SUPPORTING REPORT 4

WATER SOURCES DEVELOPMENT PLAN

WATER SOURCES DEVELOPMENT PLAN

Water Sources Development Plan

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SR4 WATER SOURCES DEVELOPMENT PLAN

SR4.1 Groundwater Development Plan

SR4.1.1 Current Situation of Groundwater Development

(1) Merit of Groundwater Use in Nigeria

Land surface is so flat in Nigeria that settlement and cultivation is possible in many places if water supply is available. All types of water resources such as surface water, groundwater and rain-harvesting water are available in Nigeria. In order to formulate groundwater management and development plan, merit and demerit of groundwater resources should be considered as mentioned below:

- Groundwater is stored in aquifer, which is distributed in every place in Nigeria.
- Groundwater can be used even in dry season. In this point, groundwater is superior to surface water and rain-harvesting water.
- Cost of groundwater development and use is less expensive than that of surface water development in case where amount of water development is small. Therefore, groundwater is suitable for rural water supply and small town water supply which cannot expect large investment.
- Generally, groundwater has better water quality than surface water and does not need high level treatment even for drinking. Treatment for groundwater for drinking is only chlorination even in Japan.

On the other hand, groundwater has demerit below:

- Groundwater level will decline regionally when groundwater is extracted more than replenishment (=groundwater recharge). As a result, environmental hazard such as land subsidence and sea water intrusion will take place.
- Groundwater must be pumped from each borehole, and amount of groundwater from each borehole may be smaller than amount of water obtained from each intake facility of surface water. Furthermore, cost of pumping is always accompanied with groundwater extraction. In this point, groundwater has disadvantage to surface water that can be conveyed by gravity system without pumping cost.
- Surface water is suitable for urban water supply because economies of scale can hold in case of surface water development. However, economies of scale cannot hold in case of groundwater development, so that groundwater has limitation for urban water supply.
- Large draw-down of groundwater level will be found by well interference when more than two wells are simultaneously operated with small distance. In case where many wells are concentrated within small area, extreme draw-down of groundwater level will take place. It will make well efficiency too low.

(2) Characteristics of Borehole

<u>Yield of Borehole</u>

Potential yield of a borehole is different in place by place. Standards yield of a borehole can be applied as shown in Table SR4-1 with relation to water supply plan.

Table SR4-1 Potential Yield of Borehole

Aquifer type		Potential Yield
Sedimentary rock and unconsolidated sediment	Sand /gravel layer	20 to 500m^3/day
	Sandstone	Less than 20 to 500m^3/day
	Argillaceous rocks	Less than 20m^3/day
Basement Complex		Less than 20m^3/day

<u>Length of Borehole</u>

Depth of borehole depends on depth of aquifer. It is different in place by place. Relationship between aquifer type and borehole depth is shown in Table SR4-2.

Table SR4-2 Type of Aquifer and Depth of Borehole

Aquifer type		Aquifer distribution	Depth of borehole
Sedimentary rock and unconsolidated sediment	Sand and gravel	Aquifer is distributed shallow in alluvial area and deep in Tertiary area.	10m to 300m
	Sandstone	Sandstone aquifer is distributed following geological structure.	30m to 300m
	Argillaceous rock	Aquifer is formed in weathered and fractured zone near the ground surface.	30m to 50m
Basement Complex		Aquifer is formed in weathered and fractured zone near the ground surface.	30m to 50m

Source: JICA Project Team

Borehole Diameter

Diameter of borehole screen is between 4 to 11 inches, and 6 inches is most common. Installation of hand-pump needs diameter more than 4 inches, and motorized pump more than 5 inches. PVC is common for materials for both screen and casing. However, if borehole depth exceeds 100m, iron screen and casing is commonly used instead of PVC in terms of material strength.

Pumping Method

Groundwater is extracted by pump. Two type pumps are commonly used in Nigeria.

Table SR4-3 Pump Type

Type of pump	Power sources	Pumping capacity
Hand-pump	Man power	7m^3/day
Motorized pump	Diesel engine, power supply, solar power generation	More than 20m^3/day

Local community has to operate and manage water supply facilities by themselves in both small town and rural area, in contrast with urban water supply that is managed by Water Board. If community's organization for water supply does not function properly, pump will not be operated and maintained sustainably, and pump will soon break down and be abandoned. There are many such cases in Nigeria.

Borehole and Shallow Well Construction Method

Drilling machine will be used for construction of borehole, and manpower will be used for construction of shallow dug well. Drilling method is classified into two types, namely rotary machine and air-hammer machine.

Table SR4-4 Borehole and Shallow Well Construction Method

Item	Geology of aquifer	Construction method
Shallow dug well	Sediment (unconsolidated)	Digging by manpower
Borehole	Unconsolidated sediments	Rotary drilling method
	Sedimentary rocks	Mainly rotary drilling method with air hammer
	Basement complex	Mainly air hammer drilling method with rotary drilling

Functional Borehole Ratio

According to infrastructure survey on water supply facilities that was carried out in 2006 by FMWR, 63% of boreholes are operational but 37% is not operational for some reasons. As life span of boreholes is considered almost permanent, so breakdown of hand-pump or motorized will make boreholes non-functional. Water Board is in charge of urban water supply, so that there are few problems in operation and maintenance of boreholes for urban water supply. On the hand, as rural community is in charge of operation and maintenance of pumps. If community organization is not properly managed, pumps will be soon abandoned after breakdown.

Table SR4-5 Condition of Borehole Operation

Number of borehole	Number of functional borehole	Number of non- functional boreholes
23,606	14,853 (63%)	8,799 (37%)

Note) Data source is result of Influrastructure survey on waer supply facilitiers implemented by FMWR (2006).

SR4.1.2 Optimum Method of Groundwater Development

As explained in SR2, groundwater recharge was analyzed in discharge analysis. Groundwater recharge is defined as maximum amount of groundwater that can be developed. Careful planning and technology is requested for effective use of groundwater recharge. In this part, groundwater development potential was evaluated based on both groundwater recharge and borehole field theory. Aquifers of Nigeria have different capacity in area by area. And even in the same area, there is difference in capacity of aquifer. Therefore, it is not easy to analyze groundwater development potential of entire Nigeria by single method due to variety of its hydrogeological capacity. However, it is possible to roughly classify aquifer capacity and evaluate groundwater development potential by aquifer.

(1) Aquifer Model

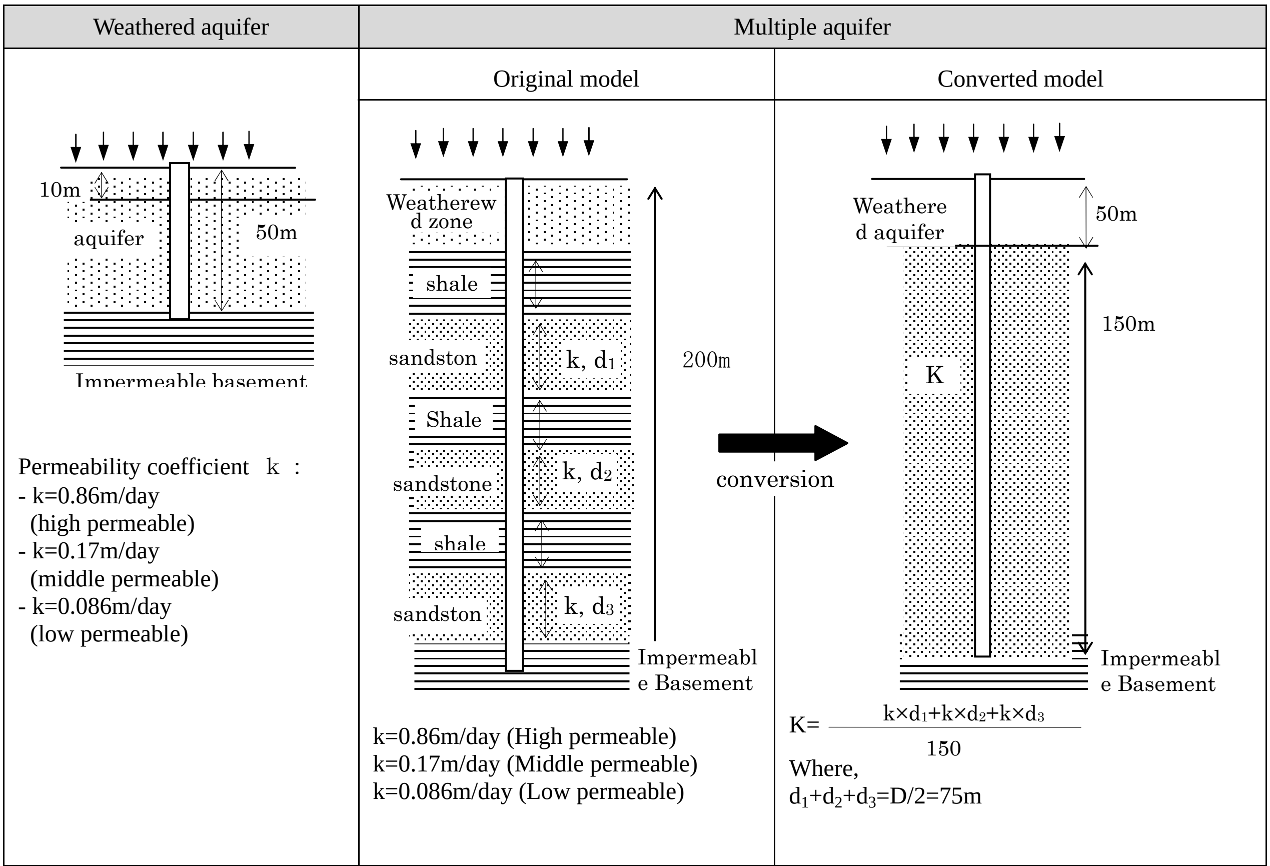
Aquifer of Nigeria is classified into two types as shown in Table SR4-6.

Table SR4-6 Aquifer Type

Geology		Model
Basement rock	Weathered rock	Weathered aquifer
Sedimentary rock	Weathered rock	
	Sandstone within alternation of sandstone and shale	Multiple aquifer

Source: JICA Project Team

Representative hydrogeological parameters were selected for analysis of groundwater development potential based on hydrogeological capacity of weathered aquifer and multiple aquifer as shown in Figure SR4-1and Table SR4-6.



Source: JICA Project Team

Figure SR4-1 Aquifer Model

Groundwater development potential was calculated for six type aquifer models as shown in Table SR4-7.

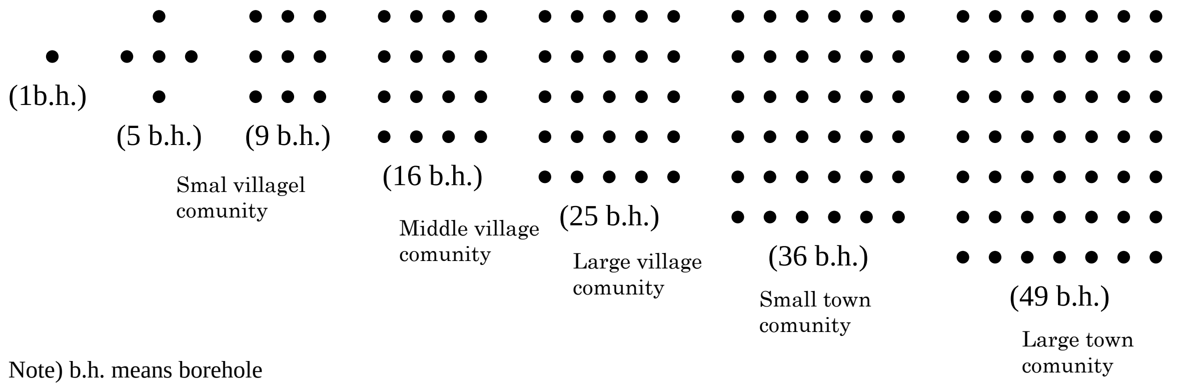
<u>Pattern of Well Field</u>

Standard pattern of borehole field was modeled as shown in Figure SR4-2. Borehole distance is assumed equal each other. This borehole layout is based on the assumption that number of boreholes will increase as population of community increases. If considering actual situation, constant borehole distance is not realistic. But such an approximation might be allowed.

Table SR4-7 Aquifer Model

Model	Symbol		Aquifer type	Thickness of aquifer	Permeability coefficient (k or K)	Static groundwater level
Weathered aquifer	**W**eathered **H**igh permeability	WH	Weathered Basement rock and weathered part of the other type rocks	50m	0.86 m/day	GL-10m
	Weathered **M**iddle permeability	WM			0.17 m/day	
	Weathered **L**ow permeability	WL			0.086 m/day	
Multiple aquifer	**M**ultiple **H**igh permeability	MH	Sandstone or sandy formation within alternation of sandstone and shale	200m	0.43 m/day	GL-50m
	Multiple **M**iddle permeability	MM			0.086 m/day	
	Multiple **L**ow permeability	ML			0.043 m/day	

Source: JICA Project Team



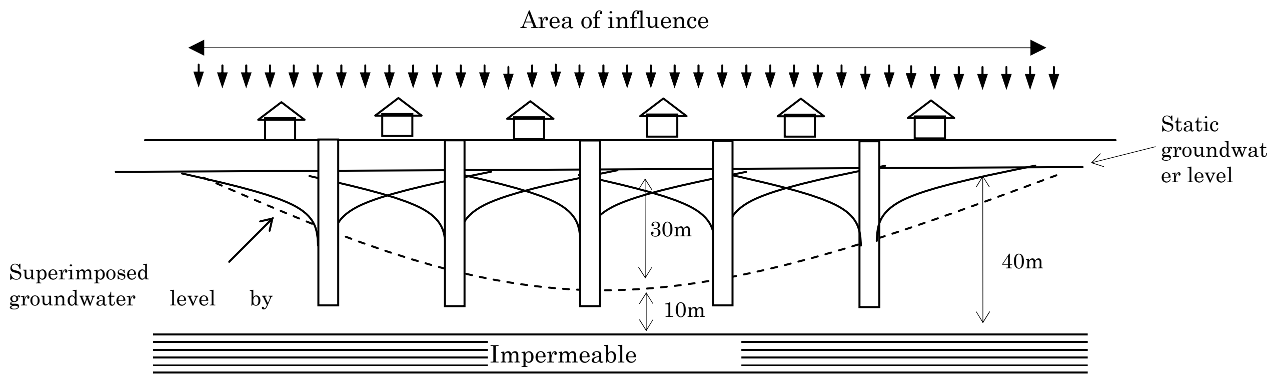
Note) b.h. means borehole
Source : JICA Project team

Figure SR4-2 Pattern of Borehole Field

Limit of Pumping

Weathered aquifer: as shown in Figure SR4-3, it is assumed that pumping reaches limit when distance between impermeable basement rock and the lowest groundwater level by pumping is 10m. It means that draw-down of groundwater level of 30m is set as pumping limit.

Multiple aquifer: Draw-down of 50m is set as pumping limit.



Source：JICA Project Team

Figure SR4-3 Pumping limit of Weathered Aquifer

(2) Calculation Method for Groundwater Level Draw-down of Borehole Field

Weathered Aquifer

Weathered aquifer can be analyzed as unconfined aquifer. Borehole formula is shown below, which express relation among groundwater recharge, pumping yield and aquifer capacity (conductivity and thickness of aquifer).

$D^2-h^2= -P/(2k)\times(R^2-r^2) + Q/(\pi k)\times Ln(R/r)$ ……Formula (1)

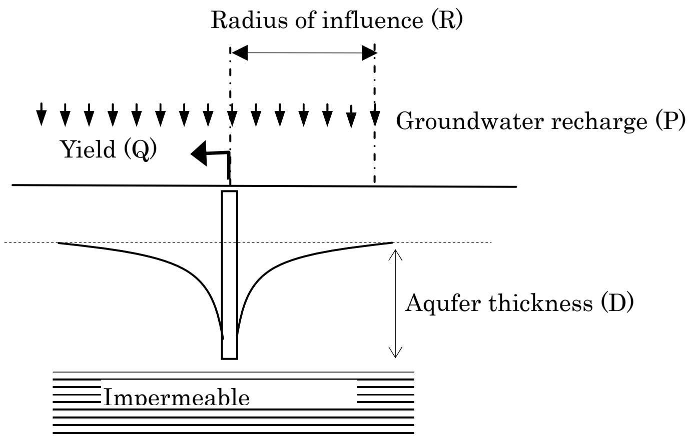
$Q= P\times\pi\times R^2$

Where:

h: Groundwater level at point of r (m) from borehole. Draw-down of borehole itself is calculated as groundwater level at r=0.05(m)
P: Groundwater recharge (mm/day)
R: Radius of influence (m)
K: Coefficient of permeability (m/day)
D: Thickness of aquifer (m)
Q: Pumping yield from borehole (m^3/day)
Ln ( ): Natural logarithm

Relation below must be held to satisfy the condition that amount of groundwater recharge is equal to amount of pumping (see Figure SR4-4).

$Q= P\times\pi\times R^2$



Source: JICA Project Team

Figure SR4-4 Relationship among Q, P and R

Multiple Aquifers

There is no formula that expresses strict relation among groundwater recharge, pumping yield and aquifer capacity (conductivity and thickness of aquifer). Therefore in this analysis, multiple aquifer was converted to single aquifer to use formula (1) above. The method of the conversion is shown in Figure SR4-1, where aquifer of alternation of sandstone and shale is converted into single aquifer.

$D^2-h^2= -P/(2K)\times(R^2-r^2) +Q/(\pi K)\times Ln(R/r)$ ……Formula (2)

$Q= P\times\pi\times R^2$

Where:

h : Groundwater level at point of r (m) from borehole. Draw-down of borehole itself is calculated as groundwater level at r = 0.05(m)
P: Groundwater recharge (mm/day)
R: Radius of influence. Relation $Q= P\times\pi\times R^2$ must be held.
K: Converted coefficient of permeability (see Figure SR4-1)
D: Thickness of converted aquifer (see Figure SR4-1)
Q: Pumping yield

Ln ( ): Natural logarithm

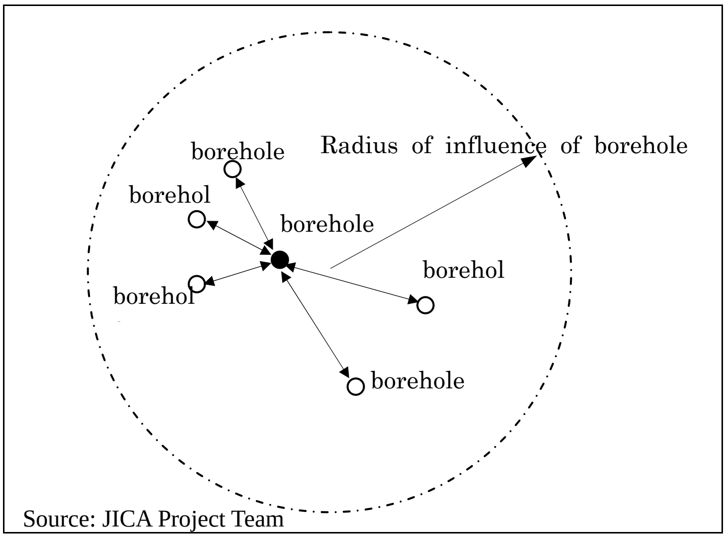
Borehole interference will occur in case of borehole field. Groundwater level of each borehole is calculated using formula below based on principle of superposition (see Figure SR4-5).

$$D^2-h_i^2=\sum (-P/ (2nk)\times(R_i^2-r_{ij}^2) +Q_i/ (\pi K)\times Ln(R/r_{ij}))$$

$$\sum Q_i= P\times\pi\times R^2$$

Where,

h_i : Groundwater level of No.n borehole
R : Radius of influence of borehole (m)
Q_i : Yield of No.i borehole (m^3/day)
r_{ij} : Distance between No.i borehole and No.j borehole (m)
k : Coefficient of permeability (m^2/day)
n : Number of borehole
Others: Same as above.



Source: JICA Project Team

Figure SR4-5 Borehole Arrangement and Influence Area of Borehole Field

(3) Result of Analysis

Result of analysis is shown in Figure SR4-6 to SR4-7. From the result, trend below can be generally recognized.

- As groundwater recharge increase, yield of borehole field will increase. This effect is more eminent in case of borehole field than in case of single borehole.
- As distance among boreholes increase, amount of yield of boreholes will increase. This effect has strong impact on borehole filed.
- Borehole interference will occur when influence area of several borehole fields are superimposed. This will cause serious drawdown of groundwater level of boreholes. Pumping rate (m^3/day) must be controlled based on monitoring result to prevent boreholes from drying up due to borehole interfetence.

Based on the result of analysis by borehole field formula as shown in Figure SR4-6 to SR4-7, available yield form borehole can be expressed as function of i) groundwater recharge, ii) number of boreholes and iii) distance among boreholes. This function is approximated by formula shown in Table SR4-8. Correlation between borehole field formula and approximation formula is shown in Figure SR4-8.

Aquifer of the entire Nigeria can be classified into 6 type aquifer models in Table SR4-7. Then, optimum groundwater development plan can be formulated using formula in Table SR4-8 for six representative aquifer models nationwide.

The planners for groundwater management and development of Federal Ministry and State Ministry are expected to implement groundwater management and development following the method mentioned above.

Radius of influence area of borehole field is shown in Table SR4-9 as function of groundwater recharge and total yield of borehole field.

Table SR4-8 Groundwater Development Potential

Aquifer type	Approximation for result of borehole formula	
	Original Approximation formula (borehole number N>2)	Modified formula (borehole number N>2)
Weathered aquifer		
High permeability (WH)	$Y=639+4.23\times P^{0.30}\times N^{0.55}\times D^{0.58}$	$Y=543+3.60\times P^{0.30}\times N^{0.55}\times D^{0.58}$
Middle permeability (WM)	$Y=164+0.33\times P^{0.37}\times N^{0.67}\times D^{0.71}$	$Y=139+0.28\times P^{0.37}\times N^{0.67}\times D^{0.71}$
Low permeability (WL)	$Y=89+0.13\times P^{0.39}\times N^{0.73}\times D^{0.76}$	$Y=76+0.11\times P^{0.39}\times N^{0.73}\times D^{0.76}$
Multiple aquifer		
High permeability (MH)	$Y=2277+7.85\times P^{0.29}\times N^{0.55}\times D^{0.67}$	$Y=1822+6.28\times P^{0.29}\times N^{0.55}\times D^{0.67}$
Middle permeability (MM)	$Y=624+0.37\times P^{0.36}\times N^{0.69}\times D^{0.86}$	$Y=499+0.30\times P^{0.36}\times N^{0.69}\times D^{0.86}$
Low permeability (ML)	$Y=209+0.58\times P^{0.27}\times N^{0.64}\times D^{0.80}$	$Y=167+0.46\times P^{0.27}\times N^{0.64}\times D^{0.80}$

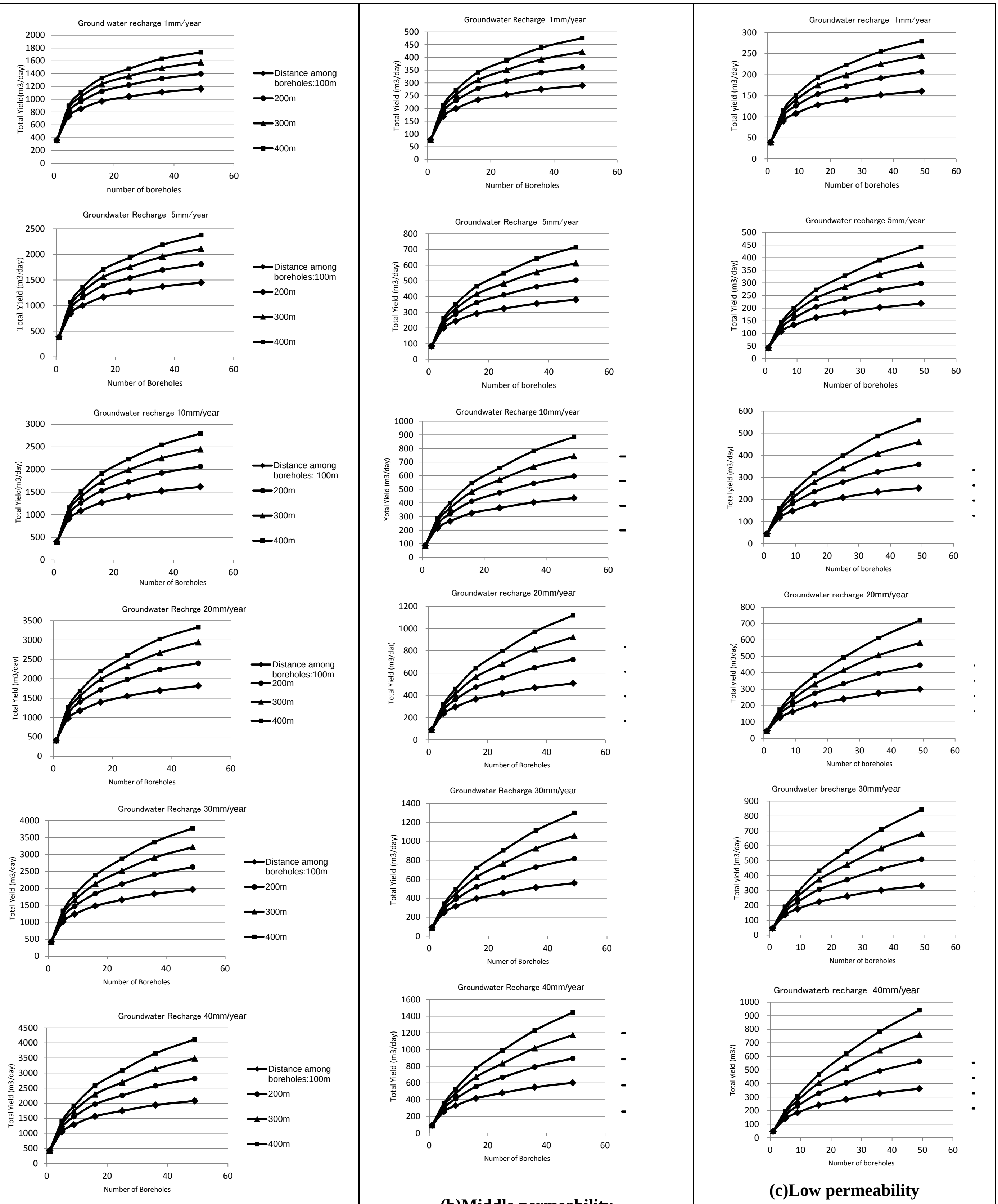
<Legend＞

Y: Total yield of borehole field (m^3/day), P: Groundwater recharge (m/day), N: Number of borehole

D: Distance among boreholes (m), R: Radius of influence of borehole field (m)

- Radius of influence should be desirable within 5,000m for sustainable pumping. Therefore, relation of: $Y<3.14\times P\times R^2=7.85\times 10^7\times P$ should be satisfied.
- In case of single borehole, formula above should be used with condition of D=200m and N=2. Then, the calculated result should be devided by 2 to get maximum yield from single borehole.

Source：JICA Project Team



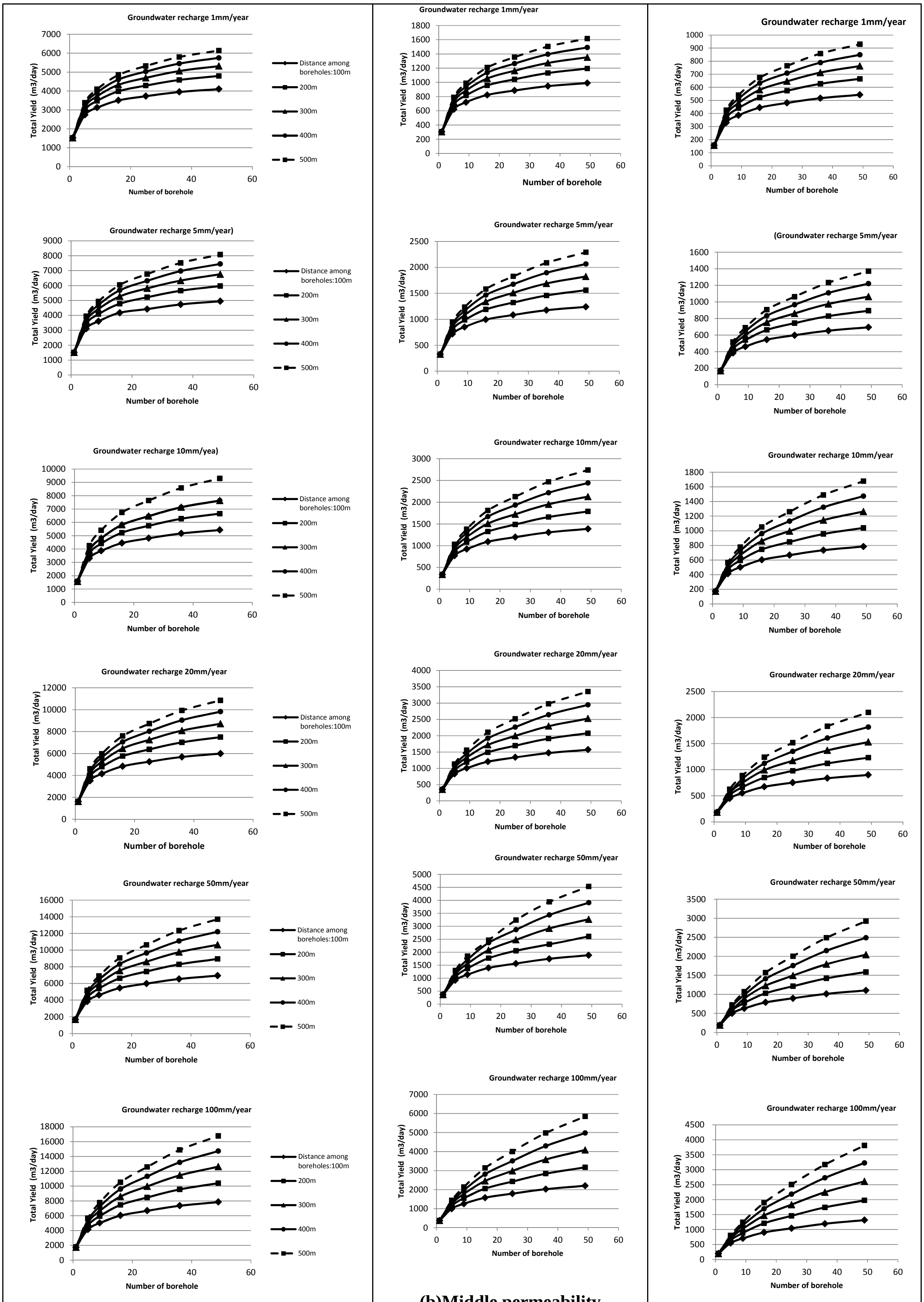
(a)High permeability

(b)Middle permeability

(c)Low permeability

Source: JICA Project Team

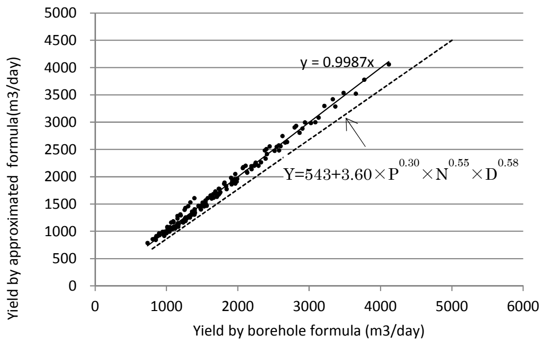
Figure SR4-6 Optimum Yield of Weathered Aquifer



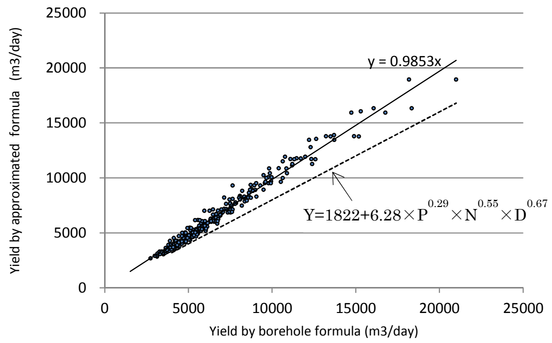
(a)High permeability **(b)Middle permeability** **(c)Low permeability**

Source: JICA Project Team

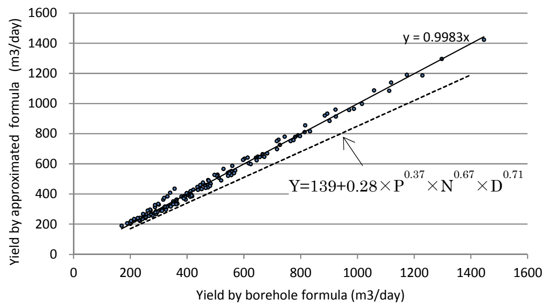
Figure SR4-7 Optimum Yield of Multiple Aquifer



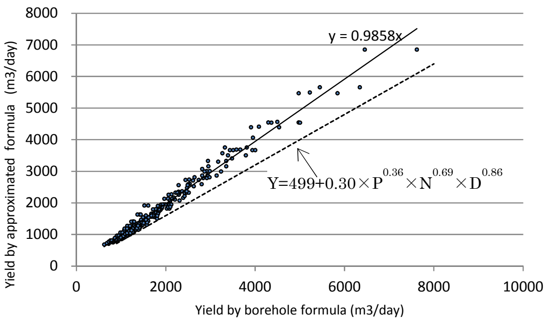
(a)Weathered aquifer (High permeability)



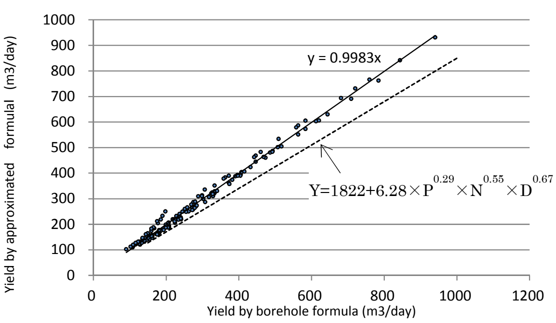
(a) Multiple aquifer (High permeability)



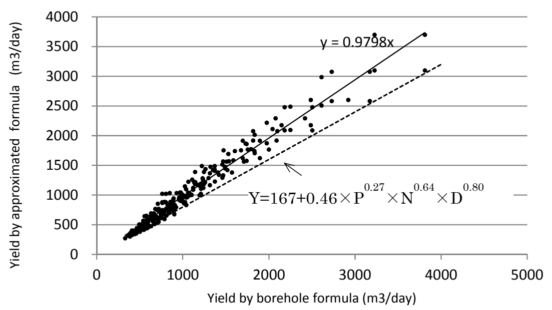
(b) Weathered aquifer (Middle permeability)



(b) Multiple aquifer (Middle permeability)



(c) Weathered aquifer (Low permeability)



(c) Multiple aquifer (Low permeability)

Source: JICA Project Team

Figure SR4-8 Correlation in Borehole Yield among Borehole Formula, Approximated Formula and Modified Approximated Formula

Optimum groundwater development is defined that groundwater recharge will be pumped up effectively within influence area by optimum borehole distribution with optimum yield. Groundwater development should be adjusted to prevent overlapping of influence area of different borehole fields. It is thought that average distance among small towns or large villages is around 10km. Thus, it is desirable that radius of influence of borehole field should be less than 5km (see Figure SR4-9). As same as this, Table SR4-9 shows relation among radius influence area, groundwater recharge and total yield of borehole field. Groundwater development of the colored part of Table SR4-9 should be carefully examined, considering borehole interference with neighboring borehole fields.

Table SR4-9 Radius of Influence Area as Function of Groundwater Recharge and Total Yield of Borehole Field

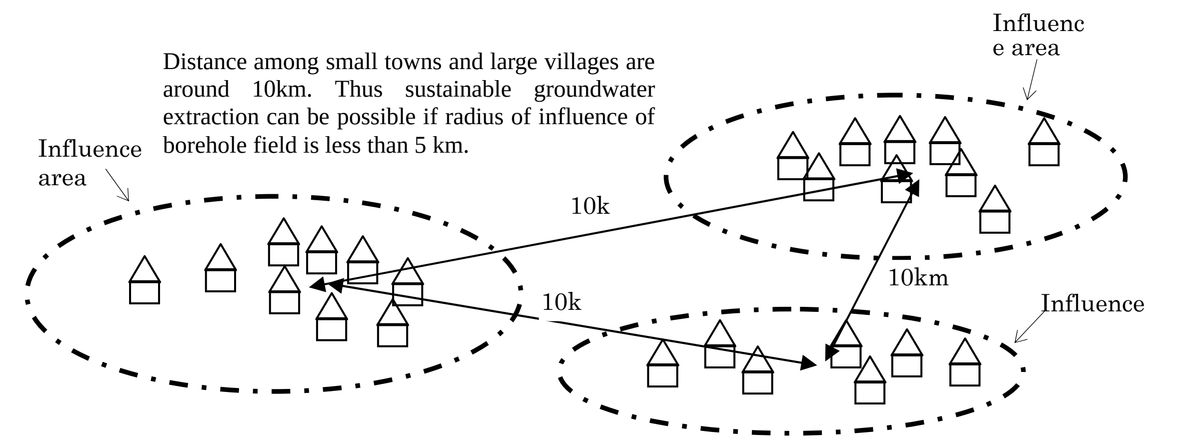
(km)

Groundwater recharge (mm/year)	Total Yield of Borehole Field（m^3/day)					
	100	500	1,000	2,000	3,000	4,000
1	3.4	7.6	10.8	15.2	18.7	24.1
5	1.5	3.4	4.8	6.8	8.4	10.8
10	1.1	2.4	3.4	4.8	5.9	7.6
20	0.8	1.7	2.4	3.4	4.2	5.4
30	0.6	1.4	2.0	2.8	3.4	4.4
40	0.5	1.2	1.7	2.4	3.0	3.8
50	0.5	1.1	1.5	2.2	2.6	3.4
60	0.4	1.0	1.4	2.0	2.4	3.1
70	0.4	0.9	1.3	1.8	2.2	2.9
80	0.4	0.9	1.2	1.7	2.1	2.7
90	0.4	0.8	1.1	1.6	2.0	2.5
100	0.3	0.8	1.1	1.5	1.9	2.4

Note) Radius of influence was calculated by the assumption that shape of influence area is a circle.

(shaded) : Area where radius of influence is larger than 5km.

Source: JICA Project Team



Source: JICA Project Team

Figure SR4-9 Optimum Distribution of Community Borehole

(4) Relation between Groundwater Demand and Borehole Development

Table SR4-10 shows standard water demand by type of water supply of Nigeria.

Table SR4-10 Standard Water Demand by Type of Water Supply

Type	Population	Supply unit (ℓ/person/day)	Total supply (m^3/day)
Rural	Less than 5,000	30	150
Small town	5,000～20,000	60	300～1,200

Source: JICA Project Team

(5) Modification of Formula

Criteria are necessary to decide conductivity to apply it to entire Nigeria. For this purpose, formula should be more general form than current one. Formula can be expressed as below:

$Y=A+B\times P^c\times N^d\times D^e$

A,B：Constant　proportional to conductivity

c, d, e : Constant that has almost the same values regardless of aquifer type

Therefore, it is more general to express formula as below.

$Y=A+B\times T\times N^c\times P^d\times D^e$

New formula that was obtained for various values of Y, T, N, P, D are shown in Table SR4-11.

Y, T, N, P, D were obtained by solving nonlinear equations below.

$H^2-h_i^2=\sum(-P/(2Nk)\times(R_i^2-r_{ij}^2)+Q_i/(\pi K)\times Ln(R/r_{ij}))$

$\sum Q_i= P\times\pi\times R^2$, i=1 to N

Where

h_i : Drawdown of No.n borehole
R : Radius of influence of borehole (m)
Q_i : Yield of No.i borehole (m^3/day)
r_{ij} : Distance between No.i borehole and No.j borehole (m)
D : Distance between neighboring 2 boreholes (m)
k : Coefficient of permeability (m/day)
H : Thickness of aquifer (m)
T : Transimissivity (m^2/day), T=k×D
N : Total number of Number of borehole
Y : Optimum yield of borehole field (m3/day), when drawdown of groundwater level at the center of borehole field is 30m for weathered aquifer, 50m for multiple-aquifer.

Table SR4-11 New formula for Optimum Groundwater Development Potential

Aquifer type T:Trannssimisibity(m^2/day) K:Conductance(m/day)		Formula to estimate sustainable yield of borehole field(m^3/day) • Number of boreholes in borehole field(N) • Groundwater recharge(P,mm/year) • Distance between boreholes(D,m)	
		One borehole	More than 2 borehole
WH	**W**eathered **H**igh permeability	$Y=11.08\times T\times P^{0.06}$	$Y=T\times(0.74+0.43\times N^{0.53}\times P^{0.25}\times D^{0.47})$
WM	**W**eathered **M**iddle permeability		
WL	**W**eathered **L**ow permeability		
MH	**M**ultiple **H**igh permeability	$Y=13.58\times T\times P^{0.05}$	$Y=T\times(0.81+1.20\times N^{0.42}\times P^{0.20}\times D^{0.37})$
MM	**M**ultiple **M**iddle permeability		
ML	**M**ultiple **L**ow permeability		

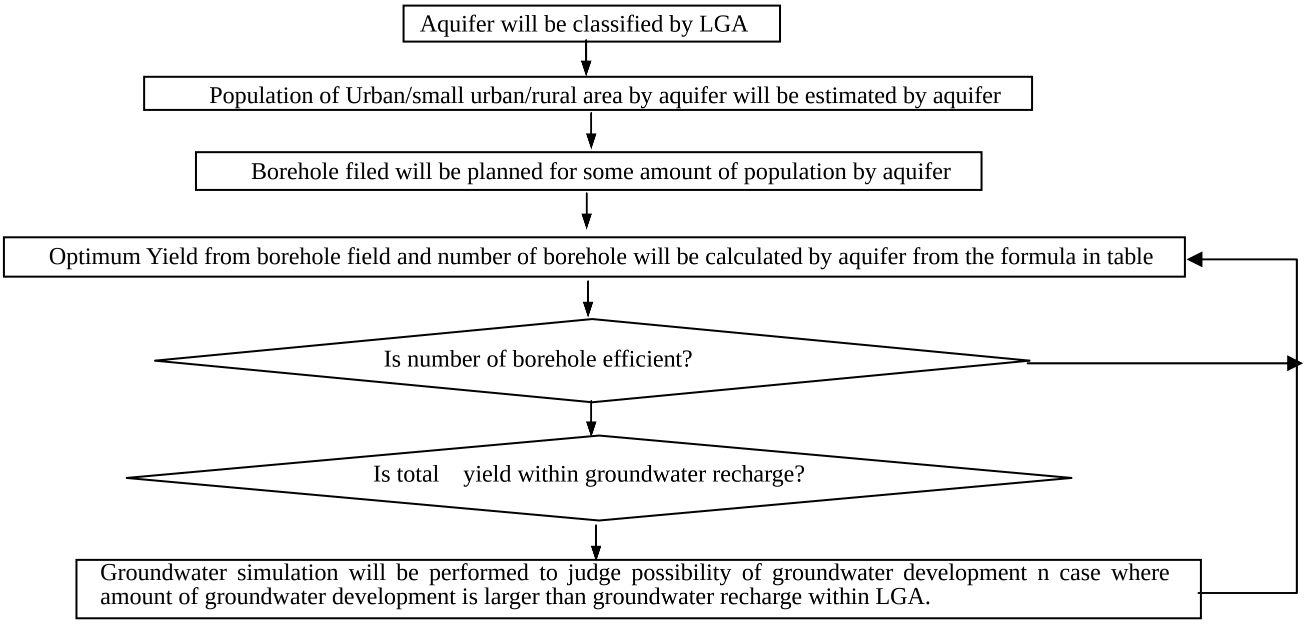
Source: JICA Project Team

SR4.1.3 Procedure of Groundwater Development

Procedure is shown below for optimum groundwater development. Groundwater development is planed LGA by LGA.

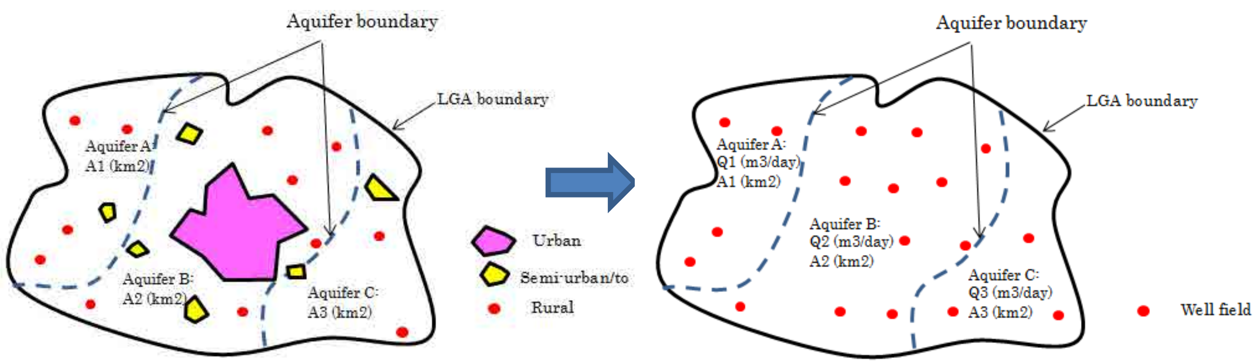
Outline of the method is described above. More detail is as follows:

- Aquifer will be classified by LGA for Optimum borehole plan within classified aquifer to meet relationship between groundwater demand and recharge by LGA.
- Water demand is not distributes equally within LGA as shown in Figure SR4-11. However to make calculation simple, groundwater demand was distributed equally as proportional to area of each aquifer.
- Optimum borehole distribution plan was made using formula in Table SR4-11, based on groundwater recharge, aquifer capacity, water demand.



Source: JICA Project Team

Figure SR4-10 Groundwater development plan by LGA



(a) Actual distribution of groundwater demand within LGA

(b) Modified distribution of groundwater borehole of uifer by LGA

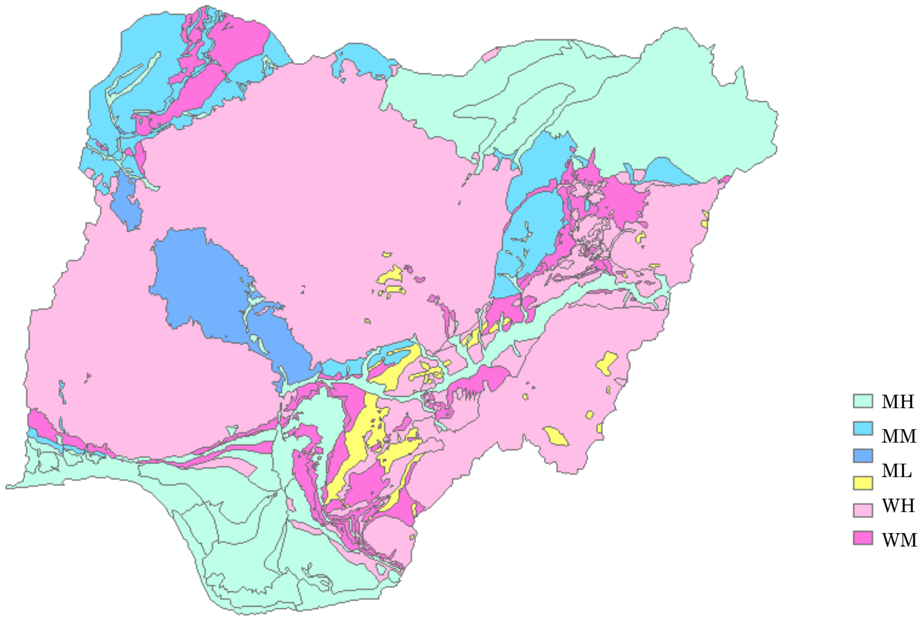
Total groundwater demand by LGA = Q1+Q2+Q3
Where Q1 :Q2 :Q3=A1 :A2 :A3

Source: JICA Project Team

Figure SR4-11 Method to Allocate Groundwater Demand within LGA

(1) Aquifer classification

Classification of aquifer type of eight hydrological areas with groundwater recharge and aquifer model is shown in Figure SR4-12 and Table SR4-12 and Table SR4-13. Relation between aquifer classification and aquifer model is based on criteria shown in Table SR4-12.



Source: JICA Project Team

Figure SR4-12 Aquifer Classification

Table SR4-12 Relation between Aquifer Type and Aquifer Model

Age	Permeability	Aquifer scale	Aquifer model
Quaternary	Large	Large (sand/clay alternation of coastal plain)	MH
	Middle	Middle (san/clay alternation of coastal plain)	MM
	Middle	Small sand layer (alluvial plain along river)	WH-WM
	small	Small (silt/clay alternation)	WL
Tertiary	Large	Large (sandstone/claystone alternation)	MH
	Middle	Middle (sandstone/claystone alternation)	MM
	Middle	Small (sandstone)	WH-WM
	Small	Small (claystone)	WL
Cretaceous	Large	Large (sandstone/shale alternation)	MM
	Middle	Middle (sandstone/shale alternation)	ML
	Middle	Small (sandstone)	WH-WM
	Small	Small (shale)	WL
Basement	Middle	Weathered rock	WM
Volcanic	High	Small	WH

Source: JICA Project Team

Table SR4-13 Groundwater Development Potential by Aquifer

Age	Formation	Lithology	Aquifer Characteristics	Ground-water recharge (mm/year)	Aquifer Model
HA-1： Niger North					
Eocene	Gwandu Formation	Sand and clay.	Aquifer with large outcropping area of maximum thickness of 300m. Basal sandstone form good aquifer.	24	MM
Paleocene	Kalambaina Formation （ Sokoto group ）	Limestone, calcareous shale.	Sandstone form perched aquifers, which provide groundwater to shallow wells.	1	ML
	Dange Formation （Sokoto group ）	Shale and limestone at bottom.	Aquitard confining underlying aquifer.	1	WL
	Wurno Formation （Rima Group）	Fine sandstone and Dukamaje clay stone at the top.	Confined aquifer of medium to coarse sand with recharge area of 330 km^2.	18	MM
Maestri-chitian	Dukamaje Formation （ Rima Group）	Shale, limestone, clay stone.	Aquitard with thickness of less than 20m.	34	WL
	Taloka Formation （Rima Group）	Sandstone and claystone.	Argillaceous aquifer with low capacity of 1～5m^3/hours. Maximum thickness is 180m.	6	ML
	Ill Formation	Sandstone	Unconfined and confined aquifer with wide recharge area.	10	MM
	Gundumi Formation	Sandstone and conglomerate.	Unconfined and confined aquifer with wide recharge area.	10	MM
Pre-Cambria	Basement complex	Granite, gneiss, schist, phyllite, quarzite.	Meta-sedimentary rock form better aquifer than gneiss and migmatite	40	WM
HA-2： Niger Central					
Quaternary	Sand and gravel	Coarse sand, gravel, silt, clay.	Excellent aquifer of high permeability with thickness less than 30m.	18	WH
Tertiary	Patti Formation	Fine to medium sandstone, clay, calcareous silt.	Thickness is less than 100m.	51	ML
cretaceous	Lokoja Sandstone/Nupe Sandstone	Highly consolidated fine to coarse sandstone, silt stone with intercalated calcareous shale and clay.	Sandstone alternates with thin clay and silt layers, resulting in low permeability. Available yield is small. Lithology is changeable making yields changeable.	37	ML
Pre-Cambria	Basement complex	Granite, gneiss, schist, phyllite, quarzite.	Available yield is small.	51	WM
HA-3：Upper Benue					
Holocene	Alluvium	Sand,gravel, silt and clay	Excellent aquifer of high permeability with thickness less than 30m.	5	WH
Pleisto-cene	Chad Formation	Clay, sandy clay, silts with coarse sand and gravel thin layers and lenses at several horizon.	Excellent aquifer with high permeability. Chad Formation covers Kerri-Kerri Formation.	7	MH
Paleocene	Kerri-Kerri Formation	Coarse sandstone, laterally and vertically changing to clay to silt.	Chad Formation has large thickness in southern-east part due to trough structure. Aquifer is distributed in three (3) horizons, upper, middle and lower formation. Chad Formation covers Kerri-Kerri Formation, with maximum thickness of 200m.	24	MM
Maestri-chtian	Lamja Sandstone/Gombe Sandstone	Fine to medium thin sandstone, silty shale, clay stone.	High permeability with deep groundwater level. Perched groundwater is stored above clayey layer at different level. Maximum	14	WL

Age	Formation	Lithology	Aquifer Characteristics	Ground-water recharge (mm/year)	Aquifer Model
			thickness is 200m.		
Campa-nian	Numanha shale/gulani sandstone/Pin diga Formation	Shale, claystone.	Argillaceous sandstone shows low permeability with low aquifer capacity.	15	WL
Santonian	Sekule Formation/Pin diga Formation	Shale, claystone.	Aquiclude. Sandstone of Pindiga Formation forms aquifer in small scale.	15	WL
Upper-Turonian	Jessu Formation/Pin diga Formation	• Jessu formation: Shale, argillaceous rock (Rau Basin) • Pindiga formation: shale, limestone, thin sandstone (Gombe Basin).	Jesuss Formation is aquitard. Sandstone of Pindiga Formation form aquifer of small scale.	15	ML
Lower-Turonian	Dukul Formation/Pin diga Formation	Shale, argillaceous rock, limestone.	Aquitard. It is confirming Yolde Formation.	15	WL
	Yolde Formation	Sandstone, Claystone, argillaceous limestone.	Sandstone and limesone form thin aquifer better than Bima Formation.	13	ML
Ceno -manian	Bima sandstone	Crystalline and hard sandstone, conglomerate, clay.	Crystalline and hard sandstone shows similar hydrogeological properties as Basement Complex. Permeability is heterogeneous place by place. 70% of Bima formation distributes in Benue Valley.	32	WM
Pre-Cambria	Basement complex	Gneiss, quartzite, schist, marble, meta-sedimentary rocks (wollastonite).	Basaltic lava distributes in some area of Biu Uplands forming aquifer. Permeability of Basement Complex is small. 40% of the Hydrological area is occupied by Basement Complex.	99	WM
HA-4: Lower Benue					
Paleocene	Volcanic			236	WH
Maestrichtian	Lafia Formation	Sandstone.	Basal sandstone and upper-most part form aquifer. Thickness is more than 10 to 15m.	138	MM
Senonian	Awgu Formation	Shale with intercalated thin sandstone and limestone.	Sandstone is highly permeable forming aquifer of small scale.	100	WH
Turonian	Ezeaku/makur di Formation	Hard sandstone.	Hard sandstone forms aquiclude. It is partially soft and permeable. Fractured zone and deep weathered zone form aquifer though it is heterogeneous.	46	WM
	Keana Formation			100	WM
Cenomanian	Awe Formation	Medium to coarse sandstone with intercalated shale and limestone.	Sandstone is permeable. But intercalated argillaceous rocks have saline groundwater.	100	WH
Mid-late Albian	Asu River Formation		Aquiclude.	46	WL
Pre-Cambria	Basement complex	Gneiss, quartzite, schist, marble, meta-sedimentary rocks.	Available yield is small.	217	WM
HA-5： Niger South					
Quaternary	Upper deltaic	Medium to coarse unconsolidated sand with intercalated silt and clay layer.	Excellent aquifer	590	MH

Age	Formation	Lithology	Aquifer Characteristics	Ground-water recharge (mm/year)	Aquifer Model
	Lower deltaic	Medium to coarse unconsolidated sand with intercalated silt and clay layer.	Excellent aquifer	458	MH
Tertiary	Benin Formation	Sand with intercalated thin clay lens.	Good aquifer with good water quality.	450	MH
	Ogwashi Asaba Formation	Sandstone and shale	Low permeability in spite of sandstone	331	WM
	Ameki Formation/Nanka sandstone	Sandstone with intercalated thin shale.	Excellent aquifer with high permeability. Groundwater level is deep.	189	ML
	Imo shale	Shale	Aquiculde	51	WL
	Nsukka Formation	Shale	Aquiclude	83	WL
Cretaceous	Ajali Formation	Coarse sandstone with intercalated thin shale	High permeability outcropping in large area receiving large groundwater recharge	122	WH
Maestrichtian	Mamu Formation	Shale with intercalated thin limestone	Aquiclude	91	WL
	Nkporo Formation	Shale with intercalated thin limestone	Aquiclude	63	WL
Pre-Cambria	Basement complex	Gneiss, quartzite, schist, marble, meta-sedimentary rocks	Available yield is small.	62	WM
HA-6 : Western Littoral					
Quaternary	Alluvium	Sand and clay.	Fluvial deposit forming excellent aquifer.	792	MH
	Deltaic Formation	Sand.	Sandstone has small thickness with faces changing in lateral direction. Over–pumping can cause sea-water intrusion.	532	MH
	Benin Formation	Sand with intercalated thin clay lens.	Good aquifer with good water quality.	291	MH
Tertiary	Ilaro Formation/Ameki Formation	Alternation of sandstone and shale.	Good aquifer.	124	MH
	Ewekoro/Imo Shale /Oshuosun Formation	Sandstone, shale, limestone.	Low permeability due to argillaceous rocks. Intercalated sandstone lens store groundwater.	180	WL
Cretaceous	Abeokuta Formation	Sandstone.	Promising aquifer. Basal sandstone bordering Basement Complex has high permeability with thickness of 250-300m.	86	MM
Pre-Cambria	Basement complex	Gneiss, quartzite, schist, marble, meta-sedimentary rocks.	Available yield is small.	93	WM
HA-7 : Niger South					
Quaternary	Benin Formation	Sand with intercalated thin clay lens.	Good aquifer with good water quality	743	MH
Tertiary	Ameki Formation	Sandstone with intercalated thin shale.	Excellent aquifer with high permeability. Groundwater level is deep.	440	ML
	Imo Formation	Shale.	Aquitard.	322	WL
	Nsukka	Shale.	Aquitard.	322	WL

Age	Formation	Lithology	Aquifer Characteristics	Ground-water recharge (mm/year)	Aquifer Model
	Formation				
	Ajali Formation	Sandstone.	Aquitard.	251	MH
	Mamu Formation	Shale.	Aquitard.	251	WL
	Nkporo shale	Shale.	Aquitard.	189	WL
Cretaceous	Awgu Formation	Shale with intercalated thin sandstone and limestone.	Sandston forms aquifer of small scale.	147	WH
	Ezeaku Formation	Hard sandstone.	Sandstone with coarse grain and low cementing materials form aquifer.	177	WM
	Asu Formation	Shale , sandy shale.	Aquitard. Only fractured zone forms aquifer.	228	WM
Pre-Cambrian	Basement complex	Gneiss, quartzite, schist, marble, meta-sedimentary rocks.	Available yield is small.	354	WM
HA-8： Eastern Littoral					
Pleistocene	Chad Formation	Clay, sandy clay, silt with coarse sand and gravel thin layers and lenses at several horizon.	<Hadejia –Yobe basin> Aquifer does not branch off into upper–middle-lower aquifer in Hadejia–Yobe Basin different form the eastern area. Aquifer consists of alternation of clay, sand and silt. Chad Formation covers Kerri-Kerri Formation with thickness of less than 165m. <South-eastern area> Thickness of Chad Formation is large in south-eastern area due to existence of trough structure. Aquifer branches off into upper -middle-lower aquifers. • Upper aquifer is confined providing groundwater to shallow wells and boreholes for Maiduguri water supply. Middle aquifer is confined covered by clayey layer. Borehole needs depth of more than 300m. Upper and middle aquifer is connected in the south of Maiduguri receiving groundwater recharge.	7	MH
Paleocene	Kerri-Kerri Formation	Sand and gravel, sandstone, clay.	Maximum thickness is 200m.	1	MM
Cretaceous	Gundumi Formation		Maximum thickness is 200m.	103	MM
Jurrassic	Younger Granite Complex	Granite covering Basement complex	Coarse sandstone forms aquifer. Thickness of aquifer becomes smaller toward border with Basement Complex. It is suitable for rural water supply though available yield is small.	61	WM
Pre-Cambria	Basement complex	Gneiss, quartzite, schist, marble, meta-sedimentary rocks (wollastonite)	Weathered zone forms aquifer. Available yield is small.	7	WM

Source: Borehole data inventory and pumping test analysis for groundwater development (in drought prone-area) of Nigeria, 1992, 1993. Preliminary data collection of boreholes, 2002, FMWR. Borehole inventory by NIHSA (2011). JICA Project Team.

(2) Setting of Parameters

Actual number of boreholes and groundwater development in Nigeria in 2010 is as follows

- Number of boreholes：64,494
- Amount of groundwater development : 6,340,000m^3/day

It is possible to estimate optimum number of boreholes by LGA using above mentioned method. Then, current total number of boreholes in the entire Nigeria can be estimated by adding up number of boreholes of all the LGAs. Of course, the number of borehole obtained by above theoretical method will not correspond to the actual number of boreholes. However, it is possible make two number, actual one and theoretical one to be the same by adjusting two parameters below:

- Conductivity of aquifers
- Yield of borehole fields by aquifer

Transmissivity

Number of boreholes will change as value of transmissivity changes in theoretical method above as shown in Figure SR4.1-13. Therefore, transmissivity can be detected which make theoretical number of boreholes to be the same as the actual number of boreholes.

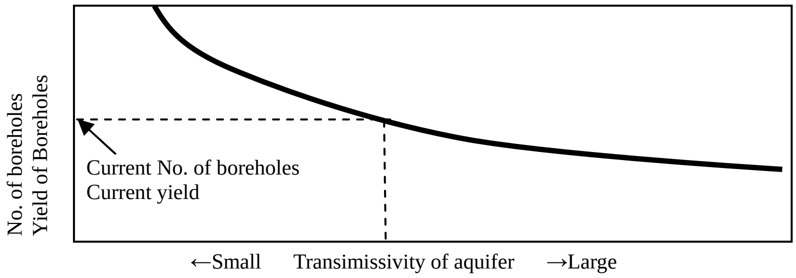


Figure SR4-13 Relationship between Transimissivity and Yield of Borehole Field

Keeping the ratio of conductivity among aquifers as below, transimissivity was selected to make theoretical and actual number of boreholes to be the same in number of boreholes and total yield of boreholes.

WH :WM :WL=4 :2 :1

MH :MM :ML=4 :2 :1

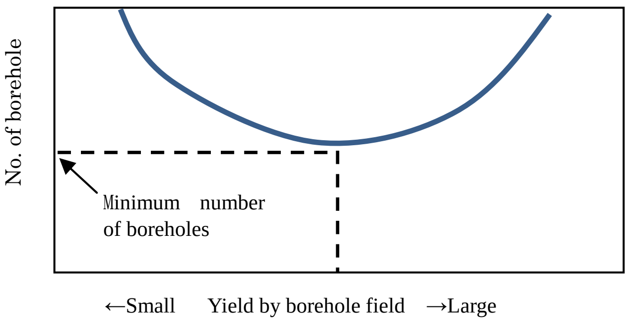
As a result of try and error, values of transimissivities in Table SR4-14 made the number theoretical and actual number of boreholes to be the same. This value will be used for representative value of conductivity and transmissivity to estimate optimum number of boreholes in this Project.

Table SR4-14 Optimum Value for Transimissivity

Aquifer Type	k(m/day)	d(m)	T(m^2/day)	Aquifer Type	k(m/day)	d(m)	T(m^2/day)
WH	1.56	40	62	MH	0.69	150	104
WM	0.78	40	31	MM	0.39	150	58
WL	0.39	40	16	ML	0.19	150	29

Yield by Borehole field

Total number of boreholes in Nigeria will change by setting limit of yield of each borehole field by aquifer type. It means the number of borehole can be made minimum by selecting adequate yield of borehole field by aquifer as shown in Figure SR4-14. Values in Table were detected as optimum ones as a result of try an error method.



Source: JICA Project Team

Figure SR4-14 Relationship between Yield of Borehole field and the Total Number of Boreholes

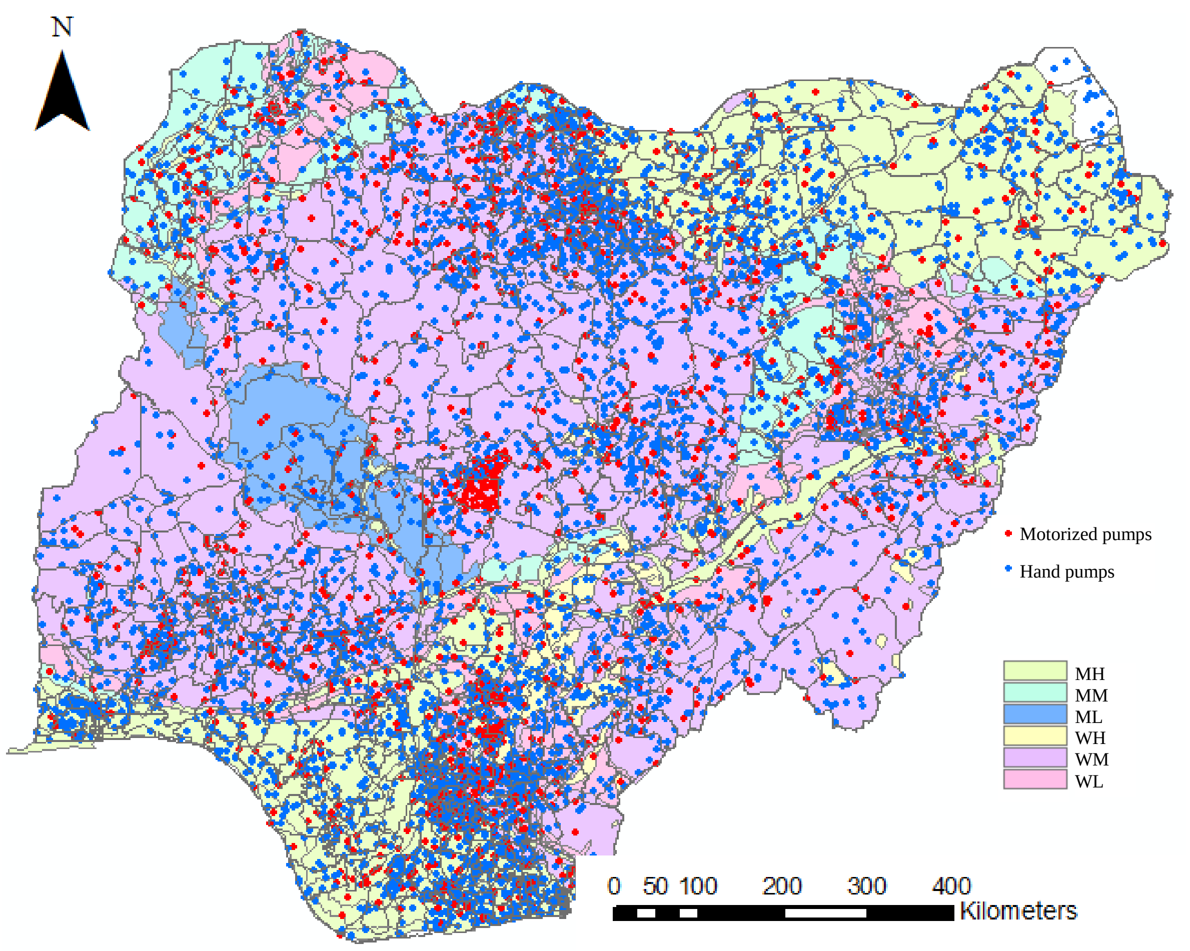
Table SR4-15 Optimum Yield of Borehole Field

Aquifer type	Urban/small urban/small town	
	Motorized pump	
	Optimum yield of boreholes field (m^3/day)	Population to be supplied (persons)
WH	1,000	10,000
WM	500	5,000
WL	400	4,000
MH	1,500	15,000
MM	1,000	10,000
ML	900	9,000

Source: JICA Project Team

(3) Result of Calculation

Result of calculation by proposed method is shown in Figure SR4-15 and Table SR4-16. Figure show image of borehole field distribution. Density of dots shows density of distribution of borehole fields.



