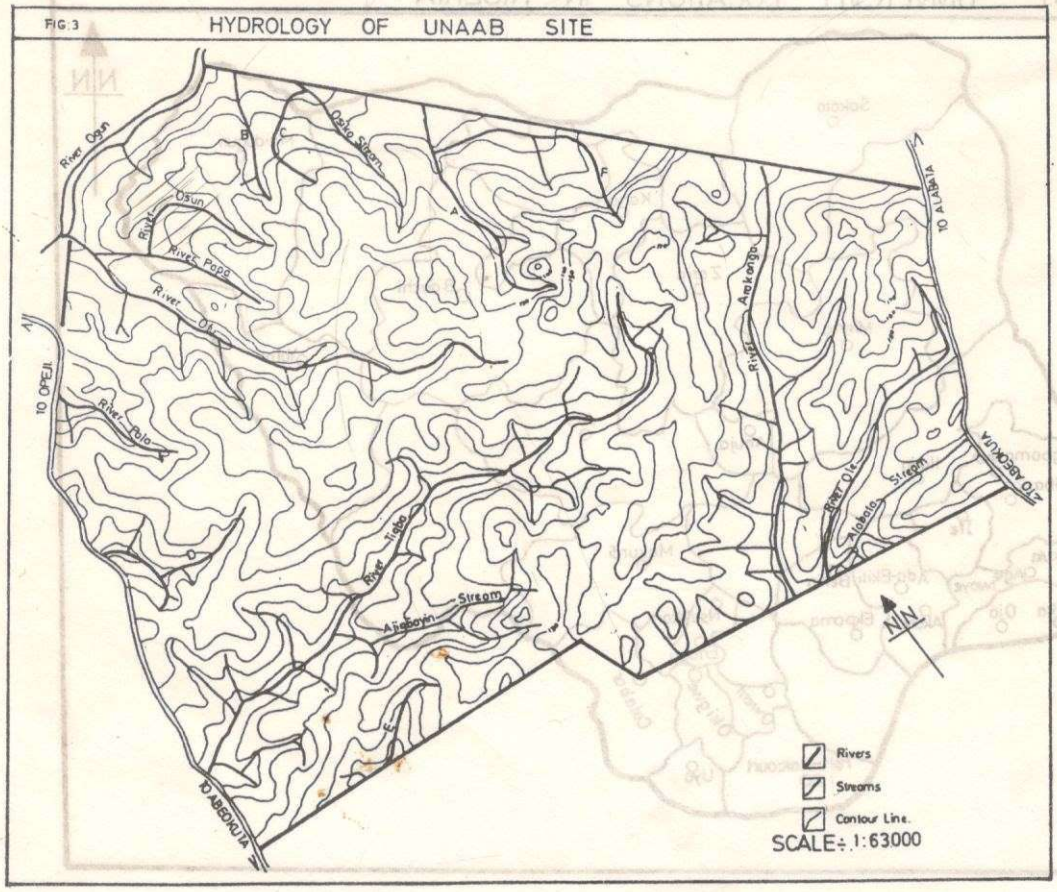
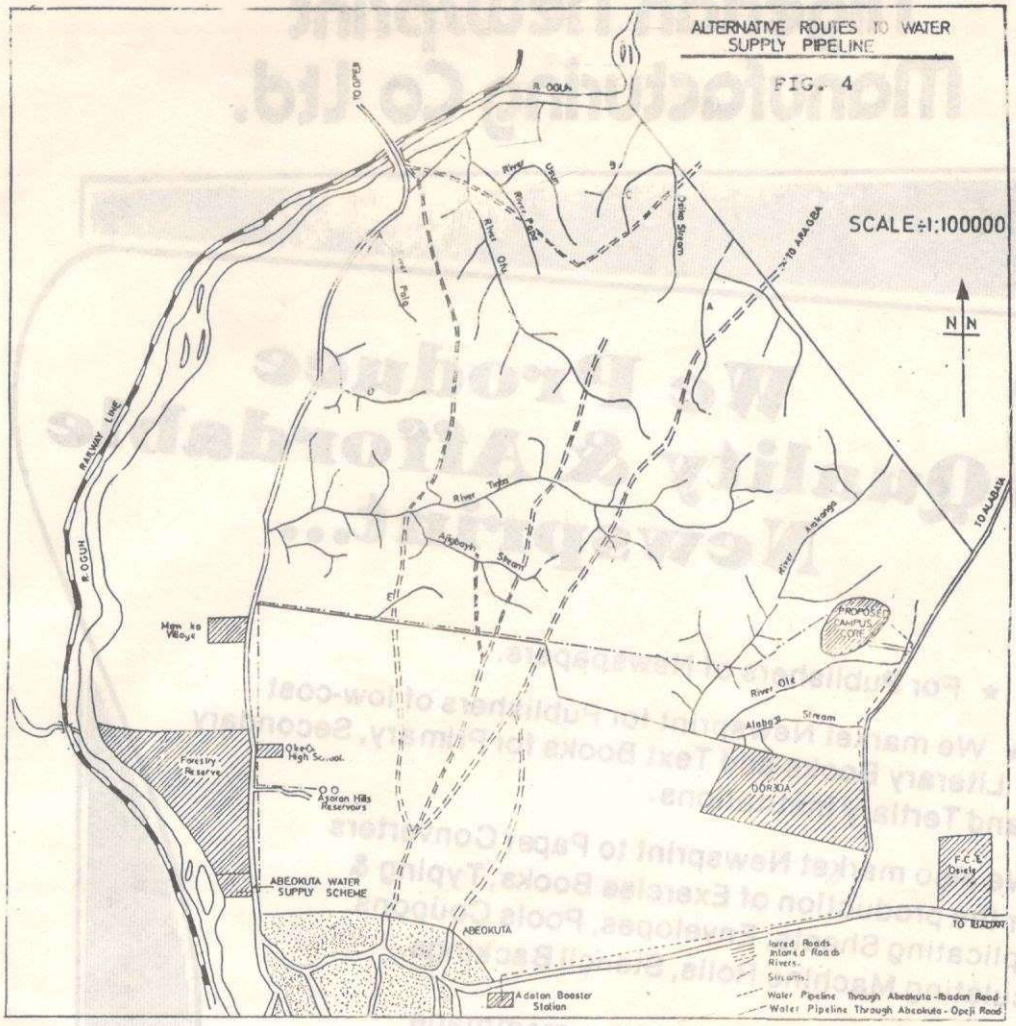


FIG: 3 HYDROLOGY OF UNAAB SITE




ALTERNATIVE ROUTES TO WATER SUPPLY PIPELINE
FIG. 4
SCALE 1:100000
N
TO OFADA
R. OGUN
TO ABA
TO ABAGBA
RAILWAY LINE
R. OGUN
River Ogun
River Pala
River Oke
River Tuyan
Afigbayin Stream
River Ankapa
Mgm ko Village
PROPOSED CAMPUS SITE
River Ote
Alaba Stream
Forestry Reserve
Oke-O High School
Asoran Hills Reservoirs
DORISA
ABEOKUTA WATER SUPPLY SCHEME
ABEOKUTA
F.C.S. Depot
TO IBADAN
Adatan Booster Station
Paved Roads
Unpaved Roads
Rivers
Streams
Water Pipeline through Abeokuta-Ibadan Road
Water Pipeline Through Abeokuta-Opeji Road