Source: JICA Project Team

Figure SR4-15 Density of Distribution of Borehole Fields (2030) by LGA

Table SR4-16 Result of Calculation

State	LGA Name	Groundwater recharge(mm/year)	Aquifer Area (km²)						Urban, small urban, town			Rural	
			MH	MM	ML	WH	WM	WL	No. of boreholes	No of boreholes by borehole fields	No. of motorized pumps	No of borehole for motorized pumps	No of boreholes for hand Pumps
Abia	Ohafia	455	55	0	0	0	0	383	6	2	7	14	125
Abia	Osisioma Ngwa	756	198	0	0	0	0	0	9	1	10	5	46
Abia	Obi Nwga	756	395	0	0	0	0	0	7	2	8	18	169
Abia	Umu-Nneochi	430	30	0	0	0	4	335	5	1	6	10	96
Abia	Umuahia South	750	131	0	0	0	9	0	4	2	4	7	65
Abia	Aba North	756	23	0	0	0	0	0	6	1	7	5	44
Abia	Umuahia North	559	221	0	0	0	22	2	5	1	5	12	111
Abia	Arochukwu	479	7	0	0	0	59	459	3	2	3	6	45
Abia	Bende	408	146	0	0	0	224	231	6	1	7	12	118
Abia	Ukwa East	804	280	0	0	0	0	0	3	1	3	6	54
Abia	Ugwunagbo	756	108	0	0	0	0	0	5	1	5	7	62
Abia	Ukwa West	806	271	0	0	0	0	0	9	1	10	0	0
Abia	Isiala-Ngwa North	756	283	0	0	0	0	0	5	1	6	13	127
Abia	Isiala-Ngwa South	756	258	0	0	0	0	0	5	1	5	11	108
Abia	Isuikwuato	416	98	0	0	0	61	235	8	1	9	8	75
Abia	Aba South	756	49	0	0	0	0	0	2	1	2	5	43
Abia	Ikwuano	698	149	0	0	0	132	0	9	1	10	0	0
Adamawa	Yola North	52	212	0	0	0	479	26	7	3	7	13	115
Adamawa	Shelleng	95	0	0	0	15	1,294	49	2	1	2	5	45
Adamawa	Song	101	18	0	0	96	4,134	2	4	1	4	10	95
Adamawa	Teungo	118	0	0	0	447	5,025	0	6	1	7	15	150
Adamawa	Yola South	32	80	0	0	0	31	2	4	2	4	6	49
Adamawa	Jada	113	0	0	0	0	2,791	0	4	1	5	10	98
Adamawa	Michika	68	0	0	0	191	774	0	33	6	64	0	0
Adamawa	Numan	28	513	0	0	0	266	125	27	3	30	27	258
Adamawa	Larmurde	35	738	0	0	0	431	1	21	4	22	21	181
Adamawa	Hong	113	0	0	0	0	2,622	0	7	2	7	7	60
Adamawa	Guyuk	48	38	0	0	0	353	366	14	5	22	18	156
Adamawa	Fufore	80	985	0	0	0	3,973	7	13	1	14	13	128
Adamawa	Ganye	129	0	0	0	388	1,498	0	12	2	13	12	104
Adamawa	Gombi	32	314	0	0	0	724	61	6	5	10	6	38
Adamawa	Mubi South	85	0	0	0	0	414	0	12	4	19	20	176
Adamawa	Mubi North	80	0	0	0	12	889	0	14	1	15	14	139
Adamawa	Girie	121	0	0	0	187	1,657	2	33	6	83	26	245
Adamawa	Madagali	71	0	0	0	0	819	0	18	3	19	15	127
Adamawa	Mayo-Belwa	105	0	0	0	0	1,766	0	14	2	15	13	123
Adamawa	Maiha	113	0	0	0	0	1,271	0	14	5	26	14	129
Adamawa	Demsa	36	341	0	0	28	1,338	116	10	1	11	5	47
Akwa Ibom	Mkpat Enin	885	330	0	0	0	0	0	18	2	20	7	57
Akwa Ibom	Nsit Ibom	756	142	0	0	0	0	0	16	3	17	11	90
Akwa Ibom	Nsit Atai	756	134	0	0	0	0	0	12	1	13	12	115
Akwa Ibom	Okobo	760	299	0	0	0	0	0	12	1	13	10	95
Akwa Ibom	Nsit Ubium	789	206	0	0	0	0	0	8	1	9	9	82
Akwa Ibom	Abak	756	190	0	0	0	0	0	23	8	47	16	143
Akwa Ibom	Mbo	1,046	215	0	0	0	0	0	5	1	5	9	89
Akwa Ibom	Udung Uko	875	60	0	0	0	0	0	3	1	3	7	61
Akwa Ibom	Eket	1,042	167	0	0	0	0	0	3	1	3	4	39
Akwa Ibom	Onna	1,016	162	0	0	0	0	0	2	1	2	6	54
Akwa Ibom	Oron	756	54	0	0	0	0	0	3	1	3	8	72
Akwa Ibom	Eastern Obolo	1,052	120	0	0	0	0	0	3	1	3	5	45
Akwa Ibom	Oruk Anam	773	524	0	0	0	0	0	3	1	3	5	40
Akwa Ibom	Esit Eket	1,052	168	0	0	0	0	0	2	1	2	3	29
Akwa Ibom	Etim Ekpo	761	206	0	0	0	0	0	8	1	8	9	87
Akwa Ibom	Etinan	756	175	0	0	0	0	0	3	1	3	3	25
Akwa Ibom	Essien Udim	756	295	0	0	0	0	0	3	1	3	3	27
Akwa Ibom	Obot Akara	752	221	0	0	0	16	0	4	1	4	12	114
Akwa Ibom	Itu	705	22	0	0	0	152	0	3	1	3	8	74
Akwa Ibom	Ini	578	91	0	0	0	119	163	2	1	2	3	26
Akwa Ibom	Ikot Ekpene	753	109	0	0	0	6	0	2	1	2	7	63
Akwa Ibom	Ikot Abasi	1,001	360	0	0	0	0	0	6	1	6	9	85
Akwa Ibom	Ikono	711	61	0	0	0	198	0	5	1	5	7	64
Akwa Ibom	Ukanafun	792	246	0	0	0	0	0	5	2	5	13	128
Akwa Ibom	Ika	756	113	0	0	0	0	0	10	2	10	6	51
Akwa Ibom	Ibiono Ibom	680	87	0	0	0	231	19	6	3	7	7	48

State	LGA Name	Groundwater recharge(mm/year)	Aquifer Area (km^2)						Urban, small urban, town			Rural	
			MH	MM	ML	WH	WM	WL	No. of boreholes	No of boreholes by borehole fields	No. of motorized pumps	No of borehole for motorized pumps	No of boreholes for hand Pumps
Akwa Ibom	Uruan	748	298	0	0	0	49	0	5	2	5	5	39
Akwa Ibom	Uyo	756	187	0	0	0	0	0	5	1	5	8	73
Akwa Ibom	Ibeno	1,052	243	0	0	0	0	0	8	2	8	6	48
Akwa Ibom	Ibesikpo Asutan	756	154	0	0	0	0	0	3	1	3	6	59
Akwa Ibom	Urue Offong/Oruko	896	127	0	0	0	0	0	2	1	2	3	27
Anambra	Ihiala	594	252	0	0	0	0	0	12	3	13	14	127
Anambra	Ogbaru	845	454	0	0	0	0	0	5	2	5	5	44
Anambra	Anaocha	364	104	0	0	0	0	0	14	1	14	0	0
Anambra	Idemili North	520	82	0	0	0	33	0	2	1	2	5	44
Anambra	Oyi	367	136	0	0	0	0	0	4	1	4	7	61
Anambra	Anambra East	409	251	0	0	0	0	0	3	1	3	6	52
Anambra	Onitsha North	844	42	0	0	0	0	0	5	1	5	18	177
Anambra	Orumba South	393	85	0	0	0	0	107	3	1	3	8	73
Anambra	Njikoka	364	95	0	0	0	0	0	5	1	5	12	117
Anambra	Nnewi North	505	4	0	0	0	55	0	13	2	13	17	164
Anambra	Nnewi South	396	131	0	0	0	43	0	3	1	3	8	76
Anambra	Orumba North	291	135	0	0	0	0	163	4	1	4	18	174
Anambra	Ayamelum	308	172	0	0	0	0	417	2	1	2	0	0
Anambra	Aguata	382	195	0	0	0	0	0	10	2	14	13	113
Anambra	Awka South	349	150	0	0	0	0	20	5	1	5	0	0
Anambra	Ekwusigo	684	87	0	0	0	30	0	9	2	9	0	0
Anambra	Idemili South	550	85	0	0	0	52	0	6	2	6	12	109
Anambra	Onitsha South	845	10	0	0	0	0	0	6	2	9	8	67
Anambra	Awka North	289	154	0	0	0	0	198	6	3	11	17	163
Anambra	Anambra West	532	954	0	0	0	0	0	5	1	5	14	136
Anambra	Dunukofia	364	66	0	0	0	0	0	6	2	7	0	0
Bauchi	Alkaleri	65	380	3,893	0	0	951	689	5	2	5	11	98
Bauchi	Bauchi	106	0	72	0	0	3,610	3	8	2	8	11	103
Bauchi	Jama'are	3	491	0	0	0	2	0	3	1	3	0	0
Bauchi	Misau	47	186	450	0	0	590	0	6	2	8	7	63
Bauchi	Itas/Gadau	3	1,397	0	0	0	0	0	3	2	3	15	140
Bauchi	Giade	52	58	234	0	0	375	0	2	1	2	5	42
Bauchi	Gamawa	3	2,906	17	0	0	0	0	21	5	26	37	347
Bauchi	Tafawa-Balewa	113	0	0	0	0	2,513	0	56	3	60	15	129
Bauchi	Ningi	71	0	0	0	0	4,623	0	5	3	9	9	77
Bauchi	Damban	28	177	900	0	0	0	0	20	4	34	25	230
Bauchi	Shira	43	499	71	0	0	749	0	7	2	14	20	192
Bauchi	Warji	65	56	0	0	0	569	0	11	4	18	17	144
Bauchi	Ganjuwa	76	2	415	0	0	4,602	37	9	3	17	19	174
Bauchi	Kirfi	66	154	1,851	0	0	249	115	17	1	19	22	213
Bauchi	Toro	79	4	0	0	0	6,925	0	30	1	33	38	371
Bauchi	Katagum	7	1,262	173	0	0	0	0	7	2	7	15	138
Bauchi	Darazo	51	2	2,635	0	0	369	6	12	4	21	19	177
Bauchi	Bogoro	113	0	0	0	0	894	0	11	2	12	14	128
Bauchi	Zaki	3	1,475	0	0	0	0	0	25	4	28	33	302
Bauchi	Dass	113	0	0	0	0	535	0	9	5	10	16	141
Bayelsa	Southern Ijaw	1,084	2,684	0	0	0	0	0	26	2	29	33	311
Bayelsa	Ekeremor	1,042	1,811	0	0	0	0	0	9	3	16	20	191
Bayelsa	Kolokuma/Opo kuma	845	361	0	0	0	0	0	12	5	14	23	203
Bayelsa	Yenegoa	842	707	0	0	0	0	0	6	1	7	8	71
Bayelsa	Sagbama	845	946	0	0	0	0	0	4	2	8	10	100
Bayelsa	Brass	1,224	1,404	0	0	0	0	0	8	1	8	10	90
Bayelsa	Ogbia	881	695	0	0	0	0	0	20	1	20	6	60
Bayelsa	Nembe	1,159	760	0	0	0	0	0	23	1	23	15	149
Benue	Bukuru	165	236	0	0	0	850	160	7	1	7	3	27
Benue	Oturkpo	203	0	0	0	861	150	258	79	1	79	0	0
Benue	Agatu	134	285	0	0	31	0	699	12	1	12	8	75
Benue	Gboko	228	1	0	0	66	1,515	252	9	1	9	5	48
Benue	Okpokwu	245	0	0	0	684	0	47	10	1	10	4	36
Benue	Gwer East	183	47	0	0	917	1,221	109	6	1	6	4	39
Benue	Markurdi	133	219	0	0	50	551	0	8	3	8	15	132
Benue	Konshisha	274	0	0	0	780	782	112	10	4	13	14	130
Benue	Tarka	140	58	0	0	0	313	0	7	4	12	12	105
Benue	Oju	267	0	0	0	856	327	100	16	4	17	20	170
Benue	Gwer West	136	168	0	0	749	177	1	5	2	5	15	142
Benue	Ogbadibo	294	88	0	0	21	0	488	6	4	6	11	93

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Benue	Logo	176	63	0	0	0	814	531	15	3	16	4	26
Benue	Apa	151	6	0	0	21	0	969	7	3	7	15	138
Benue	Ohimini	227	0	0	0	487	0	145	4	2	4	6	55
Benue	Katsina-Ala	176	65	0	0	0	2,190	147	5	3	5	12	109
Benue	Ushongo	304	0	0	0	239	911	78	5	4	5	11	79
Benue	Ado	257	0	0	0	845	375	0	7	4	12	7	60
Benue	Obi	264	0	0	0	313	65	44	10	4	14	18	168
Benue	Kwande	266	0	0	0	0	2,890	0	7	4	12	10	73
Benue	Ukum	153	0	0	0	0	1,281	233	3	3	4	7	58
Benue	Guma	153	373	0	0	860	1,621	26	9	3	9	12	109
Benue	Vandeikya	391	0	0	0	60	871	0	7	3	7	13	118
Borno	Damboa	47	813	1,967	0	0	2,919	511	5	2	6	15	132
Borno	Kwaya Kusar	83	0	0	0	0	665	66	4	3	4	7	55
Borno	Gubio	3	2,460	0	0	0	0	0	7	1	7	14	131
Borno	Konduga	7	4,990	856	0	0	0	0	7	2	7	12	108
Borno	Marte	3	3,010	0	0	0	0	0	7	4	8	15	129
Borno	Maiduguri	3	132	0	0	0	0	0	8	2	8	14	131
Borno	Biu	44	0	0	0	0	336	2,976	28	7	52	22	198
Borno	Kaga	5	2,498	198	0	0	0	0	7	3	8	6	52
Borno	Bama	3	4,988	0	0	0	0	0	11	2	22	28	270
Borno	Abadam	3	1,870	0	0	0	0	0	4	3	7	10	91
Borno	Bayo	68	0	0	0	0	851	105	7	2	14	12	111
Borno	Dikwa	3	1,771	0	0	0	0	0	25	2	50	0	0
Borno	Jere	3	866	0	0	0	0	0	27	5	99	10	97
Borno	Mafa	3	2,864	0	0	0	0	0	4	3	7	9	77
Borno	Chibok	109	0	0	0	0	1,325	23	10	2	20	13	126
Borno	Shani	92	0	0	0	0	1,261	0	4	2	8	6	59
Borno	Kukawa	3	1,696	0	0	0	0	0	7	3	9	7	65
Borno	Magumeri	3	4,849	0	0	0	0	0	4	1	4	6	56
Borno	Hawul	78	0	0	0	0	1,200	895	7	2	14	7	66
Borno	Gwoza	27	1,765	13	0	0	942	157	6	2	12	10	95
Borno	Kala/Balge	3	1,892	0	0	0	0	0	9	2	10	10	84
Borno	Ngala	3	1,462	0	0	0	0	0	9	1	10	8	75
Borno	Nganzai	3	2,463	0	0	0	0	0	8	2	16	18	174
Borno	Monguno	3	1,637	0	0	0	0	0	7	2	14	21	206
Borno	Mobbar	3	2,786	0	0	0	0	0	11	5	22	11	90
Borno	Askira/Uba	94	0	0	0	0	2,268	90	19	9	37	28	259
Borno	Guzamala	3	2,513	0	0	0	0	0	3	1	3	6	52
Cross River	Calabar South	811	74	0	0	0	110	0	14	2	28	20	198
Cross River	Yakurr	429	0	0	0	44	294	332	7	2	14	17	163
Cross River	Calabar Municipal	738	99	0	0	0	42	0	5	2	10	7	61
Cross River	Akpabuyo	829	597	0	0	0	210	0	5	2	10	13	129
Cross River	Obubra	348	0	0	0	229	465	420	10	2	10	10	88
Cross River	Abi	293	0	0	0	0	134	148	7	2	14	19	185
Cross River	Yala	276	0	0	0	535	1,109	94	9	2	9	2	11
Cross River	Bakassi	1,052	11	0	0	0	0	0	18	3	23	11	95
Cross River	Boki	550	0	0	0	4	2,548	218	9	2	9	0	0
Cross River	Akamkpa	536	158	0	0	35	4,367	442	8	2	8	23	224
Cross River	Ogoja	343	0	0	0	263	568	141	6	3	7	8	67
Cross River	Bekwarra	473	0	0	0	62	203	41	6	3	9	4	30
Cross River	Obudu	568	0	0	0	0	453	0	6	3	6	10	86
Cross River	Biase	417	28	0	0	16	822	444	2	1	2	9	83
Cross River	Etung	372	0	0	0	114	83	617	7	3	7	9	72
Cross River	Odukpani	611	433	0	0	0	710	212	7	4	7	8	57
Cross River	Ikom	339	0	0	0	403	375	1,182	9	3	10	7	59
Cross River	Obanliku	369	0	0	0	0	1,056	0	5	3	6	7	58
Delta	Ndokwa West	682	816	0	0	0	0	0	7	1	7	10	93
Delta	Sapele	826	451	0	0	0	0	0	9	4	10	11	84
Delta	Aniocha North	400	406	0	0	0	0	0	5	3	7	6	43
Delta	Oshimili South	844	268	0	0	0	0	0	7	3	7	10	92
Delta	Warri South-West	958	1,723	0	0	0	0	0	7	4	11	5	47
Delta	Aniocha South	633	868	0	0	0	0	0	5	1	5	8	75
Delta	Patani	845	217	0	0	0	0	0	5	1	5	4	30
Delta	Warri South	878	634	0	0	0	0	0	5	1	5	5	43
Delta	Ukwuani	557	409	0	0	0	0	0	4	1	4	5	48
Delta	Ndokwa East	841	1,618	0	0	0	0	0	12	1	12	7	62

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Delta	Ughelli South	886	786	0	0	0	0	0	7	1	7	13	122
Delta	Ughelli North	754	819	0	0	0	0	0	5	1	5	2	20
Delta	Udu	770	131	0	0	0	0	0	2	1	2	2	19
Delta	Ethiope East	674	381	0	0	0	0	0	15	1	15	0	0
Delta	Ethiope West	655	537	0	0	0	0	0	5	1	5	4	33
Delta	Okpe	758	445	0	0	0	0	0	3	1	3	4	37
Delta	Bomadi	880	129	0	0	0	0	0	8	1	8	10	94
Delta	Oshimili North	476	510	0	0	0	0	0	12	1	12	9	82
Delta	Burutu	974	1,939	0	0	0	0	0	7	1	7	5	43
Delta	Warri North	701	1,842	0	0	0	0	0	9	1	9	7	64
Delta	Uvwie	751	95	0	0	0	0	0	8	1	8	8	77
Delta	Isoko North	721	478	0	0	0	0	0	8	1	8	9	81
Delta	Ika North East	421	463	0	0	0	0	0	2	1	2	3	30
Delta	Isoko South	806	704	0	0	0	0	0	6	1	6	4	36
Delta	Ika South	421	436	0	0	0	0	0	4	1	4	8	73
Ebonyi	Ezza South	334	0	0	0	0	47	277	6	1	6	10	91
Ebonyi	Ivo	291	0	0	0	0	147	98	8	1	8	3	25
Ebonyi	Ezza North	342	0	0	0	0	0	305	4	1	4	3	29
Ebonyi	Ebonyi	328	0	0	0	0	107	336	6	1	6	6	55
Ebonyi	Ikwo	302	0	0	0	0	220	357	9	1	9	6	58
Ebonyi	Ishielu	302	0	0	0	160	333	380	6	1	6	5	40
Ebonyi	Ohaukwu	317	0	0	0	0	231	286	0	0	0	12	107
Ebonyi	Ohaozara	304	0	0	0	49	123	140	0	0	0	10	94
Ebonyi	Izzi	331	0	0	0	7	205	857	0	0	0	9	87
Ebonyi	Abakaliki	332	0	0	0	0	100	484	0	0	0	7	57
Ebonyi	Afikpo North	303	0	0	0	0	14	226	0	0	0	15	142
Ebonyi	Afikpo South	332	48	0	0	0	83	247	0	0	0	8	61
Ebonyi	Onicha	320	0	0	0	10	169	298	0	0	0	11	95
Edo	Ikpoba-Okha	421	863	0	0	0	0	0	0	0	0	14	127
Edo	Etsako West	260	529	0	0	0	0	417	0	0	0	19	166
Edo	Etsako East	229	490	0	0	0	280	364	0	0	0	5	42
Edo	Akoko-Edo	112	45	0	0	0	1,288	39	0	0	0	11	98
Edo	Esan South-East	374	1,277	0	0	0	30	0	0	0	0	18	165
Edo	Egor	390	93	0	0	0	0	0	0	0	0	26	252
Edo	Oredo	381	249	0	0	0	0	0	21	1	21	19	183
Edo	Orhionmwon	397	2,383	0	0	0	0	0	23	4	39	12	95
Edo	Etsako Central	287	344	0	0	0	0	316	14	4	22	9	78
Edo	Uhunmwonde	375	1,547	0	0	0	487	0	40	4	45	25	236
Edo	Esan Central	348	145	0	0	0	108	0	8	2	8	19	180
Edo	Esan West	336	158	0	0	0	344	0	25	1	25	0	0
Edo	Esan North-East	325	276	0	0	0	8	54	19	1	19	0	0
Edo	Owan West	216	435	0	0	0	23	274	4	1	4	13	123
Edo	Iguegben	362	195	0	0	0	185	0	15	3	26	8	70
Edo	Owan East	227	616	0	0	0	176	450	5	2	5	8	73
Edo	Ovia South-West	312	2,231	0	0	0	240	335	9	2	9	6	49
Edo	Ovia North-East	335	1,442	0	0	0	600	260	12	2	12	9	85
Ekiti	Oye	131	0	0	0	0	507	0	8	4	11	7	51
Ekiti	Ikole	134	0	0	0	0	1,073	0	8	4	13	8	55
Ekiti	Ikere	83	0	0	0	0	263	0	4	2	4	6	57
Ekiti	Ido-Osi	137	0	0	0	0	232	0	11	4	17	17	149
Ekiti	Ijero	86	0	0	0	0	391	0	8	4	10	14	122
Ekiti	Ise/Orun	83	0	0	0	0	432	0	12	3	13	7	58
Ekiti	Irepodun/Ifelodun	84	0	0	0	0	357	0	2	1	3	4	34
Ekiti	Ekiti South-West	83	0	0	0	0	346	0	3	1	3	6	56
Ekiti	Ekiti East	108	0	0	0	0	321	0	7	1	8	6	59
Ekiti	Ado-Ekiti	83	0	0	0	0	294	0	6	1	6	4	33
Ekiti	Emure	83	0	0	0	0	301	0	9	1	10	8	80
Ekiti	Ilejemeje	144	0	0	0	0	95	0	3	1	3	4	37
Ekiti	Ekiti West	83	0	0	0	0	366	0	4	1	4	2	19
Ekiti	Gbonyin	83	0	0	0	0	392	0	3	1	3	4	40
Ekiti	Efon	83	0	0	0	0	232	0	4	1	4	7	68
Ekiti	Moba	137	0	0	0	0	200	0	17	1	18	3	27
Enugu	Isi-Uzo	277	2	0	0	311	0	564	2	1	2	3	29
Enugu	Enugu East	297	16	0	0	47	0	320	2	1	2	2	11

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Enugu	Udi	663	558	0	0	0	16	324	4	1	4	4	33
Enugu	Igbo-Eze-South	697	101	0	0	0	0	56	4	1	5	9	80
Enugu	Nsukka	618	236	0	0	0	65	183	2	1	2	2	14
Enugu	Enugu North	289	10	0	0	38	0	59	4	1	4	2	14
Enugu	Udenu	327	93	0	0	0	0	156	24	4	44	17	142
Enugu	Igbo-Eze-North	251	292	0	0	0	0	1	106	4	204	11	86
Enugu	Aninri	317	0	0	0	61	53	250	38	3	52	11	85
Enugu	Igbo-Etiti	319	217	0	0	0	22	86	25	2	34	10	89
Enugu	Enugu South	292	2	0	0	13	0	52	43	3	58	13	123
Enugu	Ezeagu	555	100	0	0	0	0	533	88	4	155	6	37
Enugu	Uzo-Uwani	548	119	0	0	0	41	695	37	3	69	10	84
Enugu	Awgu	315	79	0	0	128	13	227	19	2	19	21	197
Enugu	Oji-River	705	87	0	0	0	0	316	19	4	33	11	102
Enugu	Nkanu East	255	0	0	0	621	143	30	27	4	41	11	90
Enugu	Nkanu West	263	8	0	0	182	0	35	72	4	136	5	27
Gombe	Akko	56	0	1,511	0	0	190	924	38	2	58	9	74
Gombe	Nafada	48	0	508	36	0	127	913	18	3	27	11	97
Gombe	Shomgom	61	0	0	0	0	747	174	26	5	44	15	137
Gombe	Balanga	50	0	0	0	0	1,055	570	24	2	36	8	74
Gombe	Kwami	54	0	1,008	0	0	180	597	13	4	14	14	116
Gombe	Kaltungo	66	0	0	0	0	878	3	13	4	17	12	110
Gombe	Yamaltu/Deba	51	0	1	0	0	1,461	516	15	3	19	12	114
Gombe	Dukku	62	0	3,315	0	0	2	495	591	1	630	0	0
Gombe	Billiri	62	0	0	0	0	463	273	344	1	366	22	216
Gombe	Gombe	47	0	11	0	0	0	41	13	4	21	7	62
Gombe	Funakaye	48	0	268	61	0	347	738	19	3	21	10	97
Imo	Oguta	743	484	0	0	0	0	0	77	1	82	16	154
Imo	Ideato South	465	88	0	0	0	0	0	19	5	39	22	201
Imo	Ideato North	467	190	0	0	0	0	0	13	7	32	16	132
Imo	Owerri West	753	295	0	0	0	0	0	16	4	32	20	194
Imo	Owerri North	756	198	0	0	0	0	0	17	5	41	17	157
Imo	Owerri Municipal	756	58	0	0	0	0	0	11	5	21	17	158
Imo	Ikeduru	752	166	0	0	0	13	0	10	2	11	13	112
Imo	Oru West	575	77	0	0	0	16	0	13	6	29	16	140
Imo	Njaba	509	9	0	0	0	75	0	10	4	13	12	97
Imo	Nkwerre	411	26	0	0	0	13	0	25	5	61	22	208
Imo	Ahiazu-Mbaise	737	76	0	0	0	37	0	39	5	144	0	0
Imo	Ohaji/Egbema	687	891	0	0	0	0	0	21	7	52	22	210
Imo	Mbatoli	714	196	0	0	0	8	0	9	1	9	7	61
Imo	Okigwe	509	60	0	0	0	0	260	7	1	7	8	79
Imo	Ngor-Okpala	756	561	0	0	0	0	0	9	1	9	15	148
Imo	Unuimo	546	87	0	0	0	0	0	5	1	5	5	44
Imo	Ehime -Mbano	615	95	0	0	0	73	0	10	1	10	5	48
Imo	Nwangele	543	17	0	0	0	46	0	24	1	24	0	0
Imo	Ihitte/Uboma	608	63	0	0	0	41	0	8	2	8	10	90
Imo	Ezinihitte	756	109	0	0	0	0	0	8	2	8	6	56
Imo	Isu	581	1	0	0	0	39	0	24	2	24	11	91
Imo	Isiala Mbano	637	58	0	0	0	108	0	8	2	8	6	54
Imo	Aboh-Mbaise	756	184	0	0	0	0	0	17	2	17	12	110
Imo	Obowo	732	55	0	0	0	39	0	9	1	9	10	98
Imo	Orsu	364	56	0	0	0	0	0	13	2	13	18	167
Imo	Oru East	540	81	0	0	0	55	0	26	3	50	10	89
Imo	Orlu	378	118	0	0	0	14	0	6	1	6	7	61
Jigawa	Kaugama	3	882	0	0	0	0	0	6	1	6	7	65
Jigawa	Taura	3	652	0	0	0	0	0	10	2	10	7	68
Jigawa	Sule Tankakar	3	1,282	0	0	0	0	0	16	2	16	10	91
Jigawa	Babura	3	992	0	0	0	0	0	11	2	11	10	92
Jigawa	Guri	3	1,059	0	0	0	0	0	9	1	9	13	126
Jigawa	Gumel	3	223	0	0	0	0	0	41	2	41	20	190
Jigawa	Kiri Kasama	3	796	0	0	0	0	0	24	2	24	17	168
Jigawa	Gwaram	65	174	0	0	0	1,737	0	11	1	11	12	117
Jigawa	Gwiwa	48	0	160	0	0	290	0	12	2	12	10	97
Jigawa	Kazaure	10	333	0	0	0	36	0	5	1	5	8	70
Jigawa	Hadejia	3	32	0	0	0	0	0	11	2	11	8	73
Jigawa	Dutse	43	463	0	0	0	636	0	8	2	8	7	59
Jigawa	Auyo	3	512	0	0	0	0	0	4	2	8	5	41
Jigawa	Miga	3	586	0	0	0	0	0	4	2	8	5	47

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			MH	MM	ML	WH	WM	WL	No. of boreholes	No of boreholes by borehole fields	No. of motorized pumps	No of borehole for motorized pumps	No of boreholes for hand Pumps
Jigawa	Roni	48	108	0	0	0	214	0	4	2	8	4	36
Jigawa	Gagarawa	3	653	0	0	0	0	0	8	2	16	8	78
Jigawa	Malam Maduri	3	765	0	0	0	0	0	3	2	6	5	40
Jigawa	Buji	12	476	0	0	0	72	0	10	2	20	3	27
Jigawa	Yankwashi	6	290	65	0	0	16	0	9	2	18	8	78
Jigawa	Ringim	3	1,056	0	0	0	0	0	21	3	41	10	99
Jigawa	Biriniwa	3	1,567	0	0	0	0	0	16	3	28	9	84
Jigawa	Birnin Kudu	59	262	0	0	0	1,155	0	14	3	18	6	54
Jigawa	Maigatari	3	870	0	0	0	0	0	8	2	16	1	9
Jigawa	Garki	3	1,407	0	0	0	0	0	21	3	38	14	128
Jigawa	kiyawa	14	867	0	0	0	163	0	6	2	12	6	54
Jigawa	Jahun	3	1,171	0	0	0	0	0	4	2	8	6	54
Jigawa	Kafin Hausa	3	1,379	0	0	0	0	0	6	3	11	3	26
Kaduna	Lere	143				4	2,153		4	2	8	4	34
Kaduna	Zaria	144	0	0	0	0	300	0	8	2	16	6	59
Kaduna	Zangon Kataf	164	0	0	0	199	2,468	0	6	3	8	5	39
Kaduna	Birnin Gwari	144	0	0	0	0	6,188	0	7	4	8	7	52
Kaduna	Sanga	250	0	0	0	130	1,126	0	5	2	10	6	54
Kaduna	Sabon Gari	144	0	0	0	0	263	0	4	1	4	5	42
Kaduna	Giwa	143	0	0	0	0	2,066	0	22	3	42	12	110
Kaduna	Kajuru	148	0	0	0	90	2,720	0	8	2	16	7	65
Kaduna	Igabi	144	0	0	0	0	3,727	0	5	2	10	6	56
Kaduna	Ikara	79	0	0	0	0	853	0	8	3	11	8	67
Kaduna	Jaba	179	0	0	0	0	368	0	6	2	12	8	77
Kaduna	Kaduna North	144	0	0	0	0	72	0	10	2	20	13	128
Kaduna	Kachia	144	0	0	0	0	4,633	0	32	3	62	10	83
Kaduna	Soba	144	0	0	0	0	2,234	0	10	1	10	4	40
Kaduna	Chikun	144	0	0	0	0	4,646	0	5	1	5	8	75
Kaduna	Makarfi	113	0	0	0	0	541	0	23	4	44	11	91
Kaduna	kaduna South	144	0	0	0	0	59	0	10	2	10	0	0
Kaduna	Jema'a	248	6	0	0	280	1,375	0	6	1	6	0	0
Kaduna	Kudan	144	0	0	0	0	400	0	14	3	14	8	57
Kaduna	Kauru	144	0	0	0	0	2,464	0	19	3	28	12	100
Kaduna	Kagarko	164	0	0	0	0	1,864	0	15	4	22	11	94
Kaduna	Kaura	252	0	0	0	318	166	0	3	1	3	3	21
Kaduna	Kuban	126	0	0	0	0	2,505	0	6	1	6	6	56
Kano	Tarauni	71	0	0	0	0	28	0	4	1	4	4	37
Kano	Takai	71	0	0	0	0	598	0	5	1	5	7	69
Kano	Garum Mallam	71	0	0	0	0	214	0	4	1	4	6	50
Kano	Ajingi	19	550	0	0	0	164	0	10	3	14	7	61
Kano	Rimin Gado	71	0	0	0	0	225	0	18	1	18	3	28
Kano	Garko	71	0	0	0	0	450	0	11	2	11	12	111
Kano	Gaya	63	79	0	0	0	534	0	14	1	16	0	0
Kano	Tsanyawa	68	0	0	0	0	492	0	6	1	6	15	148
Kano	Bagwai	71	0	0	0	0	405	0	4	1	5	10	97
Kano	Gezawa	63	42	0	0	0	297	0	4	2	4	15	136
Kano	Sumaila	71	0	0	0	0	1,250	0	4	1	4	7	68
Kano	Gwale	71	0	0	0	0	18	0	4	1	4	10	94
Kano	Shanono	66	0	0	0	0	697	0	6	2	7	14	133
Kano	Rano	71	0	0	0	0	520	0	5	2	10	15	145
Kano	Tofa	71	0	0	0	0	202	0	4	2	8	12	115
Kano	Gabasawa	10	540	0	0	0	66	0	9	2	10	26	251
Kano	Gwarzo	71	0	0	0	0	393	0	6	1	7	20	195
Kano	Ungongo	71	0	0	0	0	204	0	25	2	50	0	0
Kano	Warawa	71	0	0	0	0	360	0	4	1	5	11	109
Kano	Doguwa	85	0	0	0	0	1,473	0	5	1	5	12	118
Kano	Dawakin Tofa	71	0	0	0	0	479	0	3	1	3	7	63
Kano	Dawakin Kudu	71	0	0	0	0	384	0	3	2	3	14	133
Kano	Dambatta	3	732	0	0	0	0	0	5	1	6	14	134
Kano	Dala	71	0	0	0	0	19	0	18	1	20	33	322
Kano	Bebeji	71	0	0	0	0	717	0	4	1	4	12	111
Kano	Kabo	71	0	0	0	0	341	0	5	1	5	14	132
Kano	Wudil	71	0	0	0	0	362	0	6	1	7	21	200
Kano	Bunkure	71	0	0	0	0	487	0	6	1	6	13	127
Kano	Tudun Wada	71	0	0	0	0	1,204	0	2	2	4	15	142
Kano	Fagge	71	0	0	0	0	21	0	19	1	21	0	0
Kano	Bichi	67	42	0	0	0	569	0	5	1	6	17	161
Kano	Rogo	74	0	0	0	0	802	0	5	1	6	10	100

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Kano	Kibiya	71	0	0	0	0	404	0	8	1	8	12	111
Kano	Kiru	71	0	0	0	0	927	0	4	1	5	12	113
Kano	Kura	71	0	0	0	0	206	0	7	1	7	18	176
Kano	Madobi	71	0	0	0	0	273	0	9	2	18	0	0
Kano	Nassarawa	71	0	0	0	0	34	0	8	3	15	19	178
Kano	Albasu	71	0	0	0	0	398	0	6	1	7	20	193
Kano	Makoda	9	406	0	0	0	35	0	4	2	8	15	140
Kano	Minjibir	45	160	0	0	0	256	0	7	1	8	24	240
Kano	Karaye	71	0	0	0	0	479	0	5	1	6	9	86
Kano	Kunchi	52	192	0	0	0	479	0	6	1	7	9	81
Kano	Kano Municipal	71	0	0	0	0	17	0	34	2	68	0	0
Kano	Kumbotso	71	0	0	0	0	158	0	5	1	6	16	158
Katsina	Jibia	59	0	15	0	0	1,023	0	5	5	11	40	383
Katsina	Ingawa	65	0	0	0	0	892	0	5	2	5	19	179
Katsina	kaita	24	0	762	0	0	163	0	4	2	8	10	97
Katsina	Kafur	71	0	0	0	0	1,106	0	3	3	5	9	75
Katsina	Kankara	59	0	0	0	0	1,462	0	17	1	19	0	0
Katsina	Kankia	60	0	0	0	0	824	0	18	1	20	0	0
Katsina	Katsina	19	0	134	0	0	8	0	23	3	45	8	63
Katsina	Rimi	49	0	109	0	0	343	0	17	3	33	13	111
Katsina	Sabuwa	144	0	0	0	0	642	0	16	3	22	14	123
Katsina	Faskari	67	0	0	0	0	1,750	0	21	1	24	15	143
Katsina	Safana	12	0	282	0	0	0	0	28	2	56	16	158
Katsina	Mai'Adua	17	0	528	0	0	0	0	16	2	32	9	83
Katsina	Mani	44	0	277	0	0	508	0	36	4	72	0	0
Katsina	Musawa	60	0	0	0	0	849	0	16	3	29	8	67
Katsina	Sandamu	59	0	0	0	0	1,419	0	15	1	17	20	196
Katsina	Batagarawa	40	0	198	0	0	235	0	25	1	27	18	174
Katsina	Bindawa	59	0	0	0	0	398	0	22	1	24	13	122
Katsina	Batsari	59	0	0	0	0	1,107	0	12	2	24	17	161
Katsina	Dutsin Ma	59	0	0	0	0	527	0	13	2	26	10	95
Katsina	Daura	17	0	316	0	0	0	0	16	3	28	11	103
Katsina	Kusada	68	0	0	0	0	390	0	27	2	54	16	157
Katsina	Bakori	65	0	0	0	0	679	0	18	2	36	11	103
Katsina	Zango	27	154	234	0	0	214	0	31	3	54	15	146
Katsina	Danja	102	0	0	0	0	501	0	14	3	27	9	75
Katsina	Funtua	97	0	0	0	0	448	0	22	2	44	13	122
Katsina	Malumfashi	63	0	0	0	0	674	0	22	2	44	9	81
Katsina	Dandume	117	0	0	0	0	423	0	39	2	78	18	171
Katsina	Dan Musa	59	0	0	0	0	792	0	12	1	13	7	66
Katsina	Baure	3	706	0	0	0	0	0	12	1	13	7	66
Katsina	Matazu	59	0	0	0	0	503	0	19	4	29	14	119
Katsina	Mashi	17	0	904	0	0	1	0	9	1	10	5	49
Katsina	Dutsi	23	0	240	0	0	43	0	29	1	32	10	99
Katsina	Charanchi	59	0	5	0	0	466	0	15	1	17	9	82
Katsina	Kurfi	57	0	27	0	0	545	0	10	1	11	7	69
Kebbi	Argungu	9	302	995	0	0	0	0	16	2	32	11	108
Kebbi	Suru	10	118	1,158	66	0	0	11	9	2	18	12	116
Kebbi	Koko/Besse	20	57	668	0	0	18	557	12	1	13	8	78
Kebbi	Sakaba	59	0	0	0	0	1,261	0	9	2	9	10	83
Kebbi	Augie	9	293	894	0	0	0	0	11	3	15	12	107
Kebbi	Shanga	54	104	36	0	0	1,426	77	20	3	39	10	88
Kebbi	Gwandu	9	0	1,019	0	0	0	0	14	3	27	9	75
Kebbi	Wasagu/Danko	60	0	0	0	0	4,019	0	10	3	18	12	106
Kebbi	Bagudo	23	525	3,277	420	0	565	1	7	5	11	10	72
Kebbi	Jega	18	76	308	0	0	0	508	8	7	20	8	57
Kebbi	Fakai	59	0	0	0	0	2,224	25	12	1	13	10	95
Kebbi	Dandi	11	29	1,878	0	0	0	98	4	3	7	7	65
Kebbi	Ngaski	59	0	0	3	0	2,633	0	11	5	19	10	73
Kebbi	Kalgo	9	195	974	0	0	0	6	5	2	10	9	81
Kebbi	Arewa Dandi	9	384	3,521	0	0	0	0	9	1	10	7	70
Kebbi	Birnin Kebbi	9	235	1,093	0	0	0	0	12	8	20	17	145
Kebbi	Zuru	59	0	0	0	0	654	0	10	7	38	9	81
Kebbi	Bunza	9	120	757	0	0	0	0	24	3	47	20	192
Kebbi	Yauri	45	251	23	359	0	758	0	7	6	14	10	81
Kebbi	Maiyama	13	0	892	24	0	1	112	14	3	27	12	105
Kebbi	Aleiro	9	27	324	0	0	0	0	10	5	19	12	102
Kogi	Idah	538	36	0	0	0	0	0	7	3	13	11	100

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Kogi	Ankpa	237	991	0	0	0	0	209	22	3	41	8	71
Kogi	Ijumu	116	0	0	0	0	1,306	0	15	2	30	11	100
Kogi	Bassa	164	339	0	0	0	613	974	6	2	6	9	79
Kogi	Kabba/Bunu	139	0	0	0	0	2,707	0	10	6	18	7	46
Kogi	Dekina	240	1,877	0	0	0	121	464	9	7	18	11	86
Kogi	Igalamela-Odolu	890	1,115	0	0	0	7	1,053	4	3	7	6	45
Kogi	Lokoja	116	295	0	1,044	0	1,841	0	3	1	3	3	22
Kogi	Ibaji	530	1,347	0	0	0	0	31	16	3	23	7	59
Kogi	Kogi	90	349	0	1,149	0	0	0	12	1	13	9	89
Kogi	Ajaokuta	161	48	0	0	0	1,128	187	12	4	19	10	94
Kogi	Yagba West	144	0	0	0	0	1,277	0	18	1	19	11	107
Kogi	Yagba East	144	0	0	0	0	1,397	0	17	4	24	8	59
Kogi	Mopa-Muro	144	0	0	0	0	902	0	14	3	20	10	82
Kogi	Ogori/Magongo	89	0	0	0	0	79	0	38	4	49	9	78
Kogi	Ofu	504	1,045	0	0	0	40	596	4	2	4	9	81
Kogi	Okene	141	0	0	0	0	328	0	9	3	16	12	108
Kogi	Olamaboro	337	958	0	0	0	0	174	13	4	15	6	46
Kogi	Okehi	142	0	0	0	0	661	0	17	1	18	11	102
Kogi	Omala	160	928	0	0	0	0	739	23	1	24	12	118
Kogi	Adavi	145	0	0	0	0	719	0	6	1	6	4	38
Kwara	Irepodun	140	0	0	0	0	737	0	4	1	5	2	12
Kwara	Ilorin West	144	0	0	0	0	105	0	16	4	26	11	94
Kwara	Oke Ero	144	0	0	0	0	438	0	24	1	26	9	85
Kwara	Pategi	113	0	0	1,398	0	1,517	0	8	3	11	9	74
Kwara	Offa	111	0	0	0	0	95	0	18	1	20	14	132
Kwara	Ekiti	144	0	0	0	0	480	0	8	3	14	9	84
Kwara	Kaiama	144	0	0	0	0	6,979	0	19	1	20	11	103
Kwara	Ifelodun	144	0	0	22	0	3,417	0	8	1	9	4	34
Kwara	Edu	110	0	0	1,355	0	1,188	0	29	1	32	0	0
Kwara	Asa	143	0	0	0	0	1,287	0	3	1	3	2	19
Kwara	Isin	144	0	0	0	0	634	0	8	3	12	6	57
Kwara	Baruten	128	0	0	0	0	9,762	0	7	1	8	0	0
Kwara	Moro	144	0	0	0	0	3,276	0	3	1	3	2	13
Kwara	Ilorin East	144	0	0	0	0	486	0	11	1	11	10	94
Kwara	Oyun	113	0	0	0	0	477	0	10	2	11	7	52
Kwara	Ilorin South	144	0	0	0	0	175	0	11	3	15	11	100
Lagos	Lagos Mainland	265	19	0	0	0	0	0	6	1	6	5	48
Lagos	Lagos Island	265	9	0	0	0	0	0	4	1	4	2	14
Lagos	Alimosho	273	185	0	0	0	0	0	11	1	12	10	96
Lagos	Amuwo Odofin	265	135	0	0	0	0	0	5	1	5	3	26
Lagos	Ikeja	265	46	0	0	0	0	0	16	1	17	3	26
Lagos	Kosofe	274	82	0	0	0	0	0	7	1	7	3	28
Lagos	Eti Osa	265	193	0	0	0	0	0	19	1	20	0	0
Lagos	Apapa	265	27	0	0	0	0	0	0	0	0	0	0
Lagos	Ojo	265	158	0	0	0	0	0	0	0	0	0	0
Lagos	Mushin	265	18	0	0	0	0	0	0	0	0	0	0
Lagos	Ibeju Lekki	265	455	0	0	0	0	0	0	0	0	2	18
Lagos	Oshodi/Isolo	265	45	0	0	0	0	0	0	0	0	0	0
Lagos	Agege	265	11	0	0	0	0	0	0	0	0	0	0
Lagos	Ikorodu	279	394	0	0	0	0	0	0	0	0	0	0
Lagos	Ifako/Ijaye	265	27	0	0	0	0	0	0	0	0	0	0
Lagos	Epe	267	1,187	0	0	0	0	0	0	0	0	8	76
Lagos	Badagry	265	442	0	0	0	0	0	0	0	0	0	0
Lagos	Surulere	265	23	0	0	0	0	0	0	0	0	2	16
Lagos	Shomolu	265	12	0	0	0	0	0	0	0	0	0	0
Lagos	Ajeromi/Ifelodun	265	12	0	0	0	0	0	0	0	0	0	0
Nasarawa	Nasarawa Egon	249	0	0	0	0	1,208	0	0	0	0	8	71
Nasarawa	Nasarawa	195	736	1,807	4	38	2,832	319	0	0	0	0	0
Nasarawa	Keana	149	0	0	0	442	602	3	0	0	0	3	20
Nasarawa	Kokona	249	0	0	0	48	1,796	0	0	0	0	3	29
Nasarawa	Toto	154	290	27	1,606	0	938	43	0	0	0	0	0
Nasarawa	Doma	134	768	666	0	655	54	571	0	0	0	0	0
Nasarawa	Karu	249	0	0	0	0	2,640	0	0	0	0	0	0
Nasarawa	Wamba	249	0	0	0	0	1,156	0	10	1	10	9	86
Nasarawa	Obi	152	11	358	0	419	164	15	10	6	10	12	80
Nasarawa	Akwanga	249	0	0	0	0	996	0	5	3	6	6	41

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Nasarawa	Awe	146	541	0	0	616	1,399	0	6	2	7	5	38
Nasarawa	Keffi	249	0	0	0	0	138	0	7	5	8	8	50
Nasarawa	Lafia	195	240	660	0	508	1,347	0	6	5	7	9	70
Niger	Kontagora	101	0	0	552	0	1,530	0	17	1	18	10	97
Niger	Gurara	143	0	0	10	0	945	0	4	1	4	5	46
Niger	Tafa	144	0	0	0	0	222	0	7	5	7	11	71
Niger	Suleja	144	0	0	0	0	119	0	8	1	8	4	38
Niger	Bida	80	0	0	51	0	0	0	5	3	5	6	44
Niger	Mokwa	88	17	0	3,756	0	568	0	9	1	9	1	8
Niger	Magama	77	18	0	1,026	0	3,066	0	15	4	15	9	79
Niger	Katcha	81	550	0	975	0	158	0	5	3	7	5	39
Niger	Muya	144	0	0	0	0	2,177	0	6	2	6	6	48
Niger	Agwara	54	0	0	440	0	1,100	0	8	1	9	7	63
Niger	Edati	80	12	0	1,740	0	0	0	22	1	23	3	24
Niger	Paikoro	144	0	0	13	0	2,054	0	10	3	30	2	11
Niger	Gbako	80	14	0	1,740	0	0	0	9	5	21	14	123
Niger	Agaie	84	75	0	1,703	0	126	0	7	4	8	11	83
Niger	Shiroro	144	0	0	0	0	5,017	0	4	4	6	8	64
Niger	Rijau	59	0	0	0	0	3,198	0	6	1	7	9	86
Niger	Bosso	134	76	0	142	0	1,375	0	3	2	3	3	27
Niger	Wushishi	85	17	0	1,708	0	155	0	11	5	29	22	201
Niger	Borgu	84	0	295	2,154	0	8,831	0	7	2	8	8	69
Niger	Chanchaga	144	0	0	0	0	72	0	4	3	7	7	60
Niger	Mariga	105	0	0	0	0	5,556	0	5	4	8	8	66
Niger	Rafi	143	0	0	75	0	3,607	0	9	1	9	12	119
Niger	Lavun	80	0	0	2,837	0	0	0	6	2	12	9	84
Niger	Lapai	89	108	0	2,469	0	475	0	11	3	11	7	55
Niger	Mashegu	89	0	0	7,903	0	1,286	0	4	4	6	6	38
Ogun	Ewekoro	127	239	281	0	0	0	75	9	4	11	9	66
Ogun	Odogbolu	281	354	87	0	0	0	101	17	1	19	0	0
Ogun	Abeokuta South	82	0	2	0	0	52	17	9	1	10	14	131
Ogun	Egbado North	117	563	462	0	0	0	1,049	9	2	9	10	91
Ogun	Remo North	88	6	0	0	0	157	37	5	3	15	11	103
Ogun	Egbado South	327	629	0	0	0	0	0	5	3	6	7	56
Ogun	Abeokuta North	90	40	47	0	0	351	371	6	3	10	12	110
Ogun	Odeda	83	0	35	0	0	1,527	0	0	0	0	3	17
Ogun	Ado Odo/Ota	358	879	0	0	0	0	0	0	0	0	5	38
Ogun	Ogun waterside	281	1,002	0	0	0	0	0	0	0	0	4	19
Ogun	Obafemi Owode	114	238	176	0	0	383	615	0	0	0	8	70
Ogun	Ipokia	358	630	0	0	0	0	0	0	0	0	4	24
Ogun	Shagamu	268	479	102	0	0	0	34	0	0	0	7	61
Ogun	Imeko Afon	83	0	0	0	0	1,438	219	0	0	0	0	0
Ogun	Ijebu North East	82	0	0	0	0	46	72	0	0	0	6	49
Ogun	Ijebu ode	207	111	36	0	0	0	45	0	0	0	31	300
Ogun	Ikenne	124	31	16	0	0	4	93	0	0	0	4	35
Ogun	Ijebu North	83	0	0	0	0	824	144	0	0	0	11	88
Ogun	Ijebu East	140	706	9	0	0	1,385	136	0	0	0	6	52
Ogun	Ifo	311	519	3	0	0	0	0	0	0	0	11	91
Ondo	Owo	87	0	0	0	0	1,005	22	0	0	0	5	42
Ondo	Irele	378	906	0	0	0	1	57	0	0	0	13	115
Ondo	Ondo West	83	0	0	0	0	971	0	0	0	0	4	28
Ondo	Okitipupa	366	738	0	0	0	0	66	0	0	0	5	16
Ondo	Odigbo	187	706	0	0	0	894	221	0	0	0	7	63
Ondo	Ile Oluji/Okeigbo	83	0	0	0	0	698	0	0	0	0	7	40
Ondo	Ilaje	268	1,319	0	0	0	0	0	0	0	0	40	390
Ondo	Ifedore	83	0	0	0	0	296	0	10	2	10	10	90
Ondo	Akoko North West	83	0	0	0	0	513	0	4	3	4	8	59
Ondo	Idanre	97	119	0	0	0	1,762	35	11	1	12	13	124
Ondo	Akoko South East	83	0	0	0	0	226	0	4	2	5	9	79
Ondo	Akure North	83	0	0	0	0	661	0	9	3	10	11	101
Ondo	Akoko North East	83	0	0	0	0	373	0	7	1	7	8	74
Ondo	Ose	158	238	0	0	0	844	384	4	1	4	13	126
Ondo	Ondo East	83	0	0	0	0	354	0	11	1	12	8	73
Ondo	Akure South	83	0	0	0	0	332	0	4	1	4	5	40

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Ondo	Ese Odo	283	763	0	0	0	0	0	7	3	7	8	63
Ondo	Akoko South West	83	0	0	0	0	530	0	11	1	13	15	145
Osun	Odo Otin	83	0	0	0	0	295	0	7	1	7	9	81
Osun	Irewole	83	0	0	0	0	271	0	9	1	10	11	103
Osun	Obokun	83	0	0	0	0	527	0	7	4	9	8	65
Osun	Isokan	83	0	0	0	0	179	0	4	1	4	5	41
Osun	Irepodun	83	0	0	0	0	64	0	28	1	31	3	29
Osun	Ilesha West	83	0	0	0	0	63	0	3	1	3	9	88
Osun	Ola oluwa	83	0	0	0	0	328	0	11	1	12	12	114
Osun	Atakunmosa West	83	0	0	0	0	578	0	6	1	6	5	42
Osun	Oriade	83	0	0	0	0	466	0	7	1	8	5	48
Osun	Olorunda	83	0	0	0	0	97	0	6	1	7	5	46
Osun	Orolu	83	0	0	0	0	80	0	5	1	5	4	33
Osun	Atakunmosa East	83	0	0	0	0	238	0	7	1	8	2	14
Osun	Ilesha East	83	0	0	0	0	71	0	6	1	6	5	41
Osun	Ila	99	0	0	0	0	303	0	4	1	4	4	30
Osun	Iwo	83	0	0	0	0	215	0	4	1	4	4	31
Osun	Osogbo	83	0	0	0	0	47	0	9	1	9	5	44
Osun	Ede North	83	0	0	0	0	111	0	8	1	9	3	29
Osun	Ejigbo	83	0	0	0	0	374	0	3	1	3	3	29
Osun	Ife East	83	0	0	0	0	172	0	4	1	5	3	22
Osun	Boluwaduro	83	0	0	0	0	144	0	7	1	8	4	33
Osun	Ife North	83	0	0	0	0	890	0	4	1	5	3	29
Osun	Boripe	83	0	0	0	0	132	0	2	1	2	2	14
Osun	Ifelodun	83	0	0	0	0	115	0	10	1	11	8	70
Osun	Ede South	83	0	0	0	0	219	0	10	1	11	2	18
Osun	Aiyedire	83	0	0	0	0	263	0	5	1	5	1	4
Osun	Egbedore	83	0	0	0	0	271	0	6	1	7	6	57
Osun	Aiyedade	83	0	0	0	0	1,114	0	6	1	6	3	27
Osun	Ifedayo	87	0	0	0	0	128	0	3	1	4	3	24
Osun	Ife Central	83	0	0	0	0	111	0	5	1	5	4	40
Osun	Ife South	83	0	0	0	0	731	0	6	1	7	5	47
Oyo	Ogo Oluwa	83	0	0	0	0	369	0	4	1	4	2	18
Oyo	Ona ara	83	0	0	0	0	290	0	3	1	4	1	6
Oyo	Lagelu	83	0	0	0	0	339	0	2	1	2	2	15
Oyo	Orelope	100	0	0	0	0	918	0	6	1	7	2	11
Oyo	Ori Ire	109	0	0	0	0	2,119	0	4	1	4	4	35
Oyo	Atiba	83	0	0	0	0	1,759	0	2	1	2	2	12
Oyo	Ibarapa Central	83	0	10	0	0	431	0	11	1	12	7	69
Oyo	Oluyole	83	0	0	0	0	630	0	10	1	11	6	52
Oyo	Oyo East	83	0	0	0	0	144	0	15	1	17	16	160
Oyo	Oyo West	83	0	0	0	0	526	0	9	1	10	9	89
Oyo	Kajola	83	0	10	0	0	600	0	4	1	4	4	39
Oyo	Saki East	92	0	0	0	0	1,572	0	5	1	5	6	57
Oyo	Egbeda	83	0	0	0	0	191	0	8	1	9	6	57
Oyo	Saki West	84	0	0	0	0	2,017	0	5	2	5	6	49
Oyo	Irepo	144	0	0	0	0	986	0	14	1	15	13	126
Oyo	Surulere	111	0	0	0	0	852	0	7	1	8	2	18
Oyo	Akinyele	83	0	0	0	0	519	0	8	1	9	4	35
Oyo	Atisbo	83	0	0	0	0	3,002	0	8	2	9	11	98
Oyo	Olorunsogo	136	0	0	0	0	1,070	0	6	1	6	6	58
Oyo	Ogbomosho South	83	0	0	0	0	68	0	27	1	29	10	95
Oyo	Ogbomosho North	83	0	0	0	0	185	0	19	1	21	15	140
Oyo	Iwajowa	83	0	67	0	0	2,466	0	5	1	6	6	56
Oyo	Ibadan North	83	0	0	0	0	27	0	7	1	8	8	78
Oyo	Ido	83	0	0	0	0	987	0	9	1	10	9	86
Oyo	Itesiwaju	83	0	0	0	0	1,497	19	5	1	5	6	57
Oyo	Iseyin	83	0	18	0	0	1,319	13	4	1	4	5	42
Oyo	Ibarapa North	83	0	58	0	0	1,162	0	7	1	7	1	7
Oyo	Ibadan North East	83	0	0	0	0	18	0	17	1	19	2	19
Oyo	Afijio	83	0	0	0	0	723	0	5	2	6	6	51
Oyo	Ibadan South West	83	0	0	0	0	40	0	18	1	20	0	0

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Oyo	Ibadan North West	83	0	0	0	0	26	0	6	1	7	6	56
Oyo	Ibarapa East	83	0	0	0	0	839	0	8	2	8	10	87
Oyo	Ibadan South East	83	0	0	0	0	17	0	14	3	15	16	140
Plateau	Pankshin	183	0	0	0	0	1,365	158	6	2	7	8	67
Plateau	Qua'an Pan	244	7	0	0	0	2,428	42	16	1	18	0	0
Plateau	Riyom	233	0	0	0	181	617	8	5	1	6	6	58
Plateau	Jos South	163	0	0	0	0	442	68	15	1	17	0	0
Plateau	Langtang North	109	48	0	0	27	763	0	8	1	9	0	0
Plateau	Jos North	80	0	0	0	0	291	0	5	1	5	6	57
Plateau	Shendam	156	707	0	0	82	1,492	195	15	1	17	0	0
Plateau	Jos East	108	0	0	0	0	1,019	0	13	3	16	18	172
Plateau	Barkin Ladi	150	0	0	0	1	933	98	13	3	13	17	148
Plateau	Kanke	119	0	0	0	0	926	0	13	3	13	20	181
Plateau	Langtang South	111	216	0	0	454	516	1	43	3	53	6	47
Plateau	Wase	54	605	555	0	436	981	2,452	10	3	10	13	115
Plateau	Kanam	90	159	861	0	0	1,541	37	44	1	49	0	0
Plateau	Bokkos	238	0	0	0	0	1,640	42	9	5	10	14	121
Plateau	Bassa	138	0	0	0	7	1,673	38	6	1	6	8	76
Plateau	Mangu	148	0	0	0	0	1,521	131	15	3	16	19	175
Plateau	Mikang	222	0	0	0	0	607	132	10	1	10	14	132
Rivers	Ahoada East	693	341	0	0	0	0	0	9	4	9	16	137
Rivers	Ogba/Egbema/ Ndoni	768	970	0	0	0	0	0	11	7	24	16	135
Rivers	Andoni	538	233	0	0	0	0	0	10	4	11	15	134
Rivers	Degema	1,140	1,011	0	0	0	0	0	14	2	15	20	190
Rivers	Ogu Bolo	538	89	0	0	0	0	0	15	3	15	18	161
Rivers	Ahoada West	754	403	0	0	0	0	0	20	3	23	29	274
Rivers	Oyigbo	785	248	0	0	0	0	0	13	3	14	16	141
Rivers	Omumma	806	170	0	0	0	0	0	7	1	7	12	112
Rivers	Akuku Toru	1,203	1,444	0	0	0	0	0	15	1	15	0	0
Rivers	Bonny	559	642	0	0	0	0	0	5	1	5	11	102
Rivers	Abua/Odual	900	704	0	0	0	0	0	13	1	13	25	242
Rivers	Etche	780	805	0	0	0	0	0	4	1	4	1	8
Rivers	Port-Harcourt	809	109	0	0	0	0	0	13	1	13	26	253
Rivers	Obio/Akpor	877	260	0	0	0	0	0	6	1	6	5	46
Rivers	Ikwerre	731	656	0	0	0	0	0	5	1	5	7	67
Rivers	Gokana	643	126	0	0	0	0	0	6	1	6	9	82
Rivers	Tai	805	159	0	0	0	0	0	18	1	18	14	137
Rivers	Khana	783	560	0	0	0	0	0	11	1	11	22	218
Rivers	Okrika	573	222	0	0	0	0	0	7	1	7	9	89
Rivers	Asari-Toru	1,122	113	0	0	0	0	0	28	1	28	0	0
Rivers	Eleme	553	138	0	0	0	0	0	34	1	34	9	88
Rivers	Opobo/Nkoro	569	130	0	0	0	0	0	8	1	8	8	71
Rivers	Emuoha	818	831	0	0	0	0	0	7	1	7	13	122
Sokoto	Goronyo	7	0	130	1,575	0	0	0	4	1	4	6	58
Sokoto	Bodinga	18	0	177	68	0	0	320	8	1	8	15	147
Sokoto	Tangaza	10	0	2,269	0	0	0	210	11	1	11	3	23
Sokoto	Sokoto North	21	0	7	0	0	0	43	7	1	7	10	92
Sokoto	Tambuwal	10	49	1,256	402	0	0	12	24	1	24	16	159
Sokoto	Gada	10	0	669	622	0	0	6	10	1	10	18	177
Sokoto	Sabon Birni	8	0	302	2,053	0	0	0	6	1	6	8	73
Sokoto	Binji	9	22	537	0	0	0	0	6	7	31	8	76
Sokoto	Gwadabawa	19	0	349	8	0	0	634	8	7	28	7	63
Sokoto	Rabah	9	0	645	1,778	0	0	11	3	2	3	5	39
Sokoto	Tureta	12	0	844	1,493	0	49	0	26	6	122	0	0
Sokoto	Isa	11	9	921	1,229	0	0	0	8	6	14	10	82
Sokoto	Gudu	9	0	3,481	0	0	0	0	7	9	25	13	112
Sokoto	Sokoto South	23	0	0	0	0	0	41	5	6	21	8	71
Sokoto	Silame	9	86	705	0	0	0	0	4	3	7	7	56
Sokoto	Shagari	12	0	561	665	0	0	107	11	7	43	12	99
Sokoto	Yabo	13	0	590	0	0	0	199	5	7	17	8	65
Sokoto	Dange-Shuni	12	0	284	677	0	0	250	4	4	6	5	28
Sokoto	Kware	20	0	163	0	0	0	392	6	7	18	8	60
Sokoto	Illela	18	0	492	0	0	0	755	4	1	4	6	56
Sokoto	Wurno	16	0	398	130	0	0	156	28	5	140	0	0
Sokoto	Wamako	14	0	431	0	0	0	267	3	3	5	5	44

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Sokoto	Kebbe	31	0	511	751	0	964	394	6	8	15	8	67
Taraba	Yorro	113	0	0	0	0	1,274	0	4	4	8	6	44
Taraba	Gassol	58	1,372	0	0	0	4,142	30	7	9	23	8	61
Taraba	Takum	187	0	0	0	0	2,502	0	5	5	17	5	34
Taraba	Gashaka	115	0	0	0	235	8,150	0	4	6	16	5	41
Taraba	Bali	114	0	0	0	77	9,061	0	6	10	18	8	62
Taraba	Ardo-Kola	106	165	0	0	0	2,094	0	9	7	34	4	31
Taraba	Karim Lamido	39	3,169	0	0	0	2,505	939	8	6	14	10	72
Taraba	Kurmi	129	0	0	0	121	4,229	0	10	1	11	10	90
Taraba	Ussa	210	0	0	0	0	1,494	0	21	4	39	24	224
Taraba	Ibi	89	1,676	0	0	85	905	4	13	1	14	13	123
Taraba	Zing	113	0	0	0	0	1,029	0	12	2	13	12	105
Taraba	Lau	67	415	0	0	0	1,242	2	21	2	22	20	189
Taraba	Jalingo	113	0	0	0	0	191	0	8	2	9	8	70
Taraba	Wukari	101	752	0	0	0	810	2,743	14	6	29	19	178
Taraba	Donga	111	0	0	0	0	2,957	162	13	2	14	13	117
Taraba	Sardauna	124	0	0	0	662	3,937	0	12	1	12	11	108
Yobe	Geidam	3	4,352	0	0	0	0	0	10	4	11	7	42
Yobe	Nangere	25	268	711	0	0	0	0	14	1	16	14	137
Yobe	Damaturu	5	2,364	0	0	0	0	0	11	3	12	11	84
Yobe	Barde	3	771	0	0	0	0	0	50	1	54	0	0
Yobe	Jakusko	3	3,937	0	0	0	0	0	33	5	84	21	190
Yobe	Potiskum	33	0	558	0	0	0	0	15	3	17	14	136
Yobe	Gujba	26	2,153	22	0	0	60	999	19	2	20	19	184
Yobe	Tarmua	3	4,589	0	0	0	0	0	6	2	12	9	85
Yobe	Gulani	49	0	146	0	0	945	996	4	2	4	6	50
Yobe	Nguru	3	916	0	0	0	0	0	5	1	5	2	20
Yobe	Fune	14	3,866	786	0	0	0	291	5	2	10	4	40
Yobe	Fika	47	56	1,442	0	0	105	603	14	2	28	28	272
Yobe	Borsari	3	3,814	0	0	0	0	0	10	2	10	8	60
Yobe	Karasuwa	3	1,161	0	0	0	0	0	12	7	30	10	67
Yobe	Yusufari	3	3,925	0	0	0	0	0	3	2	6	6	56
Yobe	Yunusari	3	3,786	0	0	0	0	0	11	6	27	7	58
Yobe	Machina	25	828	0	0	0	384	0	7	2	14	7	67
Zamfara	Tsafe	59	0	0	0	0	1,699	0	19	6	31	30	290
Zamfara	Kaura Namoda	59	0	0	0	0	868	0	8	6	14	8	57
Zamfara	Anka	59	0	22	0	0	2,726	0	4	1	4	7	63
Zamfara	Bakura	18	0	1,133	149	0	86	0	5	2	10	8	78
Zamfara	Maru	97	0	0	0	0	6,657	0	4	2	8	8	70
Zamfara	Maradun	32	44	1,634	52	0	999	0	4	2	8	9	86
Zamfara	Bungudu	59	0	0	0	0	2,293	0	4	2	4	3	28
Zamfara	Talata Mafara	48	0	387	0	0	1,044	0	19	2	38	18	180
Zamfara	Gummi	34	141	870	414	0	1,187	0	11	3	21	15	134
Zamfara	Birnin Magaji/Kiyaw	59	0	0	0	0	1,188	0	6	5	11	14	131
Zamfara	Gusau	74	0	0	0	0	3,366	0	15	1	16	20	195
Zamfara	Shinkafi	17	185	393	49	0	48	0	11	5	16	15	133
Zamfara	Zurmi	50	66	526	0	0	2,243	0	12	2	24	14	137
Zamfara	Bukkuyum	55	109	181	0	0	2,927	0	12	3	22	16	148
FCT Abuja	Kwali	124	0	0	385	0	821	0	9	7	14	14	113
FCT Abuja	Municipal Area Council	163	0	0	0	0	1,769	0	12	2	24	14	138
FCT Abuja	Bwari	166	0	0	0	0	914	0	28	2	56	14	136
FCT Abuja	Abaji	114	0	0	462	0	530	0	6	4	6	8	66
FCT Abuja	Kuje	151	0	0	136	0	1,508	0	18	4	33	21	201
FCT Abuja	Gwagwalada	144	0	0	0	0	1,044	0	16	4	30	3	18

Source: JICA Project Team

(4) Weathered Aquifer

Thickness of weathered aquifer is small. Therefore, influence area is also small, and yield of borehole field cannot be large.

Rural water supply

Almost 100% of rural water supply depends on groundwater for water sources. Water demand by rural community is only around 150m3/day in total. Weathered aquifer can provide such amount, even though weathered aquifer does not show high permeability and does not receive high groundwater recharge. Adequate boreholes arrangement can enlarge influence area and provide enough groundwater.

Small town water supply

Small water supply also depends on groundwater for water sources. Water demand can be satisfied by adequate borehole distribution based on scale of groundwater recharge of the area. It is important to decide optimum yield from individual borehole. Hand-pump cannot enlarge influence area effectively due to too small pumping capacity, leading to inefficient groundwater extraction. Therefore, motorized pumping must be adopted.

(5) Multiple aquifer

Large amount of groundwater can be pumped up from boreholes in sedimentary rock area where aquifer shows large thickness, so that influence area of borehole is also large.

Rural water supply

It is easy to get necessary amount of groundwater from multiple aquifer for rural water supply. However, motorized pump is necessary for pumping in multiple aquifer area. It is disadvantage for rural water supply due to higher cost.

Small town water supply

Groundwater can be pumped up enough for small town water supply from multiple aquifer. Groundwater level is so deep that motorized pump is necessary for pumping in multiple aquifer area. Users Association Committee (UAC) must be established for operation and maintenance of boreholes.

Large urban water supply

Available amount of water is so large that groundwater can be used even for large urban water supply in multiple aquifer area. It is no problem that large amount of groundwater is pumped up in the area with high groundwater recharge. However, there is possibility of over-pumping exceeding the limit of groundwater recharge where aquifer shows high capacity for pumping. Groundwater monitoring is necessary to inspect over-pumping in above area.

Groundwater recharge is smaller in Niger North (HA-1) and Chad basin (HA-8) area than the other areas. On the other hand, there are excellent aquifers of sandstone with high permeability in both areas, where influence area of borehole can be expanded to compensate scarcity of groundwater recharge. However, influence area will continue expansion as groundwater extraction from boreholes increases, causing series drawdown of groundwater level in large area. Groundwater level must be monitored to control yield if necessary.

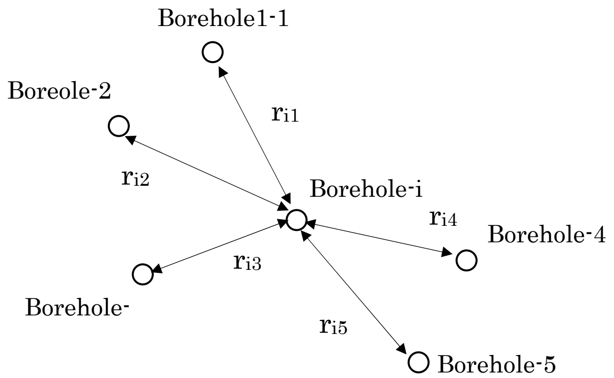
(6) Allocation of Pumping Yield to Minimize Drawdown of Groundwater Level

It is possible to minimize borehole interference by controlling yield of each borehole. Limited groundwater recharge can be utilized to maximum extent by this method. Linear programming method is applicable for this purpose. Procedure of this method is as follows.

Groundwater level of each borehole will be calculated considering borehole interference using borehole formula. Borehole formula for this calculation is show below (see Figure SR4-16).

$$s_i = Q_i/(2\pi T) \times Ln(R_i/r_{ij})$$

s_i : Drawdown of groundwater level in No.i borehole (m)
R_i : Radius of influence of No.i borehole (m)
Q_i : Yield of No.i borehole (m^3/day)
r_{ij} : Distance between No.i and No.j borehole (m)
T : Transsimisibity of aquifer (m^2/day)



Source: JICA Project Team

Figure SR4-16 Arrangement of Borehole Location

Problem below will be solved by linear programming method.

(Purpose) To maximize total yield of n boreholes

Total yield of boreholes = $Q_1 + Q_2 + Q_3 + \cdot\cdot\cdot\cdot + Q_{n-2} + Q_{n-1} + Q_n \rightarrow$ Maximum

(Condition) Drawdown of each borehole should be the same. This condition will make the smallest drawdown of groundwater level of borehole field.

$s_1 = s_2 = s_3 = \cdot\cdot\cdot\cdot = s_{n-2} = s_{n-1} = s_n$

Optimum yield of each borehole can be calculated by solving problem above using linear programming method, which will minimize drawdown of groundwater level. Example will be shown in Catchment Management Plan in Phase-2 of this Project. It is best to manage yield of borehole by above method. On the other hand, it is not easy to make this method into practice. However, this method is important in area where balance between groundwater water demand and supply is critical.

SR4.1.4 Issues on Groundwater Development and Management

Groundwater is mainly used for sources for water supply in Nigeria. Issues of groundwater development and management are described below:

(1) Groundwater Recharge

Groundwater recharge is small in northern part of Nigeria due to little precipitation and high evapotranspiration. It is desirable to promote groundwater recharge for active groundwater development. There is possibility that groundwater is recharged from river bed of large river in the northern part of Nigeria. Considering above situation, it is possible to increase groundwater recharge by controlling discharge from recharge dam. In planning of recharge dam, characteristics of groundwater recharge from river-bed should be examined as explained below:

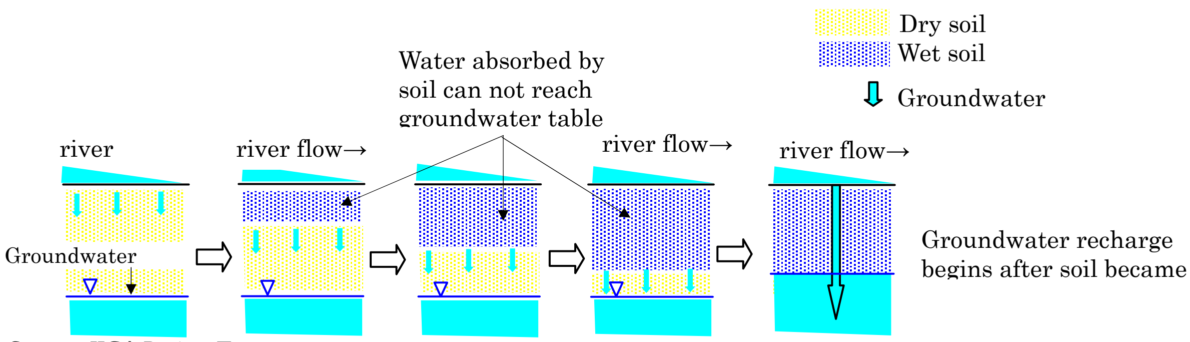
Amount of Discharge

How much groundwater can be recharged depends on scale of river discharge in dry reagion. Small discharge cannot reach target area for groundwater recharge

Interval of Discharge

Part of transmission loss of river will not become groundwater recharge. If soil between river bed and groundwater table is dry, water infiltrating from river bed will be absorbed by the soil and will not reach groundwater table (see Figure SR4-17). On the other hand, if the soil is wet, water will readily reach groundwater table. Dry/wet condition of the soil depends on interval of water discharge from upperstream dams. Discharge of shorter interval will make the soil wetter, and amount of groundwater recharge will be increased.

As mentioned above, to increase groundwater recharge, ineffective discharge should be prevented, and adequate discharge should be kept with short interval or continuously.



Source: JICA Project Team

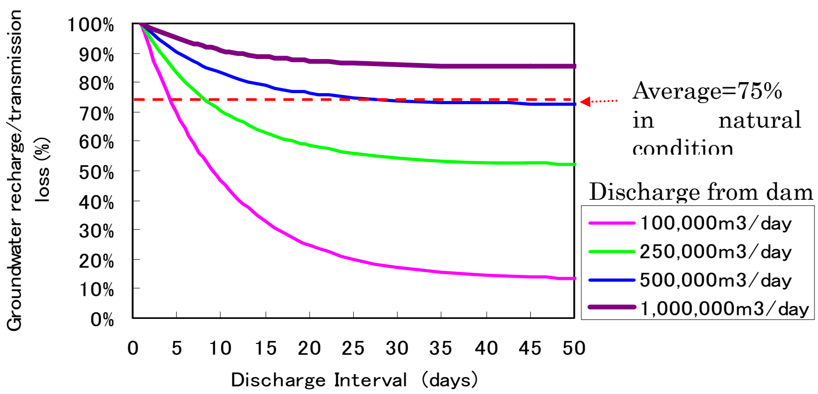
Figure SR4-17 Groundwater Recharge and Soil Moisture

Adequate Discharge amount

Amount of discharge from recharge dam should be decided considering distance between the dams to the target area for groundwater use.

Interval of Discharge

Transmission loss can be efficiently changed into ground water recharge by controlling interval of discharge. Relation between transmission loss and groundwater recharge is generally proposed as shown in Figure SR4-18. The more frequently water discharged, the more groundwater can be recharged.



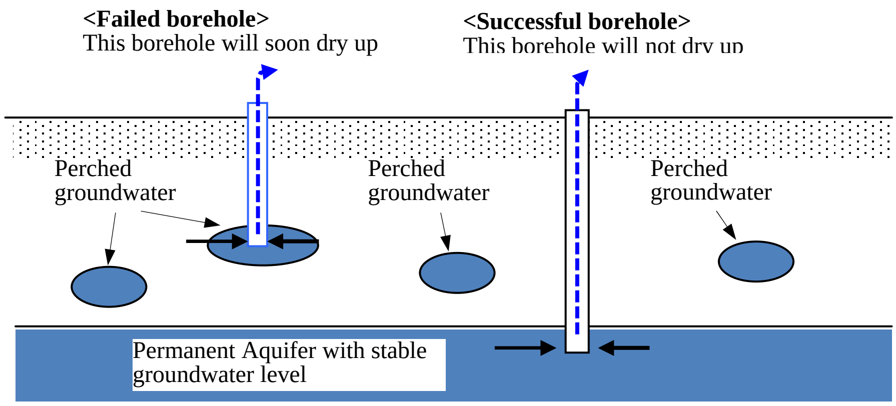
Source: JICA Project Team

Figure SR4-18 Example of Relation between Interval of Discharge and Groundwater Recharge

(2) Issue of Rural Water Supply

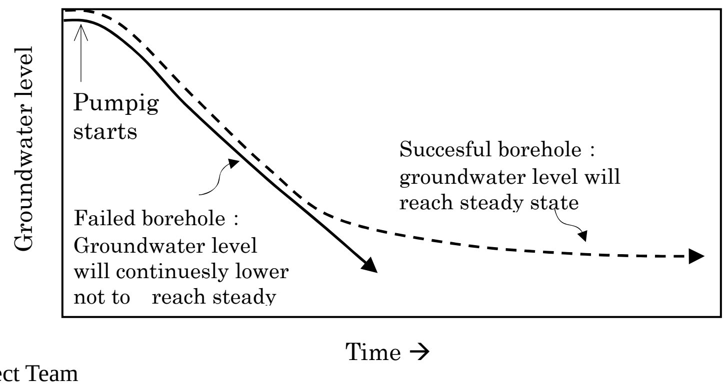
Low successful rate of borehole

Groundwater is extracted for rural water supply in the Basement Complex area. Borehole successful rate is as low as 50%-70%, so that survey technique must be improved to raise successful rate. Example of failed borehole is shown in Figure SR4-19. Some boreholes were drilled to pump up groundwater from perched aquifer, which were mistaken as large aquifer. Such mistakes can be avoided by implementation of adequate pumping test as shown in Figure SR4-20.



Source :JICA Project Team

Figure SR4-19 Reason of Borehole Failure in Basement Complex Area

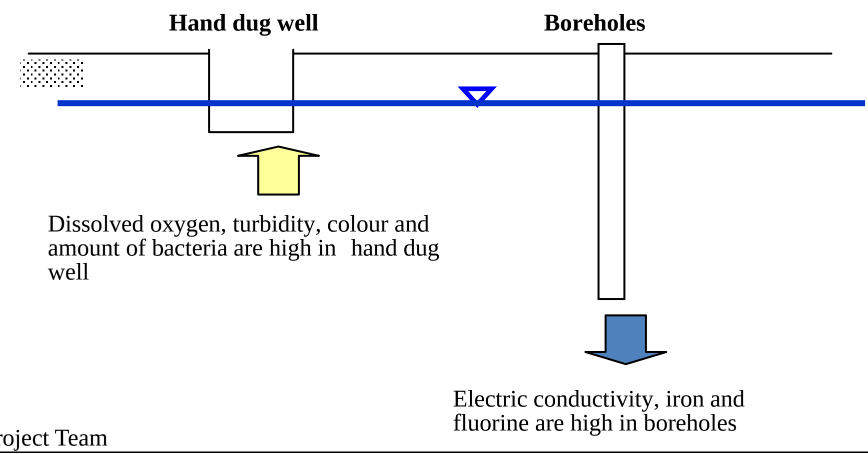


Source : JICA Project Team

Figure SR4-20 Example of Result of Pumping Test of Successful and Failed Borehole

Groundwater contamination

Groundwater quality in Basement Complex is generally excellent. However, groundwater is sometimes contaminated with domestic waste water showing Cl and NO_3 concentratin because boreholes and wells are located in the center of communities. Type of groundwater contamination is different between shallow hand-dug well and borehole (see Figure SR4-21). Groundwater of shallow hand-dug well is subject to infiltration of surface dirty water. On the other hand, groundwater of borehole is subject to chemical reaction with minerals which compose aquifer. This makes difference in water quality between shallow hand-dug well and borehole.



Source :JICA Project Team

Figure SR4-21 Difference in Groundwater Contamination between Borehole and Shallow hand-dug Well

(3) Problem in Urban Area

Lowering of groundwater level and land subsidence by over pumping

There is excellent aquifer that consists of sand formation in the coastal plain of the southern part of Nigeria. Metropolitan area such as Lagos and Port Harcourt are located in the coastal plain, where large amount of groundwater is being pumped up for industrial use. It is reported that groundwater level is lowering in those areas. The lowering of groundwater level affects many groundwater users and will bring about regional land subsidence.

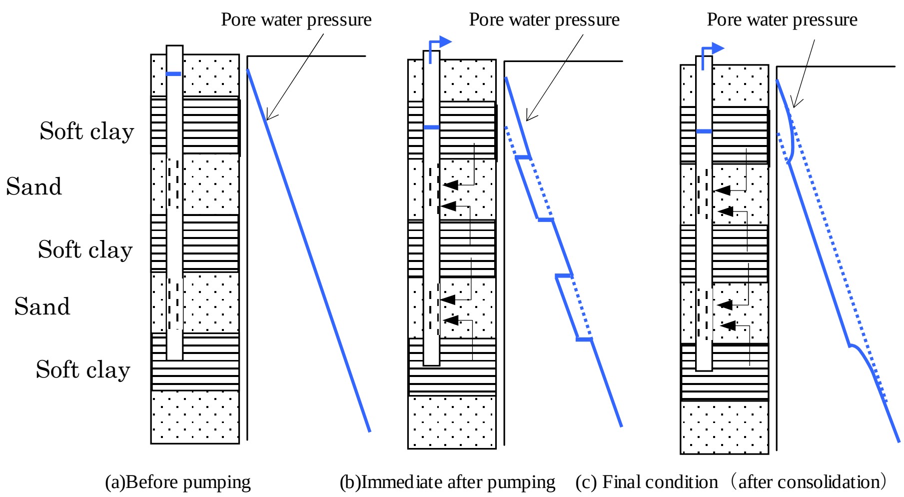
Soft clay and loose sand make alternation layer in the coastal plain. When large amount of groundwater is pumped up from sand layer, clay layers underlain and overlain by the sand layers are apt to be consolidated. The land subsidence, which is caused by over-pumping, is called as regional land subsidence. It is not easy to recognize whether or not land subsidence is occurring because large part of the ground surface subsides at the same speed, and any deformation cannot be recognized on the ground surface.

It is reported that regional land subsidence is taking place in Lagos Metropolitan area and other large cities in the southern part of Nigeria. However, there is no monitoring to judge occurrence of land subsidence.

Mechanism of land subsidence

Land subsidence occurred in the past in Japan due to over pumping of large cities in the coastal area, so that mechanism of land subsidence was studied in Japan to resolve it. Mechanism of land subsidence by pumping of groundwater is as follows.

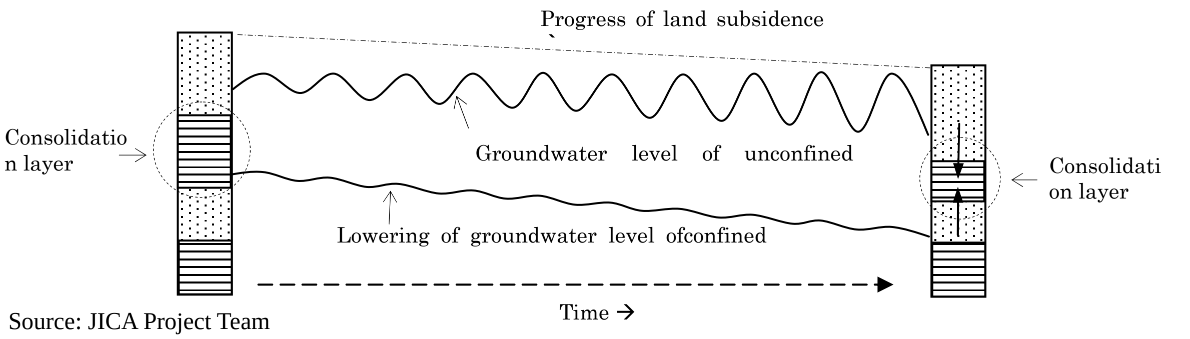
1) Water pressure of confined aquifer will be reduced by pumping groundwater from the aquifer (see Figure SR4-22(b)).
2) Confined aquifer will be compressed by reduce in water pressure within the aquifer (small scale).
3) Pore water pressure of clay layer (impermeable layer), which is over-lying and under lying the confined aquifer, will be reduced by reduction in water pressure of the confined aquifer (see Figure SR4-22(c)).
4) By difference in water pressure, groundwater within clay layer will flow toward the confined aquifer. As a result, the clay layer will be consolidated (large scale).



Source: Land subsidence and measures for it, Department of Environment of Japan, 1989.

Figure SR4-22 Mechanism of Land Subsidence

The relation between groundwater water level and land subsidence is reported as shown in Figure SR4-23 from example of land subsidence in Japan.



Source: JICA Project Team

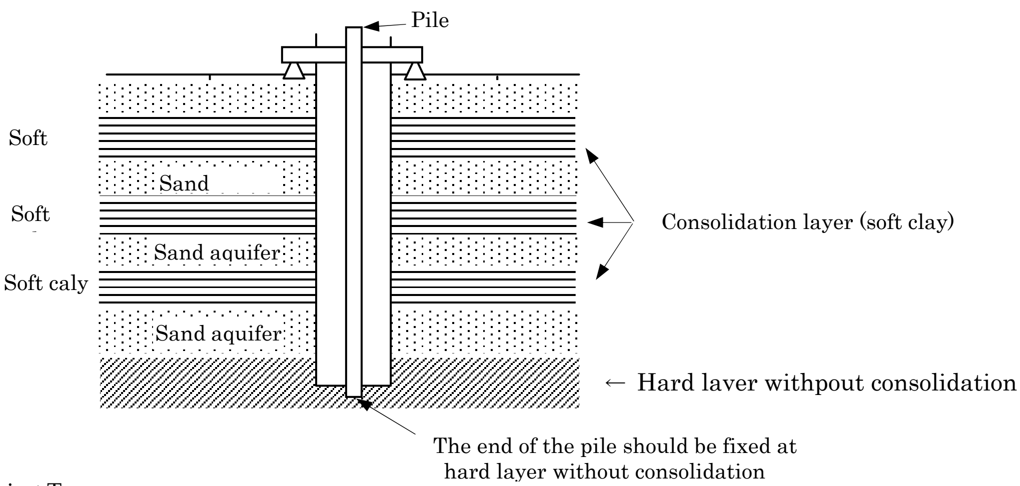
Figure SR4-23 Progress of Land Subsidence

Monitoring method for land subsidence is explained below.

1) Levering survey should be implemented from fixed leveling point without settlement where rock is outcropped.
2) Monitoring well for land subsidence should be constructed (see Figure SR4-24).
3) Groundwater level must be observed with progress of land subsidence to obtain relation between them.

Method 1) has more advantage in terms of cost for monitoring. However, usually distance is large between the coastal area and the areas of Tertiary or the older rocks without land subsidence. In this case, method 2) will have more advantage.

NIHSA is in charge of monitoring to inspect land subsidence. However, monitoring is not implemented so far. NIHSA should start monitoring taking account of mechanism of land subsidence explained above.

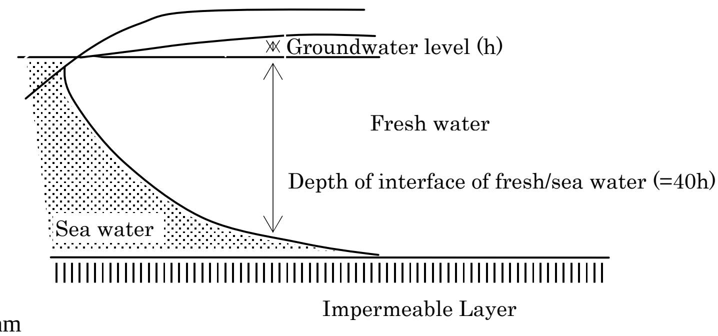


Source : JICA Project Team

Figure SR4-24 Example of Land Subsidence Monitoring Well

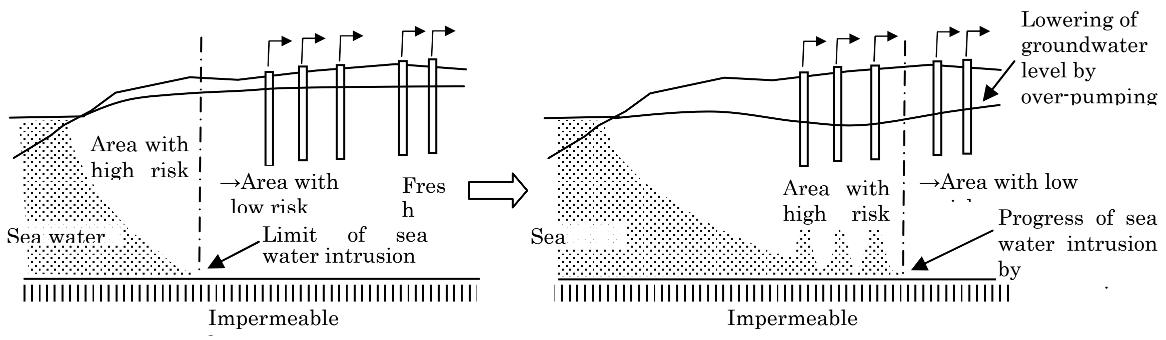
<u>Sea water intrusion</u>

Sea-water intrusion into aquifer is taking place due to lowering of groundwater level in the coastal aquifers, which will cause saline groundwater of boreholes and shallow wells. Excellent aquifers of high permeable sand layer are distributed along the coastal line in southern part of Nigeria. Over pumping of city will cause lowering of groundwater level. Depth of the interface between sea water and fresh water depend on fresh water level (see Figure SR4-25). Sea water will locally rise toward boreholes (see Figure SR4-26) within area of sea water intrusion.



Source: JICA Project Team

Figure SR4-25 Principle of Ghyben Herzberg's Law on Interface between Fresh/Sea Water



Source: JICA Project Team

Figure SR4-26 Mechanism of Sea Water Intrusion and Groundwater Contamination

It is reported that sea water intrusion is occurring in large city area in the southern part of Nigeria. NIHSA should monitor groundwater level and salt concentration of groundwater continuously to predict behavior of sea water intrusion for effective countermeasures.

Groundwater contamination

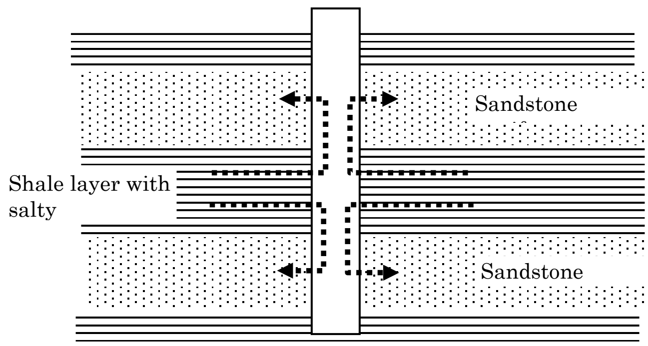
It is said that industrial waste water is injected into boreholes, which causes groundwater contamination in Logos Area.

Saline water by irrigation in Northern part of Nigeria

It is reported that salt is accumulated within soil by rising of groundwater table during the irrigation period around Kano area, which causes high saline groundwater of shallow wells around irrigation areas.

(4) Salty groundwater within sedimentary Rocks in Benue Basin

There is shale layer with salty minerals within aquifer (Awe formation) in Benue area, so that groundwater of the aquifer shows high salt concentration. Countermeasures against it are necessary. There is possibility that groundwater of high salt concentration may flow into overlaying and under laying aquifer of fresh groundwater to contaminate them within borehole. This should be noticed as manmade contamination occurring within boreholes (see Figure SR4-27).



Source: JICA Project Team

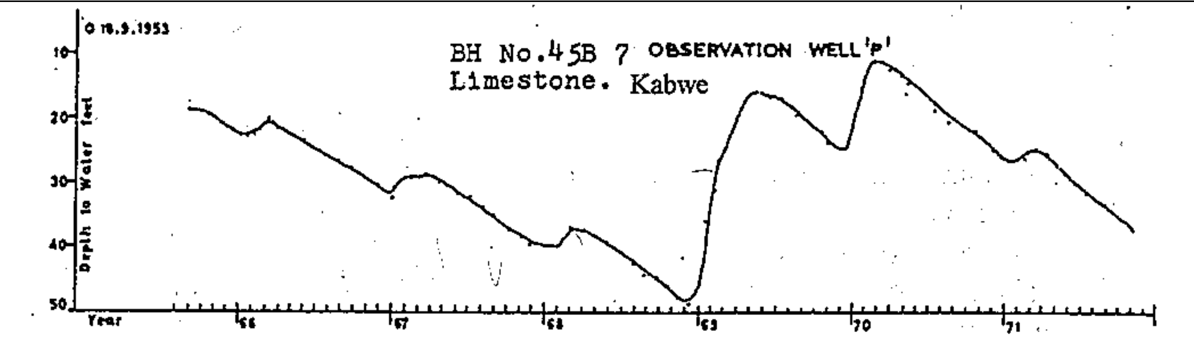
Figure SR4-27 Groundwater Contamination through Borehole

Groundwater contamination of Mining area

Groundwater can be contaminated with harmful mining residue which was deposited inadequate way. In Zamfara State, mining residue containing harmful metals was deposited on the bottom of mining pit. From bottom of the pit, the mining residue infiltrated into aquifer and contaminated groundwater causing health hazard of the residents.

(5) Groundwater Level Lowering and Drought

Groundwater fluctuation is affected by not only behavior of rainfall infiltration but also aquifer characteristics. Figure SR4-28 shows groundwater fluctuation of borehole drilled in aquifer in Basement rock area of Zambia, which clearly reflects difference in groundwater level of rainy and dry season.



Source：JICA M/P Study in Zambia, 1995

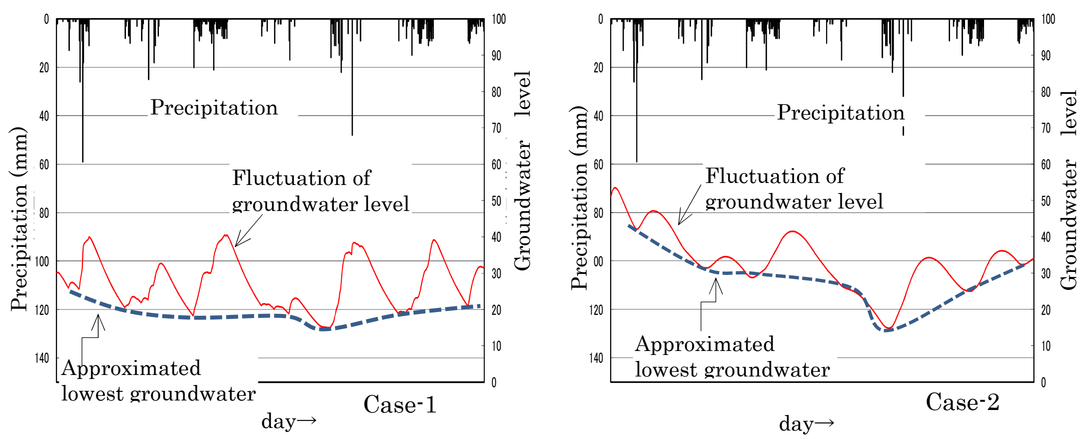
Figure SR4-28 Groundwater level Fluctuation of Basement Rock Aquifer similar to Nigeria (example of Zambia)

Figure above suggests important fact of groundwater level fluctuation in Basement rock area, as shown below:

- Lowering of groundwater level in dry season is almost same every year.
- Rising of groundwater level in rainy season is different every year.

Groundwater fluctuation of the example above shows that groundwater recharge is different every year according to amount of precipitation. On the other hand, groundwater discharge is almost the same every year. It suggests that that after several continuous years of smaller groundwater recharge than average ones, groundwater level will continuously lower to finally bring about drought disaster. Groundwater level fluctuation in Figure SR4-29 is useful to examine relation between precipitation and drought, though such an example cannot be applied to every case.

Response of groundwater fluctuation to precipitation depends on mechanism of groundwater recharge. Fluctuation of groundwater level of some boreholes is sensitive to precipitation but others not. Such example is shown in Figure SR4-29. Groundwater recharge of case-1 and case-2 below is the same. However, groundwater infiltration speed from ground surface to groundwater table is different between above two cases. The speed of case-1 is higher than that of case-2.



Source：JICA Project Team

Figure SR4-29 Groundwater Level Fluctuation Responding to Precipitation

The annual lowest groundwater level shows almost the same every year in case-1. On the other hand, it is different every year in case-2. Generally, fluctuation of groundwater level of Basement rock might be similar to that of case-2. The lowest groundwater level is different every year. Area with such condition is subject to drought disaster. Therefore, it is important to know pattern of groundwater level fluctuation by groundwater level monitoring, which will give information on vulnerability by drought disaster in area by area. This information will be used for formulation of countermeasure against drought.

(6) Issue to be Resolved

According to history on groundwater development of Nigeria, as population grows and drilling technology is improved, method of groundwater development is shifted from shallow-dug wells to boreholes. At the same time, rural community of population with less than 5,000 has changes to small town of population with 5,000 to 20,000. Then water supply instruments are change from hand pumps to motorized pumps.

<u>Shift form hand pump to motorized pump</u>

In the future, groundwater will be main source for water supply in small town and rural area as same as before. Amount of water supply must be increased responding to sudden population growth. It can be said that hand-pump, which is main instrument for current rural water supply, does not have enough capacity to utilize groundwater potential of Nigeria to full extent. On the other hand, motorized pump can utilized groundwater potential of Nigeria to full extent.

To replace hand-pump with motorized pump will cause problem in operation and maintenance. Cost of operation for motorized pump is much higher than that of hand-pump. Moreover, operation of motorized pump needs more complicated skill than that of hand-pump. It is said that communities cannot maintain even hand-pump, much less motorized pump. However, amount of water supply cannot be increased without overcoming this problem.

Borehole with groundwater production capacity of $10m^3$/day is enough for hand pump. However, borehole needs capacity of 50～$150m^3$/day for motorized pump. Most of borehole of Nigeria will have enough capacity for motorized pump according to existing record.

(7) Cooperation and Activity of Foreign Donors in Groundwater Management and Development

NICEF, DFID, EU, UNDP and World Bank implement activities as foreign donors of water supply for rural and small town in Nigeria. UNICEF is most active among the donors. UNICEF implemented continuous construction of water supply facilities since 1980s; their activities have covered 22 States. UNICEF established temporary organization called as WATSAN Project in State Ministry in charge of water supply. WATSAN Propjet was in charge of implementation of rural water supply project with assistance by UNICEF. UNICEF was funded by DFID, EC and US and so on.

UNICEF provide fund to construct water supply facilities with drilling rigs to Nigerian side. They have changed type of their activity: They stoped providing drilling rigs since 2004. Then it is general type of their assistance that RUWASSA will make contract with private drilling companies for construction of water supply facilities under their supervision.

SR4.2 Surface Water Development Plan

SR4.2.1 Related Policy and Plan

(1) Vision 20:2020

The Vision 20: 2020 as a national development plan does not directly state on water resources development and management. However, it can be said that the water resources development and management should support the achievement of the target for water supply, irrigation and hydropower etc.

(2) National Water Policy (2009)

According to the National Water Policy revised in 2009, the objectives and strategies for dams and water resources facilities are as follows.

Objectives

- To ensure all year round availability of surface water for its different socio-economic and environmental uses through the construction of dams.
- To ensure proper harnessing, protection and utilization of the surface water resources of the nation
- To ensure that dams should have hydropower components where feasible

Strategies

- Ensuring construction, operation and maintenance of medium and large dams in accordance with recognized engineering standards
- Ensuring the construction of medium and large dams in accordance with the National Water Resources Master Plan
- Ensuring the inter-basin transfer of water from areas of surplus to areas of scarcity
- Ensuring that the construction of Dams which are either trans-boundary/interstate in spread shall be the responsibility of the Federal Government
- The operation and maintenance of Federal Government dams are to be done by the Federal Government

(3) Water Sector Roadmap (2011)

The Water Sector Roadmap formulated in 2011 targeted the followings.

- Mid-term (for MDG): Increase gross storage capacity from 34,000MCM to 35,500MCM
- Long-term (post MDG): No description

SR4.2.2 Existing Water Resources Development Facilities

(1) Inventory of Existing Dams

In sorting out the inventory of existing dams, we referred to the documents 1) through 4) listed below. We summarized the specification of each dam based on these documents, which however, contained conflicting information on some dams. In the present project, we sorted out inconsistent data by giving priorities to the reference documents in the order of: 1) > 2) > 3) (Data from the 1995 survey were given the highest priority).

1) FMWR: Nigeria Register of Dams, 1995.
2) FMWR: Compendiums of Nigerian Dams, 2007.
3) NIWRMC: Inventory of Water Infrastructure Project in Nigeria, Appendix II, 2010.

In addition, the following information is also reffered.

1) List of dams in SRRBDA.
2) List of dams in Some States (Katsina and Oyo).
3) M/P1995.
4) Survey in the present project.

During the process of arranging the data, the dams that we cannot confirm their existence by satellite images and/or photographs and so on are categorized as unknown dams.

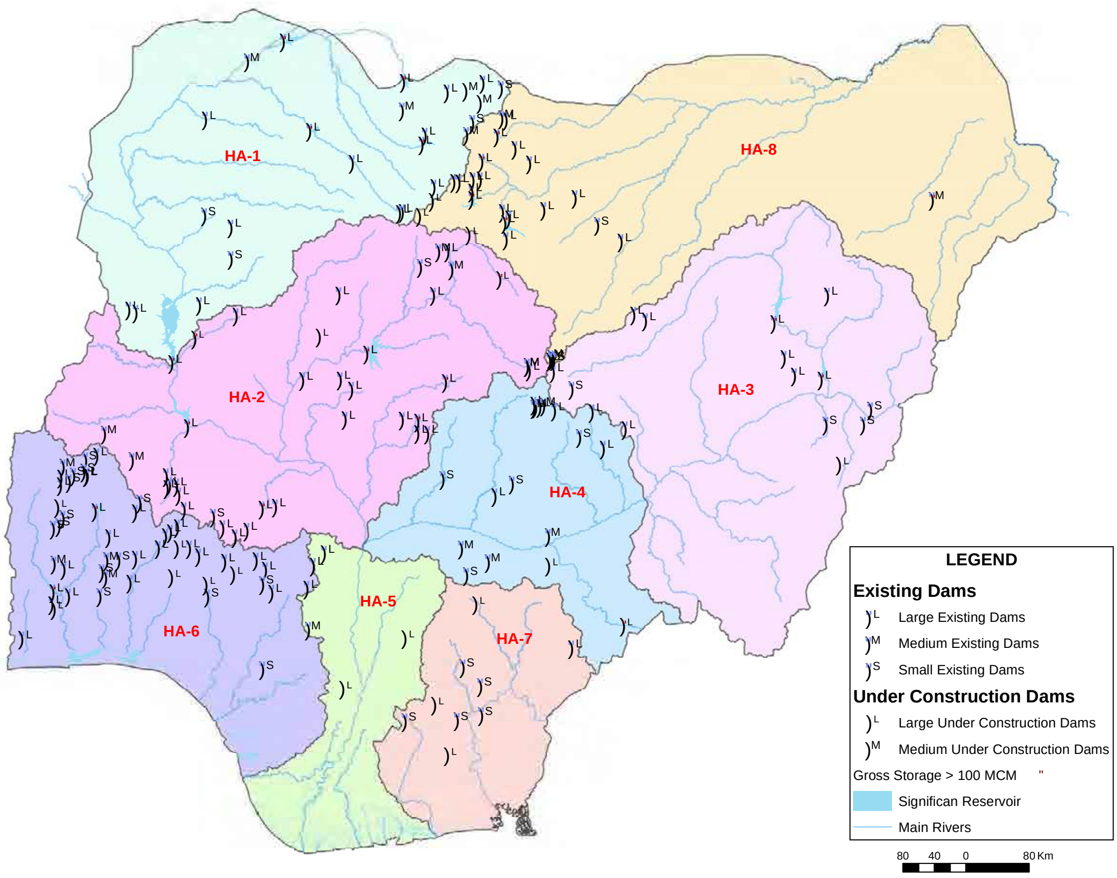
The total number of existing dams in Nigeria, which the project could confirm, is 171 as shown in Table SR4-17. The location of these dams is shown in Figure SR4-30.

The list of these dams and locations by HA are shown in Annex-T SR4-1 to SR4-3 and Annex-F SR4-1 to SR4-9.

Table SR4-17 Existing Dams in Nigeria

HA	Number of dams				
	Large	Medium	Small	Unknown	Total
HA-1	17	2	4	1	24
HA-2	27	6	2	0	35
HA-3	8	0	4	0	12
HA-4	8	5	4	0	17
HA-5	2	1	0	1	4
HA-6	26	4	14	1	45
HA-7	1	0	5	1	7
HA-8	19	5	2	1	27
Total	108	23	35	5	171

Source: JICA Project Team



Source: JICA Project Team

Figure SR4-30 Location Map of Dams in Nigeria

In the inventory list, the dams are categorized according to the definition shown in Table SR4-18.

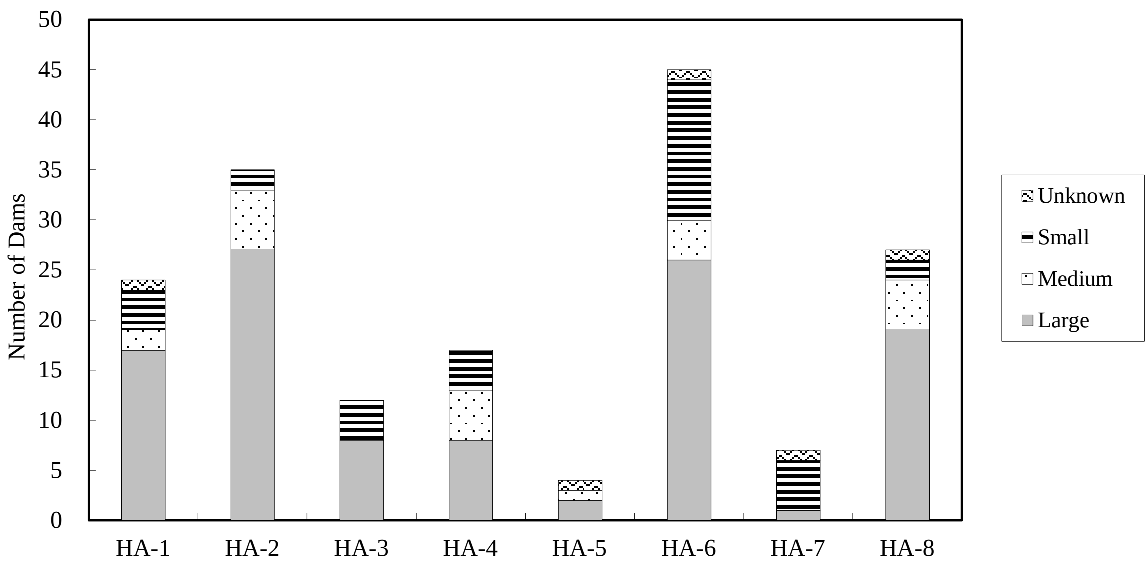
Table SR4-18 Definition of Category of Dams

Category	Criteria
Large scale	1) Dam height is higher than 15.0m 2) Dam height is higher than 10m and less than 15m, and those that fall under one of the following: ・the length of the crest is greater than 500m ・the reservoir capacity is equal to or greater than those 1MCM ・the design flood flow is greater than 2,000 m^3/s ・the dams has special foundation problems ・the dam is unusual design
Medium scale	1) Dam height is higher than 8.0m and less than 10m. 2) Any dam which does not meet the criteria for Large and Small classification
Small scale	1) Dam height is less than 8.0m, and reservoir capacity is less than 5MCM.

Source: FMWR, Nigeria Register of Dams, 1995.

Number and Scale

The number of dams is the largest in HA-6, followed by HA-2, HA-1 and HA-8. Regarding the scale of dams, almost half of the dams are categorized as Large Scale.

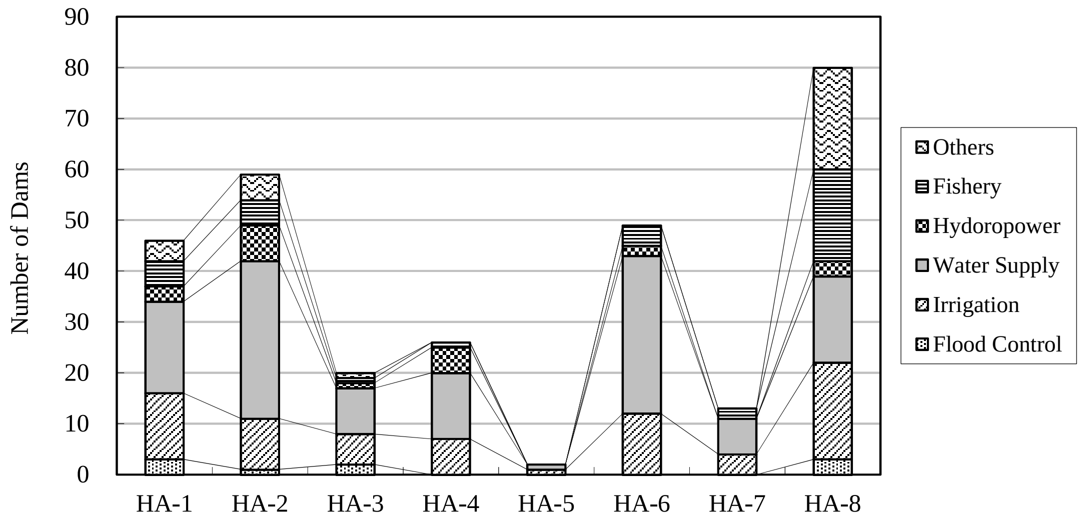


Source: JICA Project Team

Figure SR4-31 Number of Existing Dams

Purpose of Dams

About 70% of the dams are for municipal water supply and irrigation purposes, while much smaller percentages are for flood control and power generation, as shown in Figure SR4-32.



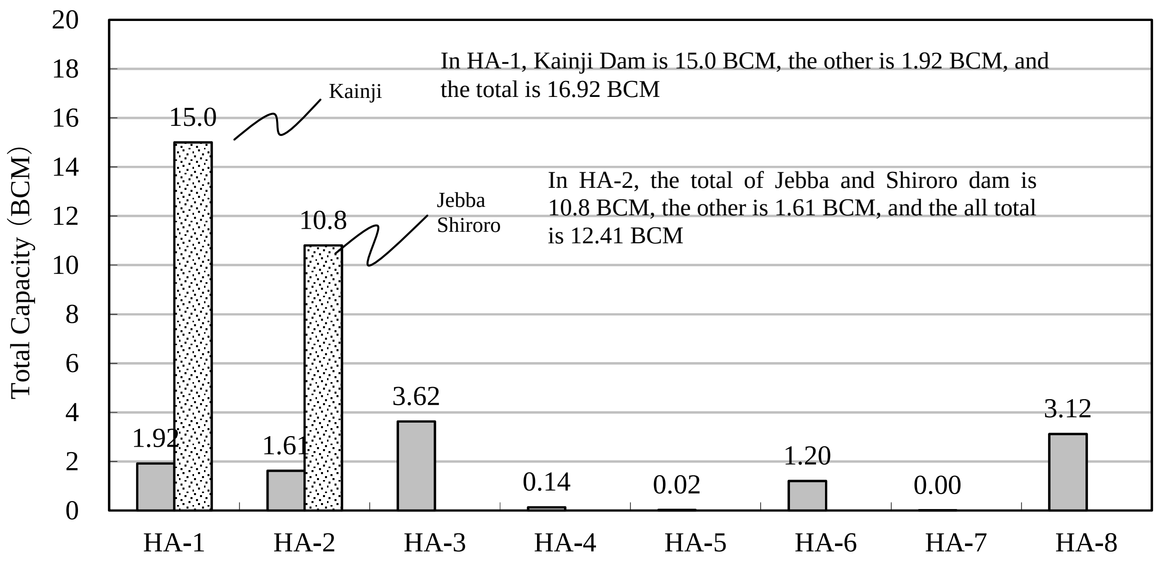
Source: JICA Project Team

Figure SR4-32 Purpose of Existing Dams

<u>Storage Capacity and Turnover Rate</u>

The existing dams in HAs-1, 2, 3, and 8 have reservoirs with relatively large (gross) capacities, while those in the southern region tend to have smaller capacities due to lack of suitable sites for dams and the topographical characteristics that prevent the construction of large-capacity dams. In HA-1 and HA-2, Kianji, Jebba, and Shriro Dams take up large percentages of the storage capacities. Table SR4-19 compares the average discharge (average outflow volume between 1970 and 2009) and the dam capacity (turnover rate) of each HA. The discharges shown in the table are the average internal generation from Nigeria between 1970 and 2009 (but do not include inflows from Niger and Cameroon).

The turnover rates of water-poor HA-1 and HA-8 fall short of 2. Dams in these HAs tend to have disproportionately large capacities compared to the inflows (meaning they are inefficient). On the other hand, it is apparent that the southern region is not effectively utilizing its abundant water resources despite good flow regimes due to lack of suitable dam sites.



Source: JICA Project Team

Figure SR4-33 Total Storage Capacity of Existing Dams

Table SR4-19 Turnover Rate of Existing Dams（Relative comparison of each HA）

HA	Storage Capacity (BCM) (A)	Runoff (BCM) (B)	Turnover rate (B/A)
HA-1	16.92	8.40	0.50
HA-2	12.41	31.70	2.55
HA-3	3.62	34.10	9.42
HA-4	0.14	30.90	More than 10
HA-5	0.02	40.10	More than 10
HA-6	1.20	35.60	More than 10
HA-7	0.00	56.20	More than 10
HA-8	3.12	7.20	2.31
Total	37.44	244.20	

Remark: Runoff is the only internal generation in Nigeria
Source: JICA Project Team

Table SR4-20 shows the turnover rate for the selected large storage dams, whose gross storage capacity is more than 100MCM (see Figure SR4-34 for their location). In this table, the runoff includes the inflow from outside Nigeria. The turnover rate of the dams in HA-1 and 8 tends to be smaller.

Table SR4-20 Reservoir Turnover Rate in Selected Large Storage Dams

HA	Name of Dam	Effective Storage Capacity (MCM) (A)	Runoff (MCM) (B)	Turnover rate (B/A)
HA-1	Bakolori	403	708	1.76
	Goronyo	933	805	0.86
	Zobe	170	203	1.19
	Jibiya	121	71	0.59
	Kainji	12,000	35,093	2.92
HA-2	Shiroro	6,050	8,766	1.45
	Jebba	1,000	40,700	40.70
	Gurara	700	1,253	1.79
	Usuma	100	87	0.87
	Omi	220	317	1.44
HA-3	Dadin kowa	1,770	3,104	1.75
	Kiri	290	5,078	17.51
HA-6	Ikere Gorge	565	754	1.33
	Oyan	265	1,241	4.68
HA-8	Challawa Gorge	904	552	0.61
	Gari	203	31	0.15
	Tiga	1,222	959	0.78
	Watari	92.7	36	0.39
	Alau	106.0	135	1.27

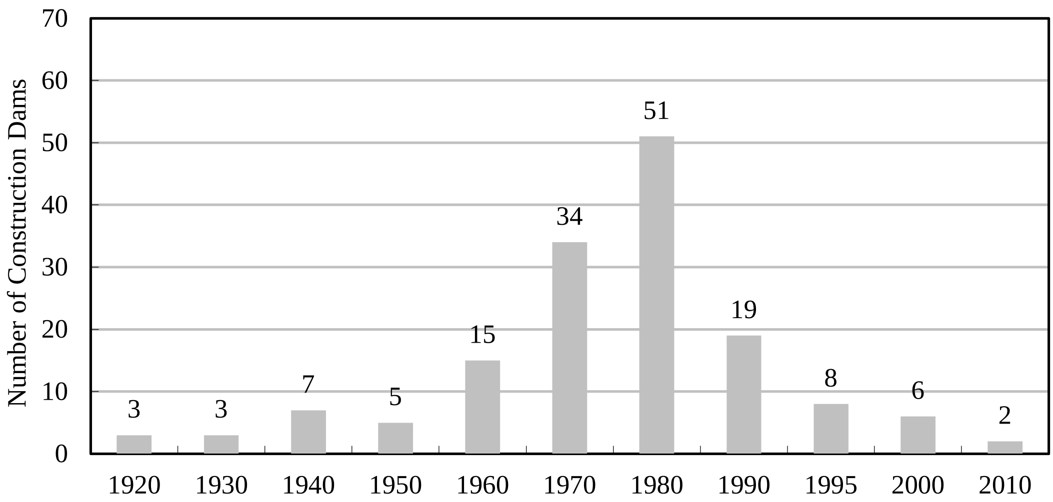
Remark:
1: Shaded Dam turnover rate is less than the 1.0
= Not be filled with water even storing the total flow for the year.
2: Dams whose gross capacity is more than 100MCM is shown in the table.
Source: JICA Project Team

Source: JICA Project Team

Figure SR4-34 Location of Dam in which Turnover Rate is examined

Construction Year

Figure SR4-35 and Table SR4-21 show the completion year of the existing dams. The peak of dam construction appears during 1980s. Only 16 dams have been completed after 1995 (see Table SR4-22).



Source: JICA Project Team

Figure SR4-35 Number of Dams by Completion Year

Table SR4-21 Number of Dams by Completion Year and by HAs

	1920	1930	1940	1950	1960	1970	1980	1990	1995	2000	2010	unknown	Total
HA1	0	0	0	0	3	5	4	5	0	1	1	5	24
HA2	2	1	2	0	3	10	9	3	2	1	0	2	35
HA3	0	0	0	0	0	0	5	2	2	1	0	2	12
HA4	1	1	1	0	2	0	8	1	2	0	0	1	17
HA5	0	0	1	0	0	0	0	2	0	0	0	1	4
HA6	0	0	3	5	5	6	16	3	1	2	1	3	45
HA7	0	0	0	0	1	0	4	0	1	0	0	1	7
HA8	0	1	0	0	1	13	5	3	0	1	0	3	27
Total	3	3	7	5	15	34	51	19	8	6	2	18	171

Remark: Only the dams whose completion year is shown is presented in the table.
Source: JICA Project Team

Table SR4-22 List of Dams built after 1995

S/N	HA	Name	State	River	Owner	Comp. Year	Category	Catchment Area (km^2)	Height (m)	Gross Storage (MCM)
11	1	Shagari	Sokoto	Gawon Gubli	SRRBDA	2007	L	3,658	13.00	15.0
23	2	Idofian	Kwara	Idofian	SWB	1996	L	60	12.00	
29	2	Omi	Kogi	Kampe	LNRBDA	1999	L	1,596	42.50	250.0
22	2	Gurara	Kaduna	Gurara	FGN	2008	L	2,637	55.00	880.0
41	3	Biu	Borno	Ndivana	SWB	1995	L	153	18.00	11.1
151	3	Gindiri	Plateau	Dundage	SWB	1996	S	3	5.00	0.7
128	3	Wuroabba	Adamawa		FMARD	2005	S	5	3.00	1.0
130	4	Kwa	Plateau	Kwa	LBRBDA	1996	S	1	6.00	0.2
110	4	Guma	Benue	Bakar	LBRBDA	1999	M	10	9.20	6.5
77	6	Oke Odan	Ogun	Oke Odan	OORBDA	1995	L	71	10.00	5.5
84	7	Obudu	Cross River	Be	CRBDA	1999	L	22	15.00	2.5
120	8	Kusada	Katsina	Tabobi	SRRBDA	2009	M	20	4.50	5.5
160	6	Alabata	Oyo	Ose	SWB	2010	M	59	11.00	2.2
161	6	Akufo	Oyo		SWB	2008	S	0.3	8.5	0.1
162	6	Sanusi	Oyo	Seleru	SWB	2007	S	59	9.5	0.6
171	1	Mahuta	Kebbi	Rafin Tsmma Mulfa	SWB	2010	S	32	5.5	0.7

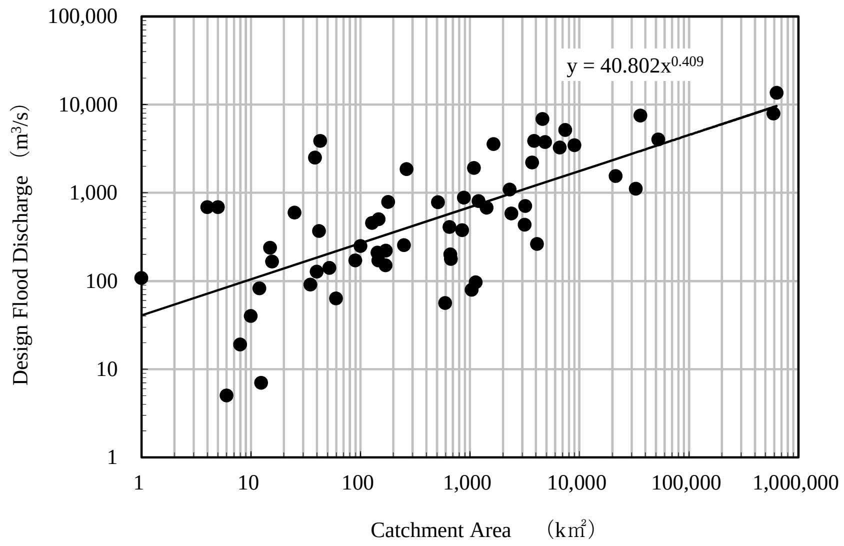
Remarks: Catchment area of Gurara and Omi is estimated by GIS data by JICA Project Team.
Source: JICA Project Team

Dam Type and Height

Of the completed dams, earth-fill type (including zone type, etc.) takes up the largest percentage. The majority of the dams have height of 30m or less, with the 8 - 15m-class being the most typical.

Design Flood Discharge

Figure SR4-36 illustrates the relationship between the design flood discharge and the catchment areas for 60 dams, about which such technical data were available. Table SR4-23 shows the flood return periods, which the JICA Project Team calculated independently based on the analysis of design floods of Asejire Dam (data at the observation point downstream of the dam) and the inflow discharge at Shiroro Dam, which were obtained from the survey conducted in the present project.



Source: JICA Project Team

Figure SR4-36 Design Flood discharge

Table SR4-23 Estimated Probable Flood Discharge (m^3/s)

Probability Year	Asejire		Shiroro	
	Asejire St.25 ($4,325km^2$)	Specific runoff ($m^3/s/100km^2$)	Shiroro ($34,702km^2$)	Specific runoff ($m^3/s/100km^2$)
10000	4,000	92	6,000	17
1000	3,200	74	5,600	16
500	2,700	62	5,200	14
200	2,000	46	4,700	13
100	1,600	37	4,300	12
50	1,300	30	4,000	11
30	1,100	25	3,700	10
10	700	16	3,100	9

Remark: Asejiri ‘s values were analyzed by the upstream value of St.25, and Catchment area of Asejire Dam is 7,646 km^2
Catchment area is estimated by GIS data by JICA Project Team.
Source: JICA Project Team

Giving the design flood discharge of $5,130m^3/s$ and the catchment area of $7,646km^2$, the design flood discharge per catchment area of Asejire Dam is $67m^3/s/100km^2$, which roughly corresponds to the 500-year return period in Table SR4-23. (Note: In Japan, 200-year return period is commonly used in determining the design flood discharge of large concrete dams, or 120% thereof in case of large fill dams.)

The design flood discharge per catchment area of Shiroro Dam is $22m^3/s/100km^2$, giving the design flood discharge of $7,500m^3/s$, the occurrence probability of which is estimated to be less than 1/10000. For reference, Goronyo Dam, the spillway of which was damaged by a recent flood, is designed for a very low design flood discharge per catchment area of $5m^3/s/100km^2$ ($1,540m^3/s$ design flood over $30,547km^2$ catchment area). Its flood occurrence probability is estimated to exceed 1/10 even at the probability flow of Shiroro Dam, which has a large catchment area.

Table SR4-24 lists the design flood discharge of major dams, of which Goronyo, Kainji, Jebba, and Dadin Kowa have relatively low design flood discharge. However, Kainji and Jebba, the catchment areas of which are particularly large, need to be re-evaluated based on their own data, as their design floods were estimated based on the probability flood of Shiroro Dam.

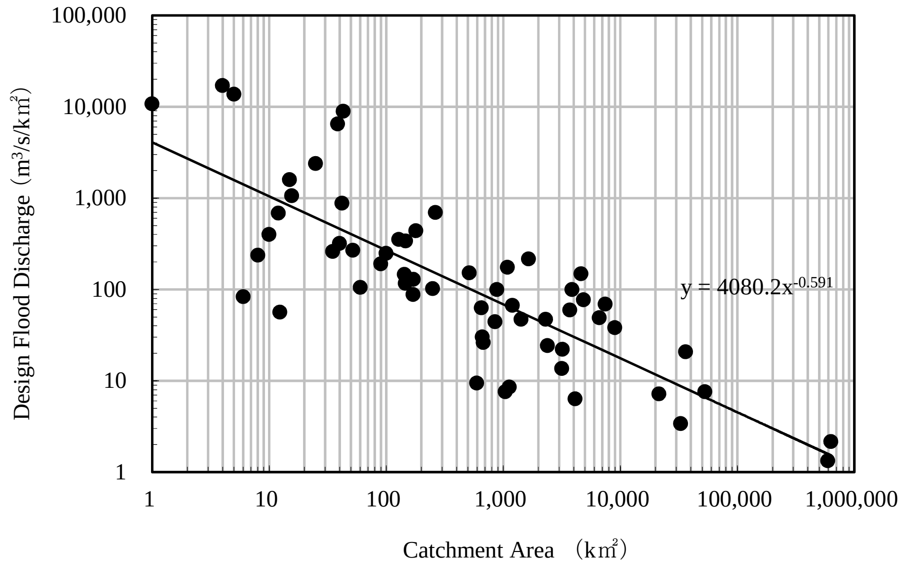
Table SR4-24 Design Flood Discharge

HA	Dam name	Catchment area (km^2)	Design flood discharge (m^3/s)	Specific runoff (m^3/s/100km^2)	Probability evaluation	Application
HA1	Goronyo	30,547	1,540	5	below 10 years	Shiroro
	Jibiya	3,509	2,200	63	roughly 400 years	Asejire
	Kainji	1,589,938	7,900	1	below 10 years	Shiroro
	Swashi	849	375	44	roughly 200 years	Asejire
	Zobe	2,514	1,087	43	roughly 200 years	Asejire
HA2	Jebba	1,629,481	13,600	1	below 10 years	Shiroro
	Shiroro	34,702	7,500	22	Over 10,000 years	Shiroro
HA3	Dadin Kowa	32,184	1,110	3	below 10 years	Shiroro
HA6	Oyan	9,113	3,440	38	roughly 100 years	Asejire
HA8	Tiga	6,538	3,257	49	roughly 200 years	Asejire

Remarks: Catchment area is estimated by GIS data by JICA Project Team, except for Swashi and Zuru dams.
Source: JICA Project Team

As described in the above, probable flood discharge of a dam varies greatly depending on the size of its catchment area (the larger the catchment area, the smaller the flow rate per catchment area and vice versa. See Figure SR4-37). For this reason, estimating an appropriate probable flood discharge based on long-term hydrological analysis data (flood discharge) at each dam point is essential for accurately evaluating the safety of the discharge capacity of each dam. Thus, long-term discharge data are indispensable to precisely analyze probable flood condition. However, inflow data are not measured or recorded in most of the dams in Nigeria, except for large hydropower dams, as discussed later in this section.

It should be recognized that the accumulation of hydrological data over a long term is extremely important for the management and safety evaluation of dams with high accuracy.



Source: JICA Project Team

Figure SR4-37 Specific Design Flood Discharge

<u>Summary of Characteristics of Existing Dams</u>

Table SR4-25 summarizes the characteristics of the existing dams

Table SR4-25 Summaries of Characteristics of Existing Dams

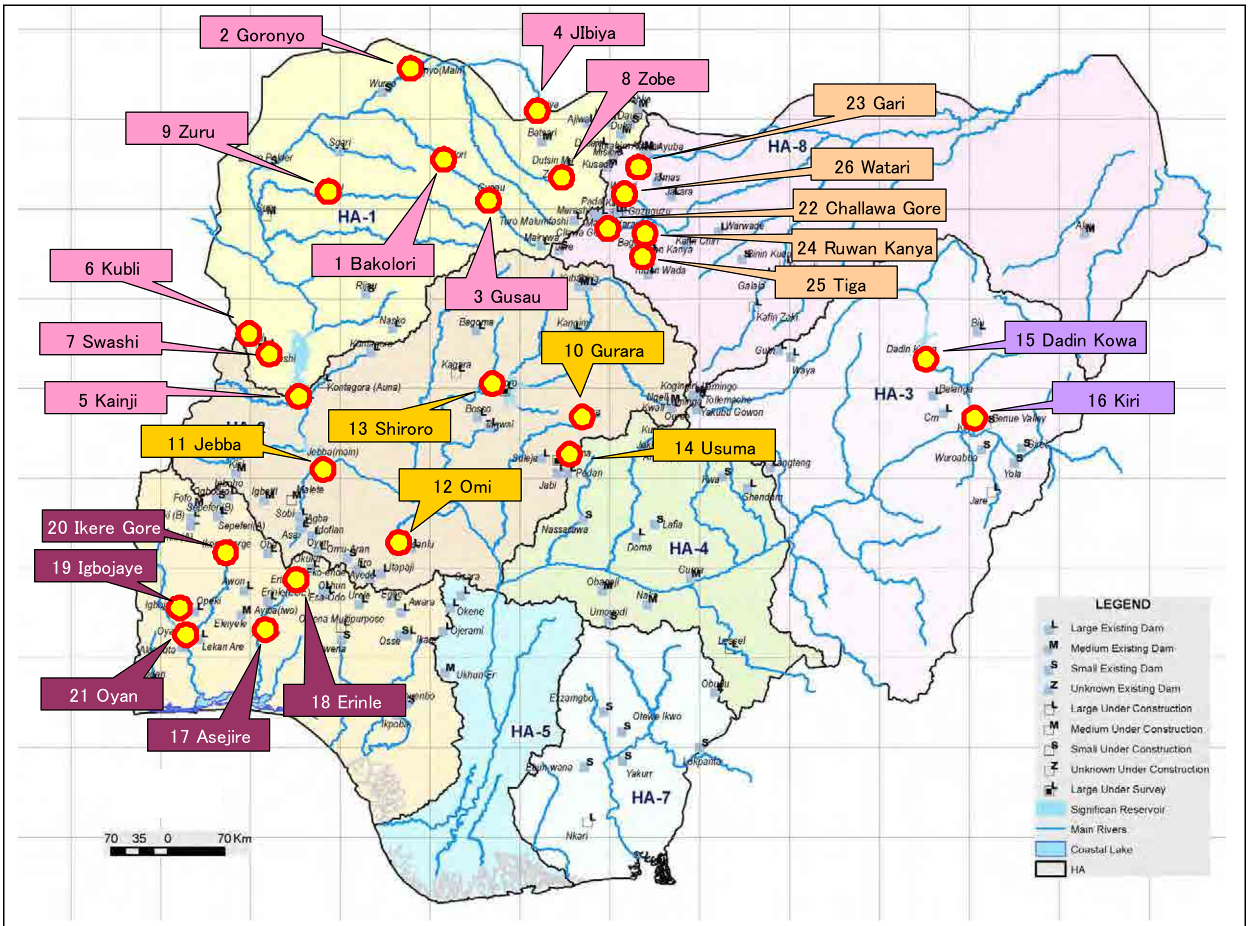
Item	Characteristics
Number of dam	There are 158 existing dams (Only those confirmed by the project), and most of them located in HA-1, HA-2, HA-6 and HA-8 regions.
Scale of dam	Large dam is more than 50 percent.
Purpose of dam	Water supply and irrigation accounted for the majority. Intended for flood control and power generation is not too much
Storage capacity	The capacity is large in HA-1, HA-2 region, which is almost capacity of Shiroro, Kainji, of Jebba. Otherwise, the capacity of the HA-3, HA-8 is greater.
Turnover rate of dam	The overall turnover rate is lower, especially the dam which flow volume is severe in north region (HA-1, HA-8), the dam turnover ratio is less tend
Construction year	The peak of dam construction was 1980, and then it has been decreasing. 12 dams have been completed Since 1995.
Dam type	Almost earth dam type.
Dam height	Less than 30m is accounted for the majority, and most of them are tending to be 8 ~ 15m class in particular.
Design flood discharge	Design is as has been done to measure the probability of 1/500 in general, more information is necessary to investigate continually.

Source: JICA Project Team

(2) Survey on Selected Large Storage Dams

(2-1) Target Dams

The project selected 26 dams with large storage capacities and/or the major dams in HA-1 and 6 in which the draft catchment management plan will be formulated in the later stage of the project, in order to study the current management status of each dam. The locations of the selected dams are shown in Figure SR4-38.



Source: JICA Project Team

Figure SR4-38 Selected Dams for Survey in the Present Project (26 dams)

The list of the selected dams and its technical specification are presented in Table SR4-26 and Table SR4-27, respectively.

Table SR4-26 List of Selected Dams for Survey in the Present Project

No	HA	Status	Owner	Name of Dam	State	River	Completed year	Dam purpose
1	1	Existing	SRRBDA	Bakolori	Zamfara	Sokoto	1982	F,I,W,P,Fi,O
2		Existing	SRRBDA	Goronyo(Main)	Sokoto	Rima	1983	F,I,W,Fi,O
3		Existing	SWB	Gusau	Zamfara	Sokoto	1990	W
4		Existing	SRRBDA	Jibiya	Katsina	Gadda	1990	F,I,W,P
5		Existing	NEPA	Kainji	Niger	Niger	1968	I,W,P,Fi,O
6		Existing	UNRBDA	Kubli	Niger	Swashi	1992	I
7		Existing	UNRBDA	Swashi	Niger	Swashi	1992	I
8		Existing	SRRBDA	Zobe	Kastina	Karaduwa	1983	I,W
9		Existing	Kebbi State	Zuru	Kebbi	Girmache	1978	W
10	2	Existing	FGN	Gurara	Kaduna	Gurara	2007	I,W,P,Fi,O
11		Existing	NEPA	Jebba(main)	Niger	Niger	1984	W,P
12		Existing	LNRBDA	Omi	Kogi	Kampe	1999	I,W
13		Existing	NEPA	Shiroro	Niger	Kaduna	1990	W,P
14		Existing	SWB	Usuma	FCT	Usuma	1984	W
15	3	Existing	UBRBDA	Dadin Kowa	Gombe	Gongola	1987	F,I,W,P,Fi
16		Existing	UBRBDA	Kiri	Adamawa	Gongola	1982	I,W
17	6	Existing	WCOS	Asejire	Oyo	Osun	1972	W
18		Existing	SWB	Erinle	Osun	Erinle	1989	W,Fi
19		UC	OORBDA	Igbojaye	Oyo	Aye	UC	I,W
20		Existing	OORBDA	Ikere Gorge	Oyo	Ogun	1991	I,W,P,Fi
21		Existing	OORBDA	Oyan	Ogun	Oyan	1983	I,W,P,Fi
22	8	Existing	HJRBDA	Challawa Gorge	Kano	Challawa	1992	F,I,W,P,Fi,O
23		Existing	MANR	Gari	Kano	Goubi	1980	I,Fi,O
24		Existing	HJRBDA	Ruwan Kanya	Kano	Tiga M.Canal	1976	I,Fi,O
25		Existing	HJRBDA	Tiga	Kano	Kano	1975	I,W,Fi,O
26		Existing	MANR	Watari	Kano	Watari	1980	I,Fi,O

Purpose: F; Flood control, I; Irrigation, W; Water supply, P; Power generation, Fi; Fish, O; Other
UC =Under Construction

Table SR4-27 Technical Specification on the Selected Dams for Survey

No	Dam type	Catchment area (km^2)	Dam height (m)	Low water level (EL.m)	Normal high water level (EL.m)	Flood high water level (EL.m)	Total reservoir capacity (MCM)	Effective storage capacity (MCM)	Design flood discharge (m^3/s)
1	Earthfill + Concrete	4,747	48.00	320.00	-	334.00	450.00	403.00	3,750
2	Earthfill + Concrete	30,547	20.00	279.50	-	288.00	942.00	933.00	1,540
3	Earthfill	2,570	22.00	-	-	441.59	3.00	2.50	-
4	Earthfill + Concrete	3,509	21.50	406.00	-	414.00	142.00	121.00	2,200
5	Concrete, Rockfill+Earthfill	1,589,938	65.50	129.00	141.90	143.50	15,000.00	12,000.00	7,900
6	Concrere	643	17.00	-	-	-	70.00	57.00	407
7	Earthfill	849	21.00	-	-	-	16.00	12.60	375
8	Earthfill (Homogeneous)	2,514	18.90	484.60	-	493.00	177.00	170.00	1,087
9	Earthfill	90	15.00	-	-	354.00	5.85	5.00	432
10	Earthfill	2,637	55.00	605.90	624.00	627.50	880.00	-	2,715
11	Concrete+ Earthfill	1,629,481	40.00	99.00	103.00	106.00	3,800.00	1,000.00	13,600
12	Earthfill	1,596	42.50	226.00	241.00	244.90	250.00	220.00	3,550
13	Rockfill	34,702	105.00	342.00	382.00	385.00	7,000.00	6,050.00	7,500
14	Earthfill	191	45.00	535.00	574.00	575.00	120.00	100.00	-
15	Rockfill + Earthfill	32,184	42.00	239.00	243.00	247.00	2,800.00	1,770.00	1,110
16	Rockfill + Earthfill	44,581	37.00	167.20	170.50	171.50	615.00	290.00	4,000
17	Earthfill + Concrete	7,712	26.20	143.00	156.40	158.20	32.90	30.50	5,130
18	Earthfill	1,220	27.00	316.00	328.00	-	94.00	92.50	-
19	Earthfill	121	18.00	-	-	-	5.60	5.20	-
20	Earthfill + Concrete	4,704	47.50	240.00	266.00	273.50	265.00	255.00	6,850
21	Earthfill	9,113	30.44	47.50	63.00	65.50	270.00	254.00	3,440
22	Earthfill + Concrete	3,842	39.62	506.00	523.76	523.76	930.00	904.00	3,850
23	Earthfill + Concrete	1,145	22.00	454.15	-	466.00	214.00	203.00	-
24	Earthfill (Zoned)	129	21.95	-	-	-	58.00	-	-
25	Earthfill (Zoned)	6,538	47.24	-	-	-	1,345.00	1,222.00	3,257
26	Earthfill (Zoned)	654	19.81	-	-	-	104.55	92.74	-

Remarks: Catchment area is estimated by GIS data by JICA Project Team, except for Swashi, Zuru and Igbojaye dams.
Source: JICA Project Team

The items to be surveyed are listed in Table SR4-28.

Table SR4-28 Survey Items

Survey item	Survey Contents
Dam dimension	To survey the various basic factors such as dam body, allocation of storage, planned supply water.
Precipitation	To collect and organize various data that measured at the dam.
Evapotranspiration	
Inflow, runoff	
Others	To collect and organize the curve of capacity and reservoir level, the amount of power generation, discharge characteristics, such as design data of dam
The status of Dam facilities	To organize the status about the dam gate and decrepit dam body by visual and interview.
Survey photo	Summarize the photography done for the appearance of the dam body and the reservoir.

Source: JICA Project Team

(2-2) Management of Dam Operation Data

In the survey, we examined how the operational data of each dam were managed in regard to the items listed below. The collection status of each type of data in the recent 10 years (after 2000) is summarized in Table SR4-29.

- Reservoir water level
- Inflow
- Discharge for water utilization (outflow from discharge facilities for irrigation, hydropower, etc.)
- Total discharge (including discharge from spillway crest gates)
- Precipitation
- Reservoir evaporation rate

Outlined below is the management status of data in and after 2000.

- Of the 26 dams, only six, namely, Kainji, Jebba, Shiroro, Dadin Kowa, Challawa Gorge, and Tiga, maintain relatively extensive data on reservoir level, inflow, and discharge, which are particularly important for the proper operation and maintenance of dams.
- Only two dams, namely, Shiroro and Tiga, retain daily data on reservoir level, inflow, and discharge (for water utilization and total disharge). However, many of the data of Tiga Dam are missing or lack accuracy. Shiroro's discharge data, precisely speaking, show only discharge volumes for hydropower generation but not the total.
- Daily inflow data are available only from four dams, namely, Kainji, Jebba, Shiroro, and Dadin Kowa.
- Daily discharge data for water utilization are available only from two dams, namely, Shiroro and Tiga.
- Although total discharge data are available from Dadin Kowa and Tiga, they lack accuracy and some data are missing. Not a single one of the 26 target dams can provide total discharge data that can be used for proper analysis, etc.
- Dams in HA-4 in particular (Asejire, Erinle, Igbojaya, Ikere Gore, and Oyan) have virtually no data.

As described above, of the 26 dams, three major hydropower dams (Kainji, Shiroro, and Jebba) are maintaining data relatively well. Data are also kept at Dadin Kowa, Challawa Gorge, and Tiga, for which they deserve credit, though the accuracy is somewhat questionable. However, the remaining 20 dams other than the above six have accumulated hardly any data especially of the recent years. The reason was found in the non-functioning measuring instruments, which were destroyed by large floods and have not been repaired since.

Table SR4-29 Management Status of Dam Operational Data (since 2000)

HA	S/N	Name of Dam	Reservoir water level	Reservoir inflow	Discharge volume for water use	Total discharge volume	rainfall	Evaporation
1	1	Bakolori	◎	×	×	×	△	△
	2	Goronyo	○	×	○	×	△	×
	3	Gusau	×	×	×	×	△	△
	4	Jibiya	×	×	×	×	△	×
	5	Kainji	◎	◎	△	×	△	△
	6	Kubli	×	×	×	×	×	×
	7	Swashi	×	×	×	×	×	×
	8	Zobe	×	×	×	×	×	×
	9	Zuru	×	×	×	×	×	×
2	10	Gurara	×	×	×	×	△	×
	11	Jebba	◎	◎	×	×	△	△
	12	Omi	×	×	×	×	×	×
	13	Shiroro	◎	◎	◎	×	△	△
	14	Usuma	×	×	×	×	△	×
3	15	Dafin Kowa	◎	○	×	○	×	×
	16	Kiri	×	×	×	×	×	×
6	17	Asejire	×	×	×	×	×	×
	18	Erinle	×	×	×	×	△	×
	19	Igbojaya	×	×	×	×	×	×
	20	Ikere Gorge	×	×	×	×	×	×
	21	Oyan	○	×	○	○	△	×
8	22	Challawa Gorge	◎	△	×	×	△	×
	23	Gari	×	×	×	×	×	×
	24	Ruwan Kanya	×	×	×	×	×	×
	25	Tiga	◎	△	○	○	△	×
	26	Watari	×	×	×	×	×	×

Remark:
◎: Daily data can be obtained. ○ : Daily data can be obtained, but there is a missing part or the less accuracy of the data
△ : monthly data can be obtained × : No data
Shaded data can be obtained about reservoir water level, the amount of inflow, discharge volume.
Source: JICA Project Team

Since the accumulation of these hydrological data is essential for accurately evaluating the water resources management projects and considering the enhancement of dam performance in the future, the management system of the above-mentioned hydrological observation needs to be improved urgently.

(2-3) Conditions of Dam Structures, Facilities and Reservoirs

Problems of each dam were identified in the survey, and the results are summarized in Table SR4-30 (Note: Items that are currently under investigation are not included in the table).

Based on the results shown in Table SR4-30, the problems of the dams can be summarized as follows:

- Aquatic grass and hyacinth are the most common problems followed by sedimentation. However, hardly any dams are recording sedimentation or water quality data.
- Many of the dams in northern parts of HA-1 and HA-8 have structural damage such as cracks and leakages. This is considered due to the drier weather than southern areas.
- Most of the dams are free of problems related to gate operation equipment (gates, control panels.)
- On the other hand, hydrological survey equipment, etc. of many dams are not functioning (broken and unrepaired) as mentioned earlier. Dams that were found by this survey not to be equipped with functioning hydrological instruments are shown in Table SR4-31.

Table SR4-30 Survey Results on Issues of Each Dam

HA	S/N	Dam Name	Decrease of inflow	Leak from the dam	Landslide	Cracks in the dam body	Erosion downstream	Sedimentation	Water pollution	Occurrence of algae	Hazardous Substances
1	1	Bakorori	-	-	-	-	-	-	-	-	-
	2	Goronyo	-	-	-	×	×	×	-	×	-
	3	Gusau	×	×	×	×	×	×	-	×	-
	4	Jibiya	-	△	△	△	-	-	-	×	-
	5	Kainji	×	-	-	-	-	×	×	×	×
	8	Zobe	-	△	△	△	-	△	-	×	-
	9	Zuru	-	△	△	△	-	×	-	×	-
2	10	Gurara	-	-	-	-	-	-	-	-	-
	11	Jebba	-	-	-	-	-	-	-	×	-
	13	Shiroro	×	-	-	-	-	-	×	-	-
	14	Usama	-	-	-	-	-	×	-	-	-
3	15	Dadin Kowa	-	-	-	-	-	×	-	×	-
	16	Kiri	-	-	-	-	-	×	-	×	-
6	17	Asejire	-	-	-	-	-	×	-	-	-
	18	Erinle	-	-	-	-	-	-	-	×	-
8	22	Challawa Gorge	-	-	-	-	-	-	-	-	-
	23	Gari	-	×	×	×	×	×	-	×	-
	24	Ruwan Kanya	-	×	×	×	×	×	-	×	-
	25	Tiga	×	-	×	×	×	-	-	×	-
	26	Watari	-	×	×	×	-	×	-	×	-

Remark: × : Those listed as a issues 、 △ : Those not observed
Source: JICA Project Team

Table SR4-31 Dams whose Hydrological Observation Facility is not Functioning

HA	S/N	Dam Name	Remarks
1	2	Goronyo	
	3	Gusau	Failed when the flood of 2005, and has not been repaired since then
	8	Zobe	
6	17	Asejire	
8	22	Challawa Gorge	
	23	Gari	
	24	Ruwan Kanya	
	26	Watari	

Remark: Except for the Dam that is currently under investigation
Source: JICA Project Team

Water Quality in Reservoirs

The greatest concerns addressed in this survey were aquatic grass and hyacinth, which are considered to be caused by eutrophication of influent water (agricultural discharge) and low turnover rates. For all the dams this water quality problem is well understood, and for Jebba Dam, especially, it seems to be recognized as the most critical issue.

Sedimentation in Reservoirs

The sedimentation problem is also well recognized for the surveyed dams though whether or not they have been taking annual sedimentation data is unknown. Asejire Dam, in particular, is said to have lost 30% of its capacity according to a recent survey though the basis of this estimation is obscure. The high awareness level of each dam suggests that sedimentation is increasing in many dams. Therefore, upon checking the availability of relevant data at each dam and sorting out the results, it is necessary to set the direction for sedimentation control.

Safety of Dam Structures (plant/algal growth, erosion)

Many of the dams in Nigeria are earth dams, and all the dams surveyed this time are earth dams (or combined earth/concrete dams). The key point in ensuring the safety of earth dam structures is to prevent piping. In doing so, it is most important to prevent deformations (cracks, erosion) in dam structures. We need to pay particular attention to depression and cracks in the dam structure, as they are likely to induce piping. The survey also found dams that were covered with plants and trees (their roots are causing cracks), as well as those that are eroded from the crest by rain or partially hollowed out by termites*.

Source: JICA Project Team

Photo-1 Intrusion Status of Vegetation in Zuru Dam Body

The dam structures of Zuru, Gari, and Watari are severely eroded. The condition of Watari Dam, on which virtually no maintenance is performed, is especially dire, and thus its safety needs to be assessed as soon as possible.

Source: JICA Project Team

Photo-2 Erosion Status in Gari Dam Body

Spillways

According to the results of the survey, no major problems have been found so far in the spillway facilities with gates (controlled spillways). Uncontrolled spillways also seem to be free of apparent malfunction though cracks at the crest sections, etc, are found in some dams. However, the discharge capacity of each spillway needs to be evaluated based on the results of flood flow rate analysis to be conducted in the future as discussed in Section SR4.2.1 above. The damaged spillway of Goronyo Dam is currently under repair as part of a rehabilitation project.

Service Roads

The service roads to the dams surveyed this time were reported to be free of problems for the most part. However, pavements of the service roads listed below are damaged and need repair. Since service roads are administrative facilities necessary for communicating information to downstream areas and patrolling, their maintenance guidelines need to be established in the Master Plan so that their conditions can be maintained to a decent degree.

- Challawa Gorge Dam, Ruwan Kanya Dam, Tiga Dam

Source: JICA Project Team

Photo-3 Erosion and Leakage Status in Stream of Watari Dam Body

(2-4) Reservoir Operation Record

We sorted out the reservoir operation records of the five dams listed below that have kept i) reservoir water level data over a relatively long period without many missing data and ii) reservoir level -volume-surface area curve. As for inflow data, we included those of only three dams (Kainji, Jebba, and Shiroro), which are deemed to possess a certain degree of accuracy. The Specifications of five dams are shown in Table SR4-32. The total discharges of these three dams were the result of our own calculations derived based on the inflows and reservoir levels.

- Bakolori Dam
- Kainji Dam
- Jebba Dam
- Shiroro Dam
- Dadin Kowa Dam

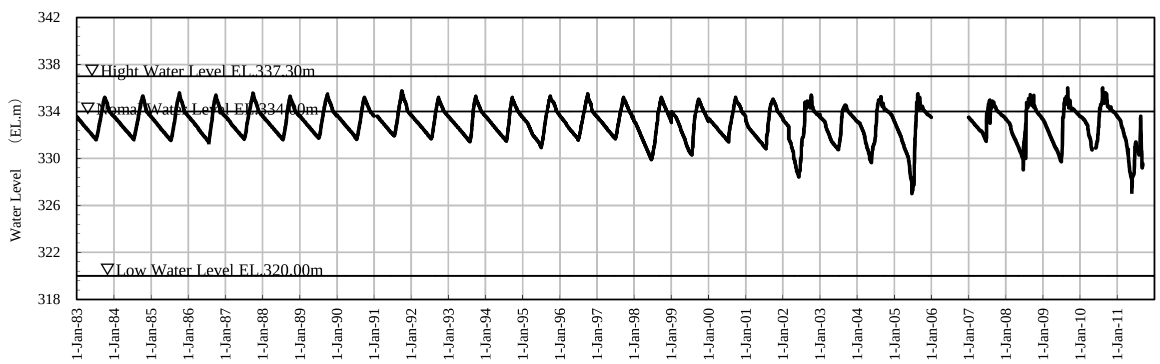
Table SR4-32 Specifications of 5 Dams for Evaluation of Reservoir Operation Data

Dam	Catchment area (km^2)	Dam height (m)	Low water level (EL.m)	Normal high water level (EL.m)	Flood high water level (EL.m)	Total reservoir capacity (MCM)	Effective storage capacity (MCM)	Design flood Discharge (m^3/s)
Bakolori	4,747	48.00	320.00	Unknown	334.00	450.00	403.00	3,750
Kainji	1,589,938	65.50	129.00	141.90	143.50	15,000.00	12,000.00	7,900
Jebba	1,629,481	40.00	99.00	103.00	106.00	3,800.00	1,000.00	13,600
Shiroro	34,702	105.00	342.00	382.00	385.00	7,000.00	6,050.00	7,500
Dadin Kowa	32,184	42.00	239.00	243.00	247.00	2,800.00	1,770.00	1,110

Remarks: Catchment area is estimated by GIS data by JICA Project Team.
Source: JICA Project Team

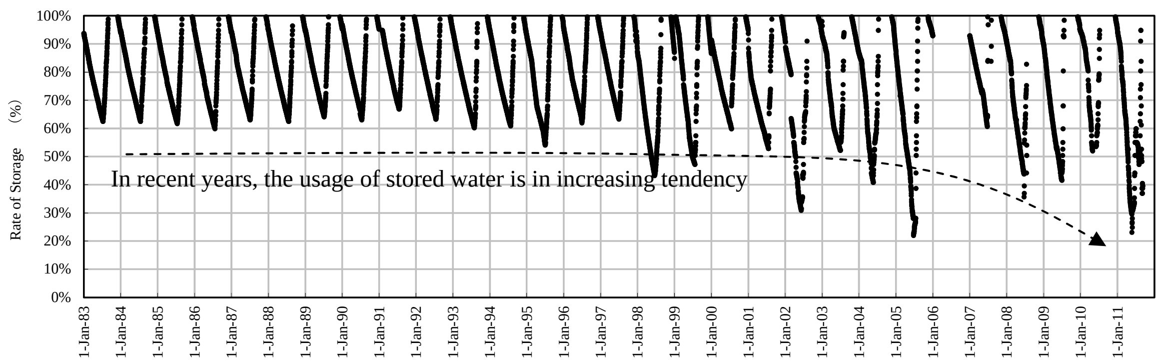
<u>Bakolori Dam: HA-1</u>

Bakolori Dam in HA-1 was constructed on the Socoto River in 1982. It is a multipurpose dam with a height of 48.0m, a catchment area of 4,747km^2, and a gross storage capacity of 450MCM. Purposes of the dam include flood control, irrigation, water supply, hydropower generation, and fisheries. Upstream of the dam, there is Gusau Dam (gross storage capacity 3 MCM, a catchment area of 2,570km^2). The reservoir operation record of Bakolori Dam is shown in Figure SR4-39. Storage ratios converted from the above reservoir levels (100% storage ratio = normal full level, 0% = lowest level) are shown in Figure SR4-40.



Source: JICA Project Team

Figure SR4-39 Change in Reservoir Water Level in Bakolori Dam（1983 - 2011）



Source: JICA Project Team

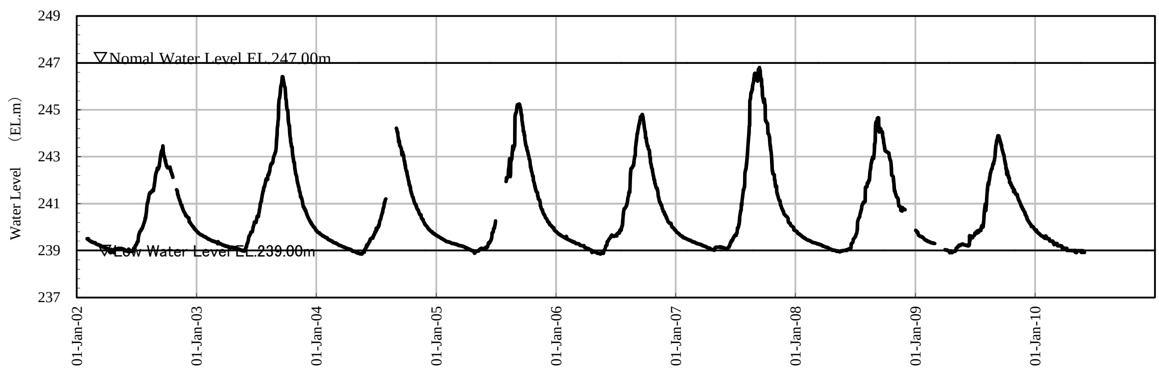
Figure SR4-40 Change in Storage Ratio in Bakolori Dam

Outlined below are the characteristics of the operation of the Bakolori dam reservoir:

- Like other dams in Nigeria, the Bakolori dam reservoir basically operates in the following cycle: [Store flood water during rainy season (replenish)] → [Supply stored (developed) water during dry season] → [Store flood water during rainy season (replenish)].
- The reservoir regains its full level at the end of rainy season every year and seems to be operating at relatively high efficiency despite low turnover rate (See Table SR4.2-4).
- While the water storage ratio decreased (as a result of water supply) only to 60% or so until 1997, the ratio tends to go down much lower (around 20%) in recent years.

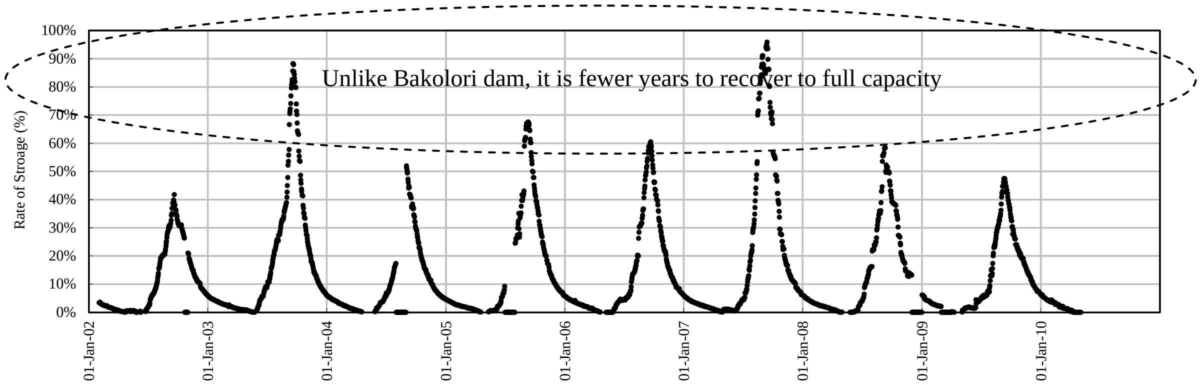
Dadin Kowa Dam: HA -3

Dadin Kowa Dam in HA-3 was constructed on the Gongola River in 1987. It is a multipurpose dam with a height of 42.0m, a catchment area of 32,184km^2, and a gross storage capacity of 2,800MCM. The purposes of the dam are flood control, irrigation, water supply, hydropower generation, and fisheries. Downstream of the dam, there is Kiri Dam (completed in 1982, catchment area 44,581km^2, gross storage capacity 615MCM). The reservoir level record of Dadin Kowa Dam is shown in Figure SR4-41. Its operational record in terms of storage ratio, like that of Bakolori Dam, is shown in Figure SR4-42.



Source: JICA Project Team

Figure SR4-41 Change in Reservoir Water Level in Dadin Kowa Dam (2002 - 2010)



Source: JICA Project Team

Figure SR4-42 Change in Storage Ratio in Dadin Kowa Dam

Outlined below are the operational characteristics of Dadin Kowa Dam.

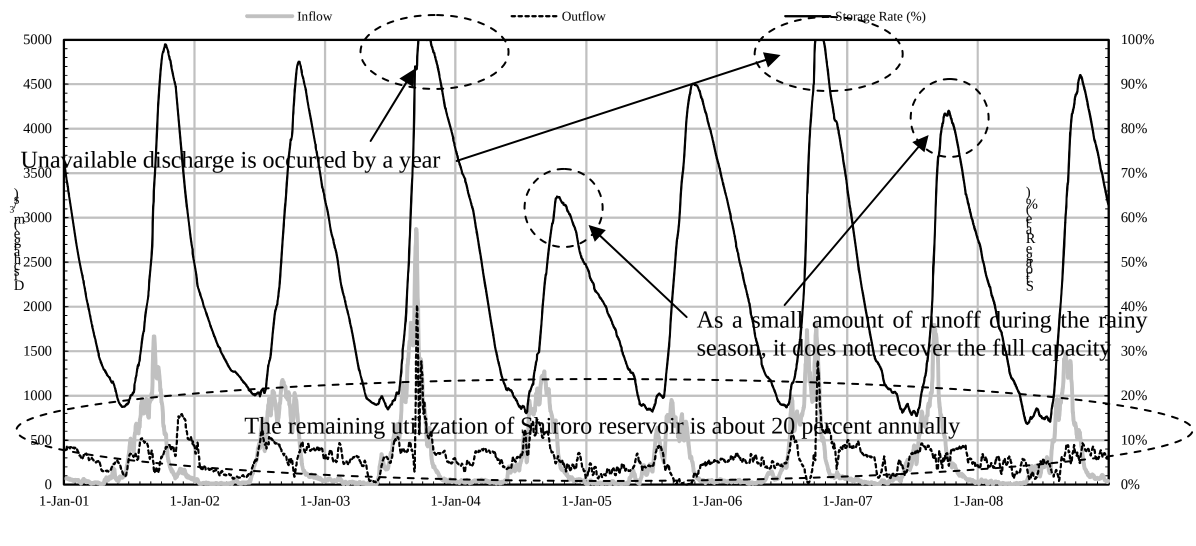
- Like other dams in Nigeria, the Dadin Kowa dam reservoir basically operates in the following cycle: [Store flood water during rainy season (replenish)] → [Supply stored (developed) water during dry season] → [Store flood water during rainy season (replenish)].
- The storage ratio decreases to zero almost every year (demand exceeding supply).
- The reservoir has never achieved its full level except 2007 (turnover rate of Dadin Kowa Dam is about 1.0 in relation to the average flow rate as shown in Table SR4.2-4). The

reservoir water level recovers only to 60 - 70% of full capacity at the end of rainy season. While various reasons for this are conceivable, such as too large a storage capacity compared to inflow and excessive discharge beyond the design level, it is difficult to pinpoint the exact cause based on the currently available data.

- As is the case with Bakolori and Gusau Dams that are located on the same river, it is possible to improve the efficiency of Dadin Kowa Dam by coordinating its operation with the downstream Kiri Dam. However, it is difficult to examine this possibility because of the absence of operational data of Kiri Dam as is the case with Gusau Dam.

<u>Shiroro Dam: HA-2</u>

Shiroro Dam in HA-2 was constructed on the Kaduna River in 1990. It is a rock-fill dam with a 105.0m height (the highest in Nigeria), a 34,702km^2 catchment area, and a 7,000MCM gross storage capacity. The purposes of the dam are hydropower generation and water supply. It is serving an extremely important role as one of the major power supply sources in Nigeria along with Kainji and Jebba Dams. Figure SR4-43 shows the reservoir operation record of Shiroro Dam. It also contains the operational records of Kaiji and Jebba, Dams, which are large-scale hydropower facilities comparable to Shiroro Dam. Figure SR4-44 shows the inflow, total outflow (total discharge volume, including discharge for hydropower generation and discharge from spillways), and water storage ratio. The total outflow was calculated by the JICA Project Team based on the reservoir water level, discharge volume for power generation, and inflow.



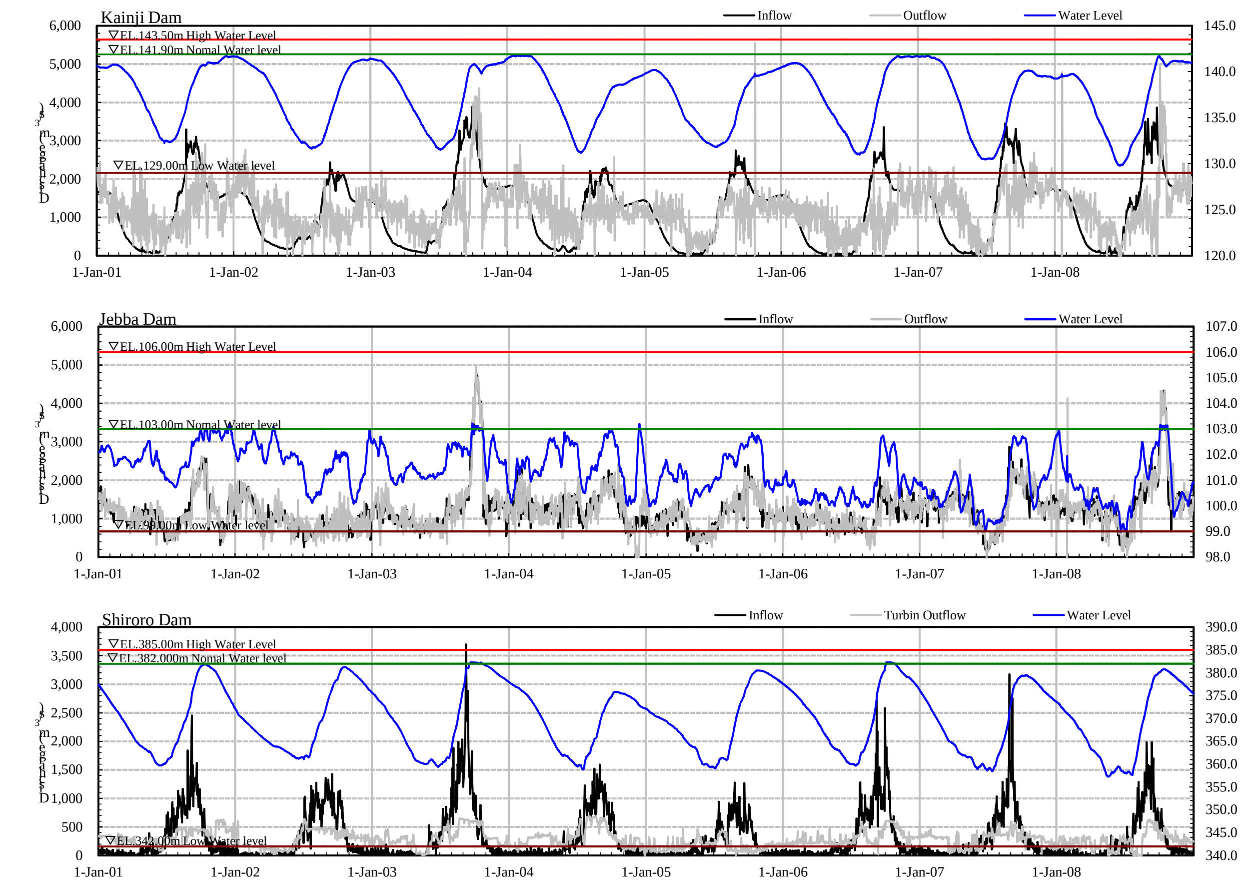
Note: Outflow is estimated by JICA Project Team based on available data. Source: JICA Project Team

Figure SR4-43 Operation Condition of Shiroro Dam

Outlined below are the operational characteristics of Shiroro Dam.

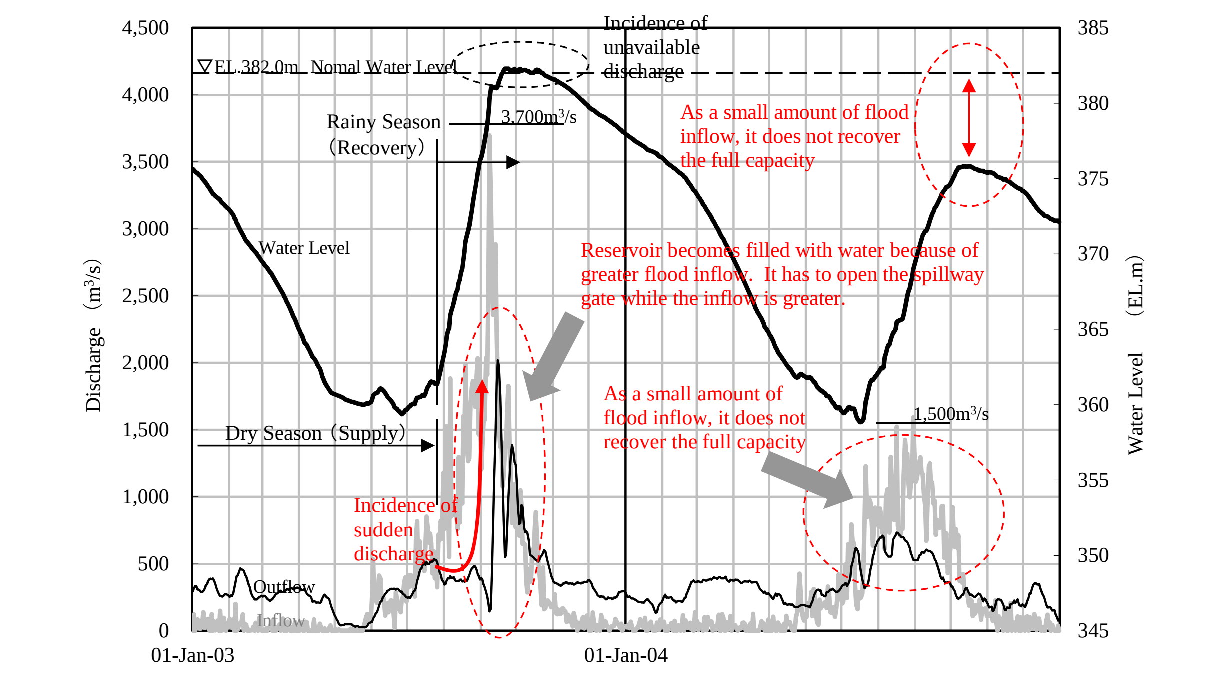
- Like other dams in Nigeria, the Shiroro dam reservoir basically operates in the following cycle: [Store flood water during rainy season (replenish)] → [Supply stored (developed) water during dry season] → [Store flood water during rainy season (replenish)].
- While the utilization rate of the reservoir is at a stable level around 80% (20% left available), its water level does not recover to the full level in some years. This indicates that if the reservoir water is used at 100% of the design rate, the frequency of not recovering to the full level will likely increase.
- The dam deserves credit for its efficient operation, as it mostly recovers the full level at the end of rainy season while the inflow of the following rainy season is predicted here.
- However, the reservoir in some years did not recover the full level due to insufficient flooding during the replenishment phase of the rainy season.
- In other years, however, rapid discharge occurred due to inflow of floodwater that exceeded the forecast rate. Figure SR4-45 shows the reservoir operation record of 2003-2004. The year 2003 saw large floods whereas the year 2004 experienced drought. As the figure indicates, inaccurate forecasts lead to various problems, including “rapid discharge,” “idle discharge,” and “failure to recover full water level.”

- As explained above, the reservoir does not recover the full level when the inflow during rainy season falls short of the forecast. On the other hand, when the inflow exceeds the forecast, rapid discharge from spillway occurs, endangering the downstream areas. This conclusively suggests that “the ability to make a long-term outflow forecast during rainy season holds key to successful replenishment of Shiroro dam reservoir.”



Note: Outflow is estimated by JICA Project Team based on available data. Source: JICA Project Team

Figure SR4-44 Operation Records of Kainji, Jebba and Shiriro Dams



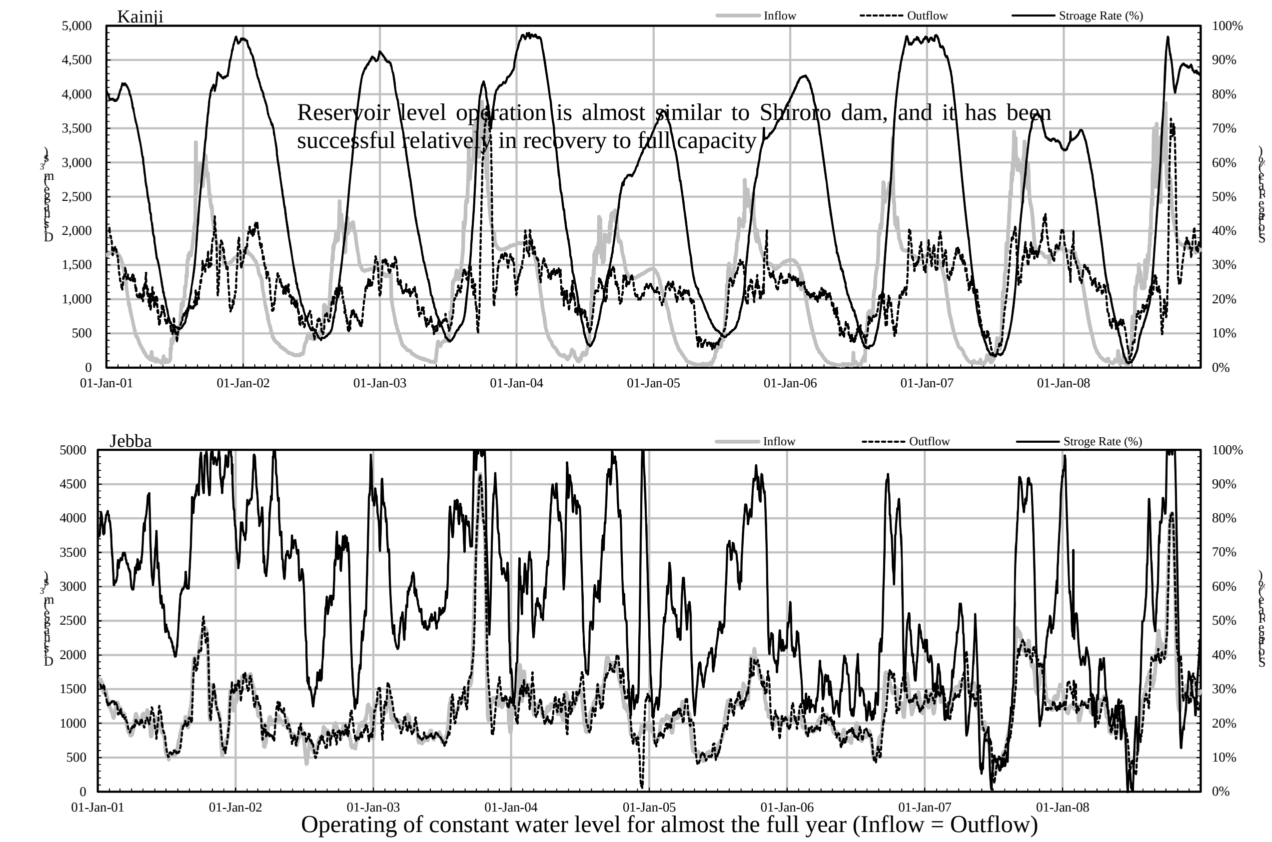
Note: Outflow is estimated by JICA Project Team based on available data. Source: JICA Project Team

Figure SR4-45 Reservoir Water Level, Inflow and Outflow of Shiroro Dam (2003 – 2004)

Kainji Dam: HA-1 / Jebba Dam: HA-2

Kainji Dam in HA-1 was constructed in 1968 at the downstream end of the Niger River. It is one of the largest dams in Nigeria with a dam height of 65.5m, a catchment area of 1,589,938km^2, and a gross storage capacity of 15,000MCM, serving multiple purposes, including irrigation, water supply, hydropower generation, and fisheries. Kainji is one of the key hydropower dams in Nigeria along with Shiroro and Jebba. Jebba Dam in HA-2 was constructed in 1984 on the Niger River downstream of Kaiji Dam. It is a multipurpose dam with a 40.0m height, a 1,629,481km^2 catchment area, and a 3,800MCM gross storage capacity.

Kainji and Jebba Dams are serial dams located on the same river, and Jebba Dam is particularly sensitive to outflow from Kainji Dam. The reservoir operation records of these dams are shown in Figure SR4-44. Their water storage ratios are shown in Figure SR4-46.



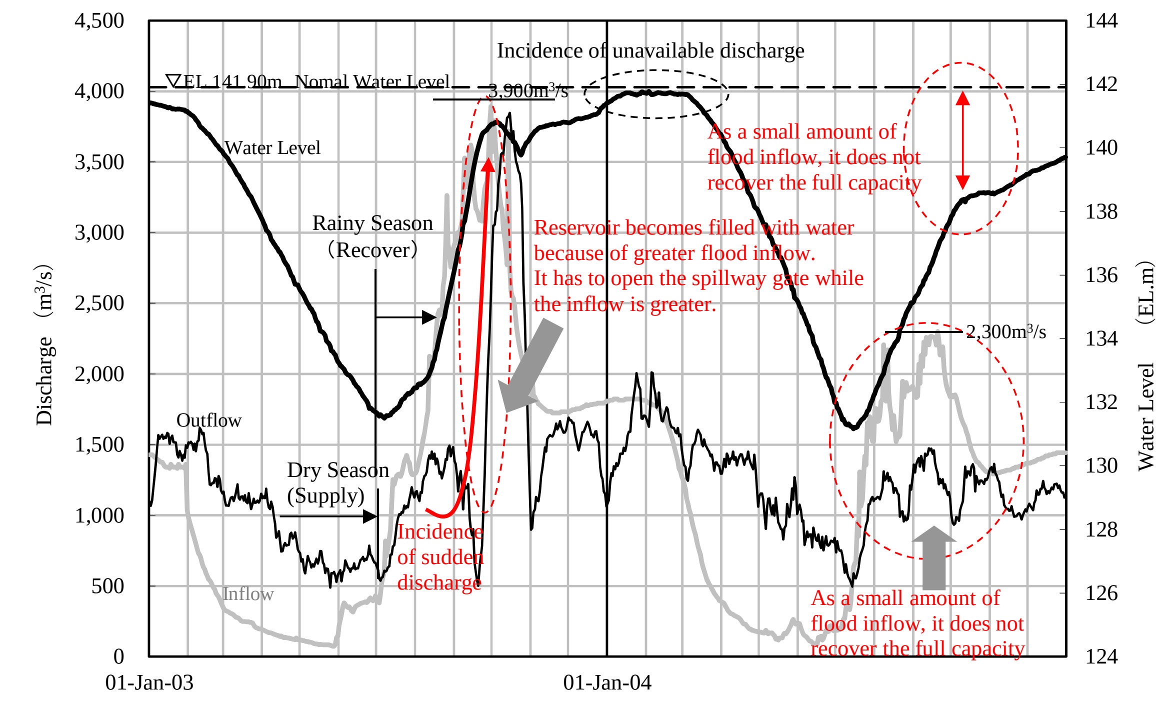
Note: Outflow is estimated by JICA Project Team based on available data. Source: JICA Project Team

Figure SR4-46 Operation Condition of Kainji and Jebba Dams

Outline below are the operational characteristics of Kainji and Jebba Dams.

- Like other dams in Nigeria, the Kainji dam reservoir basically operates in the following cycle: [Store flood water during rainy season (replenish)] → [Supply stored (developed) water during dry season] → [Store flood water during rainy season (replenish)].
- Jebba Dam, on the other hand, operates mostly on the basis of Qin = Qout throughout the year. The use rate of the reservoir is largely affected by the discharge from Kainji Dam and fluctuates greatly from year to year depending on the discharge operation of Kianji Dam rather than the river flow regime (inflow). Its operational record suggests that Jebba Dam is functioning as a re-regulating dam.
- Although the inflow into Kainji Dam becomes close to zero during peak period of dry season, the dam is able to maintain at least 500m^3/s of river flow in its downstream. Since Jabba Dam discharges water it receives from Kainji Dam, it also maintains the minimum flow rate of 500m^3/s in its downstream throughout the year.
- Kainji Dam succeeds for the most part in regaining the full water level at the end of each rainy season. Like Shiroro Dam, it deserves credit for operating the dam efficiently while forecasting the inflow during rainy reason. However, like Shiroro Dam, some years did not see full recovery due to low floodwater in the rainy reason.

- Other years, on the other hand, rapid discharge occurred due to large inflow exceeding the forecast level during the replenishment phase. This also resembles Shiroro Dam.
- The reservoir operation record of 2003-2004 is shown in Figure SR4-47. As the figure indicates, inaccurate forecasts lead to various problems, including "rapid discharge," "idle discharge," and "failure to recover full water level," as is the case with Shiroro Dam.



Note: Outflow is estimated by JICA Project Team based on available data.
Source: JICA Project Team

Figure SR4-47 Reservoir Water Level, Inflow and Outflow of Kainji Dam (2003 - 2004)

- Kainji Dam experiences two types of floods: the "white floods" occur within Nigeria between the late July and early September whereas the "black floods" are caused by monsoon around December in the upper reaches of the Niger River outside Nigeria. The peak runoff is greater in white floods.

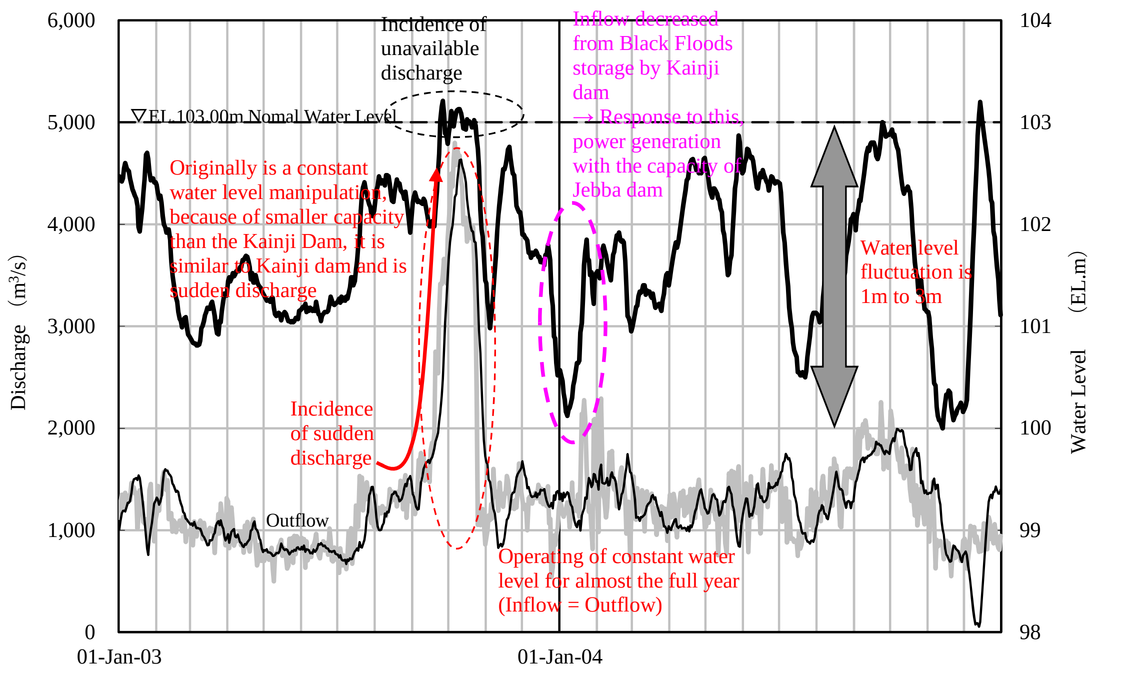
Tabkle SR4-33 Two Type of Flood in Kainji Dam

Name	Occurrence area	Occurrence period
White Floods	Occurrence in Nigeria	From late July to early September
Black Floods	Occurrence in the Upper Niger River (abroad), (by monsoon)	Around December to January of next year

Source: JICA Project Team

- The major difference between Kainji Dam and Shiroro Dam is that Kainji sets its replenishment period at the time when white floods arrive at the dam. In other words, even if Kainji Dam fails to recover the full level at the arrival of white floods, it has a second chance of full replenishment at the arrival of ensuing black floods. (Shiroro Dam has only one chance with white floods).
- The reservoir operation record of Jebba Dam for the same period as above is shown in Figure SR4-48. Since Jebba Dam is greatly affected by the discharge from Kainji Dam, it is basically passing water released from Kainji (and, of, course, catches side-flows as well). For this reason, Jebba was directly impacted by the rapid discharge caused by the arrival of white floods at Kainji Dam in 2003, which subsequently forced Jebba Dam into rapid discharge.
- During the early phase of the arrival period of black floods (around January 2004), on the other hand, Kaiji Dam went into the replenishment mode, decreasing the inflow into Jebba Dam, which, in turn, had to release stored water to augment outflow. This was the cause of the sudden drop in water storage level in January 2004.

As mentioned above, Jebba Dam is governed by the operation of the upstream Kainji Dam. These operational data clearly indicate that close coordination between the two dams is essential for enhancing their operations for both the flood control and water utilization purposes.



Note: Outflow is estimated by JICA Project Team based on available data.
Source: JICA Project Team

Figure SR4-48 Reservoir Water Level, Inflow and Outflow of Jebba Dam (2003 – 2004)

(2-5) Summary of Survey on Selected Large Storage Dams

Table SR4-34 summarizes the results of the survey on the selected large storage dams in the present project. In the table, recommended measures for improvement of the current status are also shown.

Table SR4-34 Summary of Survey on Selected Large Storage Dams

Item		Status	Recommended Measures for Improvement
Management status of operation data		Many important data has not been managed and recorded except for the part of the dam	-Rehabilitation of the hydrological observation as soon as possible together with other deteriorated equipment -Preparation of dam management manual for the observation data.
The status of dam body, facilities and reservoir	The water quality of reservoir	Recognition for water quality is high.	-Further clarification of the observation data of water quality, including accumulation of water quality data -Preparation of management manual on water quality as well as water resources conservation
	Sedimentation of reservoir	Recognition for sedimentation is high.	-Further clarification of the observation data of sedimentation. - Preparation of sediment management manual
	The safety of the dam body	There are some problems of dam crack and the vegetation in many dams. Heavy damage in the arid HA-1 and HA-8 is found particularly	- Preparation of maintenance manual of dam for safety management of the dam body -Preparation of a concrete study plan for the dams in which serious damage has been observed.
	Spillway	The structure of the spillway itself and related facilities seems to have been managed relatively well. However, the discharge capacity needs to be checked carefully.	- Confirmation of the concept of design flood discharge - Full examination of discharge capacity of spillway with the design data -Development of concept for countermeasures if the design capacity is not sufficient
	Administrative road	Some of the dam is in poor conditions.	- Preparation of maintenance manual of dam, which describes the need of proper maintenance of the maintenance road
Reservoir operation record		Supplying capacity for the dry season is determined by the storage of the rainy season, the storage operation is forced to operate difficultly. There is also a dam that does not recover to full water although the turnover rate is low.	-Further detail study for improvement of reservoir operation, especially for utilizing the storage more effectively and for avoiding sudden discharge to downstream in wet season. -Preparation of upgraded operation manual based on the detail study

Source: JICA Project Team

(3) Dams under Construction

According to dam department of FMWR, the number of dams under construction is about 30 and their total storage volume is 1.6BCM, as shown in Table SR4-35. It coincides the incremental storage volume that is set at mid-term target in Water Sector Roadmap. The representative dams of which storage volume is large are Kashimbilla, Galma and Kontagora (Auna) dams.

Table SR4-35 List of Ongoing Dam Projects

No.	Name of Dam	State	Date of Award of Contract	Project Cost (Bil. Naira)	Gross Storage (MCM)	Remarks*
1	Owiwi	Ogun	2005/9/21	6.90	30.0	Dam body completed
2	Ile-Ife	Osun	2004/4/3	3.74	14.0	Dam 75% completed
3	Ilesha	Osun	2005/1/15	2.44	25.0	Dam 55% completed
4	Inyishi	Imo	2005/8/8	0.95	25.0	Dam 75% completed
5	Owena Multipurpose	Ondo	1998/12/8	5.6 (dam) 7.2 (WTP)	36.0	Dam body completed
6	Kashimbilla	Taraba	2005/6/22	42.94	500.0	Dam 27% completed
7	Sulma Earth	Katsina	2006/1/31	1.17	4.3	Dam 90% completed
8	Amuzari	Imo	2005/3/24	1.00	2.5	Dam 97% completed
9	Ogwashi-Uku	Delta	2006/5/8	3.62	3.9	Dam 50% completed
10	Cham					Not start
11	Mashi	Katsina	2005/11/8	0.52	5.0	Dam 98% completed
12	Ivo	Enugu	2009/11/10	2.73	20.0	Dam 50% completed
13	Galma	Kaduna	2001/5/12	11.77	186.0	Dam 65% completed
14	Kontagora (Auna)	Niger	2010/9/14	11.39	340.0	Dam 50% completed
15	Kagara	Niger	1992/12/1		43.0	Dam 64% completed
16	Ogbesse	Ekiti	2010/9/14	7.80	74.0	Dam 50% completed
17	Jare	Katsina	2007/2/22	4.47	26.3	Dam 25% completed
18	Ibiono Ibom	Akwa-Ibom	2010/9/14	0.92	0.3	Dam 15% completed
19	Gimi Earth	Kaduna	2012/5/12	0.62	4.7	Dam 15% completed
20	Dutsi Earth	Katsina	2005/4/19	0.37	6.2	Dam 50% completed
21	Alkaleri Earth	Bauchi	2010/5/12	0.28		Dam 30% completed
22	Otukpo	Benue	2010/12/14	17.20	30.0	Starting stage
23	Adada River	Enugu	2010/12/23	2.70	2.7	Starting stage
24	Kwa Falls	Cross River	2010/12/23	3.42	68.0	Dam 5% completed
25	Jada	Adamawa	2010/10/27	6.00	40.6	Dam 25% completed
26	Mangu	Plateau	2005/3/22	6.00		Dam 5% completed
27	Nkari	Akwa Ibom	2003/10/20	2.91	3.5	Dam 5% completed
28	Wannune	Benue	2011/2/8	0.87	1.0	Starting stage
29	Iyamero	Ekiti	2011	0.23		Dam 26% completed
30	Aloshi	Plateau	2011	0.20		Dam 28% completed
31	Rafin Soja	Nasarawa	2011	0.20		Dam 26% completed
32	Upu-Itor	Benue	2011	0.20		Dam 26% completed
33	Igbojaye	Oyo			5.6	

Remark: As of 2011
Source: FMWR

(4) Related Matters on Large Dams

There are two on-going large scale hydropower development projects by FMP as shown in Table SR4-36.

Table SR4-36 On-Going Large Scale Hydropower Development Projects by FMP

Project	Project Site	Outline
Manbilla HPS	Upper Donga River (HA3)	Max power: 3,050MW, Design Discharge:373m^3/s, Rated Head: 927m Dams: Nya dam (H=23m), Sumsum dam (H=70m), Nghn dam (H=75m), Api dam (H=150m)
Zungeru HPS	Middle Reach in Kaduna River (HA2)	Max power:700MW, Design Discharge: 220m^3/s, Rated Head: 92m Dam: Height 90m

Source: FMP

On the other hand, the discussion on the possibility of the construction of Dasin Husa dam at around border between Nigeria and Cameroon has been starting. It is a multi-purpose water resources development project including hydropower, irrigation and inland water navigation, of which pre-feasibility study was conducted in 1982. In 2008, a feasibility study was conducted and economic evaluation was done except for irrigation component. The storage capacity and surface area of the dam is 16BCM and 1,530km^2, respectively. About 70% of the inundation area by the dam is located in the territory of Cameroon. It is said that there could be almost 100,000 people who are required to be resettled.

After the severe flood along the Benue River in 2012, the buffer function of Dasin Hausa dam against flood is attracted. The discussion between Nigeria and Cameroon Government on possibility of construction of Dasin Hausa dam has just started for exploring mutual benefit for both countries.

SR4.2.3 Problems and Issues in Surface Water Development

The problems and issues on surface water development are summarized in Table SR4-37.

Table SR4-37 Problems and Issues in Surface Water Development

Problem	Issue
Increasing Water Demand	The current (2010) population of 150 million in Nigeria is expected to reach to 250 million in 2030. It is the most fundamental and important issues in the water sector to secure the adequate volume of domestic water in accordance with the increasing population. According to the water demand projection, usage of surface water source will be increasing. It is necessary to secure enough surface water sources.
Unevenly Distributed Water Resources	The hydrological condition in Nigeria varies vary much place by place, resulting in the unevenly distributed water resources. It is necessary to consider these unevenly distributed water resources for effective and sustainable water use.
Existing Dams without Keeping Original Functions	It is necessary to revive the dams of which operation and maintenance are very poor condition for preparing the expected increase in the water demand. There are the areas where the supply capacity by the existing dams has not yet been fully utilized. The unutilized storage capacity should be used effectively including conversion of purposes.
Non-Implementation of Water Resources Development proposed in M/P1995	There are a lot of medium and small scale dams proposed in M/P1995. However, almost all of them have not yet been implemented, although some other new dams are now under-construction. One of the reasons for the non-implementation could be the mismatching between the current demand (needs) and the dams. The validation of these proposed dams are required by examining the current water demand.

Source: JICA Project Team

SR4.2.4 Strategy on Surface Water Development

The strategy on surface water development is set based on the problems and issues as shown in Table SR4-38.

Table SR4-38 Strategy on Surface Water Development

Objective	Strategy
Effective Utilization of Existing Dams	Many of the existing dams do not keep their original functions, because of lack of proper operation and maintenance including management of information on reservoir operation. It is necessary to revive these dams urgently, for preparing the expected increase in the water demand. The followings are considered. ● Enhancement of dam management, including preparation of manual for dam management ● Rehabilitation of dams ● Enhancement of dam operation
Preparation of Sufficient Surface Water Source to Address Increasing Water Demand in Consideration of Unevenly Distributed Water Resources in the Country	The necessary water resources development would be proposed by utilizing the proposed dams in M/P1995 as the potential dams as well as the other potential sites. ● By examining water balance for the potential dam sites, efficiency of each site is roughly evaluated. The priority for development should be given to the sites with higher efficiency. ● In the area where water resources is very limited and the future demand is expected to be more than the supply capacity of water source, the demand control such as reduction of the planned irrigation area and/or changing the crop should be considered as one of options for managing the available water, in order to avoid the conflict among water users. ● The integrated development with hydropower generation and irrigation components is proposed in order to promote self-reliant project.

Source: JICA Project Team

SR4.2.5 Concept of Rehabilitation of Existing Dams

It is necessary to enhance dam management including preparation of manual for dam management, in order to utilize the existing dams effectively. This is discussed in Water Resources Management.

On the basis of the results of the survey on management status of selected existing dams, the direction of rehabilitation of the existing dams is as follows.

- Equipment for meteorological and hydrological observation as well as monitoring of inflow and outflow, which is necessary for proper operation, should be rehabilitated in early stage. The integrated usage of monitoring data of river flow by NIHSA and dam operation data by dam owner should be considered.
- Rehabilitation of dam body should be conducted when severe cracks on dam body are observed.

In order to implement the rehabilitation project, it is necessary to investigate in detail on the condition of individual dam including safety management survey such as equipment related to spillway, backup power for emergency case, equipment on for meteorological and hydrological mentoring, as well as dam body survey. It is proposed to implement urgently the capacity development project on dam management for FMWR and relevant agencies. During the capacity development activities, necessary survey such as safety management survey and dam body survey should be implemented as many as possible, so as to materialize the rehabilitation project. The significant dams which have more than 100MCM and other important dams should be prioritized.

According to the results of the survey on management status of selected existing dams, the following dams may be necessary to be rehabilitated among the significant dams; Goronyo, Jibiya, Zobe, Gari, Ruwan Kanya, Tiga and Watari.

SR4.2.6 Potential Sites for Surface Water Source Development

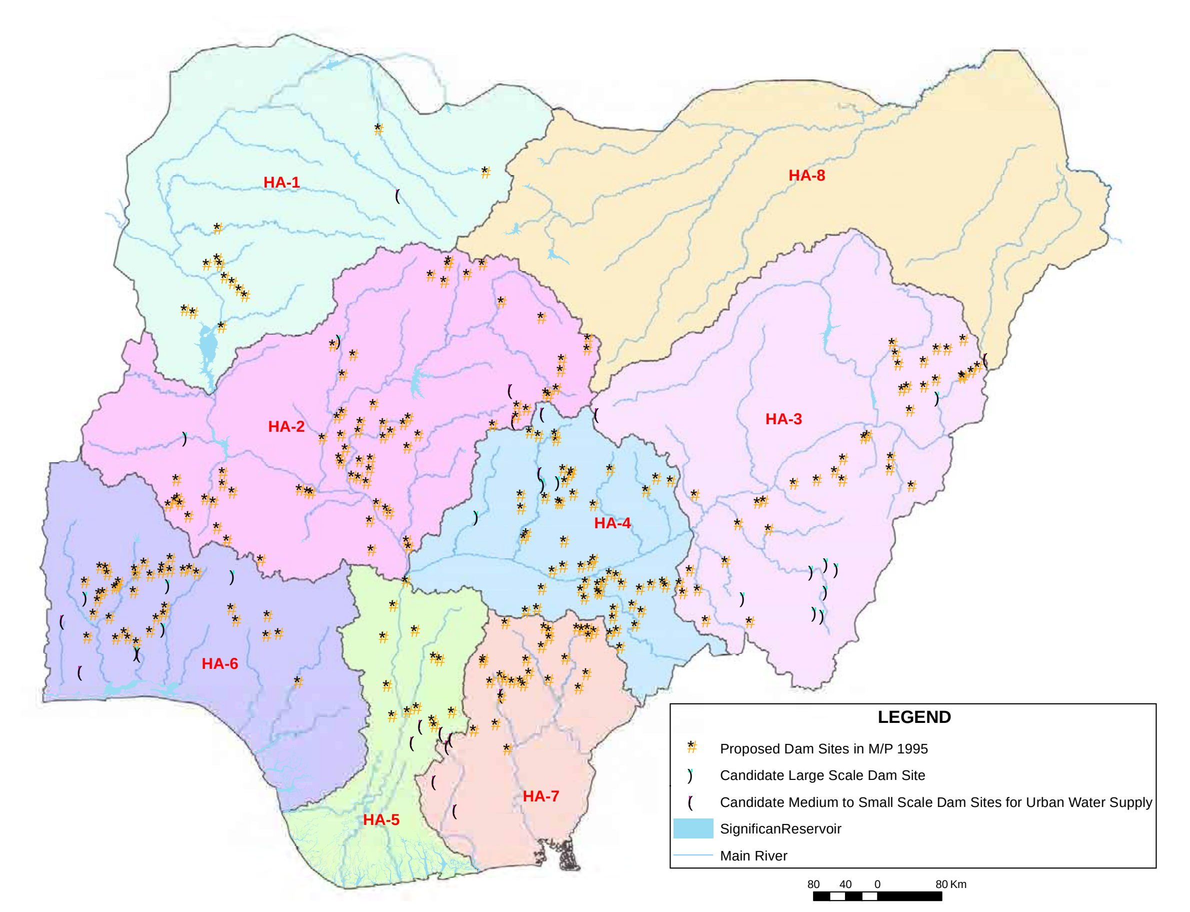
(1) Indetification of Potential Dam Sites

In addition to the proposed dam sites in M/P1995, i) candidate sites for large scale dam sites, ii) candidate small to medium scale dams sites for municipal water supply, were examined and added as potential sites for surface water source development. The total number of the potential sites is 288 in total (refer to Table SR4-39). The location of potential sites is shown in Figure SR4-49. The detail lsit of the potential dam sites are presented in Annex-T SR4-4 to SR4-6.

Table SR4-39 Potential Surface Water Source Development Sites

Type	Number	Total Storage Capacity (BCM)
Proposed dam sites in M/P1995	252	7.35
Candidate sites for large scale dam	18	7.46
Candidate small to medium scale dam sites for municipal water supply	18	0.24

Source: JICA Project Team



Source: JICA Project Team

Figure SR4-49 Location of Potential Sites for Surface Water Development

(1-1) Proposed Dam Sites in M/P1995

Clarification of Dam Sites

As for the location of the proposed dam sites in M/P1995, the coordinates shown in M/P1995 are not accurate when they are compared to SRTM-DEM. The coordinates were thereby adjusted so as to locate appropriate location in consideration with topographic condition represented by SRTM-DEM. The satellite images such as Landsat and Google-Earth were also referred for the adjustment. In some locations, there are already dam lakes in the satellite images. In such case, it is assumed that the proposed dam has already been constructed, and it is listed in the existing dam. As a result, 252 sites are remained as the potential dam sites.

Dimension of Dam

The elevation-surface area-storage volume curves for the proposed dam sites were examined by using SRTM-DEM. The height of dam was basically determined so as to obtain almost same storage volume with that shown in M/P1995. In some locations, the storage volume becomes much smaller due to the limitation of topographic condition. The width of dam was determined by topographic condition represented by SRTM-DEM as well as the height of dam.

Existence of Settlement in Expected Reservoir Area

The existence of large settlement in the expected reservoir area was roughly checked by using Google-Earth image.

(1-2) Candidate Sites for Large Scale Dam

Identification of New Large Dam Sites in HA-2, 3, 4

The candidate new large scale dam sites were identified by the following criteria.

- Target area
  - HA-2, 3and 4 where hydrological and topographical conditions are suitable for large scale dam development are targeted.
- Topographical condition
  - Topographically possible maximum water depth is more than 30m under the condition that the width of dam is less than approximately 2,000m.
  - Storage volume and drainage area can be large.
- Existence of settlements
  - The location where large settlements in the expected reservoir area when the water depth is less than 30m exist is not selected, in order to avoid large scale resettlement.

Totally 13 sites were identified.

Potential Large Dam Sites shown in Master Plan for Ogun & Oshun River Basin in 1982 as well as by Ibadan Water Supply Master Plan in 2003

In the master plan for Ogun & Oshun River Basin in 1982, potential large dam sites are presented. In addition, the Odedele dam in the Oshun River for future urban water supply for Ibadan is recommendedin Ibadan Water Supply Master Plan in 2003. Among those sites, some dam sites are selected by the following criteria.

- When a large settlement in the expected reservoir area is found in satellite image such as Google Earth, the site is not seleceted in order to avoid large scale resettlement.
- When a natonal railway in the expected reservoir area is found, the site is not seleceted, because of the difficulty to relocate the national railway.
- When there is another proposed dam nearby, it is not selected to avoid the overaping of the dams.

Totally five (5) sites were selected.

Dimension of Dam

The elevation-surface area-storage volume curves for the identified dam sites were examined by using SRTM-DEM. The height of dam was basically determined as topographically available maximum height except the following cases.

- In case that the large settlements exist in higher elevation, the height of dam is set so that the large settlements would not occur.
- In case that average annual inflow volume is larger than the storage volume, the height of dam is set so that the storage volume is almost same as the average annual inflow volume.
- For the sites shown in Master Plan for Ogun & Oshun River Basin in 1982, the height of dam is set so that the gross storage volume is almost equal to the potential storage volume shown in Master Plan for Ogun & Oshun River Basin in 1982. However, in case that average annual inflow volume is larger than the storage volume, the height of dam is set so that the storage volume is almost same as the average annual inflow volume.
- For the Odedele dam, the height of dam is set so that the active storage volume is almost equal to that shown in Ibadan Water Supply Master Plan in 2003

The width of dam was determined by topographic condition represented by SRTM-DEM as well as the height of dam.

(1-3) Candidate Small to Medium Scale Dam Sites for Municipal Water Supply

Identification of Dam Sites

The candidate small to medium scale dam sites for municipal water supply were identified by the following criteria.

- Needs for dam development
  - On the basis of the results of water balance study, it is judged that some water sources for municipal water supply cannot be supplied with stable manner for the expected demand in 2030. For such water sources, water resources development is necessary. The candidate dam sites are looked for nearby the water sources.
- Existence of settlements

- The location where large settlements in the expected reservoir area exist is not selected, in order to avoid large scale resettlement.

Totally 18 sites were identified.

Dimension of Dam

The elevation-surface area-storage volume curves for the proposed dam sites were examined by using SRTM-DEM. The height of dam was basically determined so as to obtain necessary storage volume for stable municipal water supply. The width of dam was determined by topographic condition represented by SRTM-DEM as well as the height of dam.

(1-4) Assumed Dam Type and Dimension

Because the study for the dam sites in the present project is preliminary level, the dam dimension is assumed as follows in the present project.

- Dam Type
  - Earthfill or Rockfill
- Dam Highet
  - It is assumed that dam height is maximum water depath plus margin.
  - The margin, which includes excavation depth for basement and allowance for high water, is set as follows.
    - ΔH =5m (WD<20m)
    - ΔH =7m (20m<WD<35m)
    - ΔH =15m (35m<WD)

    where ΔH=margin (m), WD=maximum water depth (m).
- Cross-sectional shape
  - For proposed dam sites in M/P1995 and candidate small to medium scale dam sites for municipal water supply
    - Width=6m
    - Slope at upstream side = 1:3.0
    - Slope at downstream side = 1:2.5
  - For candidate sites for large scale dam
    - Width=8-10m
    - Slope at upstream side = 1:2.0
    - Slope at downstream side = 1:1.8-2.0

(2) Preliminary Cost Estimate of Potential Dam Site

In order to evaluate the potential dam sites, preliminary cost estimate has been conducted. The construction cost is estimated by the following equation.

$$TC = UC \times V$$

where TC = cost (Naira), UC= unit cost per dam volume (Naira/m^3), V= dam volume (m^3).

Unit Cost

The available construction costs in the past 28 dam projects have been analyzed. Among 28 projects, the dominate dam type is earth fill type. The cost was converted to the current (2012) price level. The unit cost, which is the cost divided by the dam volume, is plotted against the dam volume as shown in Figure SR4-50. In the figure, the costs presented in M/P1995 are also plotted for reference. When the dam volume becomes large, the unit cost tends to be constant with about 5,000Naira/m^3. The change of the unit cost by the dam volume can be approximated by the following equations.

$$UC = -2{,}812\ln(V)+44{,}965 \quad (V<1{,}300{,}000m^3)$$
$$UC = -778\ln(V)+16{,}548 \quad (1{,}300{,}000m^3<V)$$

where UC= unit cost per dam volume (Naira/m^3), V= dam volume (m^3).

Dam Volume

For estimation of dam volume, the data in the past projects are analyzed as shown in Figure SR4-51. The following equations can be applied for the estimation of dam volume as a first order approximation. In the present study, these equations are basically used for the estimation of dam volume except for some large scale dams.

- For proposed dam sites in M/P1995 and candidate small to medium scale dam sites for municipal water supply

  $V = 0.193(AL)+30,097$ (H<10m)
  $V = 0.3107(AL)+91,631$ (10m<H)

  where V= dam volume (m^3), A=cross sectional area of dam body (m^2), L=dam length (m), H=dam height (m).

- For candidate sites for large scale dam

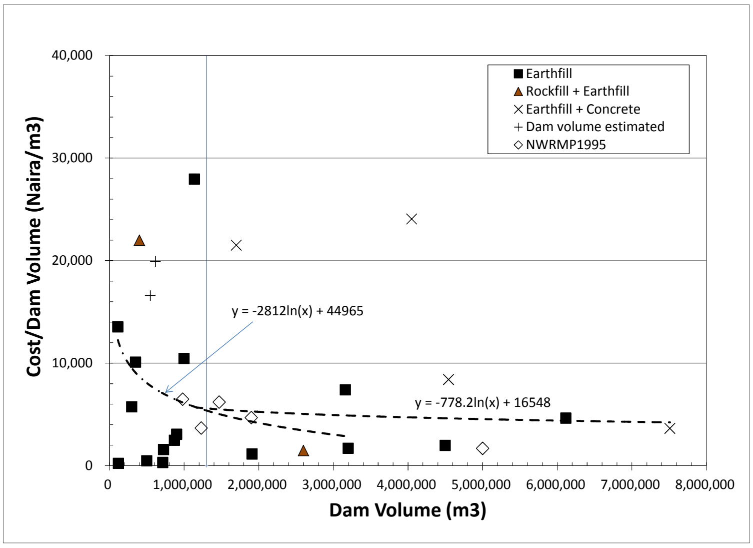
  $V = 1.0^{-8}(AL)^{2}+0.0505(AL)+1,000,000$

  where V= dam volume (m^3), A=cross sectional area of dam body (m^2), L=dam length (m), H=dam height (m).

For the following selected candidate sites for large scale dam, the actual dam volume based on the topographic condition was estimated. These sites are selected among 18 candidate sites because they are considered as i) probable sites for the integrated development schemes that are described later in Section SR4.2.7, ii) probable sites for future urban water supply for Ogun-Oshun Basin, iii) possible higher hydropower potential sites.

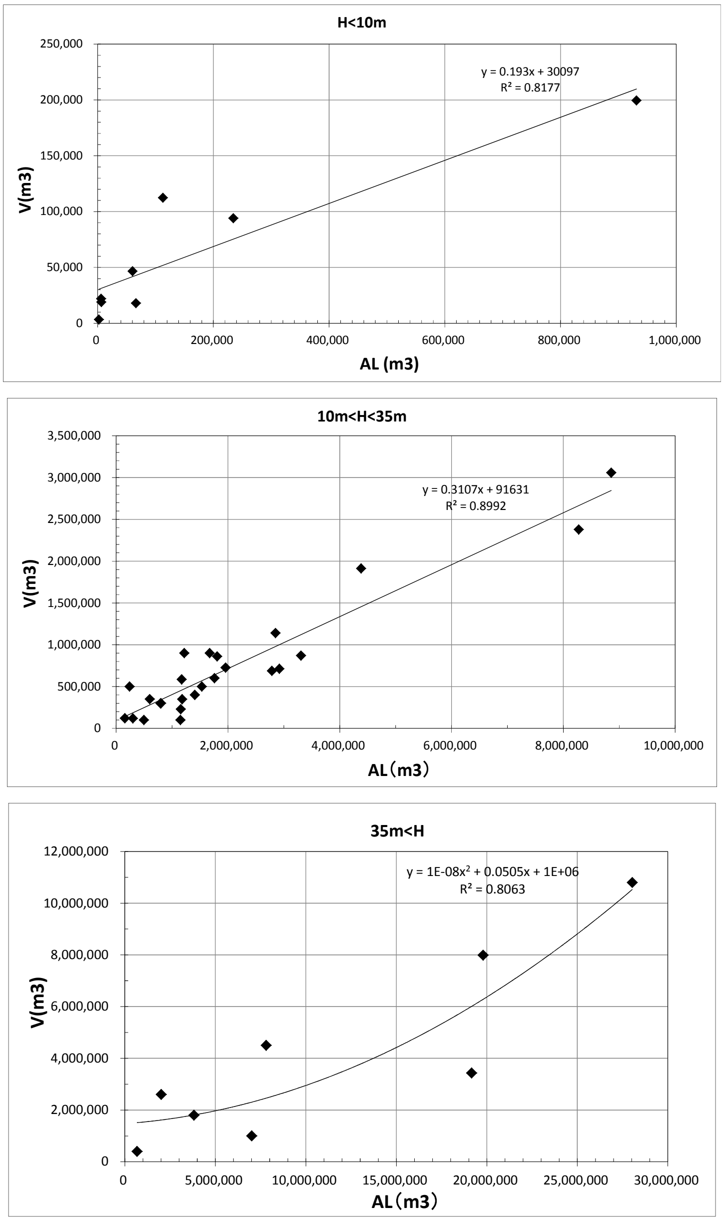
- SN 3001: Baudeu
- SN 3003: Kila
- SN 3004: Kogin Baba
- SN 3005: Kwossa
- SN 3006: Okwaregi
- SN 3010: Nyasikasi
- SN 3011: Ragwa
- SN 3501: Odedele
- SN 3502: Aiyete
- SN 3503: Oba
- SN 3504: Ijesha
- SN 3505: Ona

As for the selected dams for the integrated development schemes (SN 3003: Kogin Baba, SN 3005: Kwossa, SN 3011: Ragwa), the dam volumes for several different dam sizes are also estimated, and conserquently elevation - cost curves were preliminary established. The elevation - cost curves together with the elevation-surface area-storage volume curves are shown in Annex-F SR4-10.



Source: JICA Project Team

Figure SR4-50 Unit Cost of Dam Project

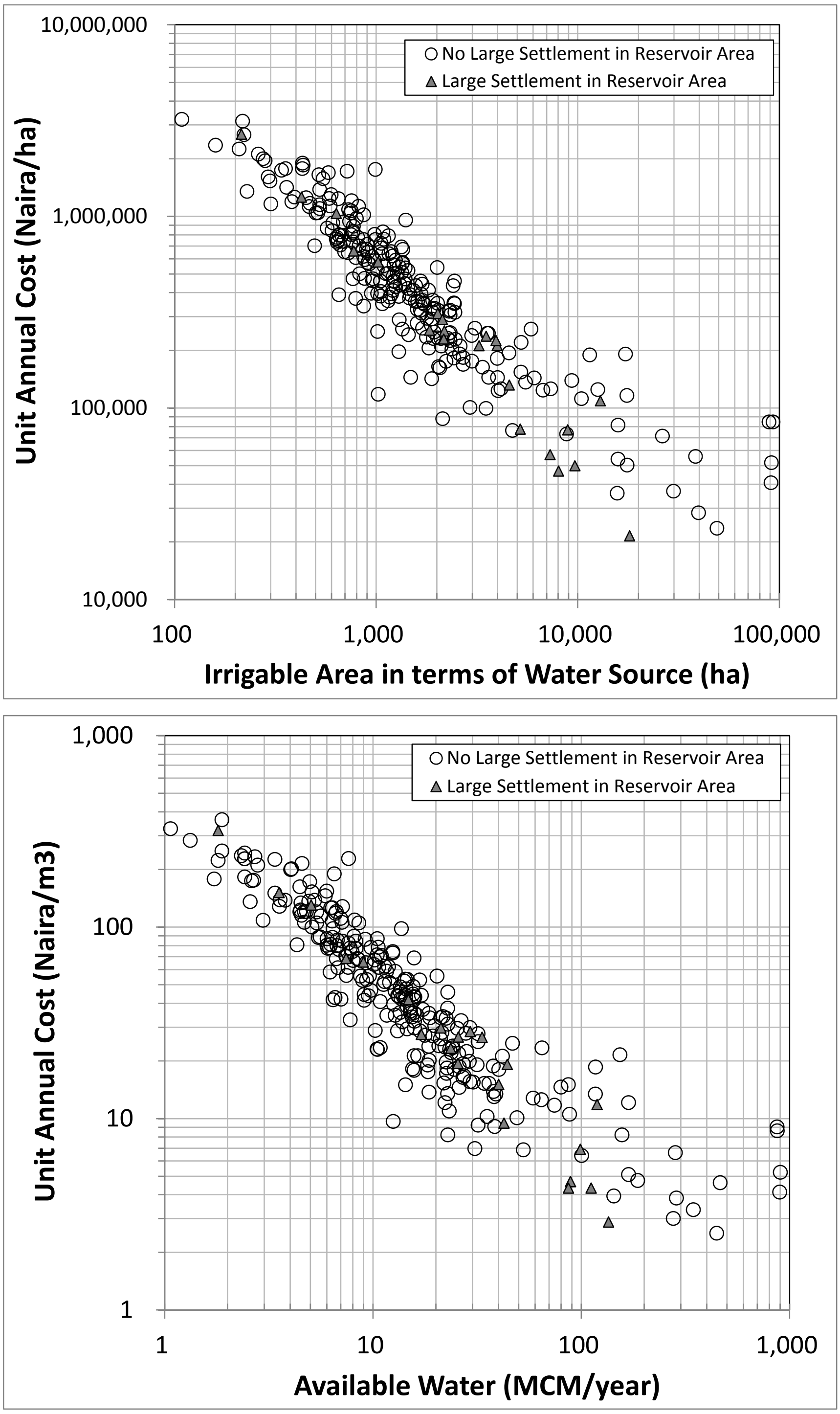


Source: JICA Project Team

Figure SR4-51 Relationship between Dam Height, Length and Dam Volume

(3) Efficiency of Potential Sites

As discussed in Vol.5 Supporting Report 3, the water balance study for each of potential dam sites has been conducted. As a result, a) irrigable area with 80% yearly dependability under the assumed copping pattern, b) available volume of municipal water supply with 90% yearly dependability, were estimated. The construction cost of each of potential dam was also roughly estimated. Using these results, a) annualized cost per 1ha of irrigation area and b) annualized cost per 1m^3 of water are calculated under the following assumptions; project duration =50years, annual operation & maintenance cost=0.5% of project cost and discount rate=10%. These indices represent efficiency of water source development. The smaller annualized cost means the more efficient development. The results are shown in Figure SR4-52 and in Annex-T SR4-4 to SR4-9.



Source: JICA Project Team

Figure SR4-52 Efficiency of Potential Sites for Surface Water Development

(4) Criteria of Selection of Sites

On the basis of needs by municipal water and irrigation development, the proposed dam sites are selected among the potential dam sites. The criteria of the selection are shown in Table SR4-40 and SR4-41.

Table SR4-40 Criteria of Selection of Water Source for Municipal Water Supply

	Item	Criteria
1	Needs on Surface water	There are needs for surface water source nearby.
2	Socio-environmental impact	No large scale resettlement required.→To avoid the site where large town will be inundated by the dam construction.
3	Efficiency	Less costly site. In case of municipal water supply, demand site is already defined. So, possible selection would be limited.

Source: JICA Project Team

Table SR4-41 Criteria of Selection of Water Source for Irrigation Development

	Item	Criteria
1	Availability of irrigation area in term of land	There is large available land area where water can be delivered basically by gravity from dam site.
2	Socio-environmental impact	No large scale resettlement required.→To avoid the site where large town will be inundated by the dam construction.
3	Efficiency	Less costly site.

Source: JICA Project Team

SR4.2.7 Proposed Projects

The proposed projects are shown in Table SR4-42**,** in consideration of the strategy.

Table SR4-42 Proposed Surface Water Development Project

Objective	Proposed Project	
Effective Utilization of Existing Dams	1-1	Capacity development of dam management
	1-2	Rehabilitation of equipment for proper operation of major dams
	1-3	Rehabilitation of deteriorated dams
Preparation of Sufficient Surface Water Source to Address Increasing Water Demand in Consideration of Unevenly Distributed Water Resources in the Country	2-1	Surface water development for municipal water supply
	2-2	Surface water development for irrigation development
	2-3	Integrated surface water development

Source: JICA Project Team

Project 1-1: Capacity Development of Dam Management

The direction of improvement of dam management is discussed in SR3 as one of important elements of water resources management. This project is to enhance the capacity of dam department of FWMR, as well as dam owners such as RBDAs, SWB on dam management. The following activities in pilot areas would be included in the project. The duration of the project is proposed to be three years.

- Preparation of manuals on dam management
- Inspection of dam
- Installation of simple monitoring equipment, if necessary
- Meteorological and hydrological monitoring
- Survey on reservoir sedimentation
- Recording, storing and transferring dam operation monitoring data
- Study on dam operation rule
- Information sharing on dam operation data, information dissemination
- Promotion of optimum use of excess storage in dams by discussion with stakeholders

Project 1-2: Rehabilitation of Equipment for Proper Operation of Major Dams

This project is to rehabilitate the equipment for proper operation of dams such as meteorological, hydrological mentoring, monitoring for reservoir operation.

In order to secure the sustainability of the equipment, the reason why the damage of the equipment occurred would be examined. Then, maintenance plan of the equipment should also be prepared. The integrated usage of monitoring data of river flow by NIHSA and dam operation data by dam owner should be considered.

Project 1-3: Rehabilitation of Deteriorated Dams

This project is to rehabilitate deteriorated dam which may threaten the downstream area. The rehabilitation would be implemented case by case up to 2030.

In case of earthfill dam, it is important to check if there is water leakage or not. Furthermore, the condition of cracks on dam body, erosion, caving should be carefully checked. All of these could cause the failure of dam. The detail conditions should be studied for individual dam and accordingly the countermeasure would be implemented.

Project 2-1: Surface Water Development for Municipal Water Supply

This project is to prepare stable water source for municipal water supply against the water source where the safety level is expected to be lower than 90% yearly dependability in 2030. On the basis of the results of water balance study shown in Vol.5 Supporting Report 3, the surface water source development projects shown in Table SR4-43 are proposed. The total storage capacity of the proposed dams is 381MCM. The locations of the proposed sites are shown in Figure SR4-54.

Table SR4-43 Surface Water Development for Municipal Water Supply

No	Project	HA	State	Water Supply Scheme	SN	H (m)	GS (MCM)
1	Aba dam project	7	Abia	Aba Water Supply Scheme	4012	11	3.4
2	Mubi dam project	8	Adamawa	Mubi Water Supply Scheme	4013	22	6.0
3	Umuseke dam project	5	Anambra	Greater Awka Water Supply Scheme	4009	16	9.5
4	Ihiala dam project	5	Anambra	Ihiala Regional Water Supply Scheme	4010	11	3.4
5	Nnewi dam project	5	Anambra	Nnewi Regional Water Supply Scheme	4011	20	24.2
6	Yedseram diversion	8	Borno	Alau/Maiduguri Water Supply Scheme	Diversion weir		
7	Monaya/Ogoja dam project	7	Cross River	Ogoja Water Supply Scheme	2245	10	5.4
8	Ezillo dam project	7	Ebonyi	Ishielu/Ezzilo Water Supply Scheme	4016	20	2.3
9	Oji/Ajali dam project	5	Enugu	Ajali Water Supply Scheme	2185	20	16.9
10	Okigwe dam project	7	Imo	Okigwe Water Supply Scheme	4015	10	9.2
11	Owerri dam project	7	Imo	Owerri/Otamiri Water Supply Scheme	4002	16	3.9
12	Kwoi dam project	2	Kaduna	Kwoi Water Supply Scheme	4017	11	2.5
13	Kafanchan dam project	2	Kaduna	Kafanchan Water Supply Scheme	4003	11	3.1
14	Kachia dam project	2	Kaduna	Kachia Water Supply Scheme	4004	11	3.5
15	Faloku/Oyun dam project	2	Kwara	Oyun Water Supply Scheme	2023	19	18.9
16	Ibu dam project	6	Ogun	Otta Ikosi/Ogere/Shagamu Water Supply Scheme	2205	19	20.6
17	Kumpa/Keffei-Mada dam project	4	Nasarawa	Keffi/Mada Water Supply Scheme	4005	12	3.1
18	Emiziko/Bida dam project	2	Niger	Bida Water Supply Scheme	2067	15	3.2
19	Ota dam project	6	Ogun	Ota Water Supply Scheme	4014	16	6.4
20	Araromi Ake/ Ijebu-Ode-Yemoji dam project	6	Ogun	Ijebu-Ode/Yemoji Water Supply Scheme	4018	12	3.3
21	Barakin dam project	3	Plateau	Yakubu Gowon/Jos Water Supply Scheme	4007	26	20.1
22	Sakin Noma/Gusau dam project	1	Zamfara	Gusau Water Supply Scheme	4008	20	29.7
23	Odedele dam project	6	Oyo	Odedele/Ibadan Water Supply Scheme	3501	30	182.6

Remarks: SN=Serial number of dam, H=Height of dam, GS=Gross storage
Source: JICA Project Team

Project 2-2: Surface Water Development for Irrigation Development

This project is to secure necessary water volume for irrigation development, according to irrigation development plan proposed in the master plan. On the basis of the results of water balance study shown in SR3, the surface water source development projects shown in Table SR4-44 are proposed. The total storage capacity of the proposed dams is 969MCM. The locations of the proposed sites are shown in Figure SR4-54.

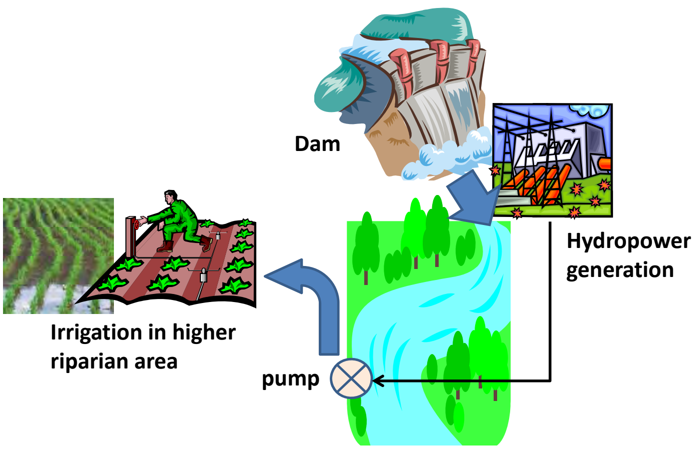
Table SR4-44 Surface Water Development for Irrigation Development

No	Project	HA	State	Irrigation Scheme	SN	H (m)	GS (MCM)
1	Lade dam project	2	Kwara	Duke Lade irrigation scheme (1,200ha)	2043	25	29.5
2	Agaie dam project	2	Niger	Agaie/ Lapai irrigation scheme (1,000ha)	2028	16	44.0
3	Mussa dam project	2	Niger	Badeggi irrigation scheme (830ha)	2066	17	13.2
4	Bakogi dam project	2	Niger	Bakogi irrigation scheme (2,000ha)	2069	17	48.7
5	Kasanu dam project	1	Kebbi	Newly proposed scheme 1,500ha	2009	18	21.0
6	Ukusu dam project	2	Niger	Newly proposed scheme 1,400ha	2039	14	11.5
7	Bado dam project	3	Plateau	Newly proposed scheme 2,200ha	2112	15	28.6
8	Mayo Ine dam project	3	Adamawa	Newly proposed scheme 9,000ha	2089	15	72.6
9	Aneri dam project	4	Benue	Newly proposed scheme 1,500ha	2139	12	14.2
10	Kereke dam project	4	Benue	Newly proposed scheme 2,000ha	2142	13	16.7
11	Dula dam project	4	Benue	Newly proposed scheme 2,000ha	2148	20	19.9
12	Obe dam project	5	Edo	Newly proposed scheme 4,100ha	2175	27	52.4
13	Okhuo dam project	6	Edo	Newly proposed scheme 1,500ha	2224	27	9.6
14	Ombi dam project	7	Benue	Newly proposed scheme 2,000ha	2229	19	24.1
15	Ogege dam project	7	Benue	Newly proposed scheme 1,000ha	2231	14	12.6
16	Abe dam project	7	Cross River	Newly proposed scheme 1,200ha	2237	13	13.0
17	Konshisha dam project	7	Benue	Newly proposed scheme 1,500ha	2240	18	16.0
18	Bejagira dam project	2	Niger	Newly proposed scheme 6,000ha	3008	21	30.0
19	Mayo Belwa dam project	3	Adamawa	Newly proposed scheme 18,000ha	2091	33	240.0
20	Muleng dam project	3	Adamawa	Newly proposed scheme 10,000ha	3012	41	113.0
21	Shemankar dam project	4	Plateau	Newly proposed scheme 16,000ha	2124	22	138.5

Remarks: SN=Serial number of dam, H=Height of dam, GS=Gross storage
Source: JICA Project Team

Project 2-3: Integrated Surface Water Development

This is an integrated project to combine hydropower generation and irrigation development. Necessary energy for pumping for supplying irrigation water is provided internally by the generated energy in the project so as to secure self-reliance and sustainability of the project (refer to Figure SR4-53). Three project sites along the Benue River are proposed. The total storage volume of the proposed dams is 960MCM. The locations of the proposed dams are shown in Figure SR4-54.



Source: JICA Project Team

Figure SR4-53 Schematic Drawing on Integrated Surface Water Development

Table SR4-45 Integrated Surface Water Development

No	Project	HA	State	Irrigation/Hydropower scheme	Dam SN	Dam Name	H (m)	GS (MCM)
1	Nasarawa Integrated Project	4	Nasarawa	New Irrigation scheme: 19,000ha Hydropower 4MW； Total generate energy 29GWh/year Required energy for irrigation 2GWh/year Excess energy 27GWh/year	3011	Ragwa	24	30
2	Taraba integrated project	3	Taraba	New Irrigation scheme: 45,000ha				
				Hydropower 7MW； Total generate energy 52GWh/year Required energy for irrigation 12GWh/year Excess energy 40GWh/year	3001	Baudeu	37	240
				Hydropower 2MW； Total generate energy 15GWh/year Required energy for irrigation 10GWh/year Excess energy 5GWh/year	3004	Kogin Baba	39	290
3	Donga-Suntai Integrated project	3	Taraba	New Irrigation scheme: 35,000ha Hydropower 9MW； Total generate energy 60GWh/year Required energy for irrigation 37GWh/year Excess energy 23GWh/year	3005	Kwossa	78	400

Remarks:
1) The size of dam is set so as to provide necessary water for hydropower generation for pumping as well as irrigation water supply with 1/5 safety level.
2) The capacity of hydropower equipment is set so as to maximize the net benefit (benefit-cost) under the following assumptions with keeping the necessary capacity for pumping of irrigation water.
Assumptions: a) Overall efficiency of hydropower generation=0.7, b) project cost of installation of hydropower equipment=2.53mil.US$/MW, c) Project duration=50year, d) Replacement of equipment=every 20year, e) O&M cost=0.5% of project cost /year, f) Discount rate=10%, and g) Selling price of electricity=0.05US$/kWh.
SN=Serial number of dam, H=Height of dam, GS=Gross storage
Source: JICA Project Team

It should be noted that the scale of dam and hydropower equipment are tentatively set at this moment. In the next step, the optimum scale and combination of component should be examined in detail. For reference, the potential of hydropower generation under the assumption that the maximum flow is annual average flow is presented in Table SR4-46.

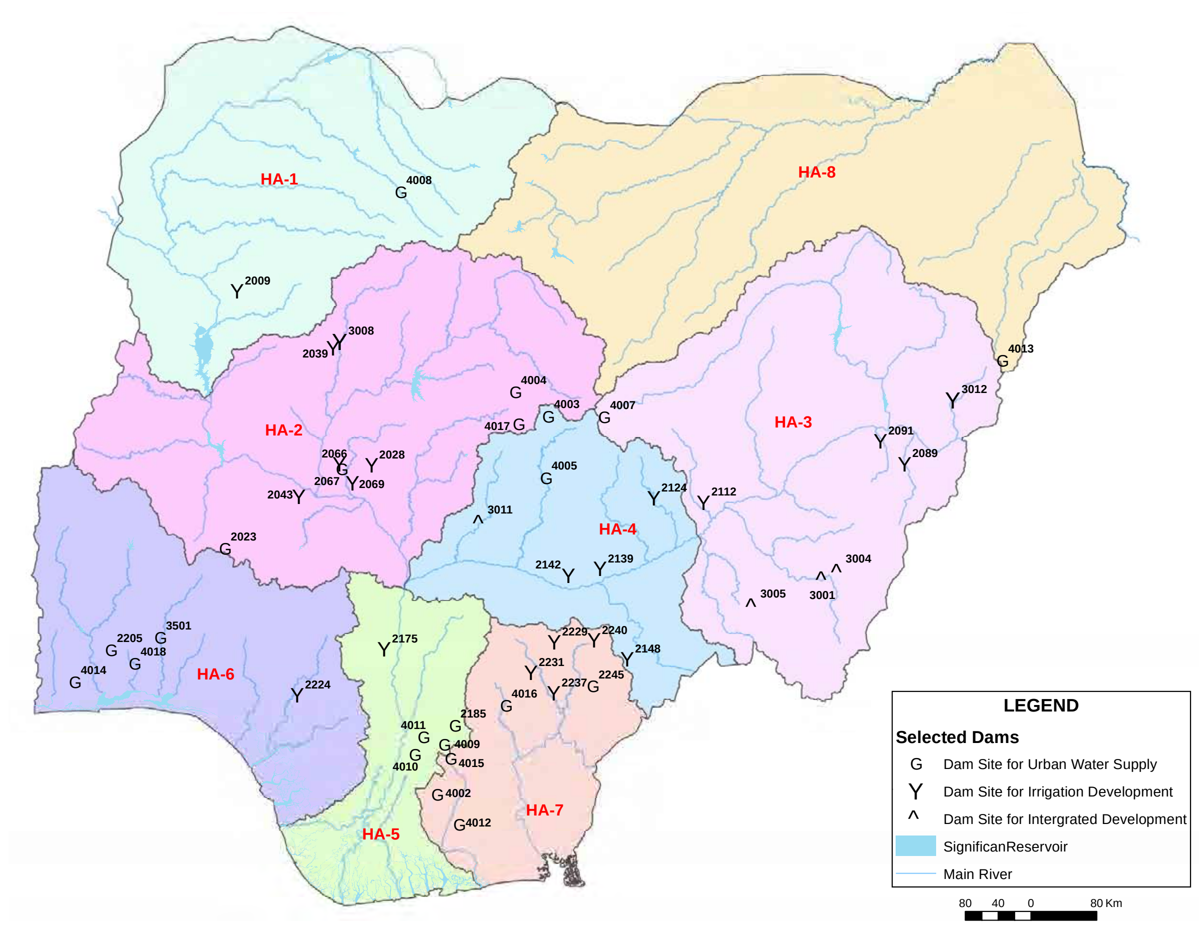
Table SR4-46 Estimated Maximum Hydropower Generation in Integrated Surface Water Development Projects

No	Projectr	Dam Size	Max Outpout (MW)	Max Generated Power (GWh/year)
1	Nasarawa Integrated Project	Proposed (Dam Height=24m)	11	54
		Max development (Dam Height=37m)	18	89
2	Taraba integrated project	3001: Proposed (Dam Height=37m)	38	167
		3001: Max development (Dam Height=37m)	38	167
		3004: Proposed (Dam Height=39m)	6	25
		3004: Max development (Dam Height=55m)	7	31
3	Donga-Suntai Integrated project	Proposed (Dam Height=78m)	16	75
		Max development (Dam Height=105m)	22	112

Source: JICA Project Team

<u>Remarks on Selected Dams Sites</u>

The selection of the dam sites is based on the preliminary study during the formulation of the master plan. It should be noted that the proposed schemes are conceptual level, and thereby further detail study would be required for their implementation.



Source: JICA Project Team

Figure SR4-54 Selected Dam Sites for Surface Water Source Development

SR4.2.8 Possibility of Hydropower Generation in Surface Water Source Development Projects for Municipal Water Supply and Irrigation Development

The dam operation for the water source development projects for municipal water supply and irrigation development basically follows the requirement from municipal and irrigation water users. So, even if hydropower equipment is installed, its operation should follow the release based on the requirement by other water users. How much energy can be generated in these cases is roughly examined by utilizing the results of water balance study. It is assumed that the installed capacity of hydropower equipment is determined so as to maximize the net benefit (benefit-cost). Table SR4-47 summarizes the assumed condition.

Table SR4-47 Assumed Condition for Examining Possible Hydropower Generation

Assumed conditions
● Hydropower generation uses released flow for other water users ● Effective head is assumed to be constant with 50% of maximum water depth. ● Overall efficiency of hydropower generation=0.7 ● Project cost of installation of hydropower equipment=2.53mil.US$/MW ● Project duration=50year ● Replacement of equipment=every 20year ● O&M cost=0.5% of project cost /year ● Discount rate=10% ● Selling price of electricity=0.05US$/kWh.

Source: JICA Project Team

Table SR4-48 shows the averaged generated energy for each of the proposed dam sites. The total installed capacity and generated energy could be 4.6MW and 30GWh/year, respectively. It is recommended that more detail study be conducted when each project will be implemented.

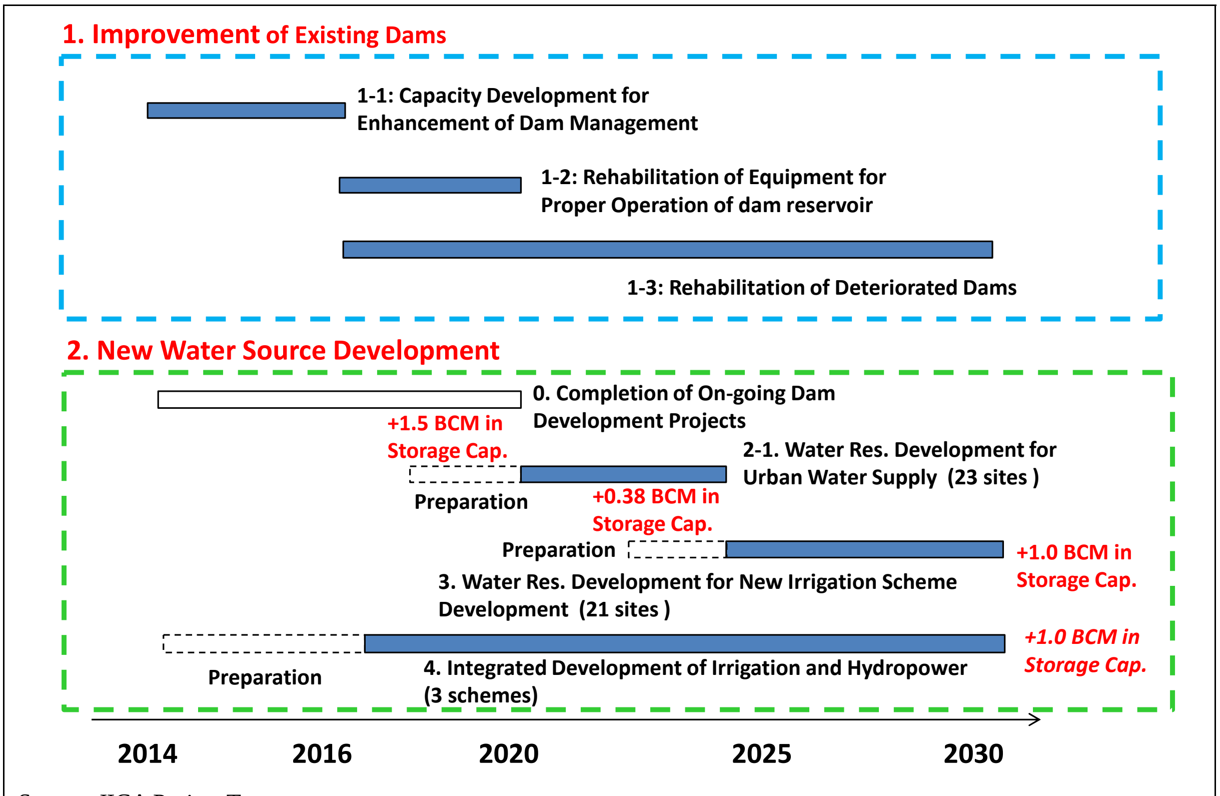
Table SR4-48 Possibility of Hydropower Generation in Surface Water Source Development Projects for Municipal Water Supply and Irrigation Development

No	Surface Water Development for Municipal Water Supply	Capacity (MW)	Power (GWh/ year)	No	Surface Water Development for Irrigation Development	Capacity (MW)	Power (GWh/ year)
1	Aba dam project	0.100	0.768	1	Lade dam project	0.025	0.161
2	Mubi dam project	0.000	0.000	2	Agaie dam project	0.030	0.202
3	Umuseke dam project	0.040	0.285	3	Mussa dam project	0.015	0.010
4	Ihiala dam project	0.130	0.954	4	Bakogi dam project	0.025	0.163
5	Nnewi dam project	0.090	0.756	5	Kasanu dam project	0.025	0.187
6	Yedseram diversion Project	0.000	0.000	6	Ukusu dam project	0.030	0.216
7	Monaya/Ogoja dam project	0.020	0.132	7	Bado dam project	0.040	0.280
8	Ezillo dam project	0.000	0.000	8	Mayo Ine dam project	0.200	1.447
9	Oji/Ajali dam project	0.090	0.761	9	Aneri dam project	0.030	0.206
10	Okigwe dam project	0.030	0.238	10	Kereke dam project	0.000	0.000
11	Owerri dam project	0.140	1.080	11	Dula dam project	0.000	0.000
12	Kwoi dam project	0.000	0.000	12	Obe dam project	0.000	0.000
13	Kafanchan dam project	0.020	0.158	13	Okhuo dam project	0.120	0.834
14	Kachia dam project	0.050	0.379	14	Ombi dam project	0.090	0.541
15	Faloku/Oyun dam project	0.000	0.000	15	Ogege dam project	0.040	0.262
16	Ibu dam project	0.035	0.244	16	Abe dam project	0.020	0.120
17	Kumpa/Keffei-Mada dam project	0.200	1.519	17	Konshisha dam project	0.040	0.237
18	Emiziko/Bida dam project	0.000	0.000	18	Bejagira dam project	0.300	2.147
19	Ota dam project	0.000	0.000	19	Mayo Belwa dam project	0.700	4.495
20	Araromi Ake/ Ijebu-Ode-Yemoji dam project	0.080	0.519	20	Muleng dam project	0.600	4.205
21	Barakin dam project	0.050	0.414	21	Shemankar dam project	0.400	0.003
22	Sakin Noma/Gusau dam project	0.070	0.580				
23	Odedele dam project	0.800	5.987				
	Total	**1.945**	**14.774**		**Total**	**2.730**	**15.716**

Remarks: The installed capacity is set at zero, if the install capacity becomes less than 0.01MW.
Source: JICA Project Team

SR4.2.9 Proposed Implementation Schedule

It is proposed that the surface water surface water source development be implemented step by step as shown in Figure SR4-55.



Source: JICA Project Team

Figure SR4-55 Proposed Implementation Schedule for Surface Water Source Development

SR4.3 Water Resources Conservation Plan

The conservation of water resources may be defined as the various types of activities to be executed by different stakeholders to conserve or protect the water quality and water quantity. Both water resources surface and groundwater must be targeted for conservation.

SR4.3.1 Groundwater Conservation

(1) Purpose and Importance of Groundwater Conservation

Groundwater must be conserved in terms of quantity and quality for sustainable groundwater use. Groundwater management is indispensable for groundwater conservation.

Quantity conservation

Groundwater can be extracted without consuming groundwater stored in aquifer if amount of groundwater extraction is less than groundwater recharge. Groundwater recharge is explained in SR2, and method for groundwater development is explained in Section SR4.1.

When groundwater is extracted more than groundwater recharge, regional groundwater level lowering will occur, which will cause decrease in pumping yield or drying up of boreholes and land subsidence. To prevent such problems, cycle of a) monitoring, b) prediction and c) measures must be continuously implemented as show in Figure SR4-56. NIWRMC and CMO should take responsibility of implementation of the cycle below.

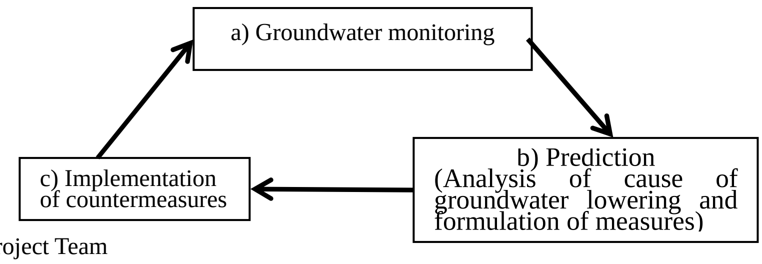


Figure SR4-56 Concept of Groundwater Management Comprising Monitoring, Prediction and Measures

Quality conservation

Groundwater will be contaminated when contaminated surface water infiltrate into aquifer. When sea water has intruded into aquifer, groundwater will become salty. Type of groundwater contamination is shown in Table SR4-49. Mechanism of land subsidence and sea water intrusion is explained in this Chapter.

Table SR4-49 Type of Groundwater Contamination and Measures

Type of groundwater contamination		Cause	Measures
Man-made contamination	Sea water intrusion into aquifer	Over pumping	Legal control of pumping
	Infiltration of domestic and industrial waste into aquifer	• Lack of sewerage system • Low quality borehole construction work • Illegal dumping waste into borehole	• Improvement of sewerage system • Perfect sealing of borehole casing • Legal control of dumping
Contamination originated from geology	Groundwater contamination by harmful minerals in underground layer	• Shale with salty minerals • Harmful materials by mining activity	Identification of contaminated aquifer and prohibition of extraction from it

Source: JICA Project Team

As same as case in quantity conservation, the cycle of a) monitoring, b) prediction and c) measures is important in case of quality conservation.

(2) Method of Groundwater Management for Conservation

Method of groundwater management for conservation should be formulated place by place based on local hydrogeological characteristics and water use condition. However, standard method should be employed as basis of groundwater management for each case. It is proposed that groundwater management should be implemented by NIWRMC and NIHSA for entire Nigeria following the standard method as shown below. More detailed method will be proposed in the next step of JICA Project for groundwater management following the standard method:

Groundwater management plan should take into account scale of target aquifer. Scale of aquifer can be classified as a) Large, b) Medium, c) Small, d) local, and management method should be decided corresponding to above classification as shown in Table SR4-50.

(1) Hydrogeology and groundwater survey and analysis

- Survey on aquifer structure and characteristics
- Analysis of groundwater recharge
- Survey on current groundwater extraction
- Survey on groundwater hazard (groundwater level lowering, sea water intrusion, saline groundwater, groundwater contamination, impact of climate change)
- Survey on groundwater regulation to control groundwater extraction

↓

(2) Water balance model

- Numerical model (aquifer distribution, groundwater recharge condition, groundwater pumping condition)

↓

(3) Groundwater usage and development plan

- Analysis on current water supply and demand balance
- Forecasting future water demand and groundwater development plan
- Examination of feasibility of proposed groundwater development based on groundwater balance
- Examination of conjunction use of groundwater and surface water

↓

(4) Groundwater Development based on M/P and Catchment Management Plan year by year

↓

(5) Groundwater management

- Monitoring of groundwater level and quality related to groundwater development
- Comparison of actual groundwater behavior and predicted one.
- Modification of groundwater development plan if necessary
- Implementation of groundwater regulation such as extraction control based on discussion and agreement among CMO and stakeholders.

Source: JICA Project Team

Figure SR4-57 Method for Groundwater Management and Development

Table SR4-50 Groundwater Management Plan and Responsible Organization

Scale of Area		Plan	Purpose of management	Responsible Organization
a) Large	Multiple-Catchment level	• Nationwide M/P • Catchment Management Plan	Groundwater Basin Management	• NIWRMC • CMO • NIHSA
b) Medium	Catchment level	State Management Plan	• Allocation of groundwater extraction • Allocation of borehole density • Measures against groundwater hazard (sea-water intrusion, land subsidence, groundwater contamination)	
c) Small	LGA level			• State Government • LGA
d) Local	Community level		• Securing necessary yield for communities • Setting adequate yields of individual borehole • Setting enough distance among boreholes to prevent borehole interference • Measures against groundwater contamination	

Source: JICA Project Team

(3) Institutional Issue on Groundwater Management

Issues of groundwater management can be summarized as shown in Table SR4-51.

Table SR4-51 Issues on groundwater resources Management and Development

Item	Urban/Rural	Issues in groundwater management and development
Groundwater management	Urban	• Over-pumping in Chad Basin and Sokoto Basin. • Over-pumping of cities in the southern coastal areas
		Sea-water intrusion and groundwater contamination of the southern coastal cities
	Rural	Groundwater contamination in rural water supply
Groundwater development	Urban	Drought and low water supply coverage in Chad Basin and Sokoto Basin
	Rural	Low water supply coverage in rural area

Institutional improvement is necessary to resolve issues above. Considering Japanese experience in groundwater management, NIWRMC should implement activities below. JICA Project Team will provide related information to NIWMC in the nest step of the Project.

Registration of borehole

- Newly drilled borehole should be registered to NIWRMC to get permission for use of groundwater.
- Groundwater use with large extraction, such as Water Boards and big private factories, should have obligation to report condition of their groundwater use regularly including groundwater level and pumping rate.

Permissible groundwater level

- Permissible groundwater extraction rate with permissible groundwater level should be established by NIWRMC for each aquifer to prevent over-pumping.
- Priority order of groundwater extraction for each purpose and user group should be decided within permissible extraction.
- Criteria on control of groundwater extraction will be proposed.

Formulation of Groundwater management manual

- Groundwater management manual should be compiled and disseminated. Content of manual should include below:
  a) Organization in charge of aquifer management
  b) Allocation of permissible pumping rate
  c) Priority order of groundwater users
  d) Permissible groundwater level for management

Information sharing among organizations in charge of groundwater management and groundwater users.

CMO can require water saving and rationalization of water usage to water users of large groundwater extraction in case of draught.

Registration system of borehole drilling company

Registration system should be introduced to guarantee technology of drilling companies and exclude companies without necessary technology. Consultants for geophysical survey should be registered as well.

Procedure of legal control of groundwater extraction in Japan is as follows:

- The Government of Japan decided the area for control of groundwater extraction where serious land subsidence is taking place due to over-pumping for industrial use.
- Size of pumping pipe at the top of riser pipe of borehole is restricted.

However, issuing above regulation needs condition that waterworks has been already constructed for industrial water supply as alternative water sources replacing groundwater.

SR4.3.2 Conservation of Surface Water Source

(1) General

The surface water resources need to be conserved from point and non-point sources of pollution. Point sources of pollution are those generated from untreated domestic, industrial and mining wastewater and the leachate generated at the solid waste disposal sites. While non-point sources are those originated from agricultural lands and solid waste that are transported into the water courses by heavy rains. In addition, soil erosion is another important source of sediments that affect directly the surface water.

The point sources of pollution may be diminished by treating the wastewater before its discharging into the surface water. The non-point sources of pollution may be diminished by good practices in the field of agriculture.

As for soil erosion, a proper forest management and protection of critical zones such as steeped areas may work efficiently to decrease these phenomena.

Following is presented the problems/issues and recommendations for rivers and for dams/reservoirs.

(2) Issues on Conservation of Surface Water Source

The following table summarizes the issues in this field.

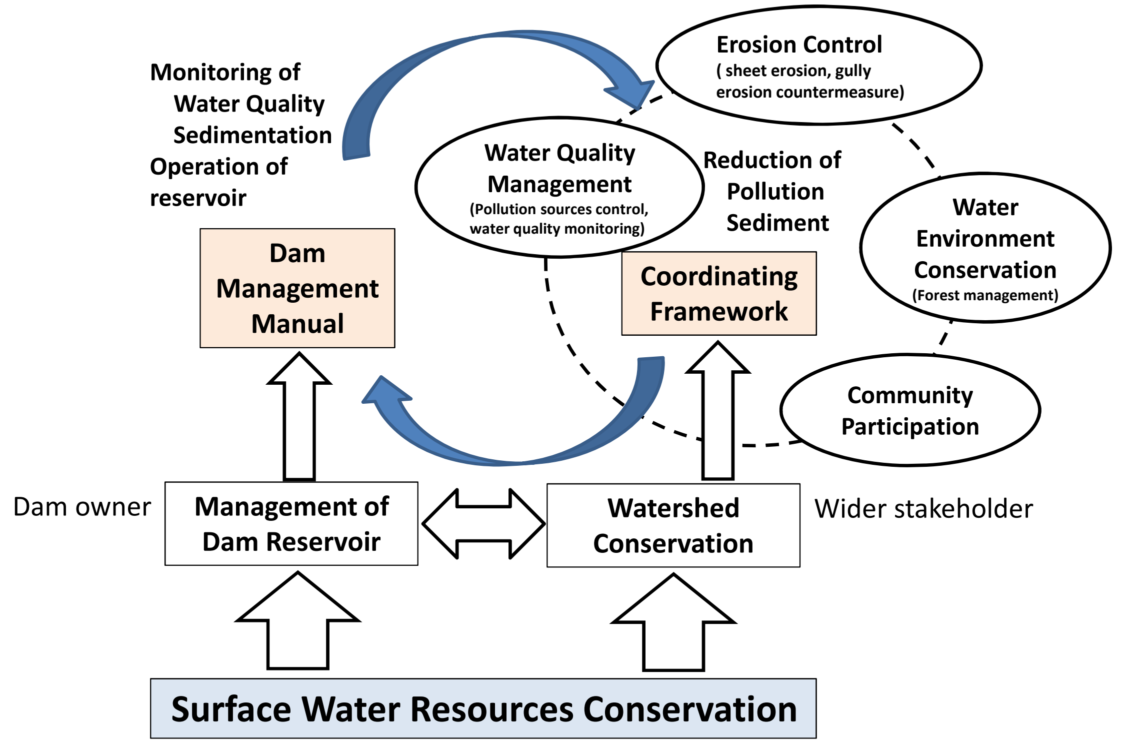
Table SR4-52 Issues on Conservation of Surface Water Source

Important Issues	Recommendations
Point Sources of Pollution	
There is a poor enforcement of Laws, regulations and standards to control water pollution in the country	The enforcement of Laws, Regulations and Standards to control discharges of effluents (liquid & solid) into the environment needs to be improved.
Lack of awareness of the people on environmental issues, therefore not collaboration from them to avoid water pollution	Environmental education and awareness campaign on water resources protection from pollution must be implemented for primary & secondary schools and for the general public.
Lack of coordination or cooperation among relevant institutions for water pollution control	A memorandum of understanding should be promoted among FME, FMWR and State Governments to prioritize programs for water pollution control of water sources used as domestic source.
In the rural communities of Nigeria are very common the activities of mining at artisanal and small-scale levels. However, most of these activities do not follow good mining practices resulting in water pollution	A joint-work between NESREA, FMM and FMWR is proposed to assess the impact of mining activities into the water sources, in order to determine possible countermeasures.
Non-Point Sources of Pollution	
Fertilizer and pesticide cause water pollution in surface water and in aquaculture farming ponds	Proper use of fertilizer and pesticides is recommended to diminish pollution of water courses. Drainage of water from farm land should not be discharged into aquaculture farming pond due to its high impact on aquatic life.
In many urban cities of Nigeria can be observed illegal disposal of solid waste which are transported into rivers during heavy rain	Solid waste management needs to be improved in the country to avoid pollution of watercourses or water sources.
Soil Erosion	
The distribution of soil erosion site is sporadic; consequently, it is necessary to carry out a lot of small scale countermeasure in the country, however, often said because of lack of fund not sustainable.	Risk assessment in nationwide in order to prioritize the critical projects to be implemented
Currently, most of the erosion control has been done for the countermeasures in the area related to people's living condition such as keeping of transportation route, protecting of residential area and mitigating soil erosion into drainage. In Nigeria there is few attention to the watershed conservation in which it takes long time the result of countermeasure prevails.	• Environmental education and awareness campaign on water resources protection • Risk assessment in nationwide in order to prioritize the critical projects to be implemented among wide range of watershed size.
Dams/Reservoirs	
The presence of aquatic plants in dams and reservoir is of great concern that must be addressed. It is considered a nuisance since interfere in the normal operation of the dams. The introduction of nutrients such as P and N promotes the proliferation of this nuisance.	Aquatic plant control programme was implemented by FME for many dams until 2011. A continuation of that programme is under preparation by FME. It is proposed to make a joint-work between FME and FMWR for the recovery of affected dams by aquatic plants
Surveyed dams in this Study present problem of sedimentation and this has direct effect in their storage capacity.	Actions to control sedimentation effectively are necessary to be implemented such as: • Risk assessment in nationwide in order to prioritize the critical projects to be implemented among wide range of watershed size. • Economic comparison between dredging in reservoir and soil erosion countermeasures in each watershed

Source: JICA Project Team

(3) Proposed Mechanism for Conservation of Surface Water Source

Conservation of surface water resources would be implemented inside dams and reservoirs as well as in a watershed area (see Figure SR4-58). Both activities are related each other. The former is a part of the dam management activities, and will thereby be proposed to be enhanced together with the measures for the recovering and upgrading function of the existing dams. This is mainly implemented by dam owners. On the other hand, the latter needs cooperation among wider range of stakeholders in a watershed, which deals with environment management, water quality management, erosion control and so.



Source: JICA Project Team

Figure SR4-58 Framework of Conservation of Surface Water Source

(4) Responsibilities of Main Stakeholders in Proposed Mechanism for Conservation of Surface Water Source

The main activities that are identified to be done inside the Dam/Reservoirs and Watershed for conservation of surface water resources are presented in Table SR4-53. Likewise, in the same table is shown the main stakeholders and their responsibilities. It is also proposed that NIWRMC be responsible for coordinating the activities by various stakeholders through formulation and implementation of Catchment Management Plan at each hydrological area.

The workable mechanism on the cooperation among stakeholders in a catchment level should be explored during the formulation of the draft Catchment Management Plan.

The details on dam management, water environmental management and erosion control are described in the following sections.

- Dam management: Section SR6.1
- Water environmental management: Section SR6.5
- Erosion control: Section SR5.3

Table SR4-53 Proposed Responsibility and Activities for Conservation of Surface Water Source

Surface Water Resources Conservation		Responsibility Assignment Matrix: M=Main Responsibility, S=Sub Responsibilities, d=Participation in discussions																									
		dam owner (RBdA, SWB, etc)	RBdA	State Water Board	FMWR (dams division)	FMWR (Water Quality & Sanitation division)	FMWR (Irrigation & drainage division)	NIWRMC	NIHSA	Ministry of Power	NIMET	NESREA	FME (Pollution Control and Environmental Health)	FME (EIA division)	FME (Forestry department)	FME (Flood & erosion control)	FME (Aquatic plant control program)	Federal/State Ministry of Health	States Ministry of Environment	Federal Ministry of Mines	Federal Ministry of Trade and Investment	Oil Spill Agency	National Orientation Agency	Farmer Association	Industrial Association	NGOs	Nigerian Citizens (community participation)
Activities																											
1.	**Management of dam/Resevoir**																										
1.1	Proper operation of water release	**M**	S	d	S			S	d	d																	
1.2	Observation of hydro-meteorological condition	**M**	S	d	d			d	S		S																
1.3	Monitoring of water quality and sedimentation	**M**	S	d	d	S		d	S																		
1.4	Removal of weeds	**M**	S	d	d		S										S										
1.5	dredging of sediment	**M**	S	d	S	d								d													
1.6	Inspection of physical-structure condition	**M**	S	d	S																						
1.7	Operation of hydropower station	**M**	S	d	d					S																	
2.	**Watershed Conservation**																										
2.1	Coordination of Watershed Conservation Activities	d	S	d	d	d	d	**M**	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d	d
2.2	Water Quality Monitoring (water source and drinking water)	d	S	S	d	**M**		d	S	d	d	d	d				d	S	d	d	d			d	d	d	d
2.3	Control of pollution sources (domestic, industrial, agriculture, mining, etc.)	d	d	d	d	d	d	d	d	d	d	**M**	S	d			d	d	S	S	d	d		d	d	d	d
2.4	Water Quality Monitoring (water environment)	d	d	d	d	**M**	d	d	d	d		**M**	d	d			d	d	d	d	d			d	d	d	d
2.5	Erosion control	d	S	d	d	d	d	d	d	d		d	d		S	**M**			S	d				d		d	d
2.6	Weeds Control on Rivers and Channels (excluding navigation)	d	S	d	d	d	d	d				d					**S**		M					d		d	d
2.7	Water environment conservation (forest management)	d	d	d	d			d		d					**M**	d			S	d				d		d	d
2.8	Environmental education & awareness campaign	d	d	d	d	d		d	d			d	d		d	d	d	d	**M**	d			S	d	d	d	d

Source: JICA Project Team

Annex-T SR4-1 Inventory of Existing Dam (1/5)

SN	SN Dam Resister	SN Comp. Dam	SN_ Proposed Dam_1995MP	HA	SHA	SN-SHA	Name	State	River	Lon	Lat	f_loc	Owner	Comp. Year	Category	DA (GIS) (km2)	Runoff height (mm/ year)	Average Inflow Volume (MCM/ year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area by HVA (km2)	Area GIS (km2)	Area 1995MP (km2)	Flood Control	Irrigation	Water Supply	Hydoropower	Fishery	Others
1	103	3		1	106082_i2	17	Ajiwa	Katsina	Tagwai	7.75104	12.95271	3	SWB	1974	L	1,782	18.2	32.4	12.00	1,500	22.0		Earthfill	Broad Crested Weir	70		6.30				x			
2	104	19		1	106093	31	Bakolori	Zamfara	Sokoto	6.18216	12.51007	3	SRRBDA	1982	L	4,747	149.1	708.0	48.00	5,491	450.0	403.0	Earthfill + Concrete	Free Overflow	3,750	56.2	57.00	80.0	x	x	x	x	x	x
3	106	33		1	1060883	28	Dutsin Ma	Katsina	Safana	7.50303	12.46213	3	SWB	1974	L	43	55.9	2.4	7.50	4,170	2.5		Earthfill	Ogee	2,000		1.10				x			
4	107	53		1	106085_i	20	Goronyo(Main)	Sokoto	Rima	5.88033	13.53124	3	SRRBDA	1984	L	30,547	26.4	805.0	20.00	5,284	942.0	933.0	Earthfill + Concrete	Ogee	1,540	192.0	125.00	200.0	x	x	x		x	x
5		61		1	106093	31	Gusau	Zamfara	Sokoto	6.66995	12.14723	3	SWB	1972	L	2,570	187.5	482.0	17.53	800	3.0	2.5	Earthfill + Concrete			3.2	3.60				x			
6	108	78		1	1060863	24	Jibiya	Katsina	Gadda	7.25199	13.07097	3	SRRBDA	1992	L	3,509	20.2	71.0	19.50	3,680	142.0	121.0	Earthfill	Ungated Free Flow	2,200		25.00	26.0	x	x	x	x	x	
7	125	84		1	101	1	Kainji	Niger	Niger	4.61111	9.86413	3	NEPA	1968	L	1,589,938	22.1	35,093.0	65.50	550	15,000.0	12,000.0	Concrete, Rockfill+Earthfil	Ogee Gated	7,900	1,294.0	1,051.00	1,270.0		x	x	x	x	x
8	130	101		1	101	1	Kubli	Niger	Swashi	4.12183	10.47596	3	UNRBDA	1992	L	643	127.3	81.9	17.00	50	70.0	57.0	Concrere	Ogee	407			9.4		x				
9	109	115		1	106093	31	Mairuwa	Katsina	Sokoto	7.23888	11.58711	3	SWB	1970	L	110	225.7	24.8	7.00	457	3.5		Earthfill	Ogee			1.70	1.6		x	x			
10	131	125		1	102	2	Nasko	Niger	Shadaguibi	4.92603	10.52851	3	UNRBDA	1990	L	56	169.8	9.5	12.00	645	1.8	1.4	Earthfill (Zoned)	Uncontroled Ogee	140		0.31	0.6		x	x		x	x
11		168		1	10606	11	Shagari	Sokoto	Gawon Gubli	4.99463	12.64238	3	SRRBDA	2007	L	3,658	22.8	83.4	13.00	1,340	15.0		Earthfill+ Rockfill	Freeoverflow Ogee			20.78			x	x			
12	137	173		1	101	1	Swashi	Niger	Swashi	4.20251	10.44345	3	UNRBDA	1992	L	849	124.2	105.4	21.00	600	5.0	1.6	Earthfill	Ogee	385		2.60			x				
13	110	183		1	106089	29	Turo Malumfashi	Katsina	Shinache	7.60345	11.87062	3	SWB	NA	L	161	75.9	12.2	12.00	55	6.3		Earthfill	Ogee	220		2.30				x			
14	111	200		1	1060883	28	Zobe	Katsina	Karaduwa	7.46547	12.35838	3	SRRBDA	1983	L	2,514	80.7	203.0	18.90	2,750	177.0	170.0	Earthfill (Homogeneous)	Ungated Free Flow	1,087		38.00	45.0		x	x			
15	112	201		1	102	2	Zuru	Kebbi	Girmache	5.28272	11.41502	3	SWB	1978	L	90	57.2	5.1	15.00	700	6.0	5.0	Earthfill		432		1.40				x			
16	119	2		2	212	65	Agba	Kwara	Agba	4.58450	8.47567	3	SWB	1949	L	4	144.2	0.6	16.50	310			Earthfill	Sideway free flow			0.27				x			
17	120	10		2	212	65	Asa	Kwara	Asa	4.55586	8.44239	3	SWB	1976	L	905	136.0	123.1	27.00	402	43.0	34.4	Concrete	Open			9.30				x			
18		14		2	209	63	Ayede	Ekiti	Ayede	5.33333	7.88333	0	SWB	1979	L	NA	NA	NA	13.00	326	1.5		Hom. Earthfill	Ungated							x			
19	121	17		2	20804	52	Bagoma	Kaduna	Kusheriki	6.51930	10.64710	3	SWB	1974	L	636	288.2	183.3	14.32	1,067	5.5	5.0	Earthfill	Ogee	177		1.80			x	x			
20	105	25		2	206	47	Bosso	Niger	Karuko	6.53175	9.67776	3	SWB	1946	L	1	181.0	0.2	17.00	132			Earthfill				0.03				x			
21	95	38		2	209	63	Ero	Ekiti	Ero	5.19230	7.98819	3	SWB	1987	L	466	193.3	90.1	22.00	1,721	20.0	18.5	Earthfill	Ogee			4.90				x			
22		58		2	20205	42	Gurara	Kaduna	Gurara	7.73294	9.64654	3	FGN	2008	L	2,637	475.2	1,253.0	55.00	3,050	880.0	700.0	Rockfill + Earthfill	Uncontrolled Ogee	2,715	61.0	32.44	61.0		x	x	x	x	x
23		181	2109	2	212	65	Idofian	Kwara	Idofian	4.69015	8.36277	3	SWB	1996	L	60	149.0	8.9	12.00	250			Concrete	Sideway	13		0.15				x			
24		182		2	20401	44	Isanlu	Kogi	Katakun	5.79217	8.22883	3	SWB	1978	L	9	109.9	1.0	12.00	160	5.9		Earthfill	Sideways	52		0.19				x			
25	113	71		2	202021	39	Jabi	FCT	Jabi	7.41617	9.06507	3	SWB	1982	L	50	358.7	17.9	15.00	850	6.0	4.8	Earthfill	OGEE			1.00				x			
26	116	77		2	211	64	Jebba(main)	Niger	Niger	4.78704	9.13740	3	NEPA	1984	L	1,629,481	25.0	40,700.0	40.00	670	3,800.0	1,000.0	Rockfill + Earthfill(Zoned)	Underflow	13,600	316.5	217.00	316.0			x	x		
27	127	93		2	20813	60	Kangimi	Kaduna	Kangimi	7.59551	10.63945	3	SWB	1977	L	363	225.7	81.9	19.00	1,525	74.1	59.3	Earthfill		237		9.30	6.6		x	x			
28	128	97		2	218	73	Kontagora	Niger	Kontagora	5.34427	10.40543	3	SWB	1988	L	144	114.7	16.5	20.00	1,000	17.7	15.7	Earthfill(Zoned)	Broad Crest Weir	209		3.50	3.7			x			
29	133	139		2	20403	45	Omi	Kogi	Kampe	5.64029	8.20279	3	LNRBDA	1999	L	1,596	198.6	317.0	42.50	1,976	250.0	220.0	Earthfill(Zoned)	Ogee	3,550			25.7		x	x			
30	80	142		2	20815	62	Ouree	Plateau	Ouree	8.69040	9.77988	2	NESCO	1936	L	65	387.3	25.2	21.00	860	6.7	5.4	Earthfill	Broad Crested Weir	257		1.20	0.1				x		
31		148		2	212	65	Oyun	Kwara	Oyun	4.75080	8.19370	3	SWB	1964	L	109	159.1	17.3	15.00	400	2.1		Earthfill + Concrete	Free Flow			1.20				x			
32	134	156		2	202021	39	Pedan	FCT	Pedan	7.52887	9.06170	3	FCDA	1993	L	11	387.7	4.3	33.00	357	5.8	5.0	Earthfill				0.42				x			x
33	135	164		2	20809	56	Shiroro	Niger	Kaduna	6.83337	9.97404	3	NEPA	1990	L	34,702	252.6	8,766.0	115.00	700	7,000.0	6,050.0	Rockfill	Ogree gated	7,500	300.0	353.00	312.0			x	x		
34		171		2	212	65	Sobi	Kwara	Moro	4.54766	8.57782	3	SWB	1982	L	751	140.2	105.3	15.00	350	***4.0***		Concrete + Earthfill	Freeflow			0.90				x			
35	136	167		2	202021	39	Suleja	Niger	Iku	7.23851	9.22012	3	SWB	1994	L	139	374.0	52.0	27.80	512	52.0	48.5	Earthfill (Zoned)	Broad Crest Weir			5.26	7.4			x		x	x

Annex-T SR4-1 Inventory of Existing Dams (2/5)

SN	SN Dam Resister	SN Comp. Dam	SN_ Proposed Dam_1995MP	HA	SHA	SN-SHA	Name	State	River	Lon	Lat	f_loc	Owner	Comp. Year	Category	DA (GIS) (km2)	Runoff height (mm/year)	Average Inflow Volume (MCM/year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area by HVA (km2)	Area GIS (km2)	Area 1995MP (km2)	Flood Control	Irrigation	Water Supply	Hydoropower	Fishery	Others
36	138	174		2	206	47	Tagwai	Niger	Tagwai	6.66031	9.56594	3	SWB	1978	L	170	225.3	38.3	25.00	1,770	28.3	26.4	Earthfill (Zoned)	Long Uncontrol			4.70	5.5		x	x	x	x	x
37	139	180		2	20805	53	Tungan Kawo	Niger	Wushishi	6.10471	9.67017	3	UNRBDA	1988	L	160	208.0	33.3	11.75	3,300	22.0	21.0	Earthfill	Ogee			4.10	4.0	x	x	x		x	
38	140	189		2	202023	40	Usuma	FCT	Usuma	7.41575	9.19769	3	SWB	1984	L	191	455.5	87.0	45.00	1,350	120.0	100.0	Earthfill	OGEE + TUNNEL	500		8.90	8.0			x			
39	142	199		2	20814	61	Zaria	Kaduna	Godina	7.75644	11.13289	3	SWB	1974	L	3,183	159.4	507.4	15.00	549	15.9		Earthfill (Zoned)	Ogee	708		5.60	8.0			x		x	x
40	41	18		3	31405	96	Balanga	Gombe	Balanga	11.59744	9.92055	3	Bauchi State	1986	L	313	244.9	76.7	44.00	160	73.0	63.0	Rockfill + Earthfill	Free flow Ogee	2,500		6.00	11.0		x				
41	42	21		3	31405	96	Biu	Borno	Ndivana	12.09089	10.63872	3	SWB	1995	L	153	87.6	13.4	18.00	300	11.1	9.6	Earthfill (Zoned)	Broad Crested Weir	500		1.50	3.0			x			
42	143	27		3	311	90	Cham	Gombe	Cham	11.71585	9.72470	2	UBRBDA	1991	L	75	330.6	24.8	10.00	1,300	5.0	3.5	Rockfill + Earthfill	Ogee	200		1.10	1.8	x	x	x			
43	144	28		3	31407	97	Dadin Kowa	Gombe	Gongola	11.47946	10.32040	3	UBRBDA	1987	L	32,184	96.4	3,104.0	42.00	520	2,800.0	1,770.0	Rockfill + Earthfill	Gated Overflow	1,110	290.0	238.00	300.0	x	x	x	x	x	
44	22	54		3	31409	99	Gubi	Bauchi	Gubi	9.88021	10.42002	3	SWB	1990	L	181	133.0	24.1	27.00	3,820	38.4	35.2	Earthfill (Zoned)	Ogee	783		7.90	5.9		x	x			x
45	145	94		3	31403	94	Kiri	Adamawa	Gongola	12.01741	9.67892	3	UBRBDA	1982	L	44,581	113.9	5,078.0	20.00	1,250	615.0	290.0	Rockfill + Earthfill	Ogee	4,000	107.0	72.00	110.0		x	x			
46	146	194		3	31409	99	Waya	Bauchi	Waya	10.01384	10.34686	3	UBRBDA	NA	L	128	128.5	16.4	23.00	400	50.0	35.0	Earthfill	Ogee				4.5		x	x			
47	84	196		3	31409	99	Yakubu Gowon	Plateau	Bukuru	8.96557	9.76176	2	PUB	1980	L	82	235.9	19.3	35.00	1,400	30.0	22.0	Earthfill	Ogee	248		4.50	5.0			x			
48	85	7		4	404	112	Ankwil(1)	Plateau	Tenti	8.80891	9.36706	1	NESCO	1964	L	123	464.4	57.1	27.00	708	31.0	29.5	Earthfill	Underflow + Tainter Gate	228		4.10	5.1				x		
49	86	23		4	408	117	Bokkos(2)	Plateau	Maber	8.97662	9.32298	2	LBRBDA	1990	L	7	452.8	3.2	15.00	340	5.0	3.6	Earthfill				0.13			x	x			
50	87	32	4242	4	404	112	Doma	Nassarav	Ohna	8.29814	8.34932	3	LBRBDA	1988	L	250	300.0	75.0	15.70	520	37.5	28.5	Earthfill		63		9.30	2.2		x	x			
51	88	102		4	404	112	Kurra	Plateau	Tenti	8.74336	9.39462	1	NESCO	1929	L	248	470.0	116.6	19.00	1,067	17.0	14.5	Earthfill	Broad Crested Weir	571		3.50	4.8				x		
52	90	108		4	304	80	Langtang	Plateau	Jos	9.78449	9.11448	3	PUB	1983	L	52	251.9	13.1	21.00	1,350	4.6	3.5	Earthfill	Ogee	79		0.60	0.6			x			
53	81	155		4	410	119	Pankshin	Plateau	Kwangwal	9.40664	9.30838	3	PUB	1982	L	10	403.6	4.0	29.50	685	4.5	2.8	Earthfill	Ogee	165		0.70	0.5			x			
54	82	170		4	410	119	Shendam	Plateau	Nkongnesso	9.53408	8.89131	3	PUB	1984	L	265	272.7	72.3	13.00	1,200	6.3		Earthfill	Ogee	1,843		1.52	2.4			x			
55	83	176		4	404	112	Tenti	Plateau	Tenti	8.75945	9.35944	1	NESCO	1943	L	142	468.3	66.5	14.00	854	14.0	9.8	Rockfill + Earthfill	Broad Crested Weir	171		3.10	4.0			x	x		
56	132	138		5	50403	125	Okene	Kogi	Okuhabi	6.22653	7.55620	2	KWUC	1937	L	6	192.6	1.2	11.00				Concrete				0.07							
57		151		5	50403	125	Osara	Kogi	Osara/Oron	6.34943	7.69692	3	NIMCO	1993	L	531	182.7	97.0	25.00	1,500	23.0		Earthfill (Zoned)	Ogee			5.60				x			
58	98	4		6	60401	133	Alagbata	Ogun	Alagbata	3.24407	7.11842	2	OORBDA	1981	L	14	87.2	1.2	10.00	1,000	1.0		Earthfill				0.05			x	x			
59	99	11		6	608	142	Asejire	Oyo	Osun	4.13314	7.36305	3	WCOS	1972	L	7,646	231.9	1,773.1	26.20		32.9	30.5	Earthfill + Concrete	Ogee	5,130		5.60	5.3			x			
60		12		6	614	147	Awara	Ondo	Ashodi	5.68147	7.50795	2	SWB	1985	L	22	274.0	6.0	11.70	900			Hom. Earthfill	Ungated			0.08				x			
61	101	13		6	60403	137	Awon	Oyo	Awon	3.89230	7.87950	2	WCOS	1942	L	454	157.9	71.7	13.10		10.0	8.4	Earthfill + Concrete	Ogee	255		1.90	2.0			x			
62	100	15		6	608	142	Ayiba(iwo)	Osun	Ayiba	4.19760	7.63690	3	WCOS	1957	L	56	219.3	12.3	11.56	455	2.6	1.5	Earthfill + Concrete	Ogee	91		0.60	0.6			x			
63	102	81		6	614	147	Egbe	Ekiti	Little Osse	5.57407	7.61460	3	SWB	1983	L	298	244.9	73.0	21.50	196	23.0	21.8	Concrete	Ogee	580		4.30				x			
64	91	35		6	608	142	Eko-ende	Osun	Otin	4.59460	7.93707	3	WCOS	1973	L	537	232.3	124.7	13.70	620	5.5	5.3	Earthfill	Ogee	877		0.94	4.9			x			
65	94	37		6	608	142	Erinle	Osun	Erinle	4.53839	7.88925	3	SWB	1989	L	1,220	217.7	265.6	27.00	677	94.0	92.5	Earthfill	Ogee			17.20	16.4			x		x	
66	93			6	608	142	Erinle(EDE)	Osun	Erinle	4.45482	7.75597	3	SWB	1954	L	1,466	217.8	319.3	10.50	236	5.3		Earthfill + Concrete	Ogee	800		1.60	1.6			x			
67	96	41		6	608	142	Esa-Odo	Osun	Osun	4.81197	7.75812	3	WCOS	1977	L	1,193	298.4	356.0	15.00	100	8.2		Hom. Earthfill	Ogee	674		0.13				x			
68	74	63		6	60405	138	Igboho	Oyo	Koisin	3.75547	8.81034	3	OSADEP	1988	L	114	172.9	19.7	11.00	420	1.2	0.9	Earthfill	Crest type			0.80			x	x			
69	10	65		6	614	147	Ikare	Ondo	Asande	5.75000	7.25000	0	SWB	1958	L		NA	NA	11.70	140	8.8	7.5	Earthfill	Ogee							x			
70	76	66		6	60405	138	Ikere Gorge	Oyo	Ogun	3.73790	8.17718	3	OORBDA	1991	L	4,704	160.3	754.0	55.00	580	690.0	565.0	Earthfill + Concrete	Ogee	6,850	53.0	48.00	53.0		x	x	x	x	

Annex-T SR4-1 Inventory of Existing Dams (3/5)

SN	SN Dam Resister	SN Comp. Dam	SN_ Proposed Dam_1995MP	HA	SHA	SN-SHA	Name	State	River	Lon	Lat	f_loc	Owner	Comp. Year	Category	DA (GIS) (km2)	Runoff height (mm/year)	Average Inflow Volume (MCM/year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area by HVA (km2)	Area GIS (km2)	Area 1995MP (km2)	Flood Control	Irrigation	Water Supply	Hydoropower	Fishery	Others
71		69		2	20403	45	Itapaji	Ekiti	Ele	5.46585	7.95634	3	SWB	1975	L	338	221.6	74.9	20.00		1.5		Hom. Earthfill	Ungated	580		1.00				x			
72	77	109		6	60401	133	Lekan Are	Ogun		3.43136	7.21030	2	OORBDA	1982	L	4	148.7	0.6	10.00	1,500	1.0		Earthfill	Ogee			0.19			x	x		x	
73	78	128		6	608	142	Oba	Oyo	Oba	4.19747	8.16584	3	WCOS	1964	L	341	181.1	61.8	13.40	500	4.6	4.1	Earthfill	Ogee	453		1.40	3.2			x			
74	79	132		6	604023_i	136	Ofiki (A)	Oyo	Ofiki	3.34081	8.47072	2	OORBDA	1983	L	11	131.3	1.4	12.60	580	1.3	1.2	Hom. Earthfill				0.50			x	x			
75	68	133		6	604023_i	136	Ofiki (B)	Oyo	Ofiki	3.34385	8.55996	2	OORBDA	1961	L	6	137.5	0.8	12.30	550	0.6	0.5	Hom. Earthfill	Ungated			0.16			x	x			
76	69	135		6	614	147	Ojerami	Edo	Onyami	6.15225	7.29694	2	SWB	1973	L	313	272.3	85.2	14.50	377	4.1	3.8	Earthfill		595		0.61				x			
77		137		6	602_i	131	Oke Odan	Ogun	Oke Odan	2.89940	6.72280	2	OORBDA	1995	L	71	129.7	9.2	10.00	525	5.5		Hom. Earthfill	Ungated			0.15				x			
78		147		6	608	142	Okuku	Osun	Alabata	4.67478	7.99678	2	SWB	1942	L	3	211.3	0.6	10.40	360	0.7		Hom. Earthfill	Ungated	175		0.22				x			
79	70	144		6	60403	137	Opeki	Oyo	Opeki	3.38115	7.51759	3	WCOS	1967	L	588	130.4	76.7	10.50	253	2.6	1.9	Earthfill + Concrete	Ogee	778		0.60	0.9			x			
80	71	145		6	608	142	Oshun	Osun	Osun	4.91667	7.66667	0	OYOWCOYS	1977	L		NA	NA	11.00	730			Earthfill		2,300						x			
81	73	143		6	604023_i	136	Oyan	Ogun	Oyan	3.25563	7.25725	3	OORBDA	1983	L	9,113	136.2	1,241.0	30.44	1,044	270.0	265.0	Earthfill	Ogee	3,440	40.0	44.00	40.0		x	x	x	x	
82	66	165		6	60405	138	Sepeferi(A)	Oyo	Owutu	3.64935	8.58517	2	OORBDA	1984	L	3	106.0	0.3	13.60	685	2.6	2.4	Hom. Earthfill	Ungated weir			0.14			x	x			
83	67	166		6	60405	138	Sepeferi(B)	Oyo	Agbado Osoruwa	3.63615	8.57903	2	OORBDA	1989	L	9	105.8	1.0	13.50	720	1.9	1.3	Earthfill	Ungated weir			0.32			x	x			
84	64	131		7	704042	157	Obudu	Cross River	Be	9.17182	6.61500	3	CRBDA	1999	L	22	1,026.4	22.6	15.00	220	2.5	2.0	Earthfill	Broad Crested Weir	165		0.57	0.5		x	x		x	
85	40	16		8	808075	193	Bagauda	Kano	Kura	8.38351	11.58379	3	WRECA	1970	L	200	48.7	9.7	20.73	2,134	22.1	20.9	Earthfill (Zoned)	Long Uncontrolle			2.90	3.8		x	x		x	x
86	43	26		8	8080745	192	Challawa Gorge	Kano	Challawa	8.03266	11.73272	3	HJRBDA	1992	L	3,842	143.7	552.0	39.62	7,760	930.0	904.0	Earthfill + Concrete	Long Uncontrolle	3,850		96.00	100.0	x	x	x	x	x	x
87	44	50		8	808063	182	Galala	Bauchi	Galala	9.73413	11.24986	3	HJRBDA	1982	L	451	136.8	61.7	12.00	440	23.0	20.0	Earthfill				9.10	1.1	x	x	x			x
88	45	51		8	8080723	186	Gari	Kano	Goubi	8.32122	12.44797	3	MANR	1980	L	1,145	27.1	31.0	22.00	6,055	214.0	203.0	Earthfill + Concrete	Uncontrolle d			30.00	33.2		x			x	x
89	23	59		8	8080743	191	Guzuguzu	Kano	Guzuguzu	8.13097	11.95647	3	WRECA	1979	L	100	72.6	7.3	17.40	2,090	24.6	21.5	Earthfill (Zoned)	Box Culvert			4.30	6.4		x			x	x
90	30	73		8	8080721_i	185	Jakara	Kano	Jakara	8.69200	12.13955	3	MANR	1976	L	563	48.6	27.4	14.33	2,438	65.3	54.4	Earthfill (Zoned)	Standard Ogee			20.00	16.6		x			x	x
91	31	90		8	808073	187	Kafin Chiri	Kano	Dudurum	8.85432	11.61188	3	MANR	1977	L	222	52.1	11.6	16.00	5,405	31.1	24.6	Earthfill (Zoned)	Concrete Ogee			4.80	8.4		x	x			x
92	52	83		8	8080743	191	Karaye	Kano	Kurma	8.03231	11.81865	3	WRECA	1971	L	83	39.0	3.2	15.24	1,585	17.2	16.6	Earthfill (Zoned)	Long Uncontrolle			2.30	2.0			x		x	x
93	89	106		8	808063	182	Laminga	Plateau	Rafin Sanyi	8.92260	9.89221	1	PUB	1972	L	30	251.3	7.5	27.00	650	20.0	15.0	Earthfill	Ogee	96		1.50				x			
94	60	113		8	8080743	191	Magaga	Kano	Magaga	8.04578	11.95011	3	WRECA	1990	L	119	57.8	6.9	19.35	2,550	19.7	17.2	Earthfill (Zoned)	Uncontrolle d			3.50	3.7		x	x		x	x
95	61	117		8	8080745	192	Marashi	Kano	Marashi	7.82731	11.92992	3	WRECA	1980	L	47	130.2	6.1	11.50	540	6.8	5.8	Earthfill (Zoned)	Box Culvert	3,850		0.60	2.1		x			x	x
96	62	121		8	8080721_i	185	Moh.Ayuba	Jigawa	Tuwari	8.42396	12.64010	3	WRECA	1975	L	383	14.9	5.7	15.85	1,012	5.5	4.3	Earthfill (Zoned)	Box Culvert			0.65				x		x	x
97	63	152		8	8080745	192	Pada	Kano	Pada	7.88625	11.92433	3	WRECA	1980	L	64	91.1	5.8	14.23	2,150	12.0	10.5	Earthfill (Zoned)	Uncontrolle d			2.40	4.1		x	x		x	x
98	46	159		8	808075	193	Ruwan Kanya	Kano	Tiga M.Canal	8.45577	11.51425	3	HJRBDA	1976	L	129	43.8	5.7	21.95	3,658	58.0		Earthfill (Zoned)	Long Uncontrolle			7.40			x			x	x
99	47	175		8	808077	194	Tiga	Kano	Kano	8.40858	11.46232	3	HJRBDA	1975	L	6,538	146.7	959.0	47.24	5,791	1,345.0	1,222.0	Earthfill (Zoned)	Long Uncontrolle	3,257			140.00		x	x		x	x
100	48	178		8	8080721_i	185	Tomas	Kano	Tomas	8.52538	12.30609	3	MANR	1976	L	696	44.8	31.2	13.72	3,553	60.3	56.6	Earthfill (Zoned)	Box Culvert			12.50	15.0		x	x		x	x
101	49	179		8	808077	194	Tudun Wada	Kano	Waina	8.42416	11.27373	3	MANR	1977	L	82	111.5	9.1	21.00	2,478	20.8	16.6	Earthfill (Zoned)	Long Uncontrolle			3.20	3.5		x			x	x
102	50	192		8	808061	180	Warwade	Jigawa	Dudurun Warwade	9.21208	11.74865	3	MANR	NA	L	129	89.0	11.5	10.00	2,780	12.3	9.7	Earthfill (Zoned)	Box Culvert			4.20	5.3		x	x		x	x

Annex-T SR4-1 Inventory of Existing Dams (4/5)

SN	SN Dam Resister	SN Comp. Dam	SN_ Proposed Dam_1995MP	HA	SHA	SN-SHA	Name	State	River	Lon	Lat	f_loc	Owner	Comp. Year	Category	DA (GIS) (km2)	Runoff height (mm/year)	Average Inflow Volume (MCM/year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area by HVA (km2)	Area GIS (km2)	Area 1995MP (km2)	Flood Control	Irrigation	Water Supply	Hydoropower	Fishery	Others
103	51	193		8	80807423	190	Watari	Kano	Watari	8.14684	12.16472	3	MANR	1980	L	654	55.0	36.0	19.81	3,658	104.6	92.7	Earthfill (Zoned)	Concrete Ogee			17.00	19.6	x	x			x	x
104	9	62		2	212	65	Igbetti	Oyo	Afonse	4.15953	8.75821	3	OSADEP	1986	M	44	173.2	7.6	9.00	400	0.9		Hom. Earthfill	Concrete auxiliary			0.16			x	x			
105	11	95		2	214_i	68	Kisi	Oyo	Tegese	3.84472	9.05902	3	OSADEP	1985	M	33	165.7	5.5	9.00	350	0.7		Earthfill	Auxiliary spillway			0.21			x	x			
106	1	100		2	20814	61	Kubani	Kaduna	Kubani	7.65551	11.13246	3	Abu	1975	M	56	1,657.0	92.8	8.50	823			Earthfill		10		1.30				x			
107	5	104		2	20815	62	Kwall	Plateau	Ouree	8.66707	9.83010	1	NESCO	1923	M	5	377.5	1.9	9.00	274	0.6	0.4	Earthfill	Ogree	271		0.06	0.1			x	x		
108	7	127		2	20815	62	Ngell	Plateau	Ngell	8.67018	9.83150	1	NESCO	1923	M	335	372.6	124.8	9.00	38	0.0		Concrete	Broad Crested Weir	108		0.01				x	x		
109	2	8		4	404	112	Ankwli(2)	Plateau	Tenti	8.85205	9.37924	1	NESCO	1963	M	18	464.5	8.4	9.00	203	1.2	1.1	Earthfill	Underflow	343		0.60	0.2				x		
110		55		4	407	116	Guma	Benue	Bakar	8.90532	7.88927	3	LBRBDA	1999	M	10	283.5	2.8	9.20	850	6.5		Earthfill				0.20			x	x			
111	3	79		4	404	112	Jekko(1)	Plateau	Tenti	8.74459	9.35503	1	NESCO	1937	M	145	468.3	67.9	9.75	128	1.4	1.1	Concrete	Ogee	685		0.30	0.4				x		
112	15	123		4	405	113	Naka	Benue	Ankpa	8.22107	7.59782	3	LBRBDA	1986	M	8	265.5	2.1	8.50	600	2.5		Earthfill	Broad Crested Weir	21		0.26	1.5		x	x		x	
113		129		4	405	113	Obagaji	Benue	Etila	7.91667	7.75000	0	LBRBDA	NA	M		NA	NA	8.10	1,520	1.1		Earthfill	channel	29					x	x			
114	12	184		5	50403	125	Ukhun-Erha	Edo	Okpoma	6.17167	6.82514	3	BORBDA	1994	M	16	417.5	6.7	12.00	180	0.8	0.7	Earthfill	Ogee	82		0.04			x				
115	92	36		6	606	140	Eleiyele	Oyo	Ona	3.85510	7.41860	3	WCOS	1942	M	321	233.4	74.9	2.44	235	7.0	5.5	Earthfill + Concrete	Ogee	368		2.10	1.6			x			
116	8	48		6	604023_i	136	Fofo	Oyo	Fofo	3.37147	8.68534	3	WCOS	1966	M	50	170.9	8.5	14.60	262	0.7	0.6	Earthfill + Concrete	Morning Glory	127		0.14				x			
117	13	1		8	806	170	Alau	Borno	Ngadda	13.28566	11.72382	3	CBDA	1992	M	3,951	34.2	135.1	9.50	344	112.4	106.0	Erthfill (Zoned)	Ogee	261			96.3		x	x			
118	14	70		8	8080721_i	185	Ibrahim Adamu	Jigawa	Warwar Rafi	8.37579	12.65336	3	MANR	1974	M	358	15.1	5.4	9.14		8.0	7.4	Erthfill (Zoned)	Controlled				2.6		x	x		x	x
119	4	96		8	808063	182	Kogingiri	Plateau	Kogingiri	8.93676	9.92711	2	PUB	1935	M	2	405.6	0.8	8.23	280	0.2	0.2	Earthfill	Broad Crested Weir	19		0.03					x		
120				8	8080723	186	Kusada	Katsina	Tabobi	7.97500	12.46757	3	SRRBDA	2009	M	20	21.8	0.4	4.50	500	5.5	5.2	Earthfill		55		0.47			x	x			
121	6	107		8	808063	182	Lamingo	Plateau	Lamingo	8.95001	9.91351	2	PUB	NA	M	3	326.8	1.0	11.50		0.5		Earthfill		5		0.30	0.1			x			
122	20	118		1	106082_i2	17	Misibil	Katsina		8.04323	12.60669	2		NA	S	51	16.0	0.8	3.40	1,535	0.8		Earthfill				0.76			x	x			
123	148	158		1	102	2	Rijau	Niger	Butulu	5.28855	11.05521	3	UNRBDA	1990	S	21	156.2	3.3	7.00	350	1.3	1.0	Earthfill	Ogee	40		0.08			x	x			
124	166	30		1	106082_i2	17	Daura	Katsina	Daura	8.37030	12.99604	2	SWB	1980	S	51	5.5	0.3	6.00		1.2		Earthfill	Broad Crested	60		0.24				x			
125	147	195		1	106081_i	14	Wurno	Sokoto	Rima	5.47392	13.30226	3	SRRBDA	1960	M	118,910	7.9	939.4	8.00	4,500	25.0	20.0	Earthfill	Freeflow			9.80			x	x			
126		150		2	209	63	Omu-Aran	Kwara	Orisa/Roro	5.08717	8.11509	2	SWB	1978	S	1	205.9	0.2	6.00	150			Concrete	Free flow	52		0.02				x			
127	149	52		3	317	102	Girei	Adamaw	Girei	12.58333	9.33333	0	UBRBDA	NA	S		NA	NA	5.00	250	0.3		Earthfill	Broad Crested Weir	10						x			
128		190		3	312	91	Wuroabba	Adamawa		12.07306	9.16539	1	FMARD	2005	S	5	118.4	0.6	3.00	400	1.0		Earthfill	Channel			0.14							
129	150	198		3	317	102	Yola	Adamaw	Yola	12.50000	9.16667	0	UBRBDA	1983	S		NA	NA	5.00		0.3		Earthfill		10									
130		103		4	410	119	Kwa	Plateau	Kwa	9.26311	9.01877	2	LBRBDA	1996	S	1	367.5	0.4	6.00	180	0.2		Earthfill	Open Channel			0.01			x	x			
131	153	105		4	404	112	Lafia	Nassara	Amba	8.49655	8.48978	3	SWB	1985	S	103	314.2	32.4	4.00	126	0.2	0.1	Concrete	Broad Crested Weir	170		0.06	0.1			x			
132	154	124		4	402	110	Nassarawa	Nassara	Uke	7.70389	8.54331	3	LBRBDA	1984	S	3,363	391.5	1,316.6	3.00	60	0.6	0.4	Concrete	Broad Crested Weir	150		0.10	0.1			x			
133	163	186		4	405	113	Umogodi	Benue	Oggahakpa	7.97520	7.44780	1	LBRBDA	1986	S	115	365.4	42.0	6.00	310	2.5	1.8	Earthfill	Broad Crested Weir				1.0		x	x			
134	160	67		6	616	148	Ikpoba	Edo	Ikpoba	5.64684	6.37664	3	SWB	1958	S	734	517.0	379.5	8.00	610	1.5		Earthfill	Ungated	105						x			
135	161	134		6	60405	138	Ogbooro	Oyo	Ata	3.62591	8.76199	3	OSADEP	1986	S	13	168.9	2.2	8.00	350	0.3		Hom. Earthfill		7		0.10			x	x			
136	162			6	614	147	Osse	Ondo	Osse	5.64576	7.34699	3	SWB	1961	S	1,224	234.0	286.4	6.00	169	0.4		Earthfill	Ogee			0.03				x			
137		153		6	612	146	Owena	Ondo	Owena	5.01836	7.19995	3	SWB	1977	S	775	269.1	208.6			10.0		Hom. Earthfill				0.40			x	x			
138	156	34		7	70402	154	Ebun-wana	Abia	Igwugwe	7.86815	5.79508	2	AIRBDA	NA	S	2	714.0	1.4		110	0.0		Earthfill (Zoned)	Side Earth Spill							x			
139	157	44		7	70402	154	Ezzamgbo	Ebonyi	Ezzamgbo	7.93333	6.40000	0	SWB	1964	S		NA	NA	2.44	91	0.4		Concrete								x			

Annex-T SR4-1 Inventory of Existing Dams (5/5)

SN	SN Dam Resister	SN Comp. Dam	SN_ Proposed Dam_1995MP	HA	SHA	SN-SHA	Name	State	River	Lon	Lat	f_loc	Owner	Comp. Year	Category	DA (GIS) (km2)	Runoff height (mm/ year)	Average Inflow Volume (MCM/ year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area by HVA (km2)	Area GIS (km2)	Area 1995MP (km2)	Flood Control	Irrigation	Water Supply	Hydoropower	Fishery	Others
140	159	136		7	70403	155	Ohatewe Ikwo	Enugu		8.13333	6.18333	0	AIRBDA	1989	S		NA	NA	3.60	100	0.0		Zoned	Side Earth Spill							x			
141	164	197		7	70403	155	Yakurr	Cross River		8.14520	5.85130	3	CRBDA	1984	S	2	788.9	1.6	2.20	80	0.0		Earthfill	Broad Crested Weir			0.01			x	x		x	
142	165	22		8	808062	181	Binin Kudu	Jigawa	Dogwalo	9.47020	11.43893	3	WRECA	1970	S	36	106.1	3.8	6.70	1,931	1.2	0.9	Erthfill (Zoned)				0.60				x		x	x
143	155	177		8	808063	182	Tollemache	Plateau	Rafin Sanyi	8.96858	9.89747	1	PUB	1961	S	9	248.9	2.2	7.60	374	0.4	0.4	Earthfill	Concrete Weir			0.08					x		
144		187		6	614	147	Ureje	Ekiti	Ureje	5.21535	7.59950	3	SWB	1957	L	30	264.3	7.9	12.00	500			Concrete+ Earthfill	Ungated			0.15			x				
145				2	20812	59	Kerawa	Kaduna	Turo	7.44650	10.96460	3		1966	S	279	135.4	37.8	7.00	500	3.5	2.8			2,000		0.65			x	x			
146				2	20814	61	Matari	Kaduna	Kargi	7.80430	10.93410	3	MANR	1967	M	513	162.3	83.3	7.50	550	12.6	8.2			1,900		1.40			x				
147				1	1060863	24	Batsari	Katsina		7.24034	12.74873	2	SRRBDA	E	M	34	12.4	0.4	5.00	450	5.40	4.90	Earthfill		52		0.08							
148				1	106082_i2	17	Sabke	Katsina		8.15893	13.05991	2	SRRBDA	E	L	1,352	9.5	12.8	12.50		31.60		Earthfill		45		5.20							
149	158	111		7	702	151	Lokpanta	Imo	Edede	7.27202	5.78499	2	AIRBDA	1987	S	538	829.4	446.2	3.00	140	0.11		Zoned	Side Earth Spill	12					x	x			
150				7	704043	158	Otobi Akpegede	Benue	Akpegede	8.16316	7.13168	2	LBRBDA	1986	z	12	615.1	7.4									0.11			x	x			
151		161		3	31409	99	Gindiri	Plateau	Dundage	9.17583	9.56705	2	SWB	1996	S	3	236.0	0.7	5.00	33	0.70		Concrete				0.01				x			
152				1	106089	29	Modomawa	Zamfara	Gagare	6.62488	12.55362	3	SWB	1960	z	28	19.6	0.5		470		3.00	Earthfill	Concrete			1.20				x			
153			1103	1	106093	31	Gwaigwaye	Katsina	Sokoto	7.20540	11.57710	3		NA	L	128	240.7	30.8	12.00	500	7.20						1.90							
154			2110	2	212	65	Ago	Kwara	Oyun	4.66590	8.46680	3		NA	L	711	146.3	104.0		200	0.4						0.30							
155			2123	2	206	47	Bakajeba	Niger	Jatau	6.58929	9.22785	3		NA	L	1,020	193.7	197.6		1,200	34.0						9.00							
156				8	808077	194	Ikare	Kaduna	Kargi	8.30992	11.17530	3	SWB	NA	z	107	138.3	14.8									0.90							
157				5	50403	125	Ekuku	Kogi		6.21894	7.53197	3		NA	z	9	197.7	1.8									0.04							
158				6	610	144	Ifewara	Osun		4.68645	7.48141	3		NA	z	9	197.7	1.8									0.20							
159				6	608	142	Pade	Oyo	Oniyanrin	4.00450	7.62106	3		1992	S	2	219.8	0.5	9.5	350	0.74													
160				6	60403	137	Alabata	Oyo	Ose	3.86636	7.61811	3		2010	M	59	198.8	11.6	11	420	2.025													
161				6	606	140	Akufo	Oyo		3.81458	7.48494	3		2008	S	0	146.2	0.0	8.5	120	0.11													
162				6	606	140	Sanusi	Oyo	Seleru	3.79133	7.21056	3		2007	S	26	169.9	4.3	9.5	250	0.64													
163				6	608	142	Ajinapa	Oyo	Oniyele	4.24603	8.27508	3			S	1	181.1	0.2	8.5	250	0.78													
164				6	60405	138	Ago Amodu	Oyo	Adu	3.60986	8.62567	3			S	21	107.1	2.3	6	200	0.09													
165				6	60405	138	Oje Owode	Oyo		3.48926	8.58532	2		1985	S	17	164.5	2.8	7.5	250	0.29													
166				6	604023_i	136	Ago Are	Oyo	Owo	3.44148	8.51158	2		1984	S	47	145.8	6.9	8.5	350	0.45													
167				6	604023_i	136	Ayete	Oyo	Okugba	3.26775	7.57811	2		1991	M	10	133.9	1.3	11	410	1.138													
168				6	604023_i	136	Okeho	Oyo	Ifo-Ile	3.32139	8.00749	2		1987	S	21	169.7	3.5	10	400	0.818													
169				6	604023_i	136	Ilero	Oyo	Ipalo	3.36690	8.09567	2		1984	S	6	138.8	0.9	9.5	250	0.51													
170				6	604023_i	136	Iganna	Oyo		3.25849	7.97703	2		1985	S	28	105.9	3.0	7.6	300	0.17													
171				1	104	4	Mahuta	Kebbi	Rafin Tsmma Mulfa	4.98579	11.54534	3		2010	S	32	106.6	3.4	5.5	350	0.65	0.58			120						x			

Annex-T SR4-2 Inventory of Under Construction Dams (1/1)

SN	SN Dam Resister	SN Comp. Dam	Code_ Proposed Dam_ 1995MP	HA	SHA	SN-SHA	Name	State	River	Lon	Lat	f_loc	Category	DA (GIS) (km2)	Runoff height (mm/year)	Average Inflow Volume (MCM/year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area by Report (km2)	Area Google Earth (km2)		Flood Control	Irrigation	Water Supply	Hydropower	Fishery	Others
1001				6	60401	133	Owiwi	Ogun		3.26758	7.06189	3	L	168	87.6	14.7	20.0	900	30.0									x	x			
1002				6	610	144	Ile-Ife	Osun		4.60662	7.42334	3	L	170	225.2	38.3	19.7		14.0										x			
1003				6	608	142	Ilesha	Osun		4.67270	7.75820	2	L	285	249.9	71.2		450	25.0		Earthfill							x	x		x	
1004				5			Inyishi	Imo	Mbaa			0	L				12.0	210	25.0		Earthfill	Ogee										
1005			6230	6	612	146	Owena Multipurpose	Ondo	Owena	5.00000	7.34160	3	L	695	266.5	185.2	24.0	1,686	36.0		Hom. Earthfill	Gated	1161		4.40			x	x			
1006				4	406_i	115	Kashimbilla	Taraba	Katisna-Ala	9.76229	6.87152	3	L	8,445	1,449.0	12,236.8	35.0	1,585	500.0								x	x	x	x		
1007				8	8080745	192	Sulma Earth	Katsina		7.58100	11.71320	3	L	10	137.7	1.4	14.0	1,030	4.3		Earthfill	Concrete gravity ogee	250	0.27	0.10			x	x			x
1008				5			Amuzari	Imo	Nwangela			0	S				7.5	480	2.5		Earthfill	Ogee										
1009			5109	5	502	122	Ogwashi-Uku	Delta	Ubu	6.56064	6.15247	3	L	127	562.7	71.5	15.7	280	3.9		Zoned Earthfill	Broad Creasted Concrete Weir		0.76				x		x		
1010	143	27					Cham																									
1011				1	106082_i	17	Mashi	Katsina		7.96564	12.97000	3	M	10	12.1	0.1	5.5	480	5.0	4.5	Earthfill				0.20				x			
1012				7	70402	154	Ivo	Enugu		7.60937	5.96962	3	L	293	681.0	199.5	15.0	250	20.0										x			
1013			2113	2	20814	61	Galma	Kaduna		8.35041	10.82383	3	L	1,228	170.3	209.1	28.0	2,300	186.0									x	x			
1014				2	218	73	Kontagora (Auna)	Niger	Kontagora	4.87284	10.14664	3	L	1,922	182.0	349.8	32.0	2,200	340.0	180.0	Earthfill	Broad Crest Weir	209					x				
1015				2	20805	53	Kagara	Niger	Kagara	6.29280	10.16820	3	L	157	272.5	42.8	31.0	1,313	43.0	40.0	Earthfill	Ogee + Broad Crest Weir						x	x		x	x
1016			6233	6	614	147	Ogbesse	Ekiti		5.31520	7.45919	3	L	1,360	296.0	402.6	14.5	1,050	74.0		Earthfill	Broad Crested Concrete						x	x	x		
1017				8	8080745	192	Jare	Katsina	Jare	7.43609	11.54286	3	L	323	151.8	49.0	20.0	2,900	26.3	22.2	Earthfill											
1018				7	70401	153	Ibiono Ibom	Akwa-Ibom				0	S				11.5	200	0.3													
1019				2	20814	61	Gimi Earth	Kaduna		8.00017	11.33171	2	L	22	126.1	2.8	11.0	928	4.7			Ungated ogee			0.20			x	x			x
1020				1	106082_i	17	Dutsi Earth	Katsina		8.12530	12.82801	3	M	64	13.2	0.8	5.2	460	6.2	6.10	Earthfill				0.70							
1021							Alkaleri Earth	Bauchi				0	S																			
1022				7	704043	158	Otukpo	Benue		8.07735	7.11670	3	L	1,108	627.6	695.4	31.0	2,300	30.0									x	x	x		
1023				5	50402	124	Adada River	Enugu		7.26946	6.73084	3	L	235	423.0	99.4	18.0	347	2.7										x			
1024				7	705	161	Kwa Falls	Cross River				0	L				29.0	530	68.0									x	x	x	x	
1025			3108	3	316	101	Jada	Adamawa		12.22713	8.70564	3	L	1,561	289.2	451.4	18.0	996	40.6		Earthfill	Ogee					x	x	x	x		
1026							Mangu	Plateau				0																	x			
1027				7	70401	153	Nkari	Akwa Ibom	Itu	7.75482	5.39578	3	L	21	1,015.0	21.3	11.5	1,950	3.5		Hom. Earthfill	Ogee						x	x		x	
1028				4	406_i	115	Wannune	Benue		8.91068	7.55402	3	L	13	329.3	4.3	12.0	446	1.0									x	x		x	
1029				6			Iyamero	Ekiti	Iyamero			0	S															x	x			x
1030				4			Aloshi	Plateau	Aloshi			0	S															x	x			x
1031				4			Rafin Soja	Nasarawa				0	S															x	x			
1032				4			Upu-Itor	Benue	Okete			0	S															x	x			x
1033	75	64		6	604023_i	136	Igbojaye	Oyo	Aye	3.30696	8.22243	2	L	233	124.4	29.0	18.0		5.6	5.2	Earthfill							x	x			

Annex-T SR4-3 Inventory of Unknown Dams (1/2)

SN	SN Dam Resister	SN Comp. Dam	SN_ProposedDam_1995 MP	HA	SHA	Name	State	River	Lon	Lat	f_loc	Owner	Comp. Year	Category	DA (km2)	DA (GIS) (km2)	Average Inflow Volume (MCM/year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area HVA (km2)	Area GIS (km2)	Area 1995MP (km2)	Flood Control	Irrigation	Water Supply	Hydoropower	Fishery	Others
9001	105	29		1		Dallaje	Katsina	Dakau			0	SWB	UC	L				13.00		19.50		Earthfill	Free Overflow						x	x			
9002				1		Fakuna/Charaki	Katsina				0	SRRBDA	N/A	L				11.00	1,500	8.60	7.90	Earthfill	Weir	1,087					x	x			
9003				1		Gada Benye	Katsina				0	SRRBDA	N/A	L				20.80	2,080			Earthfill		667					x	x			
9004	4			1		Kurfi	Katsina	Kurfi			0	SRRBDA	N/A	L				24.00	2,000	15.20	14.40	Earthfill		200					x	x			
9005				1		Ruma	Katsina				0	SRRBDA	N/A	L	2,309			18.00	1,400	8.60	5.50	Earthfill		138					x	x			
9006	123	57		2		Guzan	Niger	Yiko			0	MANR	UC	L				20.00	950	20.00	18.00	Earthfill+ Concrete	Broad Crest	67					x			x	
9010				4		Aduka Okaflo	Benue	Onaje			0	LBRBDA	UC	L				14.50						14					x	x			
9011				4		Aghashi	Nassarawa	Okpagigbu			0	LBRBDA	UC	L	10.0			10.50		1.30				62					x	x			
9012				4		Ganwuri	Plateau	Afel			0	LBRBDA	UC	L				17.70						37					x	x			
9013		110		4		Lessel	Benue	Agbudu			0	LBRBDA	UC	L				15.10	750	4.00		Earthfill	Uncontrolled Ogee	153					x	x			
9015	97	9		6		Aisegba	Ekiti	Akpariko			0	BORBDA	N/A	L	21			12.60	700	4.70	4.00	Earthfill	Ogee	1					x	x			
9020	32	91		8		Kafin Zaki	Bauchi	Bunga			2	HJRBDA	UC	L	531			40.00	11,000	2700.00	2500.00	Earthfill	Ogee	1,460				x	x	x	x		x
9021	33	82		8		Kango	Kano	Kango			2	MANR	UC	L	41			14.51	1,220	8.73	7.87	Earthfill (Zoned)	Box Culvert						x	x			x
9022	53	88		8		Kawali	Bauchi	Bunga			2	HJRBDA	UC	L				15.00	4,500			Earthfill	Ogee					x	x	x	x		x
9023				1		Pandabuwa	Katsina				0	SRRBDA	N/A	M				5.00	520	6.00	5.50	Earthfill		50									
9024	21	172		1		Suru	Kebbi				2		UC	M				6.30	800	5.00		Earthfill							x	x			
9025		114		2		Malete	Kwara	Moro			2	SWB	N/A	M				6.00		5.90		Earthfill	Sideway freeflow							x			
9026				4		Mbakusu	Benue	Asu			0	LBRBDA	UC	M	3.0			8.00											x	x			
9027				4		Wuhuna Maav	Benue	Warhuna			0	LBRBDA	UC	M	7.9			9.00											x	x			
9029	16	5		1		Achida	Sokoto				0		UC	S				4.00	135			Rockfill + Earthfill							x	x			
9030	17	31		1		Dinawa	Sokoto				0		UC	S	0.3			4.00	127	0.15		Earthfill											
9031	18	87		1		Karkirko	Sokoto				0		UC	S	1.2			7.00	180	0.24		Earthfill											
9032	19	116		1		Marnova	Sokoto				0		UC	S	1.2			7.00	220	0.28		Earthfill											
9033	124	68		2		Iku	FCT	Iku			0	SWB	N/A	S				7.00	870			Earthfill		385			4.3			x			
9034				2		Miango	Plateau	N'gell			0	LBRBDA	UC	S				6.00						8					x	x			
9035		20		3		Benue Valley	Adamawa	Beti			0	Benue Valley Farm Ltd	N/A	S				2.50	800	1.00		Earthfill	Open Channel										
9036				4		Ajopachi	Kogi	Osuma Mayi			0	LBRBDA	UC	S				5.50											x	x			
9037				4		Akpagher	Benue	Okeawe			0	LBRBDA	UC	S	7.3			7.00											x	x			
9038				4		Azara	Nassarawa	Tukunwa			0	LBRBDA	N/A	S				8.00											x	x			
9039				4		Gbemocho	Benue	Mu			0	LBRBDA	UC	S				7.00											x	x			
9040				4		Nakaokaflo	Benue	Ana			0	LBRBDA	UC	S				7.00						100					x	x			
9041				4		Raav	Benue	Agabtu			0	LBRBDA	UC	S				6.00		5.60				22					x	x			
9042	167	157		8		Rimin Gado	Kano	Rimin Gado			0	WRECA	N/A	S	5.0			7.04	210	0.30		Earthfill (Zoned)	ncontrolle							x			x
9043				1		Niger V.P	Kebbi	Niger Valley			0	SRRBDA	N/A	z						18.40	17.50	Dyke	Weir	170					x	x			
9044				2		Kpada	Kwara	Kampe			0		N/A	z										134					x				
9046				2		Offa	Kwara	Oyun			0	SWB	N/A	z	107.0															x			
9047				2		Paki	Kaduna	Kargi			0	MANR	N/A	z										85					x				
9048				4		Goraga	Plateau	Rimi			0	LBRBDA	UC	z															x	x			

Annex-T SR4-3 Inventory of Unknown Dams (2/2)

SN	SN Dam Resister	SN Comp. Dam	SN_ProposedDam_1995MP	HA	SHA	Name	State	River	Lon	Lat	f_loc	Owner	Comp. Year	Category	DA (km2)	DA (GIS) (km2)	Average Inflow Volume (MCM/year)	Height (m)	Crest length (m)	Gross Storage (MCM)	Active Storage (MCM)	Dam Type	Spillway Type	Spillway Design Dis. (m3/s)	Area HVA (km2)	Area GIS (km2)	Area 1995MP (km2)	Flood Control	Irrigation	Water Supply	Hydropower	Fishery	Others
9050		185		4		Ugboju	Benue	Ugboju			0	LBRBDA	UC	z								Earthfill											
9051				5		Ifite	Anambara	Trib			0	MANR	N/A	z															x				
9052				5		Igbakwu	Enugu	Ishu			0	AIRBDA	N/A	z															x	x			
9053				5		Nchia	Rivers	Nchia			0	AIRBDA	N/A	z																			
9054				5		Nkisi	Anambara	Nksi			0	SWB	N/A	z						0.80										x			
9055				5		Okweghi	Edo	Okweghi			0	MANR	N/A	z	12.0														x	x			
9056				5		Omerobi	Anambara	Ugbo			0	MANR	N/A	z															x				
9057				5		Ubo	Anambara	Ugbo			0	MANR	N/A	z															x				
9058				7		Abina	Enugu	Aboinie			0	SWB	N/A	z																x			
9059				7		Apariko	Ondo	Apariko			0	MANR	N/A	z	21.0														x	x			
9060				7		Effium	Enugu	Aboinie			0	SWB	N/A	z																x			
9061				7		Igbere	Abia	Igwu			0	CRBDA	N/A	z	2.0														x				
9062				7		Ijegu Yala	Cross River	Onwul			0	CRBDA	N/A	z						80.00									x	x			
9063		122		7		Mgbowo	Enugu	Asa			0	AIRBDA	UC	z															x	x			
9064				7		Umuopara	Abia	Cross River			0	AIRBDA	N/A	z																			
9065				1		Jare-Tsiga	Katsina	Sandara			0	SRRBDA	2008	L				20.00	2,900	30.70	26.30	Earthfill		783					x	x			
9070				1		Birln Yauri (1)	Kebbi				0	SWB	1984	S	4.0						1.10									x			
9071				1		Birln Yauri (2)	Kebbi				0	SWB	1984	S	5.0						0.50									x			
9072				1		Marafe	Kebbi	Ka			0	SWB	1984	S	2.0						0.10									x			
9073	72	141		6		Otin	Osun	Otin			0	SWB	1974	L	884.0			14.00	557	5.50	4.60	Earthfill								x			
9074		98		7		Konshisha	Benue	Konshisha			0	LBRBDA	1986	L				15.00	1,200	44.00		Earthfill							x	x			
9076	151	24		4		Bukkos(1)	Plateau	Dakata			0	PUB	1985	S					340			Concrete		5						x			
9077	152	80		4		Jekko(2)	Plateau	Sanga			0	NESCO	1950	S	5.0			6.00	23	0.01		Concrete	Ogee	685						x	x		
9078		191		6		Warake	Edo	Owan East			0	FAO/EDOADP	1990	S				4.50	244	0.70		Hom. Earthfill	Ungated					x					
9081				1		Bani	Kebbi	Rima			0	SWB	1990	z	2.0					0.70										x			
9082				1		Ilo	Kebbi	Gwanare			0	MANR	1990	z	10.0														x	x			
9083				1		Tambura	Kebbi	Kambua			0	SWB	1983	z	5.0					4.90										x			
9084				1		Tubo	Katsina	Cahinache			0	SWB	1983	z	171.0					35.50	25.10			220					x	x			
9085				2		Birin-Gwari	Kaduna	Kubheriwi			0	SWB	1972	z	594.0									56					x	x			
9086				2		Kargi	Kaduna	Kargi			0	MANR	1967	z										400			35.0		x				
9089				2		Wandon	Kaduna	Ubandawake			0	MANR	1988	z															x				
9091				6		Ido-Ani	Ondo	Agbaisa			0	SWB	1973	z						1.00										x			
9092				6		Mokoloki	Ogun	Ogun			0	OORBDA	1967	z	20,558.0															x			
9093				6		Owo	Ondo	Little Osse			0	SWB	1982	z	23.0					0.20										x			
9094		42		6		Evbokhuenbo	Edo	Okhuahe			0	BORBDA	NA	S								Hom. Earthfill										x	
9095				1		Zauro Polder	Kebbi	Rima			3	SRRBDA	1982	S						3.50	3	Barrage							x	x			
9096				6		Ilua	Oyo	Isanrin			0		1987	S				7.00	250	0.13													
9097				6		Irawo	Oyo	Esinomu			0		1988	S				9.20	400	0.30													

Annex-T SR4-4 List of Potential Dam Sites (Proposed in M/P1995) (1/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
2001	1101	1	1060883	28	Karaduwa	Karaduwa	Katsina	Matazu	7.68630	12.32010	123.0	96.1	504.0	516.0	518.0	12.0	17	2,700	28.5	1,025	79	81	0.84	1,615
2002	1102	1	106089	28	Kaya	Gagare	Zamfara	Zurmi	6.48410	12.80390	137.9	107.8	342.0	360.1	362.1	18.1	24	2,600	23.9	6,662	52	347	3.22	1,757
2003	1201	1	10602	7	Ka	Ka	Sokoto	Kebbe	4.68161	11.68406	121.9	95.2	193.0	206.0	208.0	13.0	18	700	25.2	9,012	120	1,081	11.36	1,801
2004	1202	1	105	5	K.Sakachi	K.Sakachi	Kebbi	Shanga	4.56020	11.28060	22.8	17.8	171.0	183.4	185.4	12.4	18	1,500	5.2	57	113	6	0.36	1,761
2005	1203	1	104	6	Kotsu	Kotsu	Kebbi	Shanga	4.67866	11.34276	13.9	10.9	199.0	210.0	212.0	11.0	16	1,300	3.8	230	111	26	2.35	1,747
2006	1204	1	104	6	Danzaki	Danzaki	Kebbi	Shanga	4.70810	11.27509	56.0	43.7	170.0	189.0	191.0	19.0	25	400	11.5	2,640	119	315	7.20	1,745
2007	1205	1	103	3	Wasa	Wasa	Kebbi	Shanga	4.76040	11.13390	30.6	23.9	186.0	202.0	204.0	16.0	21	1,200	5.8	147	125	18	0.77	1,724
2008	1206	1	103	3	Bakin Turu	Bakin Turu	Kebbi	Shanga	4.85010	11.07650	13.0	10.2	211.0	222.4	224.4	11.4	17	700	2.7	32	127	4	0.40	1,709
2009	1207	1	103	3	Kasanu	Kasanu	Kebbi	Shanga	4.92515	10.99434	21.0	16.4	197.0	209.7	211.7	12.7	18	900	5.2	409	133	54	3.31	1,704
2010	1208	1	103	3	Bambiri	Bambiri	Kebbi	Ngaski	4.98850	10.92640	15.5	12.1	218.0	227.0	229.0	9.0	14	1,000	5.2	150	153	23	1.89	1,696
2011	1209	1	101	1	Wata	Wata	Kebbi	Ngaski	4.72857	10.57485	55.1	43.0	148.0	161.0	163.0	13.0	18	1,600	13.3	695	169	118	2.74	1,723
2012	1210	1	101	1	Utula	Utula	Niger	Agwara	4.40850	10.73430	15.2	11.9	157.0	168.0	170.0	11.0	16	800	4.2	307	89	27	2.30	1,725
2013	1211	1	101	1	Shafaci	Shafaci	Niger	Borgu	4.31430	10.76640	46.1	36.0	167.0	186.2	188.2	19.2	25	1,200	8.9	278	89	25	0.69	1,732
2014	2101	2	212	65	Jokoro	Molu	Kwara	Moro	4.21960	8.85580	12.8	10.0	364.0	383.4	385.4	19.4	25	1,400	2.1	71	175	12	1.24	1,600
2015	2102	2	212	65	Ajelanwa	Weru	Kwara	Asa	4.23380	8.64810	86.5	67.6	286.0	302.4	304.4	16.4	22	1,400	14.1	673	138	93	1.37	1,643
2016	2103	2	212	65	Yanku	Weru	Oyo	Ori Ire	4.20290	8.61900	48.8	38.1	294.0	310.2	312.2	16.2	22	1,300	8.3	289	125	36	0.95	1,634
2017	2104	2	212	65	Ala	Ohan	Kwara	Asa	4.26550	8.58440	51.0	39.9	287.0	303.4	305.4	16.4	22	1,300	8.5	290	130	38	0.94	1,644
2018	2105	2	212	65	Shao	Busamu	Kwara	Moro	4.54260	8.64030	25.8	20.1	264.0	280.5	282.5	16.5	22	500	4.0	132	150	20	0.98	1,675
2019	2106	2	212	65	Oloye	Weru	Oyo	Ori Ire	4.13030	8.56810	14.4	11.2	319.0	333.6	335.6	14.6	20	1,000	3.0	71	120	9	0.76	1,621
2020	2107	2	212	65	Mogaji	Moro	Kwara	Asa	4.35150	8.43990	52.1	40.7	309.0	327.2	329.2	18.2	24	1,000	9.2	268	134	36	0.88	1,624
2021	2108	2	212	65	Okanle	Oyun	Kwara	Oyun	4.67690	8.31440	16.1	12.6	341.0	353.0	355.0	12.0	17	1,200	3.0	270	150	40	3.22	1,601
2022	2111	2	212	65	Okeoyi	Awun	Kwara	Moro	4.63550	8.60510	12.7	10.0	276.0	296.2	298.2	20.2	28	1,000	2.0	69	138	10	0.96	1,649
2023	2112	2	212	65	Faloku	Oyun	Kwara	Irepodun	4.78810	8.17550	18.9	14.7	397.0	410.4	412.4	13.4	19	1,000	3.5	93	162	15	1.03	1,573
2024	2114	2	20814	61	Galma(2)	Shica	Kaduna	Kudan	7.65250	11.27890	83.0	64.9	630.0	644.3	646.3	14.3	20	2,500	16.7	398	154	61	0.95	1,523
2025	2115	2	20814	61	Galma(3)	Likarbu	Kaduna	Soba	7.86460	10.85940	49.7	38.8	607.0	623.2	625.2	16.2	22	2,100	11.7	983	182	179	4.60	1,515
2026	2116	2	206	47	Essan	Lawi	Niger	Paikoro	6.76890	9.48580	39.0	30.4	261.0	278.4	280.4	17.4	23	700	6.5	208	239	50	1.63	1,703
2027	2117	2	206	47	Eniko	Eniko	Niger	Gbako	6.11640	9.19740	21.4	16.7	79.0	93.5	95.5	14.5	20	1,500	5.0	160	142	23	1.36	1,819
2028	2118	2	206	47	Agaie	Bakogi	Niger	Agaie	6.39790	9.08526	44.0	34.4	112.0	122.6	124.6	10.6	16	1,700	9.5	270	168	45	1.32	1,793
2029	2119	2	206	47	Tungawain	Wayin	Niger	Bosso	6.28450	9.50110	25.3	19.8	146.0	167.1	169.1	21.1	29	1,800	5.5	223	200	45	2.25	1,787
2030	2120	2	20805	53	Sanakpan	Bako	Niger	Wushishi	6.07850	9.61440	25.8	20.2	91.0	101.5	103.5	10.5	16	2,100	7.9	227	170	39	1.91	1,835
2031	2121	2	206	47	Jariga	Jatau	Niger	Gurara	6.93360	9.35600	5.6	4.4	373.0	402.4	404.4	29.4	37	800	0.5	90	271	24	5.61	1,624
2032	2122	2	206	47	Yankpako	Chanchaga	Niger	Katcha	6.26040	9.39670	143.6	112.2	96.0	118.2	120.2	22.2	30	2,300	20.7	2,285	218	498	4.44	1,821
2033	2124	2	206	47	Nabi	Gora	Niger	Shiroro	6.82240	9.54780	27.9	21.8	292.0	308.2	310.2	16.2	22	1,500	4.6	247	259	64	2.94	1,690
2034	2125	2	206	47	Faka	Kemi	FCT Abuja	Abaji	6.81110	9.21750	40.9	31.9	234.0	240.0	242.0	6.0	11	1,300	15.8	253	192	49	1.52	1,718
2035	2201	2	209	63	Igporin	Oshin	Kwara	Ilorin East	4.84630	8.71570	38.3	29.9	221.0	239.0	241.0	18.0	24	1,200	6.4	1,064	154	164	5.47	1,689
2036	2202	2	209	63	Elebu	Oshin	Kwara	Moro	4.73820	8.80110	27.3	21.3	197.0	220.1	222.1	23.1	31	1,300	3.8	141	134	19	0.89	1,703
2037	2203	2	209	63	Lasaki	Oshin	Kwara	Moro	4.74060	8.93450	13.2	10.3	175.0	190.4	192.4	15.4	21	1,200	2.3	67	128	9	0.83	1,722

Annex-T SR4-4 List of Potential Dam Sites (Proposed in M/P1995) (2/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
2038	2204	2	209	63	Okunrun	Okunrun	Ekiti	Moba	5.16650	7.95320	10.6	8.3	516.0	528.0	530.0	12.0	17	600	2.2	36	179	6	0.78	1,467
2039	2205	2	20804	52	Ukusu	Ukusu	Niger	Mariga	5.97710	10.36930	11.5	9.0	225.0	233.5	235.5	8.5	14	900	3.5	784	247	193	21.62	1,730
2040	2206	2	20804	52	K. Chaaruma	K. Chaaruma	Niger	Rafi	6.20140	10.25920	6.9	5.4	256.0	267.4	269.4	11.4	17	1,100	2.1	160	260	42	7.68	1,718
2041	2207	2	20804	52	Kombou	Kombou	Niger	Rafi	6.08200	10.03420	15.0	11.7	228.0	241.0	243.0	13.0	18	1,500	3.8	108	327	35	3.01	1,750
2042	2208	2	20801	49	Kaduna	Kaduna	Niger	Mokwa	5.85640	9.32210	223.6	174.7	72.0	79.7	81.7	7.7	13	3,500	89.5	63,052	243	15,303	87.61	1,834
2043	2209	2	209	63	Lade	Tributary	Kwara	Pategi	5.60080	8.74630	29.5	23.1	92.0	111.7	113.7	19.7	25	1,300	4.2	162	117	19	0.82	1,769
2044	2210	2	209	63	Auge	Tributary	Kwara	Pategi	5.69400	8.71840	31.1	24.3	90.0	111.0	113.0	21.0	29	1,400	4.1	114	112	13	0.53	1,777
2045	2211	2	209	63	Pategi	Tributary	Kwara	Pategi	5.72840	8.70640	18.1	14.2	93.0	111.1	113.1	18.1	24	1,300	2.8	88	101	9	0.63	1,766
2046	2212	2	203	43	Sunawa	Tributary	Kogi	Lokoja	6.38740	8.38880	14.0	10.9	92.0	107.5	109.5	15.5	21	2,000	2.9	84	232	20	1.78	1,745
2047	2213	2	201	37	Kakanda	Tributary	Kogi	Kabba/Bunu	6.40440	8.06380	7.3	5.7	291.0	320.5	322.5	29.5	37	700	0.6	54	282	15	2.65	1,554
2048	2214	2	20812	59	M. dutse	M. dutse	Katsina	Dandume	7.27660	11.31580	35.0	27.4	632.0	647.2	649.2	15.2	21	1,900	6.8	146	117	17	0.62	1,525
2049	2215	2	20812	59	Jusawo	Jusawo	Kaduna	Giwa	7.26540	11.27740	19.5	15.2	639.0	651.0	653.0	12.0	17	1,300	4.2	91	125	11	0.74	1,523
2050	2216	2	20812	59	Kalegi	Kalegi	Kaduna	Birnin Gwari	7.07120	11.15490	35.1	27.4	650.0	663.3	665.3	13.3	19	1,300	7.2	152	130	20	0.72	1,516
2051	2217	2	20812	59	Gazare	Gazare	Kaduna	Giwa	7.22345	11.08515	25.2	19.7	625.0	638.3	640.3	13.3	19	1,400	5.1	167	132	22	1.12	1,526
2052	2218	2	20812	59	Maraku	Maraku	Kaduna	Giwa	7.47777	11.16803	24.9	19.5	631.0	643.0	645.0	12.0	17	2,000	6.0	117	129	15	0.78	1,522
2053	2219	2	20815	62	Karami	Karami	Kaduna	Kuban	8.31377	10.68050	13.1	10.2	664.0	677.0	679.0	13.0	18	1,600	3.0	70	222	16	1.52	1,509
2054	2220	2	20815	62	Bishiwa	Bishiwa	Bauchi	Toro	8.83780	10.44050	13.5	10.5	801.0	817.2	819.2	16.2	22	1,600	2.1	108	296	32	3.04	1,452
2055	2221	2	20815	62	Gambo	Gambo	Plateau	Bassa	8.82810	10.31950	17.9	14.0	820.0	836.3	838.3	16.3	22	1,100	2.7	171	366	63	4.47	1,447
2056	2222	2	20815	62	Gora	Gora	Kaduna	Lere	8.54130	10.20530	18.0	14.1	762.0	775.0	777.0	13.0	18	1,500	4.3	86	277	24	1.69	1,466
2057	2223	2	20815	62	Gurza	Gurza	Kaduna	Lere	8.52858	10.08347	41.5	32.4	767.0	783.0	785.0	16.0	21	1,800	7.5	121	309	37	1.15	1,456
2058	2224	2	20815	62	Bakin kogi	Kaduna	Kaduna	Zangon Kataf	8.48300	9.87650	67.1	52.4	740.0	752.5	754.5	12.5	18	800	13.3	1,334	393	524	9.99	1,458
2059	2225	2	20815	62	Zonzon	Zonzon	Kaduna	Zangon Kataf	8.36370	9.83170	9.3	7.3	761.0	777.5	779.5	16.5	22	1,300	1.9	76	391	30	4.08	1,435
2060	2226	2	20815	62	Atom	Atom	Kaduna	Zangon Kataf	8.39400	9.79740	12.0	9.4	780.0	804.0	806.0	24.0	31	1,300	1.8	31	394	12	1.30	1,439
2061	2227	2	206	47	Gadoko	Gadoko	Niger	Bosso	6.43042	9.70282	7.2	5.6	270.0	283.4	285.4	13.4	19	1,400	1.5	25	218	5	0.97	1,725
2062	2228	2	206	47	Maidna	Maidna	Niger	Paikoro	6.53610	9.48420	11.0	8.6	201.0	218.0	220.0	17.0	22	1,000	2.6	82	214	18	2.05	1,761
2063	2229	2	206	47	Edndnade	Edndnade	Niger	Paikoro	6.62394	9.38962	10.7	8.3	260.0	275.0	277.0	15.0	20	1,600	2.5	45	223	10	1.20	1,721
2064	2230	2	206	47	Kondi	Kondi	Niger	Gbako	6.06370	9.35150	13.2	10.3	97.0	109.5	111.5	12.5	18	1,200	3.3	70	148	10	1.00	1,824
2065	2231	2	206	47	Noayma	Gudna	Niger	Paikoro	6.54240	9.33050	11.8	9.3	192.0	212.0	214.0	20.0	27	1,400	2.0	218	216	47	5.08	1,740
2066	2233	2	206	47	Mussa	Mussa	Niger	Bida	6.04710	9.09900	13.2	10.3	91.0	102.6	104.6	11.6	17	1,400	3.1	120	148	18	1.73	1,812
2067	2234	2	206	47	Emiziko	Tributary	Niger	Edati	6.06790	9.04330	3.2	2.5	86.0	95.4	97.4	9.4	15	600	1.0	35	142	5	2.00	1,809
2068	2235	2	206	47	Esama	Esama	Niger	Katcha	6.27610	9.06510	11.3	8.8	99.0	112.4	114.4	13.4	19	900	2.5	34	155	5	0.60	1,800
2069	2236	2	206	47	Bakoji	Bakoji	Niger	Katcha	6.18810	8.89470	48.7	38.1	70.0	81.6	83.6	11.6	17	1,200	10.4	839	156	131	3.43	1,810
2070	2237	2	206	47	Yewar	Tributary	Niger	Agaie	6.38420	8.96610	14.1	11.0	109.0	119.5	121.5	10.5	16	1,000	3.3	98	159	16	1.41	1,785
2071	2238	2	205	46	Anbero	Tributary	Niger	Katcha	6.26250	8.87330	14.7	11.5	76.0	90.4	92.4	14.4	20	1,000	2.9	88	149	13	1.15	1,801
2072	2239	2	203	43	Kateha	Tributary	Niger	Agaie	6.34990	8.82010	24.6	19.2	80.0	94.4	96.4	14.4	20	1,000	4.7	201	156	31	1.63	1,789
2073	2240	2	20803	51	Kanko	Kanko	Niger	Wushishi	6.02400	9.55400	23.5	18.4	94.0	110.2	112.2	16.2	22	1,900	5.0	76	168	13	0.69	1,830
2074	2241	2	203	43	Ebbo	Tributary	Niger	Lapai	6.60580	8.47700	21.0	16.4	78.0	96.2	98.2	18.2	24	900	3.1	70	235	16	1.00	1,757

Annex-T SR4-4 List of Potential Dam Sites (Proposed in M/P1995) (3/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
2075	2242	2	201	37	Ossen Seni	Tributary	Kogi	Kogi	6.80040	8.16350	13.9	10.9	70.0	89.2	91.2	19.2	25	800	1.9	79	205	16	1.49	1,658
2076	2243	2	201	37	Koten karifi	Oshere	Kogi	Kogi	6.82650	8.09090	35.1	27.4	71.0	93.9	95.9	22.9	30	400	3.9	137	235	32	1.18	1,677
2077	2244	2	203	43	Baro	Elu	Niger	Agaie	6.46700	8.58220	275.9	215.5	65.0	85.3	87.3	20.3	28	600	33.6	1,167	221	258	1.20	1,774
2078	2245	2	203	43	Nugmagi	Tributary	Niger	Lapai	6.57080	8.52120	23.3	18.2	87.0	99.4	101.4	12.4	18	800	4.3	63	228	14	0.79	1,755
2079	2246	2	20203	41	Takara	Tributary	Kaduna	Kagarko	7.76764	9.46786	35.3	27.6	597.0	617.3	619.3	20.3	28	1,000	5.9	190	533	101	3.67	1,501
2080	2247	2	20205	42	Kuda	Kuda	Kaduna	Kachia	8.04220	9.68660	27.3	21.4	707.0	720.4	722.4	13.4	19	1,100	6.1	137	475	65	3.04	1,453
2081	2248	2	20205	42	Marasa	Gurara	Kaduna	Zangon Kataf	8.14460	9.64760	26.8	20.9	728.0	741.0	743.0	13.0	18	1,400	6.9	98	507	50	2.37	1,444
2082	2249	2	20205	42	Chori	Chori	Kaduna	Kachia	8.03260	9.56330	39.3	30.7	712.0	725.3	727.3	13.3	19	1,100	7.5	132	506	67	2.17	1,453
2083	3101	3	318	103	Hona gombi	Dogaba	Adamawa	Song	13.02720	10.01980	64.0	50.0	447.0	465.1	467.1	18.1	24	2,000	11.4	935	149	139	2.78	1,611
2084	3102	3	318	103	Mubi	Pakka	Adamawa	Mubi South	13.20700	10.12700	14.9	11.7	578.0	605.1	607.1	27.1	35	1,100	1.9	63	154	10	0.83	1,538
2085	3103	3	318	103	Dumne Song	Baunra	Adamawa	Song	12.73490	9.97630	14.7	11.5	432.0	448.0	450.0	16.0	21	1,700	2.6	192	131	25	2.18	1,608
2086	3104	3	318	103	Dumne	Loko	Adamawa	Song	12.35920	9.86700	0.9	0.7	393.0	402.0	404.0	9.0	14	900	0.4	84	143	12	17.35	1,619
2087	3105	3	316	101	Kiri Ganye	Kinikoi	Adamawa	Fufore	12.21860	8.97200	12.0	9.4	268.0	285.0	287.0	17.0	22	1,800	2.2	85	151	13	1.37	1,724
2088	3106	3	316	101	Mukan	Mukan	Adamawa	Fufore	12.46234	8.78019	33.4	26.1	321.0	344.1	346.1	23.1	31	1,200	4.0	333	392	130	5.00	1,649
2089	3107	3	316	101	Mayo Ine	Mayo Ine	Adamawa	Fufore	12.23174	9.10342	72.6	56.7	204.0	213.3	215.3	9.3	15	2,600	17.1	4,658	259	1,206	21.26	1,740
2090	3109	3	31404	95	Askira Uba	Kwareta	Adamawa	Hong	13.04417	10.42932	12.4	9.7	475.0	485.5	487.5	10.5	16	1,300	3.3	205	126	26	2.67	1,554
2091	3110	3	312	91	Mayo Belwa	Belwa	Adamawa	Demsa	11.96748	9.35089	240.0	187.5	177.0	204.2	206.2	27.2	35	2,700	29.6	2,257	173	391	2.09	1,754
2092	3111	3	312	91	Monkin Zin	Monkin	Taraba	Zing	11.68930	8.84920	23.9	18.7	512.0	537.1	539.1	25.1	33	1,800	3.4	87	296	26	1.38	1,557
2093	3112	3	311	90	Bali	Lamurde	Taraba	Jalingo	11.39930	8.85050	72.2	56.4	199.0	220.1	222.1	21.1	29	2,700	10.4	494	308	152	2.70	1,728
2094	3113	3	311	90	Mutumbu	Pan Petel	Taraba	Ardo-Kola	11.14290	8.81210	52.9	41.3	157.0	178.2	180.2	21.2	29	1,700	8.3	250	151	38	0.91	1,740
2095	3114	3	30601	82	Tella	Taraba	Taraba	Gassol	10.51820	8.35490	367.2	286.9	118.0	130.0	132.0	12.0	17	4,900	78.7	21,313	437	9,305	32.44	1,751
2096	3115	3	30602	83	Sardauna	Kam	Taraba	Bali	10.85876	8.28950	74.2	58.0	163.0	171.7	173.7	8.7	14	1,700	17.2	3,555	340	1,208	20.83	1,720
2097	3116	3	30202	83	Suntai	Suntai	Taraba	Bali	10.37650	7.93160	47.3	36.9	126.0	132.7	134.7	6.7	12	1,400	15.4	3,995	603	2,407	65.18	1,721
2098	3201	3	318	103	Nguli	Nguli	Adamawa	Maiha	13.13380	10.07100	6.7	5.2	498.0	512.0	514.0	14.0	19	1,600	1.2	55	133	7	1.39	1,581
2099	3202	3	318	103	Nbumngo	Nbumngo	Adamawa	Song	13.04190	10.00470	18.6	14.6	460.0	478.1	480.1	18.1	24	2,200	3.5	109	149	16	1.11	1,609
2100	3203	3	318	103	Sensen	Sensen	Adamawa	Song	12.41350	9.89690	20.2	15.8	468.0	497.4	499.4	29.4	37	900	2.2	142	143	20	1.28	1,557
2101	3204	3	318	103	Song	Song	Adamawa	Song	12.60220	9.90300	3.1	2.4	377.0	393.0	395.0	16.0	21	700	0.8	272	128	35	14.47	1,642
2102	3205	3	315	100	Baunra	Baunra	Adamawa	Song	12.44510	9.63200	14.9	11.7	240.0	256.3	258.3	16.3	22	1,300	3.0	131	95	12	1.06	1,730
2103	3206	3	31404	95	M. Jamba	M. Jamba	Adamawa	Girie	12.59830	10.18350	15.5	12.1	444.0	461.4	463.4	17.4	23	1,300	3.1	201	138	28	2.29	1,582
2104	3207	3	31404	95	M. Gerewa	M. Gerewa	Adamawa	Girie	12.31480	10.14970	32.8	25.6	568.0	593.2	595.2	25.2	33	2,500	4.4	120	153	18	0.72	1,512
2105	3208	3	31404	95	M. Zangula	M. Zangula	Adamawa	Hong	12.74300	10.32610	23.1	18.0	446.0	462.3	464.3	16.3	22	1,700	4.2	214	127	27	1.50	1,568
2106	3209	3	31404	95	M. Faa	M. Faa	Adamawa	Hong	12.86290	10.32330	64.1	50.1	472.0	486.4	488.4	14.4	20	2,000	11.8	232	132	31	0.61	1,568
2107	3210	3	31404	95	Hawal D.D	Hawal	Borno	Hawul	12.24800	10.38680	117.7	92.0	246.0	265.2	267.2	19.2	25	1,100	12.9	9,635	97	937	10.20	1,630
2108	3211	3	31404	95	M. Leningo	M. Leningo	Adamawa	Shelleng	12.28510	10.26800	9.0	7.0	449.0	470.0	472.0	21.0	28	1,100	1.4	214	146	31	4.46	1,574
2109	3212	3	312	91	Zurhu	jenche	Adamawa	Demsa	11.93150	9.32760	31.5	24.6	193.0	213.0	215.0	20.0	27	1,700	5.6	183	123	22	0.91	1,743

Annex-T SR4-4 List of Potential Dam Sites (Proposed in M/P1995) (4/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
2110	3213	3	311	90	Danwoiba	Danwoiba	Taraba	Yorro	11.69420	9.08700	8.7	6.8	371.0	400.7	402.7	29.7	35	600	0.9	104	188	20	2.88	1,631
2111	3214	3	311	90	Kunini	Kunini	Taraba	Zing	11.60290	8.94240	2.8	2.2	357.0	386.6	388.6	29.6	35	400	0.5	281	253	71	32.96	1,617
2112	3215	3	304	80	Bado	Bado	Plateau	Wase	10.03140	8.68100	28.6	22.3	129.0	138.9	140.9	9.9	15	2,000	10.1	510	172	88	3.93	1,752
2113	3216	3	307	86	Loyerima	Loyerima	Taraba	Gassol	10.73720	8.59490	13.6	10.6	141.0	160.1	162.1	19.1	25	1,700	2.2	54	155	8	0.79	1,750
2114	3217	3	307	86	Dankuturu	Dankuturu	Taraba	Gassol	10.80430	8.61310	35.7	27.9	134.0	149.0	151.0	15.0	20	1,500	6.6	225	147	33	1.19	1,746
2115	3218	3	30203_i	78	Adashange	Adashange	Taraba	Wukari	9.97520	7.83000	19.6	15.3	122.0	136.3	138.3	14.3	20	2,000	4.2	74	378	28	1.83	1,700
2116	3219	3	30203_i	78	Mboosa	Mboosa	Taraba	Donga	9.86020	7.68130	16.5	12.9	154.0	168.5	170.5	14.5	20	1,200	3.2	60	417	25	1.94	1,676
2117	3220	3	30203_i	78	Goragh	Goragh	Taraba	Takum	9.89920	7.57740	22.4	17.5	161.0	176.2	178.2	15.2	21	1,300	4.6	81	443	36	2.05	1,672
2118	3221	3	30203_i	78	Adu	Adu	Taraba	Donga	10.06310	7.61120	70.9	55.4	130.0	149.0	151.0	19.0	25	2,000	11.0	331	487	161	2.91	1,701
2119	3222	3	30203_i	78	Tati	Tati	Taraba	Ussa	10.15630	7.26360	11.0	8.6	191.0	202.0	204.0	11.0	16	1,000	2.9	159	660	105	12.17	1,675
2120	3223	3	30203_i	78	Mala	Mala	Taraba	Kurmi	10.64870	7.24870	38.5	30.1	229.0	250.0	252.0	21.0	26	1,400	6.3	283	683	193	6.42	1,672
2121	4101	4	410	119	Shendam	Shendam	Plateau	Shendam	9.59920	8.87030	32.6	25.5	197.0	212.0	214.0	15.0	20	2,300	7.1	308	253	78	3.05	1,757
2122	4102	4	408	117	Dansak	Wujam	Plateau	Qua'an Pan	9.08318	8.96434	5.9	4.6	299.0	307.0	309.0	8.0	13	300	1.1	522	440	230	49.94	1,696
2123	4103	4	410	119	Baushe	Baushe	Plateau	Shendam	9.76313	8.83961	53.0	41.4	164.0	179.2	181.2	15.2	21	2,500	10.5	257	207	53	1.28	1,762
2124	4104	4	410	119	Shemankar	Shemankar	Plateau	Shendam	9.48694	8.73052	138.5	108.2	161.0	177.8	179.8	16.8	22	2,200	25.4	2,918	314	917	8.47	1,774
2125	4201	4	409	118	Ujany	Ujany	Benue	Ukum	9.67440	7.69880	15.5	12.1	148.0	160.0	162.0	12.0	17	2,000	3.4	37	258	10	0.79	1,683
2126	4202	4	409	118	Riti	Riti	Benue	Ukum	9.70500	7.65370	30.4	23.8	151.0	167.0	169.0	16.0	21	1,600	5.9	111	277	31	1.29	1,677
2127	4203	4	407	116	Uweyande	Uweyande	Benue	Logo	9.07860	7.79310	15.1	11.8	110.0	123.4	125.4	13.4	19	1,100	3.1	52	263	14	1.16	1,717
2128	4204	4	407	116	Fofi	Fofi	Benue	Logo	9.15540	7.77040	14.5	11.3	114.0	134.2	136.2	20.2	26	1,300	2.1	41	256	10	0.93	1,695
2129	4205	4	406_i	115	Ajiba	Rogo	Benue	Ukum	9.41690	7.62140	15.7	12.3	130.0	142.0	144.0	12.0	17	1,900	4.1	65	282	18	1.49	1,684
2130	4206	4	408	117	Karma(1)	Karma	Nasarawa	Wamba	8.65200	8.93850	18.4	14.4	355.0	378.1	380.1	23.1	29	1,000	2.1	162	554	90	6.24	1,656
2131	4207	4	408	117	Karma(2)	Karma	Nasarawa	Wamba	8.63340	8.90770	13.9	10.8	284.0	309.9	311.9	25.9	33	800	1.7	211	555	117	10.81	1,701
2132	4208	4	408	117	gudi	Gudi	Nasarawa	Wamba	8.55670	8.96440	22.7	17.7	378.0	400.0	402.0	22.0	29	1,300	3.9	122	564	69	3.88	1,637
2133	4209	4	408	117	Ukon	Ukon	Nasarawa	Wamba	8.57830	8.83280	13.7	10.7	233.0	255.2	257.2	22.2	30	1,000	2.1	56	552	31	2.88	1,724
2134	4210	4	408	117	Feteruwa	Feteruwa	Nasarawa	Nasarawa Egon	8.66920	8.68900	27.5	21.5	152.0	162.5	164.5	10.5	16	1,200	5.8	163	424	69	3.21	1,764
2135	4211	4	404	112	Ganye	Ganye	Nasarawa	Lafia	8.50490	8.59780	20.9	16.3	125.0	137.6	139.6	12.6	18	1,200	3.9	76	373	28	1.74	1,771
2136	4212	4	404	112	Katari	Katari	Nasarawa	Lafia	8.52220	8.58910	17.2	13.5	128.0	140.5	142.5	12.5	18	1,600	3.8	122	345	42	3.12	1,771
2137	4213	4	408	117	Tsorom	Akwenyi	Nasarawa	Lafia	8.89840	8.56840	17.6	13.7	126.0	137.0	139.0	11.0	16	1,700	6.6	408	333	136	9.91	1,777
2138	4214	4	407	116	Ovena	Ovena	Benue	Guma	8.86780	7.89410	12.3	9.6	96.0	109.5	111.5	13.5	19	1,600	2.8	42	295	12	1.29	1,716
2139	4215	4	407	116	Aneri	Aneri	Benue	Guma	8.89750	7.95370	14.2	11.1	95.0	101.4	103.4	6.4	12	600	4.7	505	278	140	12.64	1,726
2140	4216	4	406_i	115	Tsemngo	Katso	Benue	Guma	9.00670	7.69960	11.2	8.8	92.0	105.0	107.0	13.0	18	1,500	2.9	50	260	13	1.48	1,706
2141	4217	4	406_i	115	Vakugu	Vakugu	Benue	Logo	9.21430	7.67800	13.7	10.7	128.0	140.4	142.4	12.4	18	1,600	2.6	48	275	13	1.24	1,685
2142	4218	4	405	113	Kereke	Kereke	Benue	Markurdi	8.55234	7.87649	16.7	13.0	84.0	91.5	93.5	7.5	13	1,700	7.4	550	291	160	12.25	1,718
2143	4219	4	405	113	Baa	Baa	Benue	Markurdi	8.43640	7.82050	3.0	2.3	81.0	92.0	94.0	11.0	16	1,900	3.0	42	302	13	5.42	1,727
2144	4220	4	405	113	Ube	Tributary	Benue	Guma	8.76200	7.87420	11.9	9.3	99.0	107.0	109.0	8.0	13	700	3.3	51	297	15	1.63	1,717
2145	4221	4	407	116	Afiae	Afiae	Benue	Ukum	9.54100	7.67260	20.6	16.1	138.0	150.0	152.0	12.0	17	1,100	5.4	162	273	44	2.74	1,689

Annex-T SR4-4 List of Potential Dam Sites (Proposed in M/P1995) (5/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
2146	4222	4	406_i	115	Agbunko	Agbunko	Benue	Bukuru	9.15710	7.15580	12.3	9.6	132.0	149.2	151.2	17.2	23	1,100	2.3	49	989	48	5.02	1,666
2147	4223	4	406_i	115	Mnyande	Mnyande	Benue	Ushongo	9.08540	7.12010	9.6	7.5	146.0	159.0	161.0	13.0	18	1,400	2.6	53	1,035	55	7.34	1,666
2148	4224	4	406_i	115	Dula	Dula	Benue	Ushongo	9.19580	6.96200	19.9	15.6	158.0	172.6	174.6	14.6	20	1,000	4.6	154	1,150	177	11.36	1,657
2149	4225	4	406_i	115	Mishe	Mishe	Benue	Katsina-Ala	9.36380	7.20940	22.9	17.9	119.0	135.3	137.3	16.3	22	1,500	4.3	121	966	117	6.52	1,685
2150	4226	4	405	113	Uchi Mbako	Tributary	Benue	Tarka	8.80970	7.69850	12.2	9.5	100.0	113.4	115.4	13.4	19	1,300	2.6	48	245	12	1.24	1,700
2151	4227	4	406_i	115	Dzer	Tributary	Benue	Bukuru	8.94530	7.67240	10.3	8.1	93.0	104.4	106.4	11.4	17	1,700	2.6	43	280	12	1.49	1,710
2152	4228	4	406_i	115	Yelen(1)	Tributary	Benue	Bukuru	8.94350	7.59090	10.0	7.8	111.0	121.5	123.5	10.5	16	1,600	2.2	60	311	19	2.40	1,693
2153	4229	4	406_i	115	Yelen(2)	Tributary	Benue	Bukuru	8.96510	7.57210	30.7	24.0	95.0	115.3	117.3	20.3	28	2,000	5.0	89	323	29	1.20	1,697
2154	4230	4	406_i	115	Amber	Amber	Benue	Gboko	9.12280	7.39450	14.9	11.6	131.0	150.4	152.4	19.4	25	1,300	2.5	61	884	54	4.64	1,668
2155	4231	4	406_i	115	Ambighir	Ambighir	Benue	Gboko	9.11485	7.29335	46.8	36.6	126.0	144.3	146.3	18.3	24	1,900	7.4	222	941	209	5.71	1,672
2156	4232	4	406_i	115	Ukwye	Ukwye	Benue	Katsina-Ala	9.33410	7.43670	11.5	9.0	135.0	151.3	153.3	16.3	22	1,400	2.1	35	851	30	3.31	1,674
2157	4233	4	406_i	115	Daudu	Loko	Benue	Katsina-Ala	9.43490	7.36710	10.6	8.3	130.0	142.4	144.4	12.4	18	1,300	2.3	40	868	35	4.18	1,685
2158	4234	4	405	113	Kamken	Tributary	Benue	Gboko	8.75890	7.60770	13.8	10.8	103.0	115.0	117.0	12.0	17	900	3.0	72	295	21	1.97	1,692
2159	4235	4	405	113	Safuga	Tributary	Benue	Tarka	8.79750	7.51330	9.8	7.7	114.0	128.0	130.0	14.0	19	1,100	2.4	55	324	18	2.32	1,681
2160	4236	4	405	113	Kpawaju	kpawaju	Benue	Gwer West	8.31660	7.62470	8.1	6.3	82.0	90.0	92.0	8.0	13	1,400	3.7	193	276	53	8.41	1,704
2161	4237	4	405	113	Ogari(1)	Ogari	Benue	Oturkpo	8.13609	7.37177	15.9	12.4	151.0	161.0	163.0	10.0	15	1,600	5.1	297	370	110	8.86	1,650
2162	4238	4	405	113	Ogari(2)	Ogari	Benue	Gwer East	8.26170	7.39740	21.3	16.6	122.0	133.0	135.0	11.0	16	1,700	5.8	378	357	135	8.13	1,673
2163	4239	4	402	110	Takwa	Ahini	Nasarawa	Kokona	8.07720	8.67930	15.4	12.0	294.0	307.5	309.5	13.5	19	1,000	3.0	51	348	18	1.48	1,654
2164	4240	4	404	112	G. Shehu	Tributary	Nasarawa	Nasarawa	8.08570	8.52860	13.7	10.7	148.0	168.0	170.0	20.0	28	1,600	2.4	66	348	23	2.15	1,744
2165	4241	4	404	112	Leizi	Kojin,Doji	Nasarawa	Nasarawa Egon	8.35580	8.64820	24.0	18.8	118.0	132.5	134.5	14.5	20	1,100	4.2	237	434	103	5.48	1,768
2166	4243	4	404	112	Kyereku(1)	Kyereku	Nasarawa	Nasarawa	8.14620	8.24280	15.4	12.0	96.0	106.7	108.7	10.7	16	1,100	3.5	212	307	65	5.41	1,740
2167	4244	4	404	112	Kyereku(2)	Kyereku	Nasarawa	Nasarawa	8.11820	8.19730	21.5	16.8	84.0	99.0	101.0	15.0	20	1,200	4.7	169	293	49	2.94	1,740
2168	4245	4	405	113	Ushongu	Ushongu	Nasarawa	Keana	8.56660	8.15610	17.1	13.3	150.0	165.3	167.3	15.3	21	1,100	3.4	100	313	31	2.35	1,713
2169	4246	4	404	112	Kwagiri	Pynaha	Kaduna	Jema'a	8.18210	9.38560	43.5	34.0	482.0	494.0	496.0	12.0	17	1,400	8.7	138	502	69	2.04	1,576
2170	4247	4	404	112	Dongwa	Dongwa	Kaduna	Jema'a	8.27970	9.34790	23.2	18.1	476.0	498.3	500.3	22.3	30	1,200	3.1	78	534	42	2.29	1,573
2171	4248	4	404	112	Kormi	Sanga	Kaduna	Sanga	8.47700	9.29500	16.7	13.0	485.0	492.0	494.0	7.0	12	1,100	4.9	118	465	55	4.21	1,561
2172	4249	4	404	112	Sanga	Sanga	Kaduna	Jema'a	8.46420	9.36460	34.6	27.0	484.0	505.2	507.2	21.2	29	1,000	6.7	693	458	317	11.75	1,575
2173	5101	5	50403	125	Ghagede	Tributary	Kogi	Bassa	6.79100	7.70780	13.6	10.6	60.0	82.3	84.3	22.3	30	700	1.4	46	249	11	1.08	1,716
2174	5102	5	50403	125	Onado	Tributary	Kogi	Ajaokuta	6.65040	7.43430	33.5	26.2	85.0	109.0	111.0	24.0	31	600	4.6	153	230	35	1.35	1,661
2175	5103	5	50403	125	Obe	Obe	Edo	Etsako East	6.53730	7.07730	52.4	41.0	74.0	95.5	97.5	21.5	29	600	5.4	298	242	72	1.76	1,673
2176	5104	5	50403	125	Urhobo	Urhobo	Edo	Esan South-East	6.58010	6.53220	23.0	18.0	47.0	65.1	67.1	18.1	24	700	3.4	193	377	73	4.04	1,679
2177	5105	5	50402	124	Okupo	Okupo	Kogi	Igalamela-Odolu	7.10590	6.85210	17.7	13.9	81.0	103.9	105.9	22.9	30	900	2.4	101	285	29	2.08	1,673
2178	5106	5	50402	124	Nibo	Tshe	Enugu	Uzo-Uwani	7.16980	6.82250	57.7	45.1	153.0	179.2	181.2	26.2	34	1,000	5.9	153	409	63	1.39	1,615
2179	5107	5	50402	124	Oforochi	Tributary	Kogi	Igalamela-Odolu	6.89200	7.15540	20.1	15.7	72.0	90.0	92.0	18.0	24	600	2.9	1,071	256	274	17.47	1,695
2180	5108	5	50401	123	Atapo	Atapo	Delta	Oshimili North	6.64050	6.19310	22.9	17.9	60.0	83.0	85.0	23.0	30	1,000	2.5	93	565	53	2.94	1,670
2181	5110	5	50402	124	Umuleri	Tributary	Anambra	Oyi	6.91540	6.28470	10.1	7.9	50.0	61.6	63.6	11.6	17	300	2.4	51	537	27	3.46	1,705

Annex-T SR4-4 List of Potential Dam Sites (Proposed in M/P1995) (6/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
2182	5111	5	50402	124	Ukwa, Abwa	Tributary	Anambra	Anambra East	6.81410	6.23960	22.2	17.3	32.0	38.0	40.0	6.0	11	200	6.3	161	530	85	4.92	1,705
2183	5112	5	50402	124	Obibia	Obibia	Anambra	Awka South	7.08721	6.14008	10.4	8.1	87.0	111.0	113.0	24.0	32	900	1.3	21	546	11	1.41	1,690
2184	5113	5	50402	124	Ugbio	Ugbio	Anambra	Orumba North	7.11280	6.07920	10.4	8.2	90.0	110.4	112.4	20.4	28	400	1.6	33	622	21	2.52	1,655
2185	5114	5	50402	124	Oji	Oji	Enugu	Udi	7.30647	6.23571	16.9	13.2	104.0	118.7	120.7	14.7	20	300	2.6	219	622	136	10.35	1,629
2186	6101	6	604023_i	136	Igangan	Elu	Oyo	Ibarapa North	3.19130	7.69990	16.8	13.2	133.0	144.6	146.6	11.6	17	1,600	3.7	140	130	18	1.38	1,702
2187	6102	6	60403	137	Ilora	Itosi	Oyo	Afijio	3.76650	7.77510	16.5	12.9	187.0	201.3	203.3	14.3	20	900	3.5	89	151	13	1.04	1,648
2188	6103	6	60403	137	Ose	Ose	Oyo	Ido	3.73890	7.58660	30.2	23.6	173.0	193.3	195.3	20.3	28	1,100	4.5	311	180	56	2.38	1,646
2189	6104	6	606	140	Omi	Omi	Oyo	Ona ara	3.99470	7.28940	23.3	18.2	120.0	138.4	140.4	18.4	24	1,400	4.4	235	181	43	2.34	1,658
2190	6201	6	604023_i	136	Adeniji	Tributary	Oyo	Kajola	3.36590	7.86570	32.4	25.3	180.0	196.3	198.3	16.3	22	900	5.6	164	123	20	0.79	1,678
2191	6202	6	604023_i	136	Egbebi	Tributary	Oyo	Iseyin	3.42820	7.85420	15.4	12.0	187.0	201.5	203.5	14.5	20	800	3.1	176	147	26	2.15	1,664
2192	6203	6	60403	137	Washinmi	Opeki	Oyo	Iseyin	3.44690	7.79110	25.8	20.1	157.0	171.6	173.6	14.6	20	900	4.0	88	143	13	0.62	1,685
2193	6204	6	60403	137	Oko	Olopoto	Oyo	Ibarapa North	3.35460	7.56740	27.9	21.8	119.0	137.4	139.4	18.4	24	1,600	3.9	60	122	7	0.34	1,699
2194	6205	6	60403	137	Ohu	Olopoto	Oyo	Ibarapa East	3.39820	7.57970	42.7	33.4	110.0	125.4	127.4	15.4	21	1,200	9.3	457	132	60	1.81	1,704
2195	6206	6	60403	137	Eketa	Tributary	Oyo	Afijio	3.75130	7.84060	23.6	18.5	197.0	210.4	212.4	13.4	19	1,000	4.4	50	144	7	0.39	1,640
2196	6207	6	60403	137	Agida	Awon	Oyo	Oyo West	3.86020	7.91020	13.8	10.8	227.0	245.3	247.3	18.3	24	800	2.3	32	154	5	0.46	1,625
2197	6208	6	60403	137	Akinmorin	Tributary	Oyo	Afijio	3.92620	7.77420	14.8	11.6	265.0	281.2	283.2	16.2	22	900	3.1	50	175	9	0.75	1,588
2198	6209	6	60403	137	Aba	Ogun	Oyo	Ibarapa East	3.57150	7.69620	24.1	18.8	152.0	171.4	173.4	19.4	25	1,400	4.1	257	144	37	1.96	1,674
2199	6210	6	60403	137	Alapa	Ogun	Oyo	Ibarapa East	3.55380	7.65230	11.2	8.7	156.0	169.5	171.5	13.5	19	900	1.9	28	134	4	0.43	1,681
2200	6211	6	60403	137	Are Ago	Ogun	Oyo	Ibarapa East	3.52870	7.63140	12.3	9.6	149.0	166.2	168.2	17.2	23	1,300	2.8	33	129	4	0.44	1,677
2201	6212	6	60403	137	Elesin	Ayin	Oyo	Ibarapa Central	3.28790	7.33670	11.8	9.2	86.0	97.5	99.5	11.5	17	600	2.3	99	139	14	1.49	1,700
2202	6213	6	60403	137	Oyebode	Opeki	Oyo	Ibarapa Central	3.33750	7.49000	36.6	28.6	114.0	136.2	138.2	22.2	30	1,100	5.4	54	135	7	0.25	1,704
2203	6214	6	60403	137	Atopa	Atadi	Ogun	Odeda	3.47030	7.29280	14.5	11.3	92.0	108.5	110.5	16.5	22	900	2.4	61	190	12	1.02	1,698
2204	6215	6	60401	133	Cuta	Onigbongbo	Ogun	Abeokuta North	3.21780	7.07480	23.9	18.7	45.0	60.4	62.4	15.4	21	1,000	4.3	52	90	5	0.25	1,693
2205	6216	6	605	139	Ibu	Ibu	Ogun	Obafemi Owode	3.54170	7.06100	20.6	16.1	75.0	89.0	91.0	14.0	19	1,000	4.6	260	143	37	2.31	1,673
2206	6217	6	606	140	Olobi	Idero	Ogun	Obafemi Owode	3.63630	7.12910	14.7	11.5	99.0	114.0	116.0	15.0	20	1,200	3.0	67	173	12	1.01	1,676
2207	6218	6	606	140	Ojo	yesalu	Ogun	Obafemi Owode	3.67900	7.06610	15.2	11.9	86.0	102.0	104.0	16.0	21	900	2.7	43	232	10	0.84	1,688
2208	6219	6	606	140	Bale	Tributary	Ogun	Remo North	3.77480	7.01870	13.6	10.6	60.0	76.4	78.4	16.4	22	800	2.6	36	201	7	0.68	1,692
2209	6220	6	606	140	Opebi	Opebi	Oyo	Oluyole	3.92170	7.13910	21.5	16.8	90.0	109.0	111.0	19.0	24	600	3.0	64	192	12	0.73	1,672
2210	6221	6	608	142	Mobi	Oba	Oyo	Oyo East	4.06100	7.86540	14.9	11.6	256.0	272.3	274.3	16.3	22	900	2.8	62	255	16	1.36	1,610
2211	6222	6	608	142	Otamakun	Oba	Oyo	Ogo Oluwa	4.15510	7.95800	36.6	28.6	280.0	301.0	303.0	21.0	28	700	5.4	112	271	30	1.06	1,597
2212	6223	6	608	142	Ajekale	Oba	Oyo	Afijio	4.05020	7.81030	27.5	21.5	246.0	275.1	277.1	29.1	37	1,300	3.2	50	217	11	0.50	1,613
2213	6224	6	608	142	Ifeodan	Oba	Osun	Ejigbo	4.14900	7.82530	26.4	20.7	255.0	274.2	276.2	19.2	25	1,100	4.7	202	203	41	1.99	1,606
2214	6225	6	608	142	Ijimoba	Oshun	Osun	Ejigbo	4.30190	7.83080	11.6	9.1	309.0	322.4	324.4	13.4	19	1,200	2.4	46	214	10	1.08	1,595
2215	6226	6	608	142	Llobu	Oshun	Osun	Egbedore	4.36950	7.84510	21.1	16.5	314.0	328.0	330.0	14.0	19	800	3.7	132	224	30	1.80	1,586
2216	6227	6	608	142	Isaki Igbc	Eyinle	Osun	Egbedore	4.45110	7.79780	22.6	17.6	290.0	308.3	310.3	18.3	24	1,000	3.8	91	224	20	1.15	1,600
2217	6228	6	608	142	Edagun	Oshun	Oyo	Egbeda	4.09310	7.41420	12.5	9.8	168.0	179.0	181.0	11.0	16	1,200	3.4	31	185	6	0.58	1,651

Annex-T SR4-4 List of Potential Dam Sites (Proposed in M/P1995) (7/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
2218	6229	6	608	142	Adokanra	Oshun	Oyo	Egbeda	4.07860	7.33740	12.6	9.9	167.0	181.0	183.0	14.0	19	1,200	3.4	22	220	5	0.49	1,641
2219	6231	6	610	144	Oni	Oni	Osun	Oriade	4.83290	7.39900	28.9	22.6	240.0	256.3	258.3	16.3	22	600	6.1	270	244	66	2.92	1,597
2220	6232	6	610	144	Oke Awo	Oni	Ondo	Ile Oluji/Okeigbo	4.88870	7.26320	12.6	9.9	234.0	248.0	250.0	14.0	19	900	2.7	57	301	17	1.74	1,589
2221	6234	6	614	147	Bolorunduro	Ogbesse	Ondo	Akure North	5.24090	7.31990	12.2	9.5	334.0	347.0	349.0	13.0	18	1,200	3.1	52	299	16	1.64	1,518
2222	6235	6	612	146	Ofosun	Ofosun	Ondo	Idanre	5.22550	7.09550	17.2	13.4	254.0	275.0	277.0	21.0	28	600	3.3	122	333	41	3.02	1,546
2223	6236	6	614	147	Ala	Ala	Ondo	Akure North	5.36500	7.11950	16.5	12.9	261.0	272.0	274.0	11.0	16	900	2.5	278	282	78	6.08	1,546
2224	6237	6	614	147	Okhuo	Okhuo	Edo	Ovia North-East	5.58420	6.57400	9.6	7.5	27.0	48.5	50.5	21.5	29	500	1.6	189	529	100	13.34	1,602
2225	7101	7	704043	158	Okete	Okete	Benue	Ohimini	7.90750	7.23620	14.4	11.2	135.0	152.3	154.3	17.3	23	1,200	2.3	64	616	39	3.51	1,637
2226	7102	7	70402	154	Ajide-Eko	Eke	Benue	Ado	7.89850	6.59930	43.1	33.7	83.0	94.0	96.0	11.0	16	700	11.6	194	528	102	3.04	1,708
2227	7103	7	70402	154	Emezu	Ora	Ebonyi	Ishielu	7.73720	6.56950	8.0	6.3	92.0	101.0	103.0	9.0	14	3,500	3.6	532	561	298	47.58	1,685
2228	7201	7	704043	158	Panbele	Panbele	Benue	Gwer East	8.34650	7.18610	8.9	7.0	89.0	99.0	100.0	10.0	15	900	2.7	72	608	44	6.28	1,689
2229	7202	7	704043	158	Ombi	Ombi	Benue	Gwer East	8.39873	7.15094	24.1	18.8	86.0	99.6	101.6	13.6	19	1,000	5.9	217	624	135	7.19	1,694
2230	7203	7	704043	158	Ugboba	Ugboba	Benue	Obi	8.40120	7.06680	9.9	7.8	82.0	92.0	94.0	10.0	15	1,300	3.2	50	675	34	4.35	1,699
2231	7204	7	704043	158	Ogege	Ogege	Benue	Ado	8.14100	6.81820	12.6	9.9	56.0	64.3	66.3	8.3	14	1,400	3.9	198	704	139	14.11	1,726
2232	7205	7	704043	158	Adam East	Awn	Benue	Obi	8.31560	6.96850	16.1	12.6	71.0	85.3	87.3	14.3	20	1,700	4.2	27	716	19	1.54	1,705
2233	7206	7	704043	158	Ieheri	Ieheri	Ebonyi	Izzi	8.17480	6.67420	12.2	9.6	70.0	81.4	83.4	11.4	17	1,600	3.0	40	808	32	3.38	1,724
2234	7207	7	70403	155	Ogwuawu	Ogwuawu	Ebonyi	Ohaukwu	7.98360	6.56840	8.7	6.8	91.0	101.0	103.0	10.0	15	1,400	2.8	28	584	16	2.42	1,714
2235	7208	7	70403	155	Ogbogbo(1)	Ogbogbo	Ebonyi	Ohaukwu	8.07730	6.58190	13.2	10.3	79.0	88.0	90.0	9.0	14	1,600	4.1	58	547	32	3.08	1,724
2236	7209	7	70403	155	Ogbogbo(2)	Ogbogbo	Ebonyi	Ebonyi	8.11240	6.53630	14.3	11.2	66.0	77.0	79.0	11.0	16	2,600	4.5	53	553	29	2.63	1,740
2237	7210	7	704043	158	Abe	Abe	Cross River	Yala	8.39250	6.59300	13.0	10.2	46.0	53.5	55.5	7.5	13	500	4.2	72	845	61	5.99	1,737
2238	7211	7	704042	157	Gbumacha	Gbumacha	Benue	Gboko	8.71190	7.17620	11.8	9.2	94.0	102.0	104.0	8.0	13	1,200	3.7	108	614	66	7.22	1,686
2239	7212	7	704042	157	Uwebende	Uwebende	Benue	Gboko	8.77110	7.16060	47.2	36.9	94.0	108.0	110.0	14.0	19	1,000	10.2	133	617	82	2.23	1,690
2240	7213	7	704042	157	Konshisha	Konshisha	Benue	Ushongo	8.83460	7.16960	16.0	12.5	99.0	111.5	113.5	12.5	18	1,000	5.4	226	629	142	11.36	1,685
2241	7214	7	704042	157	Ukyoha	Ukyoha	Benue	Ushongo	8.90710	7.13730	12.8	10.0	110.0	124.0	126.0	14.0	19	1,100	3.7	152	688	105	10.42	1,677
2242	7215	7	704042	157	Kaakya	Kaakya	Benue	Ushongo	8.84660	7.08650	10.2	8.0	112.0	122.0	124.0	10.0	15	1,200	2.7	58	677	39	4.93	1,674
2243	7216	7	704042	157	Adum	Konshisha	Benue	Oju	8.58210	6.83370	10.9	8.5	71.0	82.0	84.0	11.0	16	1,900	3.0	31	751	23	2.72	1,700
2244	7217	7	704042	157	Moi	Moi	Cross River	Ogoja	8.73060	6.50230	2.8	2.2	65.0	72.6	74.6	7.6	13	500	0.9	106	1,074	114	52.02	1,698
2245	7218	7	704042	157	Monaya	Monaya	Cross River	Ogoja	8.81570	6.66430	5.4	4.3	61.0	65.4	67.4	4.4	10	500	3.1	163	901	147	34.52	1,683
2246	7219	7	70402	154	Akpoga	Aboine	Enugu	Udenu	7.66300	6.82410	12.8	10.0	173.0	183.5	185.5	10.5	16	700	2.4	98	519	51	5.10	1,627
2247	7220	7	70402	154	Ikem	Aboine	Enugu	Isi-Uzo	7.65570	6.79490	14.5	11.3	159.0	176.4	178.4	17.4	23	800	2.5	138	536	74	6.54	1,627
2248	7221	7	70402	154	Agala	Aboine	Benue	Ado	7.85320	6.64280	19.3	15.1	100.0	110.0	112.0	10.0	15	1,900	6.7	58	507	29	1.95	1,691
2249	7222	7	70402	154	Okpoto	Aboine	Ebonyi	Ishielu	7.86336	6.39918	11.3	8.9	75.0	84.0	86.0	9.0	14	1,700	3.1	50	615	31	3.47	1,720
2250	7223	7	70402	154	Ndeaboh	Asu	Enugu	Aninri	7.55490	6.02610	14.6	11.4	52.0	60.0	62.0	8.0	13	1,200	6.7	185	693	128	11.27	1,703
2251	7224	7	70402	154	Eneagu	Asu	Ebonyi	Onicha	7.79670	6.09720	8.8	6.9	60.0	67.0	69.0	7.0	12	800	2.8	32	678	22	3.15	1,716
2252	7225	7	70401	153	Ubei	Ukei	Ebonyi	Afikpo North	7.92930	5.81740	49.0	38.3	14.0	26.5	28.5	12.5	18	600	11.3	148	742	110	2.87	1,729

Annex-T SR4-5 List of Potential Dam Sites (Large Scale)

SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/ year)
30603_i	85	Baudeu	Taraba	Taraba	Gashaka	11.34250	7.84090	240.0	187.5	213.0	243.0	245.0	30.0	37	830	22.0	9,872	552	5,449	29.06	1,686
30603_i	85	Gashaka	Taraba	Taraba	Gashaka	11.47000	7.34390	380.0	296.9	345.0	390.0	395.0	45.0	60	650	21.0	555	696	386	1.30	1,607
30603_i	85	Kila	Taraba	Taraba	Gashaka	11.38060	7.37780	1,200.0	937.6	326.0	378.0	383.0	52.0	67	1,330	79.0	1,925	633	1,219	1.30	1,626
30603_i	85	Kogin Baba	Taraba	Adamawa	Teungo	11.51240	7.92410	443.0	346.1	260.0	300.0	305.0	40.0	55	1,060	32.4	1,771	438	776	2.24	1,623
30202	76	Kwossa	Suntai	Taraba	Donga	10.57550	7.54110	1,150.0	898.5	220.0	310.0	315.0	90.0	105	890+560	36.0	1,615	724	1,169	1.30	1,675
404	112	Okwaregi	Mada	Nasarawa	Nasarawa Egon	8.33330	8.82000	547.0	427.4	282.0	360.0	365.0	78.0	93	2,000	19.3	4,617	502	2,318	5.42	1,665
408	117	Wana	Ankwe	Nasarawa	Nasarawa Egon	8.50390	8.84940	223.0	174.2	238.0	278.0	283.0	40.0	55	1,720	12.1	1,264	546	690	3.96	1,706
20804	52	Bejagira	Kojin Maringo	Niger	Rafi	6.04940	10.44000	30.0	23.4	235.0	251.0	253.0	16.0	21	600	1.4	7,197	237	1,706	72.77	1,672
30603_i	85	Mamam	Taraba	Taraba	Gashaka	11.50440	7.61330	210.0	164.1	274.0	310.0	315.0	36.0	51	1,200	19.4	405	535	217	1.32	1,600
30603_i	85	Nyasikasi	Taraba	Taraba	Gashaka	11.62690	7.87030	1,200.0	937.6	265.0	325.0	330.0	60.0	75	1,200	69.5	2,173	563	1,223	1.30	1,657
402	110	Ragwa	Akini	Nasarawa	Nasarawa	7.59080	8.45940	115.0	89.9	148.0	178.0	180.0	30.0	37	830	12.5	6,869	382	2,623	29.18	1,698
318	103	Muleng	Kiriange	Adamawa	Song	12.75980	9.79870	112.8	88.2	242.0	276.0	278.0	34.0	41	1,520	8.5	2,425	139	338	3.83	1,693
214_i	68	Bad Es Sem	Moshi	Kwara	Kaiama	4.32490	9.34480	139.6	109.1	200.0	235.0	237.0	35.0	42	580	10.4	8,538	143	1,218	11.17	1,695
608	142	Odedele	Osun	Oyo	Ona ara	4.07960	7.19710	182.6	142.7	102.0	125.0	127.0	23.0	30	1,350	22.9	1,675	233	1,887	13.23	1,675
604023_i	136	Aiyete	Ofiki	Oyo	Ibarapa North	3.20320	7.54790	543.0	424.2	90.0	128.0	133.0	38.0	53	1,300	50.7	1,716	134	551	1.30	1,716
608	142	Oba	Oba	Osun	Iwo	4.12890	7.68600	197.0	153.9	217.0	234.0	236.0	17.0	22	1,600	32.0	1,629	204	424	2.76	1,629
608	142	Ijesha	Osun	Osun	Obokun	4.85430	7.79230	247.7	193.5	352.0	374.0	376.0	22.0	29	1,900	30.8	1,550	301	334	1.73	1,550
606	140	Ona	Ona	Ogun	Ijebu North	3.77490	6.93540	297.4	232.4	28.0	62.0	64.0	34.0	41	1,340	31.1	1,703	201	396	1.70	1,703

Annex-T SR4-6 List of Potential Dam Sites (Small to Medium Scale)

SN-Dam		HA	SHA	SN-SHA	Name	River	State	LGA	Lon	Lat	Gross Storage (MCM)	Active Storage (MCM)	Bottom EL (m)	Max WL (m)	Crest EL (m)	Water Depth (m)	Dam Height (m)	Dam Length (m)	Area (km2)	Total Drainage Area (km2)	Runoff Height (mm/y)	Inflow (MCM/y)	Turn Over Rate (-)	EP (mm/year)
4001		7	702	151	Obulo Eziama	tributary	Abia	Umu-Nneochi	7.30370	5.95610	18.3	14.3	147.0	167.1	169.1	20.1	28	700	3.3	93	862	80	5.61	1,624
4002		7	702	151	Owerri	tributary	Imo	Owerri North	7.11220	5.47950	3.9	3.0	84.0	94.5	96.5	10.5	16	500	1.2	230	962	221	72.58	1,605
4003		4	404	112	Kafanchan	tributary	Kaduna	Zangon Kataf	8.32770	9.62120	3.1	2.4	751.0	756.3	758.3	5.3	11	500	1.3	181	561	102	41.95	1,440
4004		2	20205	42	Kacha	tributary	Kaduna	Kachia	7.96740	9.88410	3.5	2.7	699.0	704.1	706.1	5.1	11	800	1.5	554	436	241	88.31	1,463
4005		4	404	112	Kumpa	tributary	Nasarawa	Akwanga	8.30180	8.94770	3.1	2.4	424.0	430.2	432.2	6.2	12	500	1.0	201	509	102	42.20	1,603
4006		6	602_i	131	Bale	Yewa	Ogun	Egbado North	2.94460	7.28530	82.6	64.5	61.0	77.7	79.7	16.7	22	1,200	12.7	833	94	78	1.21	1,719
4007		3	31409	99	Barakin	tributary	Plateau	Barkin Ladi	8.94040	9.61400	20.1	15.7	1,226.0	1,246.0	1,248.0	20.0	27	1,600	2.8	126	249	31	2.00	1,258
4008		1	106093	31	Sakin Noma	Sokoto	Zamfara	Gusau	6.71150	12.07630	29.7	23.2	444.0	458.9	460.9	14.9	20	800	5.6	2,252	182	409	17.63	1,642
4009		5	50402	124	Umuseke	tributary	Anambra	Orumba South	7.19050	6.02370	9.5	7.4	67.0	77.7	79.7	10.7	16	400	3.4	132	579	76	10.30	1,682
4010		5	506	126	Ihiala	tributary	Anambra	Ekwusigo	6.86770	5.91760	3.4	2.7	23.0	28.2	30.2	5.2	11	600	1.3	677	699	473	178.07	1,675
4011		5	506	126	Nnewi	tributary	Anambra	Idemili South	6.96320	6.10720	24.2	18.9	70.0	84.3	86.3	14.3	20	500	3.6	136	591	80	4.25	1,656
4012		7	702	151	Aba	tributary	Abia	Osisioma Ngwa	7.35150	5.15040	3.4	2.7	40.0	50.5	52.5	10.5	16	600	0.7	158	977	154	58.12	1,617
4013		8	80403_i	169	Mubi	Yedseram	Adamawa	Mubi South	13.30050	10.23140	6.0	4.7	615.0	631.4	633.4	16.4	22	600	0.9	130	74	10	2.05	1,511
4014		6	603	132	Ota	tributary	Ogun	Ado Odo/Ota	3.14530	6.71350	6.4	5.0	22.0	32.3	34.3	10.3	16	600	1.5	57	167	10	1.90	1,660
4015		7	702	151	Okigwe	tributary	Imo	Okigwe	7.26190	5.87590	9.2	7.2	109.0	113.3	115.3	4.3	10	400	4.3	222	852	189	26.32	1,649
4016		7	70402	154	Ezillo	tributary	Ebonyi	Ishielu	7.86440	6.45410	2.3	1.8	80.0	94.5	96.5	14.5	20	600	0.5	6	547	3	1.83	1,714
4017		2	20205	42	Kwoi	tributary	Kaduna	Kagarko	8.00560	9.53570	2.5	2.0	715.0	720.5	722.5	5.5	11	700	1.1	82	529	43	22.21	1,440
4018		6	606	140	Araromi Ake	tributary	Ogun	Ijebu North	3.80040	6.91350	3.3	2.6	23.0	29.1	35.2	10.2	12	400	1.5	1,997	201	401	155.68	1,709

Annex-T SR4-7 Evaluation of Potential Dam Sites (Proposed in M/P1995) (1/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
2001	1101	1	1060883	28	Karaduwa	Karaduwa	844,000	6,593	5,600	7,084	751	NA	NA	NA	NA	X				X	NS
2002	1102	1	106089	28	Kaya	Gagare	1,488,000	5,487	8,200	10,373	1,100	NA	NA	NA	NA		X				NS
2003	1201	1	10602	7	Ka	Ka	309,000	9,418	2,900	3,669	389	18,112	21,469	135.1	2.9					X	NS
2004	1202	1	105	5	K.Sakachi	K.Sakachi	557,000	7,761	4,300	5,440	577	215	2,681,301	1.8	319.5	X				X	NS
2005	1203	1	104	6	Kotsu	Kotsu	415,000	8,589	3,600	4,554	483	792	609,803	6.2	78.1						NS
2006	1204	1	104	6	Danzaki	Danzaki	324,000	9,285	3,000	3,795	402	5,186	77,562	42.5	9.5					X	NS
2007	1205	1	103	3	Wasa	Wasa	591,000	7,595	4,500	5,693	603	895	674,029	7.8	77.7	X					NS
2008	1206	1	103	3	Bakin Turu	Bakin Turu	287,000	9,626	2,800	3,542	375	160	2,350,929	1.3	283.7	X					NS
2009	1207	1	103	3	Kasanu	Kasanu	371,000	8,904	3,300	4,175	442	1,597	277,100	13.8	32.0						1,500
2010	1208	1	103	3	Bambiri	Bambiri	285,000	9,646	2,700	3,416	362	767	471,936	6.2	58.2						NS
2011	1209	1	101	1	Wata	Wata	588,000	7,609	4,500	5,693	603	4,584	131,623	40.1	15.0					X	NS
2012	1210	1	101	1	Utula	Utula	290,000	9,597	2,800	3,542	375	1,075	349,359	9.1	41.5						NS
2013	1211	1	101	1	Shafaci	Shafaci	788,000	6,786	5,300	6,705	711	1,302	545,969	11.4	62.5	X					NS
2014	2101	2	212	65	Jokoro	Molu	904,000	6,400	5,800	7,337	778	598	1,300,504	5.1	152.6						NS
2015	2102	2	212	65	Ajelanwa	Weru	728,000	7,008	5,100	6,452	684	3,238	211,198	25.7	26.6					X	NS
2016	2103	2	212	65	Yanku	Weru	683,000	7,188	4,900	6,199	657	1,671	393,285	13.5	48.7	X					NS
2017	2104	2	212	65	Ala	Ohan	683,000	7,188	4,900	6,199	657	2,032	323,408	15.7	41.7	X					NS
2018	2105	2	212	65	Shao	Busamu	319,000	9,329	3,000	3,795	402	1,049	383,635	9.1	44.4	X					NS
2019	2106	2	212	65	Oloye	Weru	471,000	8,233	3,900	4,934	523	502	1,040,817	3.8	138.1	X					NS
2020	2107	2	212	65	Mogaji	Moro	629,000	7,419	4,700	5,946	630	1,922	327,833	14.3	44.0	X					NS
2021	2108	2	212	65	Okanle	Oyun	426,000	8,515	3,600	4,554	483	1,049	460,361	8.7	55.5						NS
2022	2111	2	212	65	Okeoyi	Awun	814,000	6,694	5,400	6,831	724	524	1,381,084	4.5	162.4	X					NS
2023	2112	2	212	65	Faloku	Oyun	435,000	8,457	3,700	4,681	496	NA	NA	NA	NA	X			X		NS
2024	2114	2	20814	61	Galma(2)	Shica	1,039,000	6,008	6,200	7,843	831	3,511	236,787	29.3	28.4	X				X	NS
2025	2115	2	20814	61	Galma(3)	Likarbu	1,046,000	5,989	6,300	7,970	845	3,988	211,840	44.1	19.1					X	NS
2026	2116	2	206	47	Essan	Lawi	438,000	8,437	3,700	4,681	496	2,591	191,449	20.7	24.0				(Minna)		NS
2027	2117	2	206	47	Eniko	Eniko	660,000	7,284	4,800	6,072	644	1,272	506,002	10.1	63.8						NS
2028	2118	2	206	47	Agaie	Bakogi	514,000	7,987	4,100	5,187	550	2,609	210,723	21.1	26.1			X			NS
2029	2119	2	206	47	Tungawain	Wayin	1,482,000	5,491	8,100	10,247	1,086	2,008	540,884	15.7	69.0						NS
2030	2120	2	20805	53	Sanakpan	Bako	614,000	7,487	4,600	5,819	617	1,694	364,063	13.5	45.8						NS
2031	2121	2	206	47	Jariga	Jatau	1,083,000	5,892	6,400	8,096	858	519	1,652,331	5.9	145.6						NS
2032	2122	2	206	47	Yankpako	Chanchaga	1,989,000	5,262	10,500	13,283	1,408	12,941	108,793	119.0	11.8					X	NS
2033	2124	2	206	47	Nabi	Gora	773,000	6,840	5,300	6,705	711	2,324	305,851	21.1	33.7						NS
2034	2125	2	206	47	Faka	Kemi	253,000	9,981	2,500	3,163	335	2,068	162,063	15.7	21.3						Small
2035	2201	2	209	63	Igporin	Oshin	736,000	6,978	5,100	6,452	684	1,070	638,869	10.2	67.3						NS
2036	2202	2	209	63	Elebu	Oshin	1,234,000	5,525	6,800	8,602	912	1,150	792,703	10.5	87.1	X					NS
2037	2203	2	209	63	Lasaki	Oshin	591,000	7,595	4,500	5,693	603	524	1,150,904	4.5	133.9	X					NS

Note: NS=Not Studied

Annex-T SR4-7 Evaluation of Potential Dam Sites (Proposed in M/P1995) (2/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
2038	2204	2	209	63	Okunrun	Okunrun	259,000	9,915	2,600	3,289	349	300	1,161,451	2.6	135.7	X					NS
2039	2205	2	20804	52	Ukusu	Ukusu	266,000	9,840	2,600	3,289	349	1,446	241,027	16.4	21.3						3,000
2040	2206	2	20804	52	K. Chaaruma	K. Chaaruma	398,000	8,706	3,500	4,428	469	663	708,080	7.6	61.7						NS
2041	2207	2	20804	52	Kombou	Kombou	557,000	7,761	4,300	5,440	577	1,142	504,743	13.6	42.3						NS
2042	2208	2	20801	49	Kaduna	Kaduna	682,000	7,192	4,900	6,199	657	NA	NA	NA	NA						Small
2043	2209	2	209	63	Lade	Tributary	846,000	6,586	5,600	7,084	751	1,208	621,425	10.5	71.7	X		X			NS
2044	2210	2	209	63	Auge	Tributary	1,173,000	5,667	6,600	8,349	885	868	1,019,852	8.1	108.7	X					NS
2045	2211	2	209	63	Pategi	Tributary	790,000	6,779	5,400	6,831	724	584	1,239,194	5.2	138.0	X					NS
2046	2212	2	203	43	Sunawa	Tributary	924,000	6,338	5,900	7,464	791	982	805,633	9.2	86.4						NS
2047	2213	2	201	37	Kakanda	Tributary	959,000	6,234	6,000	7,590	805	649	1,239,043	6.4	126.1						NS
2048	2214	2	20812	59	M. dutse	M. dutse	882,000	6,469	5,700	7,211	764	1,057	723,166	9.8	78.2	X					NS
2049	2215	2	20812	59	Jusawo	Jusawo	454,000	8,336	3,800	4,807	510	689	739,470	6.3	81.2	X					NS
2050	2216	2	20812	59	Kalegi	Kalegi	539,000	7,854	4,200	5,313	563	1,221	461,274	11.2	50.1	X					NS
2051	2217	2	20812	59	Gazare	Gazare	573,000	7,682	4,400	5,566	590	1,214	485,964	11.4	51.9						NS
2052	2218	2	20812	59	Maraku	Maraku	649,000	7,331	4,800	6,072	644	901	714,513	8.3	77.6	X					NS
2053	2219	2	20815	62	Karami	Karami	588,000	7,609	4,500	5,693	603	752	802,874	7.1	84.5						NS
2054	2220	2	20815	62	Bishiwa	Bishiwa	819,000	6,677	5,500	6,958	737	1,157	637,666	14.1	52.3						NS
2055	2221	2	20815	62	Gambo	Gambo	592,000	7,590	4,500	5,693	603	1,735	347,879	21.4	28.2						NS
2056	2222	2	20815	62	Gora	Gora	557,000	7,761	4,300	5,440	577	1,314	438,826	13.1	43.9						NS
2057	2223	2	20815	62	Gurza	Gurza	840,000	6,606	5,500	6,958	737	2,306	319,803	21.6	34.1						NS
2058	2224	2	20815	62	Bakin kogi	Kaduna	340,000	9,149	3,100	3,922	416	7,295	56,983	88.8	4.7					X	NS
2059	2225	2	20815	62	Zonzon	Zonzon	683,000	7,188	4,900	6,199	657	867	757,602	10.6	61.7						NS
2060	2226	2	20815	62	Atom	Atom	1,234,000	5,525	6,800	8,602	912	756	1,206,556	7.1	127.9						NS
2061	2227	2	206	47	Gadoko	Gadoko	573,000	7,682	4,400	5,566	590	339	1,740,966	2.8	210.9						NS
2062	2228	2	206	47	Maidna	Maidna	546,000	7,817	4,300	5,440	577	822	701,586	6.7	85.6						NS
2063	2229	2	206	47	Edndnade	Edndnade	698,000	7,127	5,000	6,325	670	592	1,133,328	4.9	136.4						NS
2064	2230	2	206	47	Kondi	Kondi	464,000	8,275	3,800	4,807	510	604	844,002	5.1	100.1						NS
2065	2231	2	206	47	Noayma	Gudna	1,034,000	6,022	6,200	7,843	831	1,093	760,784	10.6	78.4						NS
2066	2233	2	206	47	Mussa	Mussa	482,000	8,168	3,900	4,934	523	925	565,328	6.9	76.3			X			NS
2067	2234	2	206	47	Emiziko	Tributary	224,000	10,323	2,300	2,910	308	229	1,349,400	1.7	178.5				X		NS
2068	2235	2	206	47	Esama	Esama	401,000	8,685	3,500	4,428	469	292	1,608,852	2.7	175.5	X					NS
2069	2236	2	206	47	Bakoji	Bakoji	426,000	8,515	3,600	4,554	483	2,097	230,181	17.8	27.2			X			NS
2070	2237	2	206	47	Yewar	Tributary	340,000	9,149	3,100	3,922	416	829	501,676	6.8	61.3						NS
2071	2238	2	205	46	Anbero	Tributary	471,000	8,233	3,900	4,934	523	655	798,728	6.0	86.9						NS
2072	2239	2	203	43	Kateha	Tributary	471,000	8,233	3,900	4,934	523	1,673	312,563	15.4	34.0						NS
2073	2240	2	20803	51	Kanko	Kanko	955,000	6,245	6,000	7,590	805	752	1,069,703	6.7	120.7	X					NS
2074	2241	2	203	43	Ebbo	Tributary	575,000	7,672	4,400	5,566	590	1,022	577,091	9.0	65.6					X	NS

Note: NS=Not Studied

Annex-T SR4-7 Evaluation of Potential Dam Sites (Proposed in M/P1995) (3/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
2075	2242	2	201	37	Ossen Seni	Tributary	556,000	7,766	4,300	5,440	577	859	671,488	8.4	68.5						NS
2076	2243	2	201	37	Koten karifi	Oshere	422,000	8,542	3,600	4,554	483	1,938	249,048	16.9	28.6						1,000
2077	2244	2	203	43	Baro	Elu	525,000	7,928	4,200	5,313	563	15,676	35,926	143.1	3.9						Small
2078	2245	2	203	43	Nugmagi	Tributary	340,000	9,149	3,100	3,922	416	875	475,250	7.4	55.8	X					NS
2079	2246	2	20203	41	Takara	Tributary	814,000	6,694	5,400	6,831	724	3,985	181,722	40.1	18.0						Small
2080	2247	2	20205	42	Kuda	Kuda	470,000	8,239	3,900	4,934	523	2,264	231,030	22.1	23.6						Small
2081	2248	2	20205	42	Marasa	Gurara	526,000	7,922	4,200	5,313	563	2,468	228,193	24.0	23.4						Small
2082	2249	2	20205	42	Chori	Chori	470,000	8,239	3,900	4,934	523	3,613	144,743	34.2	15.3				X		Small
2083	3101	3	318	103	Hona gombi	Dogaba	1,165,000	5,686	6,600	8,349	885	4,563	193,930	31.9	27.7						Small
2084	3102	3	318	103	Mubi	Pakka	1,315,000	5,584	7,300	9,235	979	579	1,690,887	4.6	214.9	X					NS
2085	3103	3	318	103	Dumne Song	Baunra	799,000	6,747	5,400	6,831	724	1,057	685,146	8.1	89.5						NS
2086	3104	3	318	103	Dumne	Loko	266,000	9,840	2,600	3,289	349	109	3,208,218	1.1	326.6						NS
2087	3105	3	316	101	Kiri Ganye	Kinikoi	910,000	6,381	5,800	7,337	778	746	1,042,832	7.0	111.0						NS
2088	3106	3	316	101	Mukan	Mukan	1,146,000	5,733	6,600	8,349	885	3,605	245,506	41.8	21.2						Small
2089	3107	3	316	101	Mayo Ine	Mayo Ine	664,000	7,267	4,800	6,072	644	8,800	73,140	100.4	6.4						30,000
2090	3109	3	31404	95	Askira Uba	Kwareta	415,000	8,589	3,600	4,554	483	646	746,853	5.5	88.3						NS
2091	3110	3	312	91	Mayo Belwa	Belwa	3,094,000	4,918	15,200	19,228	2,038	17,520	116,334	168.3	12.1						18,000
2092	3111	3	312	91	Monkin Zin	Monkin	1,877,000	5,307	10,000	12,650	1,341	1,401	956,882	13.7	98.1						NS
2093	3112	3	311	90	Bali	Lamurde	2,178,000	5,191	11,300	14,295	1,515	5,866	258,311	64.7	23.4				(Jalingo)		NS
2094	3113	3	311	90	Mutumbu	Pan Petel	1,405,000	5,532	7,800	9,867	1,046	2,405	434,921	22.9	45.7	X					NS
2095	3114	3	30601	82	Tella	Taraba	1,457,000	5,504	8,000	10,120	1,073	NA	NA	NA	NA						Small
2096	3115	3	30602	83	Sardauna	Kam	421,000	8,549	3,600	4,554	483	9,681	49,863	111.6	4.3					X	NS
2097	3116	3	30202	83	Suntai	Suntai	295,000	9,549	2,800	3,542	375	8,028	46,765	86.7	4.3					X	NS
2098	3201	3	318	103	Nguli	Nguli	642,000	7,362	4,700	5,946	630	355	1,774,865	2.7	233.0						NS
2099	3202	3	318	103	Nbumngo	Nbumngo	1,273,000	5,437	6,900	8,729	925	819	1,129,595	6.0	154.4						NS
2100	3203	3	318	103	Sensen	Sensen	1,206,000	5,589	6,700	8,476	898	1,082	830,646	8.5	105.2						NS
2101	3204	3	318	103	Song	Song	383,000	8,815	3,400	4,301	456	382	1,193,928	3.6	128.3						NS
2102	3205	3	315	100	Baunra	Baunra	683,000	7,188	4,900	6,199	657	635	1,034,392	5.1	130.0					X	NS
2103	3206	3	31404	95	M. Jamba	M. Jamba	735,000	6,982	5,100	6,452	684	771	887,451	6.4	107.5						NS
2104	3207	3	31404	95	M. Gerewa	M. Gerewa	2,572,000	5,062	13,000	16,445	1,743	990	1,760,206	7.6	228.2	X					NS
2105	3208	3	31404	95	M. Zangula	M. Zangula	864,000	6,527	5,600	7,084	751	990	758,242	7.1	105.8						NS
2106	3209	3	31404	95	M. Faa	M. Faa	850,000	6,573	5,600	7,084	751	1,440	521,471	10.8	69.8	X					NS
2107	3210	3	31404	95	Hawal D.D	Hawal	730,000	7,001	5,100	6,452	684	8,906	76,787	99.0	6.9					X	NS
2108	3211	3	31404	95	M. Leningo	M. Leningo	886,000	6,456	5,700	7,211	764	430	1,777,819	3.4	225.9						NS
2109	3212	3	312	91	Zurhu	jenche	1,236,000	5,520	6,800	8,602	912	1,354	673,217	12.4	73.3	X					NS

Note: NS=Not Studied

Annex-T SR4-7 Evaluation of Potential Dam Sites (Proposed in M/P1995) (4/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
2110	3213	3	311	90	Danwoiba	Danwoiba	759,000	6,891	5,200	6,578	697	739	944,053	8.3	84.4						NS
2111	3214	3	311	90	Kunini	Kunini	536,000	7,869	4,200	5,313	563	449	1,253,206	4.7	120.3						NS
2112	3215	3	304	80	Bado	Bado	532,000	7,890	4,200	5,313	563	2,293	245,620	25.8	21.9						7,000
2113	3216	3	307	86	Loyerima	Loyerima	1,079,000	5,902	6,400	8,096	858	545	1,573,885	5.0	172.9	X					NS
2114	3217	3	307	86	Dankuturu	Dankuturu	660,000	7,284	4,800	6,072	644	1,942	331,460	17.3	37.1						NS
2115	3218	3	30203_i	78	Adashange	Adashange	850,000	6,573	5,600	7,084	751	1,692	443,748	17.1	44.0						NS
2116	3219	3	30203_i	78	Mboosa	Mboosa	546,000	7,817	4,300	5,440	577	1,473	391,335	15.1	38.1						NS
2117	3220	3	30203_i	78	Goragh	Goragh	632,000	7,406	4,700	5,946	630	2,024	311,411	21.2	29.7					X	NS
2118	3221	3	30203_i	78	Adu	Adu	1,253,000	5,482	6,900	8,729	925	7,342	126,024	87.8	10.5						Small
2119	3222	3	30203_i	78	Tati	Tati	340,000	9,149	3,100	3,922	416	1,776	234,103	22.7	18.3						Small
2120	3223	3	30203_i	78	Mala	Mala	968,000	6,207	6,000	7,590	805	5,218	154,181	64.2	12.5						Small
2121	4101	4	410	119	Shendam	Shendam	963,000	6,222	6,000	7,590	805	3,085	260,761	31.9	25.2						4,000
2122	4102	4	408	117	Dansak	Wujam	142,000	11,605	1,600	2,024	215	1,484	144,581	14.3	15.0						Small
2123	4103	4	410	119	Baushe	Baushe	1,132,000	5,767	6,500	8,223	872	3,551	245,482	29.2	29.9						14,000
2124	4104	4	410	119	Shemankar	Shemankar	1,092,000	5,868	6,400	8,096	858	15,833	54,200	168.3	5.1						20,000
2125	4201	4	409	118	Ujany	Ujany	649,000	7,331	4,800	6,072	644	687	936,596	5.6	114.4	X					NS
2126	4202	4	409	118	Riti	Riti	757,000	6,899	5,200	6,578	697	1,909	365,345	15.6	44.7						NS
2127	4203	4	407	116	Uweyande	Uweyande	470,000	8,239	3,900	4,934	523	911	574,176	7.5	70.0						NS
2128	4204	4	407	116	Fofi	Fofi	906,000	6,393	5,800	7,337	778	797	975,627	6.6	117.9	X					NS
2129	4205	4	406_i	115	Ajiba	Rogo	621,000	7,455	4,600	5,819	617	1,386	444,963	12.0	51.4						NS
2130	4206	4	408	117	Karma(1)	Karma	864,000	6,527	5,600	7,084	751	2,318	323,998	25.4	29.6						NS
2131	4207	4	408	117	Karma(2)	Karma	885,000	6,459	5,700	7,211	764	1,346	567,947	14.3	53.5						NS
2132	4208	4	408	117	gudi	Gudi	1,096,000	5,858	6,400	8,096	858	2,449	350,457	26.4	32.5						NS
2133	4209	4	408	117	Ukon	Ukon	917,000	6,359	5,800	7,337	778	1,352	575,142	14.6	53.3						NS
2134	4210	4	408	117	Feteruwa	Feteruwa	390,000	8,764	3,400	4,301	456	2,702	168,726	29.2	15.6						Small
2135	4211	4	404	112	Ganye	Ganye	464,000	8,275	3,800	4,807	510	1,873	271,980	15.8	32.2						Small
2136	4212	4	404	112	Katari	Katari	588,000	7,609	4,500	5,693	603	1,907	316,390	19.8	30.5						NS
2137	4213	4	408	117	Tsorom	Akwenyi	514,000	7,987	4,100	5,187	550	2,181	252,117	23.6	23.3					X	NS
2138	4214	4	407	116	Ovena	Ovena	642,000	7,362	4,700	5,946	630	766	822,355	6.4	98.0						NS
2139	4215	4	407	116	Aneri	Aneri	179,000	10,953	2,000	2,530	268	1,887	142,087	22.1	12.1						1,500
2140	4216	4	406_i	115	Tsemngo	Katso	557,000	7,761	4,300	5,440	577	982	587,393	8.5	67.7						NS
2141	4217	4	406_i	115	Vakugu	Vakugu	588,000	7,609	4,500	5,693	603	1,092	552,560	9.3	65.1						NS
2142	4218	4	405	113	Kereke	Kereke	378,000	8,851	3,300	4,175	442	2,431	181,994	27.0	16.4						2,000
2143	4219	4	405	113	Baa	Baa	564,000	7,726	4,400	5,566	590	221	2,671,249	2.4	243.9						NS
2144	4220	4	405	113	Ube	Tributary	210,000	10,504	2,200	2,783	295	867	340,108	7.0	42.0						NS
2145	4221	4	407	116	Afiae	Afiae	398,000	8,706	3,500	4,428	469	1,843	254,654	17.1	27.5					X	NS

Note: NS=Not Studied

Annex-T SR4-7 Evaluation of Potential Dam Sites (Proposed in M/P1995) (5/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
2146	4222	4	406_i	115	Agbunko	Agbunko	636,000	7,388	4,700	5,946	630	1,533	411,022	18.7	33.6						NS
2147	4223	4	406_i	115	Mnyande	Mnyande	526,000	7,922	4,200	5,313	563	1,232	457,097	15.8	35.8						NS
2148	4224	4	406_i	115	Dula	Dula	471,000	8,233	3,900	4,934	523	2,980	175,470	38.9	13.4						2,000
2149	4225	4	406_i	115	Mishe	Mishe	773,000	6,840	5,300	6,705	711	2,977	238,739	37.8	18.8						Small
2150	4226	4	405	113	Uchi Mbako	Tributary	539,000	7,854	4,200	5,313	563	766	735,623	6.4	88.2						NS
2151	4227	4	406_i	115	Dzer	Tributary	565,000	7,721	4,400	5,566	590	909	648,768	7.9	74.3						NS
2152	4228	4	406_i	115	Yelen(1)	Tributary	489,000	8,127	4,000	5,060	536	1,014	528,724	9.6	55.8						NS
2153	4229	4	406_i	115	Yelen(2)	Tributary	1,536,000	5,463	8,400	10,626	1,126	2,446	460,525	20.3	55.5						NS
2154	4230	4	406_i	115	Amber	Amber	846,000	6,586	5,600	7,084	751	1,819	412,859	22.5	33.4						NS
2155	4231	4	406_i	115	Ambighir	Ambighir	1,112,000	5,817	6,500	8,223	872	6,077	143,429	74.3	11.7						Small
2156	4232	4	406_i	115	Ukwye	Ukwye	728,000	7,008	5,100	6,452	684	1,340	510,262	15.8	43.4						NS
2157	4233	4	406_i	115	Daudu	Loko	495,000	8,093	4,000	5,060	536	1,252	428,492	15.1	35.4						NS
2158	4234	4	405	113	Kamken	Tributary	342,000	9,133	3,100	3,922	416	1,146	362,702	9.5	43.8						NS
2159	4235	4	405	113	Safuga	Tributary	470,000	8,239	3,900	4,934	523	880	594,417	7.4	70.8						NS
2160	4236	4	405	113	Kpawaju	kpawaju	328,000	9,250	3,000	3,795	402	1,016	396,010	11.6	34.6						NS
2161	4237	4	405	113	Ogari(1)	Ogari	444,000	8,399	3,700	4,681	496	2,167	228,910	25.6	19.4					X	NS
2162	4238	4	405	113	Ogari(2)	Ogari	514,000	7,987	4,100	5,187	550	1,887	291,278	15.1	36.4						Small
2163	4239	4	402	110	Takwa	Ahini	435,000	8,457	3,700	4,681	496	1,208	410,551	9.3	53.2						NS
2164	4240	4	404	112	G. Shehu	Tributary	1,247,000	5,495	6,900	8,729	925	1,335	693,289	12.4	74.5						NS
2165	4241	4	404	112	Leizi	Kojin,Doji	509,000	8,015	4,100	5,187	550	3,369	163,206	36.0	15.3						Small
2166	4243	4	404	112	Kyereku(1)	Kyereku	365,000	8,950	3,300	4,175	442	2,099	210,799	22.4	19.7						Small
2167	4244	4	404	112	Kyereku(2)	Kyereku	546,000	7,817	4,300	5,440	577	2,332	247,245	24.1	23.9						2,000
2168	4245	4	405	113	Ushongu	Ushongu	549,000	7,802	4,300	5,440	577	1,603	359,653	13.3	43.5						NS
2169	4246	4	404	112	Kwagiri	Pynaha	482,000	8,168	3,900	4,934	523	4,157	125,804	37.8	13.8						Small
2170	4247	4	404	112	Dongwa	Dongwa	1,082,000	5,894	6,400	8,096	858	2,427	353,603	22.8	37.7						NS
2171	4248	4	404	112	Kormi	Sanga	252,000	9,992	2,500	3,163	335	2,037	164,541	21.9	15.3						Small
2172	4249	4	404	112	Sanga	Sanga	864,000	6,527	5,600	7,084	751	5,507	136,345	58.7	12.8						Small
2173	5101	5	50403	125	Ghagede	Tributary	669,000	7,246	4,800	6,072	644	768	837,655	5.4	120.1						NS
2174	5102	5	50403	125	Onado	Tributary	619,000	7,465	4,600	5,819	617	2,133	289,134	14.8	41.7					X	NS
2175	5103	5	50403	125	Obe	Obe	555,000	7,771	4,300	5,440	577	4,001	144,099	29.0	19.9						5,000
2176	5104	5	50403	125	Urhobo	Urhobo	467,000	8,257	3,900	4,934	523	2,325	224,961	27.1	19.3						1,000
2177	5105	5	50402	124	Okupo	Okupo	834,000	6,626	5,500	6,958	737	1,248	591,040	11.9	62.2						NS
2178	5106	5	50402	124	Nibo	Tshe	1,143,000	5,740	6,600	8,349	885	3,932	225,066	33.4	26.5					X	NS
2179	5107	5	50402	124	Oforochi	Tributary	414,000	8,596	3,600	4,554	483	2,374	203,322	25.9	18.6						1,500
2180	5108	5	50401	123	Atapo	Atapo	917,000	6,359	5,800	7,337	778	2,460	316,168	27.9	27.9						NS
2181	5110	5	50402	124	Umuleri	Tributary	175,000	11,017	1,900	2,404	255	1,016	250,806	10.8	23.5						Small

Note: NS=Not Studied

Annex-T SR4-7 Evaluation of Potential Dam Sites (Proposed in M/P1995) (6/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
2182	5111	5	50402	124	Ukwa, Abwa	Tributary	116,000	12,173	1,400	1,771	188	2,136	87,887	22.9	8.2						Small
2183	5112	5	50402	124	Obibia	Obibia	933,000	6,311	5,900	7,464	791	729	1,085,081	6.3	126.2						NS
2184	5113	5	50402	124	Ugbio	Ugbio	380,000	8,837	3,400	4,301	456	965	472,593	9.8	46.7						NS
2185	5114	5	50402	124	Oji	Oji	205,000	10,572	2,200	2,783	295	2,925	100,861	31.9	9.2				X		NS
2186	6101	6	604023_i	136	Igangan	Elu	537,000	7,864	4,200	5,313	563	609	924,608	5.4	105.0						NS
2187	6102	6	60403	137	Ilora	Itosi	433,000	8,469	3,700	4,681	496	571	868,889	4.7	106.0						NS
2188	6103	6	60403	137	Ose	Ose	886,000	6,456	5,700	7,211	764	1,660	460,361	15.6	49.1						NS
2189	6104	6	606	140	Omi	Omi	843,000	6,596	5,600	7,084	751	1,394	538,861	12.8	58.7						NS
2190	6201	6	604023_i	136	Adeniji	Tributary	501,000	8,059	4,000	5,060	536	867	618,973	8.0	66.9	X					NS
2191	6202	6	604023_i	136	Egbebi	Tributary	395,000	8,728	3,400	4,301	456	697	654,331	6.7	68.4						NS
2192	6203	6	60403	137	Washinmi	Opeki	433,000	8,469	3,700	4,681	496	638	777,640	5.6	89.0	X					NS
2193	6204	6	60403	137	Oko	Olopoto	951,000	6,257	6,000	7,590	805	435	1,851,437	4.0	199.8	X					NS
2194	6205	6	60403	137	Ohu	Olopoto	591,000	7,595	4,500	5,693	603	1,710	352,871	14.3	42.1						NS
2195	6206	6	60403	137	Eketa	Tributary	435,000	8,457	3,700	4,681	496	393	1,261,731	3.6	138.8	X					NS
2196	6207	6	60403	137	Agida	Awon	521,000	7,949	4,100	5,187	550	281	1,953,415	2.4	227.3	X					NS
2197	6208	6	60403	137	Akinmorin	Tributary	501,000	8,059	4,000	5,060	536	426	1,259,108	3.5	151.3	X				X	NS
2198	6209	6	60403	137	Aba	Ogun	904,000	6,400	5,800	7,337	778	1,187	655,002	11.0	71.0						NS
2199	6210	6	60403	137	Alapa	Ogun	401,000	8,685	3,500	4,428	469	209	2,246,905	1.9	249.4	X					NS
2200	6211	6	60403	137	Are Ago	Ogun	735,000	6,982	5,100	6,452	684	218	3,143,354	1.9	363.4	X					NS
2201	6212	6	60403	137	Elesin	Ayin	259,000	9,915	2,600	3,289	349	495	704,082	4.3	80.8						NS
2202	6213	6	60403	137	Oyebode	Opeki	999,000	6,119	6,100	7,717	818	431	1,897,436	4.1	201.7	X					NS
2203	6214	6	60403	137	Atopa	Atadi	501,000	8,059	4,000	5,060	536	513	1,044,792	4.5	120.4						NS
2204	6215	6	60401	133	Cuta	Onigbongbo	508,000	8,020	4,100	5,187	550	260	2,113,716	2.3	235.7	X					NS
2205	6216	6	605	139	Ibu	Ibu	435,000	8,457	3,700	4,681	496	1,296	382,940	12.6	39.5				X		NS
2206	6217	6	606	140	Olobi	Idero	546,000	7,817	4,300	5,440	577	524	1,099,752	4.8	120.5						NS
2207	6218	6	606	140	Ojo	yesalu	466,000	8,263	3,900	4,934	523	465	1,125,257	4.5	115.4	X					NS
2208	6219	6	606	140	Bale	Tributary	455,000	8,330	3,800	4,807	510	360	1,416,654	3.4	150.6	X					NS
2209	6220	6	606	140	Opebi	Opebi	414,000	8,596	3,600	4,554	483	633	762,224	6.0	80.5	X					NS
2210	6221	6	608	142	Mobi	Oba	501,000	8,059	4,000	5,060	536	676	793,990	6.7	80.0						NS
2211	6222	6	608	142	Otamakun	Oba	597,000	7,566	4,500	5,693	603	1,435	420,523	14.0	43.2						NS
2212	6223	6	608	142	Ajekale	Oba	1,702,000	5,383	9,200	11,638	1,234	717	1,720,265	6.5	189.6	X					NS
2213	6224	6	608	142	Ifeodan	Oba	730,000	7,001	5,100	6,452	684	1,573	434,786	14.4	47.5						NS
2214	6225	6	608	142	Ijimoba	Oshun	504,000	8,043	4,100	5,187	550	470	1,169,927	4.5	122.7						NS
2215	6226	6	608	142	Llobu	Oshun	367,000	8,935	3,300	4,175	442	1,168	378,716	10.8	40.8						NS
2216	6227	6	608	142	Isaki Igbc	Eyinle	629,000	7,419	4,700	5,946	630	808	779,499	7.6	82.7						NS
2217	6228	6	608	142	Edagun	Oshun	390,000	8,764	3,400	4,301	456	297	1,532,745	2.6	174.5	X					NS

Note: NS=Not Studied

Annex-T SR4-7 Evaluation of Potential Dam Sites (Proposed in M/P1995) (7/7)

SN-Dam	Code	HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
2218	6229	6	608	142	Adokanra	Oshun	504,000	8,043	4,100	5,187	550	275	1,999,749	2.4	227.3	X					NS
2219	6231	6	610	144	Oni	Oni	364,000	8,958	3,300	4,175	442	1,922	230,181	18.5	23.9						Small
2220	6232	6	610	144	Oke Awo	Oni	401,000	8,685	3,500	4,428	469	641	732,393	6.1	77.5						NS
2221	6234	6	614	147	Bolorundur o	Ogbesse	464,000	8,275	3,800	4,807	510	774	658,045	7.4	68.6					X	NS
2222	6235	6	612	146	Ofosun	Ofosun	525,000	7,928	4,200	5,313	563	1,566	359,697	16.2	34.7						NS
2223	6236	6	614	147	Ala	Ala	315,000	9,364	2,900	3,669	389	2,222	175,007	22.6	17.2						Small
2224	6237	6	614	147	Okhuo	Okhuo	478,000	8,191	3,900	4,934	523	1,783	293,368	19.4	27.0						1,500
2225	7101	7	704043	158	Okete	Okete	685,000	7,180	4,900	6,199	657	1,393	471,671	18.5	35.5						NS
2226	7102	7	70402	154	Ajide-Eko	Eke	266,000	9,840	2,600	3,289	349	3,507	99,418	38.3	9.1						Small
2227	7103	7	70402	154	Emezu	Ora	769,000	6,854	5,300	6,705	711	2,016	352,432	22.8	31.1						NS
2228	7201	7	704043	158	Panbele	Panbele	290,000	9,597	2,800	3,542	375	947	396,650	13.1	28.7						NS
2229	7202	7	704043	158	Ombi	Ombi	435,000	8,457	3,700	4,681	496	2,704	183,501	38.1	13.0						2,000
2230	7203	7	704043	158	Ugboba	Ugboba	378,000	8,851	3,300	4,175	442	960	460,957	12.8	34.6						NS
2231	7204	7	704043	158	Ogege	Ogege	363,000	8,965	3,300	4,175	442	1,695	261,030	24.5	18.0						1,000
2232	7205	7	704043	158	Adam East	Awn	736,000	6,978	5,100	6,452	684	1,226	557,948	11.6	58.9						NS
2233	7206	7	704043	158	Ieheri	Ieheri	537,000	7,864	4,200	5,313	563	1,121	502,542	14.6	38.7						NS
2234	7207	7	70403	155	Ogwuawu	Ogwuawu	400,000	8,692	3,500	4,428	469	728	645,038	8.9	52.7						NS
2235	7208	7	70403	155	Ogbogbo(1)	Ogbogbo	401,000	8,685	3,500	4,428	469	1,192	393,624	15.8	29.7						NS
2236	7209	7	70403	155	Ogbogbo(2)	Ogbogbo	738,000	6,970	5,100	6,452	684	1,228	556,924	15.9	43.0						NS
2237	7210	7	704043	158	Abe	Abe	176,000	11,001	1,900	2,404	255	1,296	196,583	18.6	13.7						1,500
2238	7211	7	704042	157	Gbumacha	Gbumacha	294,000	9,558	2,800	3,542	375	1,301	288,695	18.6	20.2						NS
2239	7212	7	704042	157	Uwebende	Uwebende	435,000	8,457	3,700	4,681	496	4,026	123,239	49.1	10.1						Small
2240	7213	7	704042	157	Konshisha	Konshisha	402,000	8,678	3,500	4,428	469	2,018	232,597	30.3	15.5						1,500
2241	7214	7	704042	157	Ukyoha	Ukyoha	470,000	8,239	3,900	4,934	523	1,599	327,036	23.7	22.1						NS
2242	7215	7	704042	157	Kaakya	Kaakya	356,000	9,020	3,200	4,048	429	1,058	405,590	14.6	29.4						NS
2243	7216	7	704042	157	Adum	Konshisha	564,000	7,726	4,400	5,566	590	954	618,461	12.7	46.3						NS
2244	7217	7	704042	157	Moi	Moi	176,000	11,001	1,900	2,404	255	653	389,950	7.8	32.8						NS
2245	7218	7	704042	157	Monaya	Monaya	62,000	13,935	900	1,139	121	1,022	118,041	12.5	9.7				X		NS
2246	7219	7	70402	154	Akpoga	Aboine	266,000	9,840	2,600	3,289	349	1,351	258,047	18.3	19.1						Small
2247	7220	7	70402	154	Ikem	Aboine	488,000	8,133	4,000	5,060	536	1,657	323,783	23.3	23.0						NS
2248	7221	7	70402	154	Agala	Aboine	510,000	8,009	4,100	5,187	550	1,464	375,575	15.1	36.4						NS
2249	7222	7	70402	154	Okpoto	Aboine	421,000	8,549	3,600	4,554	483	1,049	460,361	13.5	35.8						NS
2250	7223	7	70402	154	Ndeaboh	Asu	294,000	9,558	2,800	3,542	375	1,827	205,468	25.9	14.5						Small
2251	7224	7	70402	154	Eneagu	Asu	208,000	10,531	2,200	2,783	295	791	373,148	10.2	28.8						NS
2252	7225	7	70401	153	Ubei	Ukei	278,000	9,716	2,700	3,416	362	4,739	76,400	52.7	6.9						Small

Note: NS=Not Studied

Annex-T SR4-8 Evaluation of Potential Dam Sites (Large Scale)

SN-Dam		HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
3001		3	30603_i	85	Baudeu	Taraba	1,528,200	5,467	8,400	10,626	1,126	39,686	28,382	446.7	2.5						
3002		3	30603_i	85	Gashaka	Taraba	1,501,000	5,481	8,200	10,373	1,100	29,842	36,845	285.7	3.8						
3003		3	30603_i	85	Kila	Taraba	6,336,500	4,360	27,600	34,914	3,701	90,833	40,744	896.2	4.1						
3004		3	30603_i	85	Kogin Baba	Taraba	3,275,700	4,873	16,000	20,240	2,145	38,376	55,905	464.3	4.6						
3005		3	30202	76	Kwossa	Suntai	15,226,600	3,678	56,000	70,840	7,509	88,723	84,635	870.9	8.6						
3006		4	404	112	Okwaregi	Mada	16,161,800	3,631	58,700	74,256	7,871	92,957	84,675	869.5	9.1						
3007		4	408	117	Wana	Ankwe	2,810,000	4,993	14,000	17,710	1,877	26,299	71,380	282.7	6.6						
3008		2	20804	52	Bejagira	Kojin Maringo	1,036,000	6,016	6,200	7,843	831	6,717	123,760	276.4	3.0						6,000
3009		3	30603_i	85	Mamam	Taraba	1,793,000	5,342	9,600	12,144	1,287	15,833	81,300	156.7	8.2						
3010		3	30603_i	85	Nyasikasi	Taraba	8,525,900	4,129	35,200	44,528	4,720	91,169	51,772	901.2	5.2						
3011		4	402	110	Ragwa	Akini	1,573,800	5,444	8,600	10,879	1,153	49,001	23,534	345.3	3.3						19,000
3012		3	318	103	Muleng	Kiriange	1,598,000	5,432	8,700	11,006	1,167	10,429	111,859	79.8	14.6						10,000
3013		2	214_i	68	Bad Es Sem	Moshi	1,163,000	5,691	6,600	8,349	885	17,576	50,352	186.5	4.7						
3501		6	608	142	Odedele	Osun	1,577,900	5,442	8,600	10,879	1,153	5,238	220,137	46.7	24.7						
3502		6	604023_i	136	Aiyete	Ofiki	5,515,100	4,468	24,600	31,119	3,299	17,243	191,299	153.2	21.5						
3503		6	608	142	Oba	Oba	1,825,500	5,328	9,700	12,271	1,301	9,347	139,150	86.6	15.0						
3504		6	608	142	Ijesha	Osun	2,278,700	5,156	11,700	14,801	1,569	12,583	124,681	116.8	13.4						
3505		6	606	140	Ona	Ona	3,331,800	4,860	16,200	20,493	2,172	11,469	189,406	117.0	18.6						

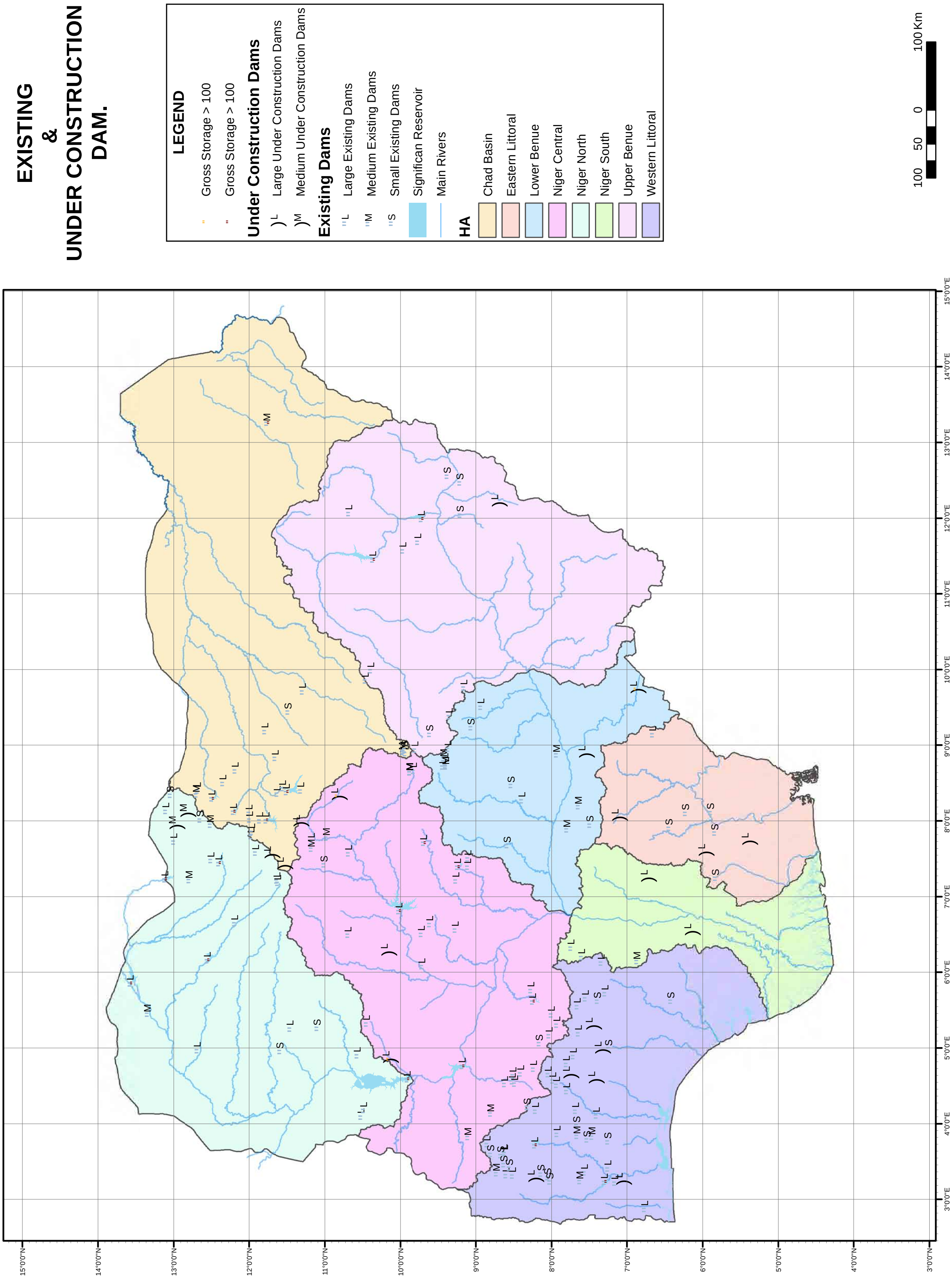
Note: NS=Not Studied

Annex-T SR4-9 Evaluation of Potential Dam Sites (Small to Medium Scale)

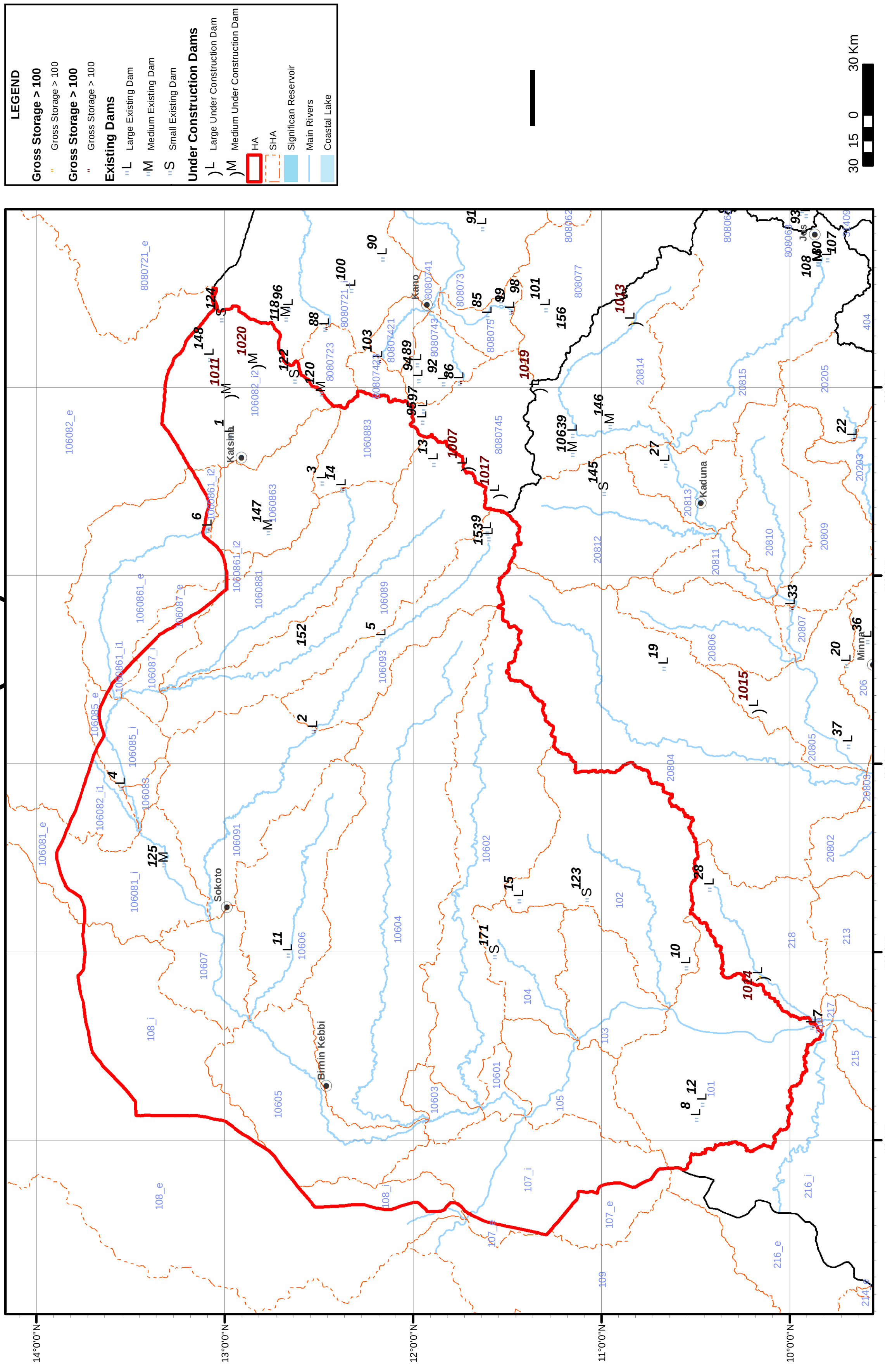
SN-Dam		HA	SHA	SN-SHA	Name	River	Embankment V(m3)	Unit Cost (Naira/m3)	Construction Cost (Mil.Naira)	Project Cost (Mil. Naria)	Annualized Cost (Mil.Naira /year)	Irrigable Area with safty factor (ha)	Annual Cost /Irrigation area (Naira/ha)	Available Water with safty factor (MCM/y)	Annual Unit Cost of Water (Naira/m3)	Turn Over Rate - less than 1	Turn Over Rate at D.S. Dam - less than 1	Supplement for Existing Irrigation	Supplement for Municipal Water Supply	Settelment in reservoir area	Roughly evaluated possible irrigation area by gravity
4001		7	702	151	Obulo Eziama	tributary	597000	7,566	4,500	5,693	603			32	19.1						
4002		7	702	151	Owerri	tributary	216000	10,425	2,300	2,910	308			23	13.5						
4003		4	404	112	Kafanchan	tributary	154000	11,376	1,800	2,277	241			10	23.1						
4004		2	20205	42	Kacha	tributary	191000	10,771	2,100	2,657	282			15	18.2						
4005		4	404	112	Kumpa	tributary	164000	11,200	1,800	2,277	241			11	23.0						
4006		6	602_i	131	Bale	Yewa	637000	7,384	4,700	5,946	630			28	22.4						
4007		3	31409	99	Barakin	tributary	1169000	5,677	6,600	8,349	885			17	52.9						
4008		1	106093	31	Sakin Noma	Sokoto	395000	8,728	3,400	4,301	456			27	16.7						
4009		5	50402	124	Umuseke	tributary	191000	10,771	2,100	2,657	282			16	17.9						
4010		5	506	126	Ihiala	tributary	166000	11,165	1,900	2,404	255			23	11.0						
4011		5	506	126	Nnewi	tributary	281000	9,685	2,700	3,416	362			35	10.3						
4012		7	702	151	Aba	tributary	241000	10,117	2,400	3,036	322			18	17.5						
4013		8	80403_i	169	Mubi	Yedseram	364000	8,958	3,300	4,175	442			2	182.9						
4014		6	603	132	Ota	tributary	241000	10,117	2,400	3,036	322			3	108.6						
4015		7	702	151	Okigwe	tributary	133000	11,789	1,600	2,024	215			31	7.0						
4016		7	70402	154	Ezillo	tributary	319000	9,329	3,000	3,795	402			2	223.2						
4017		2	20205	42	Kwoi	tributary	178000	10,969	2,000	2,530	268			6	41.7						
4018		6	606	140	Araromi Ake	tributary	191000	10,771	2,100	2,657	282			19	42.9						

Note: NS=Not Studied

Annex-F SR4-1 Location Map of Existing Dams (Nation Wide)

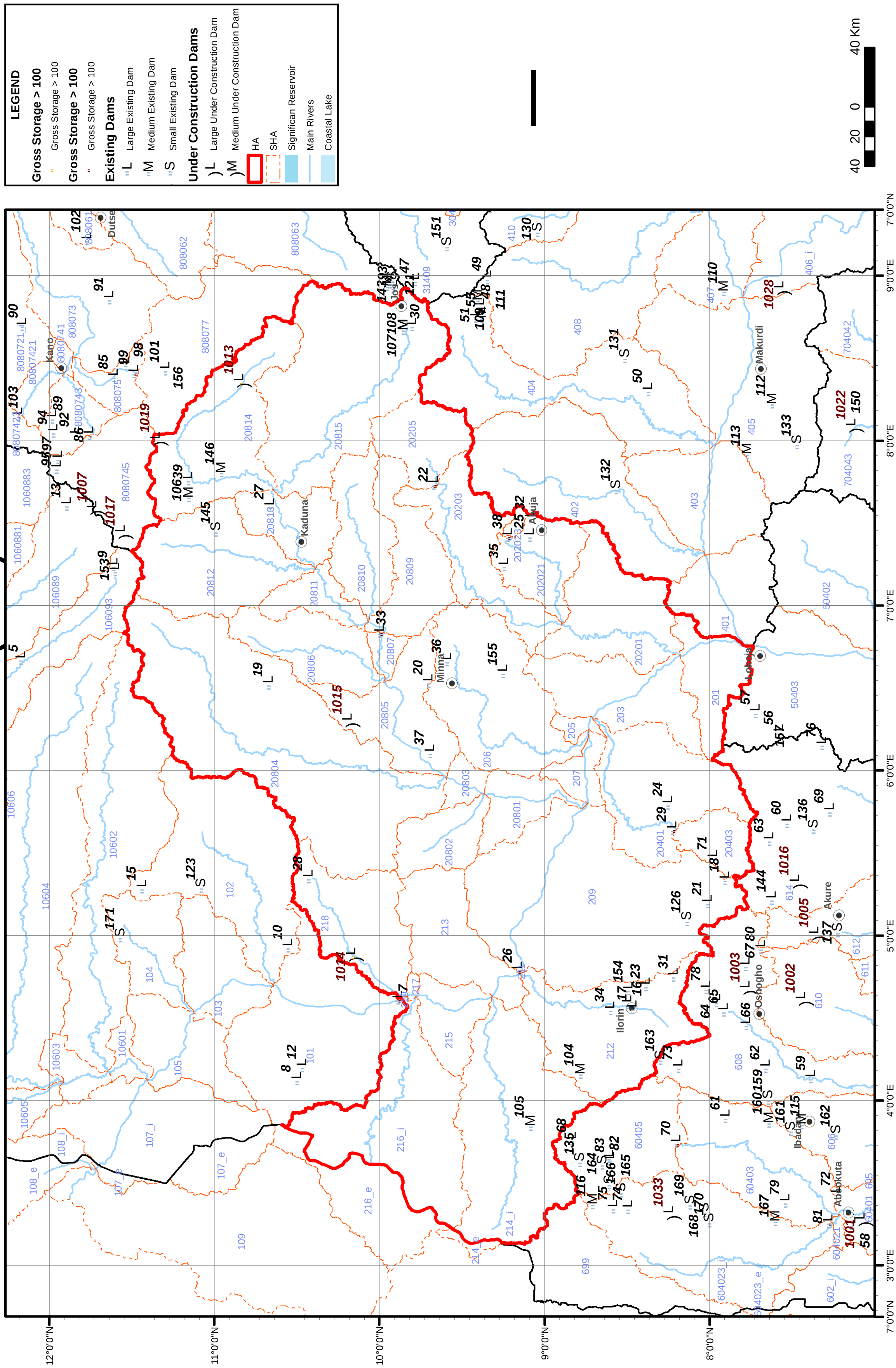


Annex-F SR4-2 Location Map of Existing Dams (HA-1)

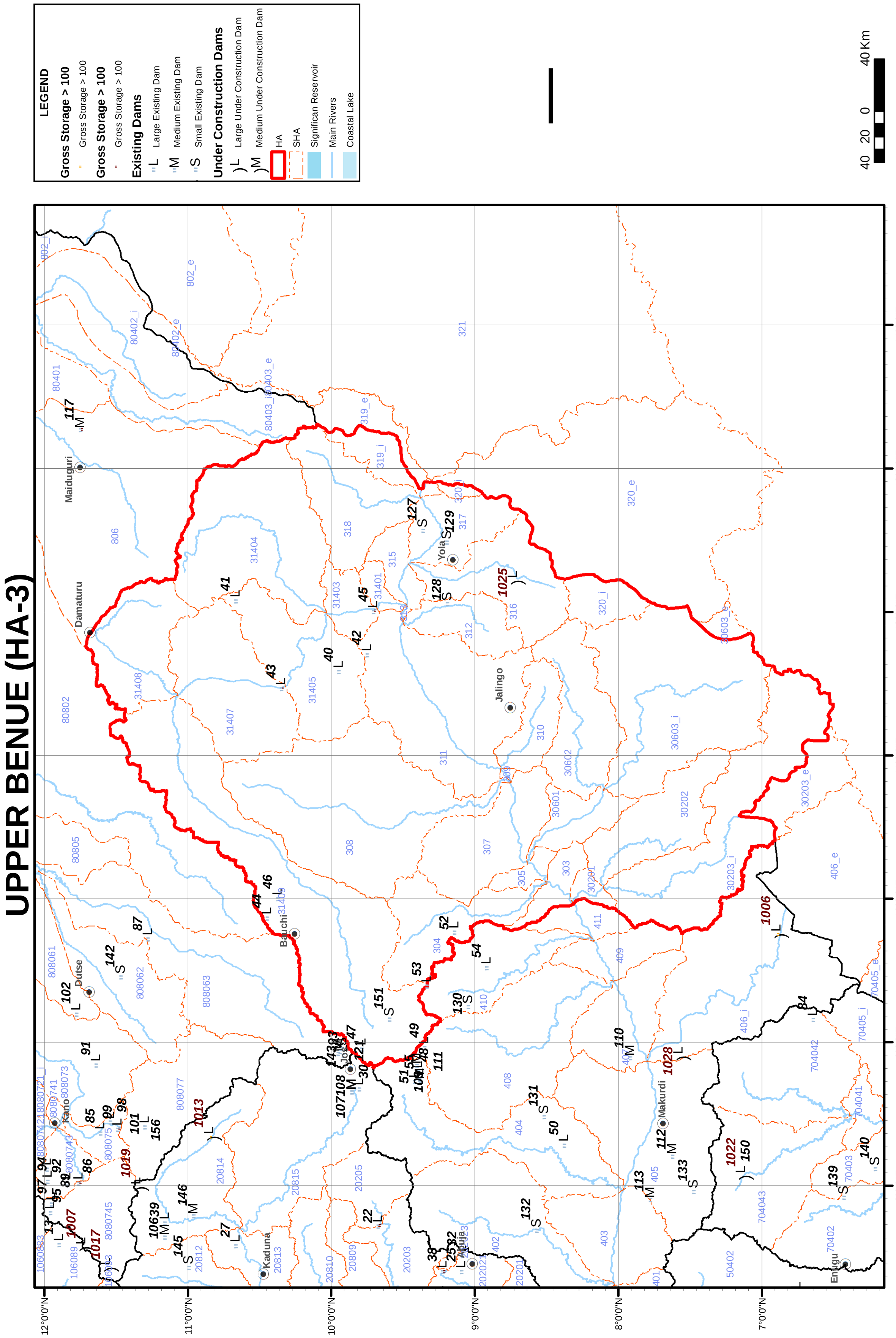


1

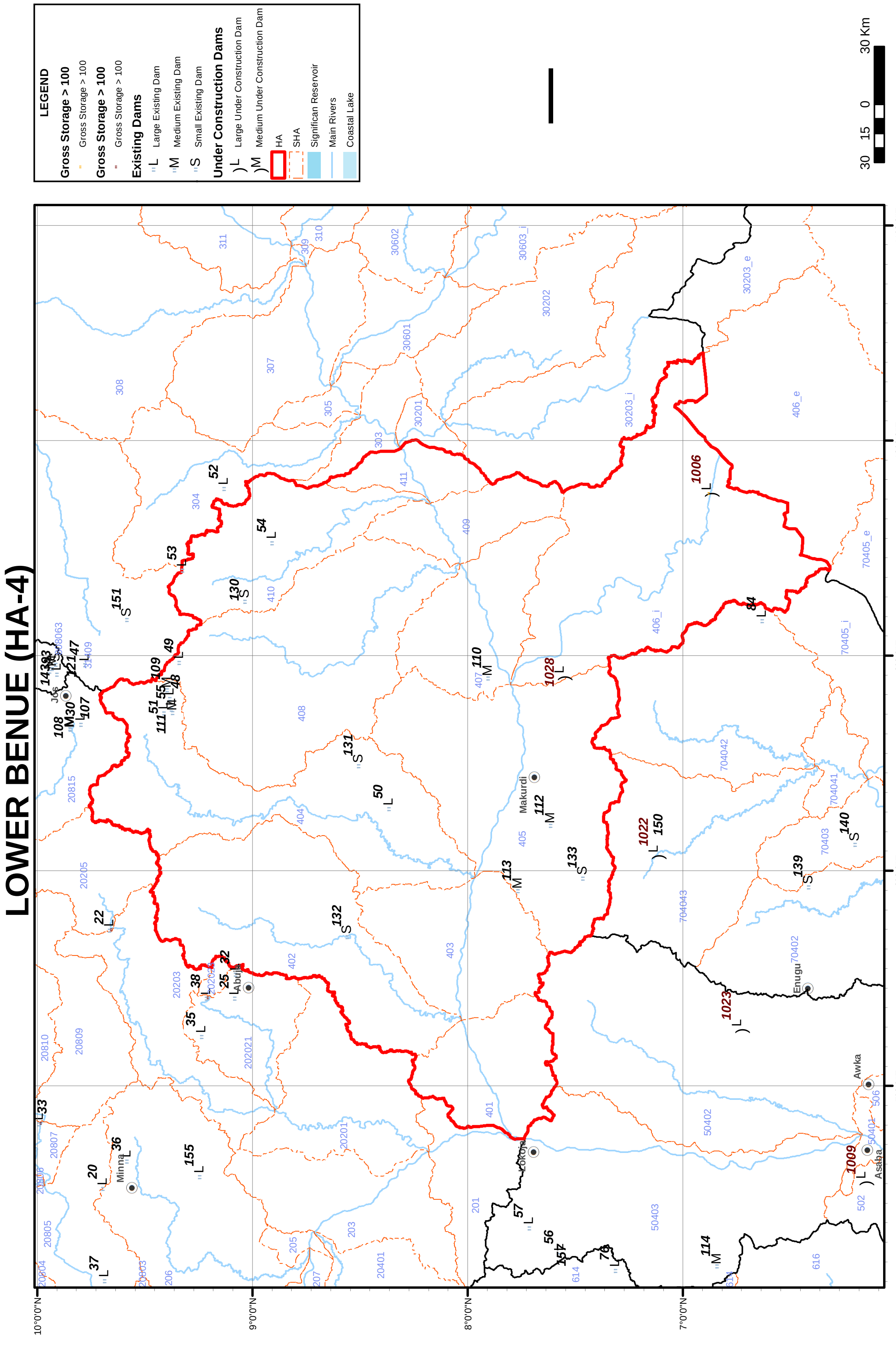
Annex-F SR4-3 Location Map of Existing Dams (HA-2)



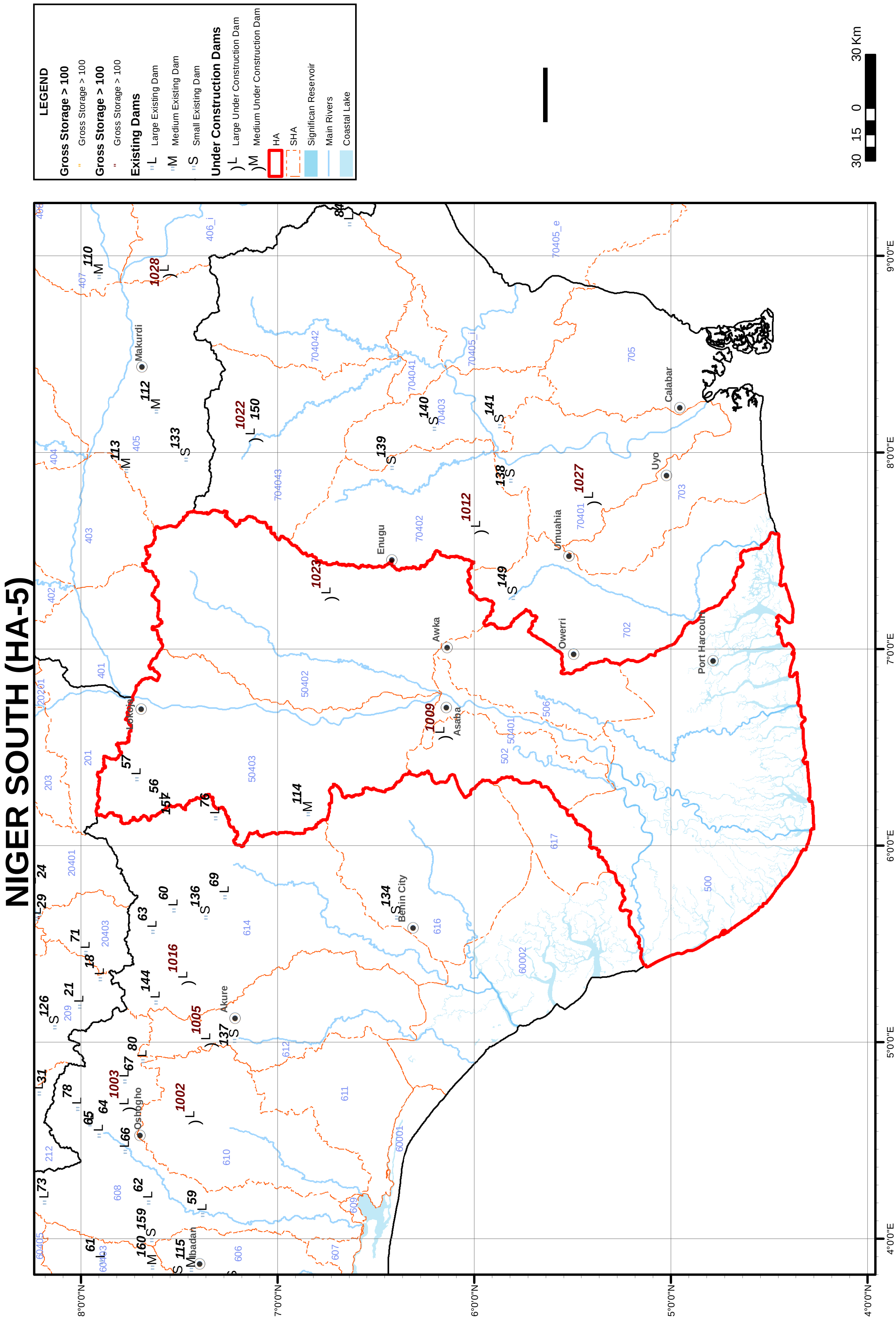
Annex-F SR4-4 Location Map of Existing Dams (HA-3)



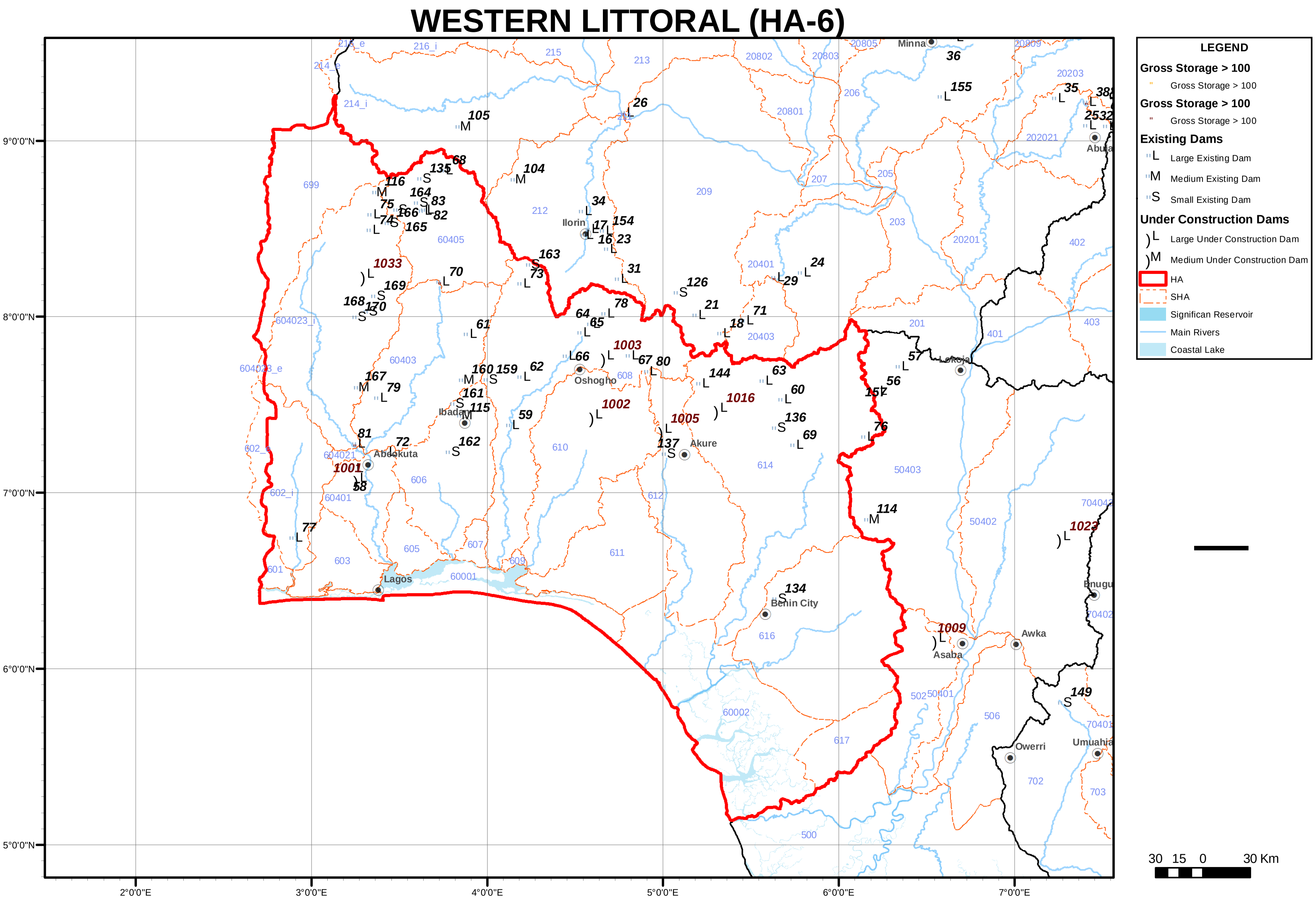
Annex-F SR4-5 Location Map of Existing Dams (HA-4)



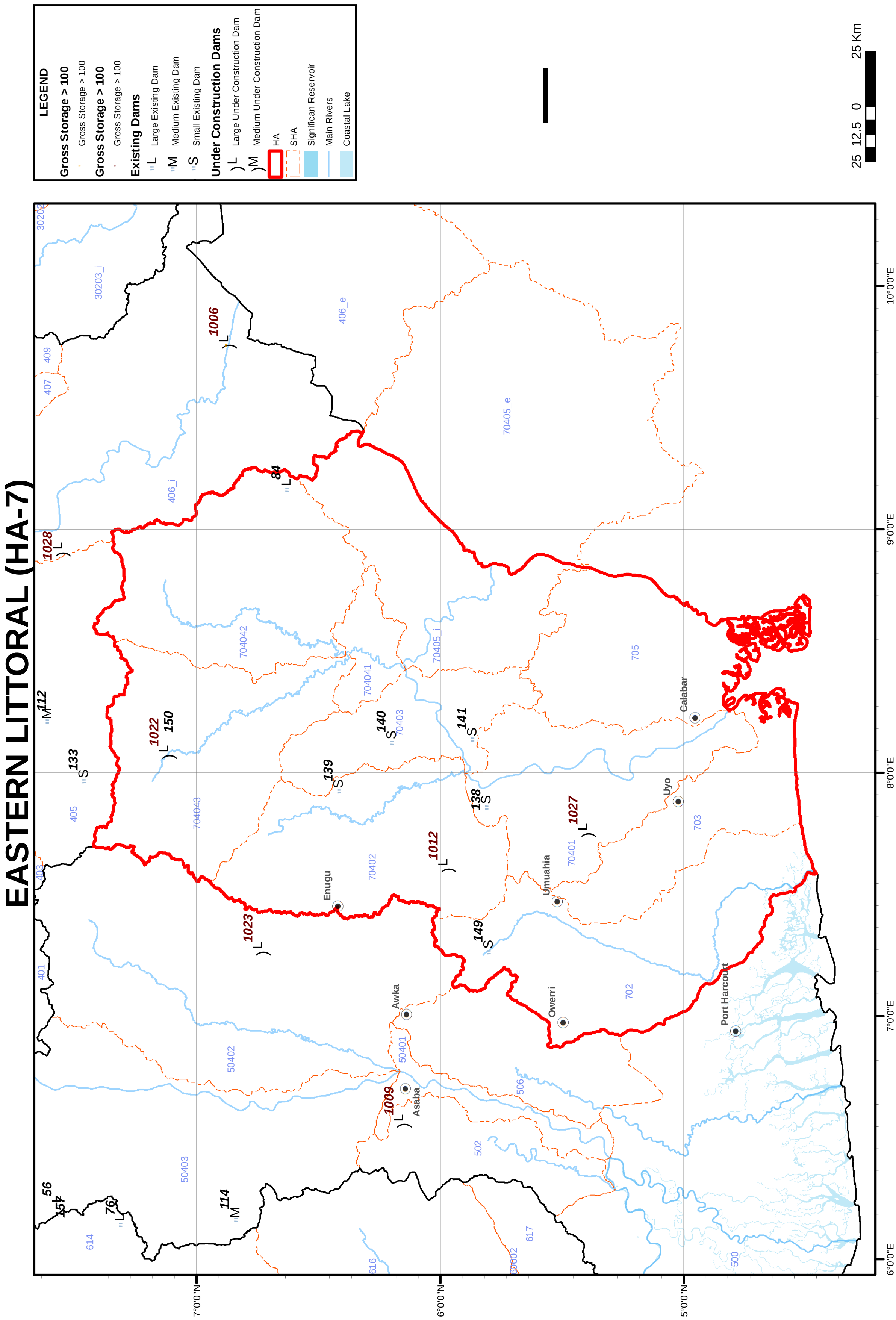
Annex-F SR4-6 Location Map of Existing Dams (HA-5)



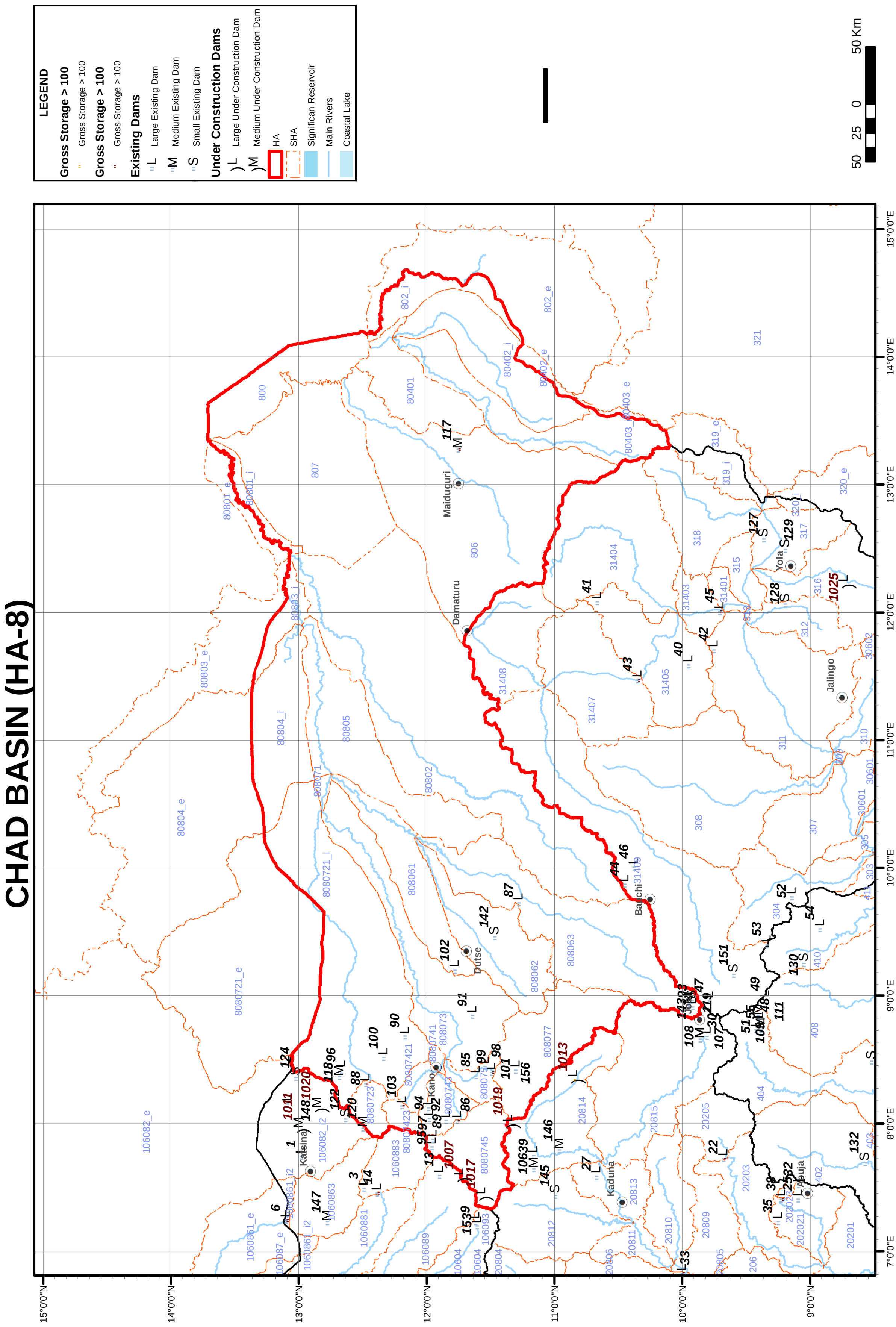
Annex-F SR4-7 Location Map of Existing Dams (HA-6)



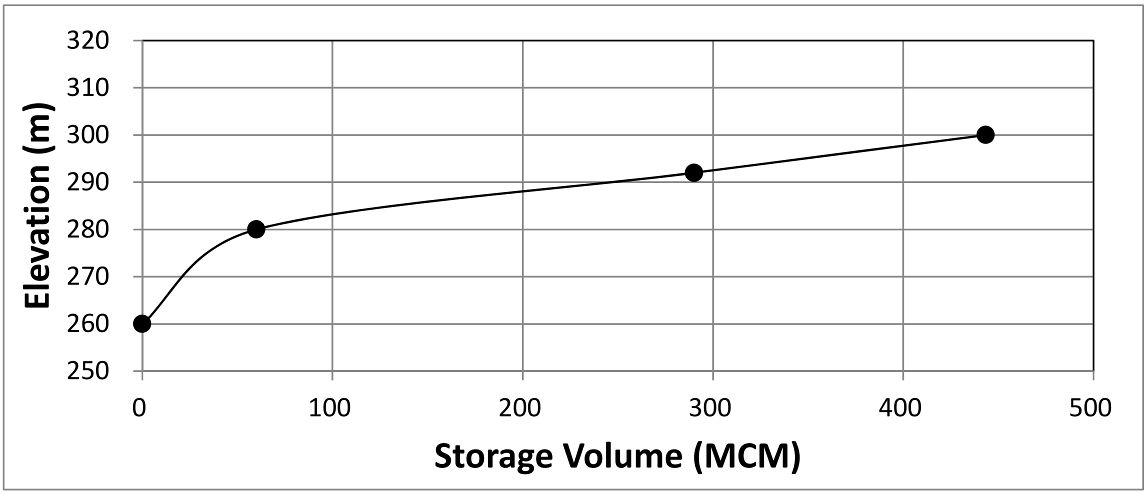
Annex-F SR4-8 Location Map of Existing Dams (HA-7)

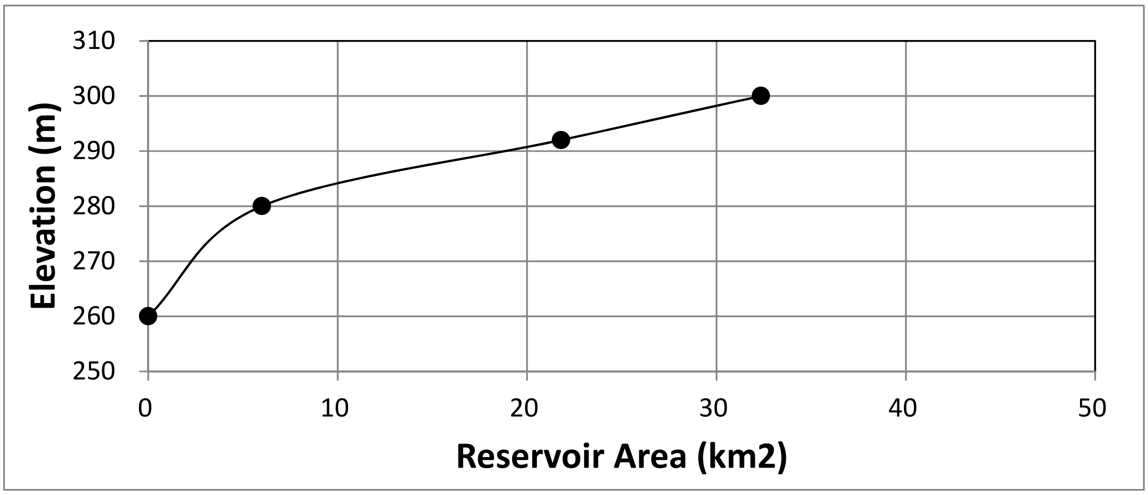


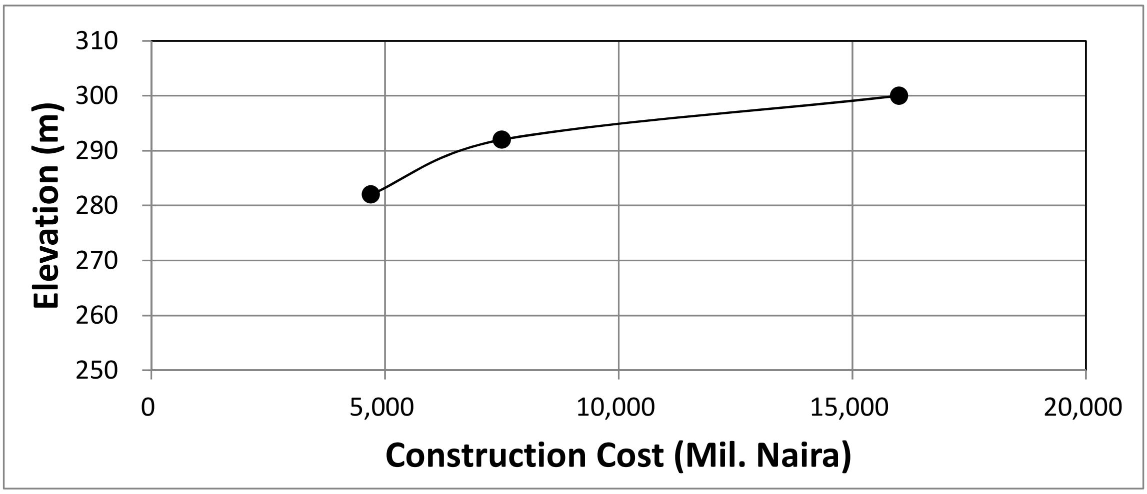
Annex-F SR4-9 Location Map of Existing Dams (HA-8)



SN 3004: Kogin Baba

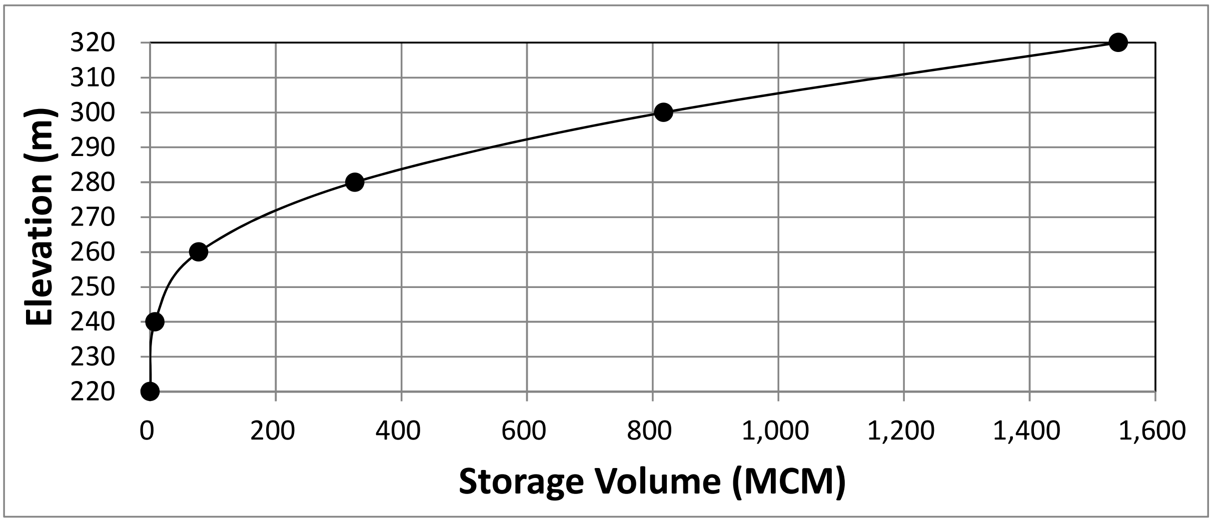


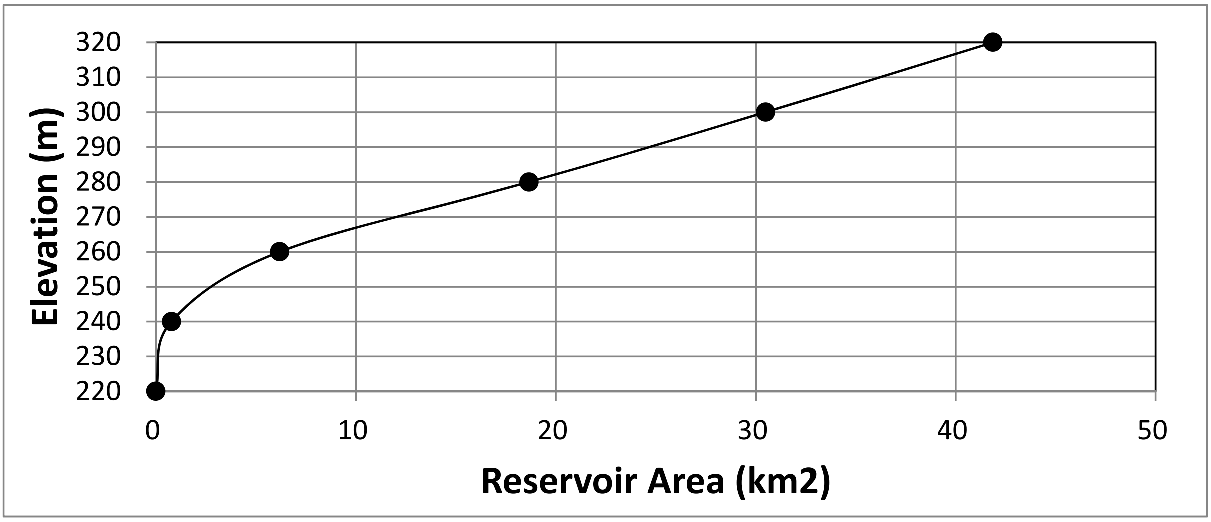


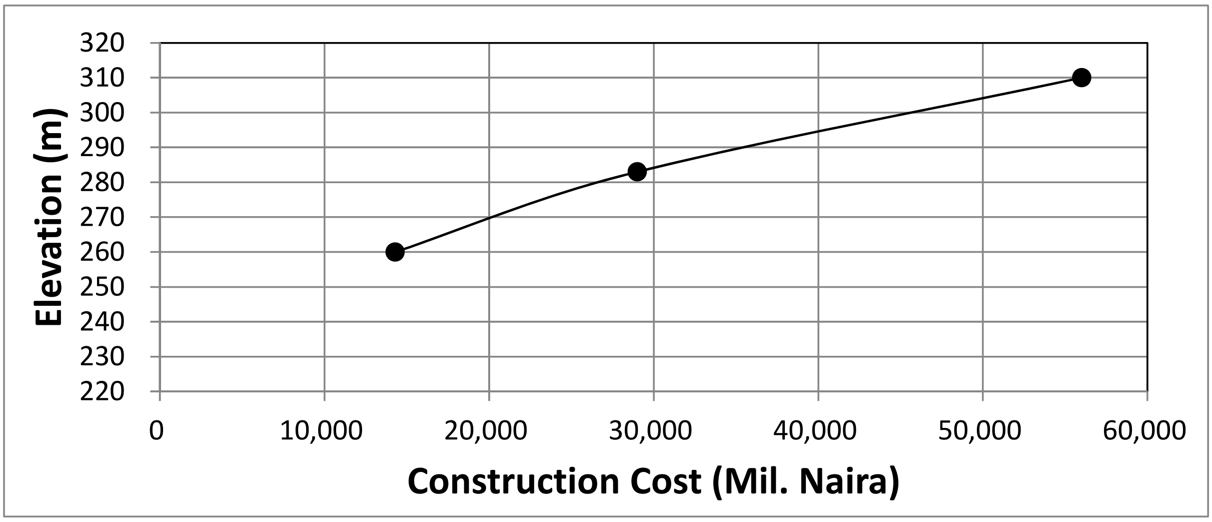


Annex-F SR4-10 Relationship among Elevation, Storage Volume, Surface Area and Construction Cost (1/3)

SN 3005: Kwossa

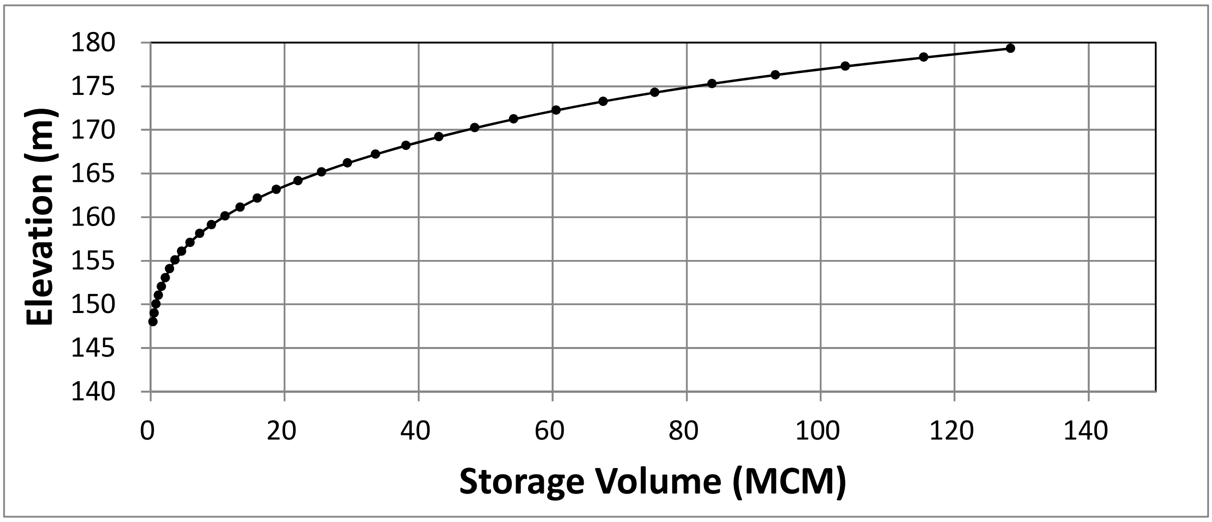


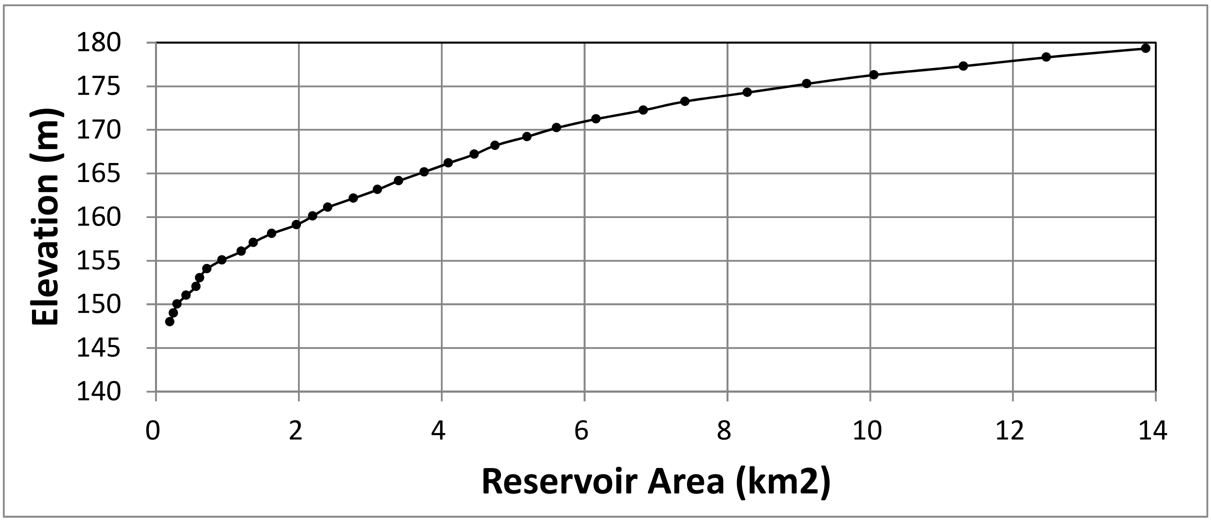


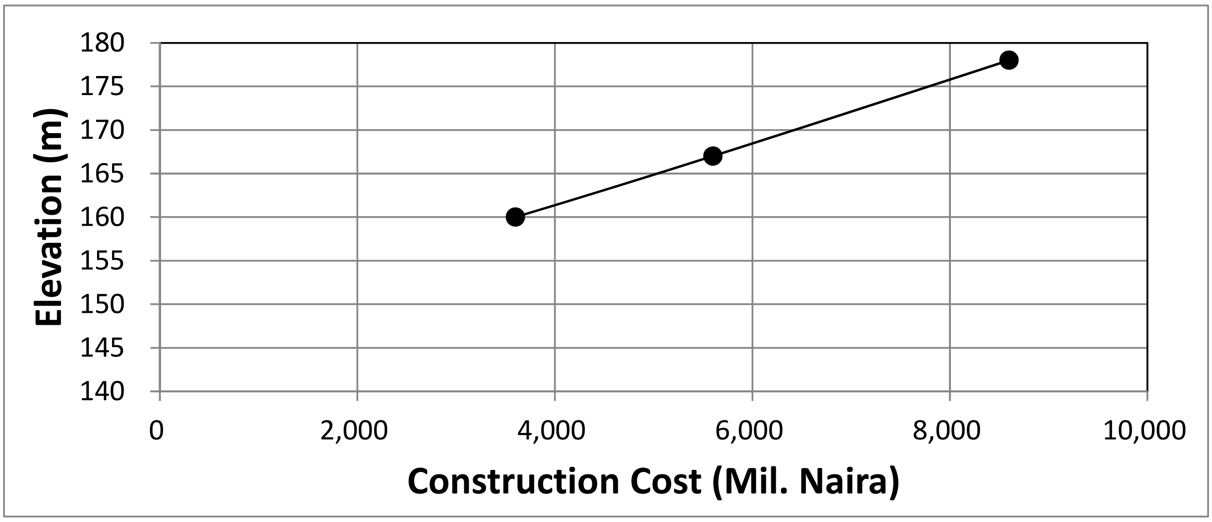


Annex-F SR4-10 Relationship among Elevation, Storage Volume, Surface Area and Construction Cost (2/3)

SN 3011: Ragwa







Annex-F SR4-10 Relationship among Elevation, Storage Volume, Surface Area and Construction Cost (3/3)