FEDERAL REPUBLIC OF NIGERIA

FEDERAL MINISTRY OF WATER RESOURCES (FMWR)

THE PROJECT FOR REVIEW AND UPDATE OF NIGERIA NATIONAL WATER RESOURCES MASTER PLAN

VOLUME 6

NATIONAL WATER RESOURCES MASTER PLAN 2013

OFFICIAL DISSEMINATION VERSION

JANUARY 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

YACHIYO ENGINEERING CO., LTD.
CTI ENGINEERING INTERNATIONAL CO., LTD.
SANYU CONSULTANTS INC.

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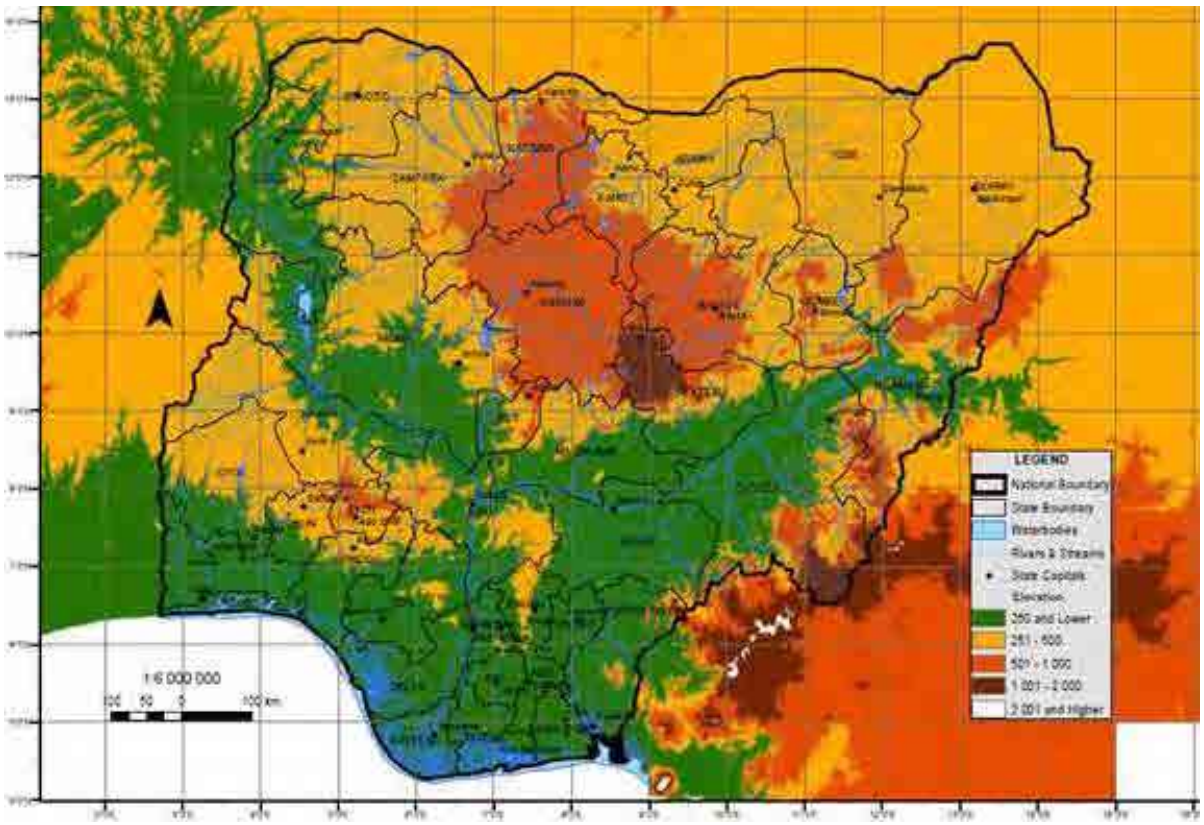
Federal Ministry of Water Resources

Nigeria National Water Resources Master Plan 2013

Official Dissemination Version



General Map of Nigeria

Hydrological Map of Nigeria

PREFACE

It is my honor and pleasure to present to you the Report for the Review and Update of Nigeria National Water Resources Master Plan which comprises the development plans, utilization/sector plans and management plans of the nation's water resources. The relevance of water to our national development cannot be overemphasized; the demand for water has progressively increased over the years with population growth, urbanization, agriculture and industrial development.

It will be recalled that the 1995 Master Plan developed by JICA was the first comprehensive development plan which promises optimization of the nation's Water Resources as well as financial and economic investment options in water resources development in order to achieve accelerated growth, integrated and coordinated water resources development and management, agricultural production and food security.

Over the past decade, a lot of issues and challenges have continued to confront the development and management of the nation's water resources namely; increasing water demand due to population growth, uncoordinated water development among the three tiers of government , development partners and end users, uneven distribution of rainfall across the country which have led to over abstraction of groundwater resources in some parts of northern Nigeria and the impact of climate change being experienced in extreme weather events like flooding.

In response to these challenges, the Government of Nigeria made request to the government of Japan for implementation of Technical Cooperation of Development Study in order to revise the 1995 Master Plan. Consequently, JICA preparatory study Team came to Nigeria and held discussions with the national officials on the background and content of the request, institutional setting in the water sector as well as current cooperation of foreign donors, the outcome of these findings led to the formulation of the scope of work for the project which was concluded in March, 2011.

The JICA Study Team ,had worked tirelessly from August,2011 till date collating and analyzing the available data and information on water resources and related sectors across the country to review and update the Nigeria National Water Resources Master Plan .The JICA Project Team actively engaged relevant Stake holders in discussion, field visits and workshops during the implementation of this project and relevant comments and observations of stakeholders had been very useful in preparation of this report.

In light of the foregoing to the effect that this document is a report of the extensive study undertaken to review and update the 1995 national water resources master plan, the Master Plan 2013 takes a primary characteristic of a technical report. Accordingly, this official dissemination document which is an abridged form of the main report differs in format from the usual development plan or master plan as we know them to be. The format notwithstanding, the document contains both the contents and thrust of a master plan. To this extent, the Master Plan 2013 is richer as it also highlights the

scientific and technological basis on which it was developed throughout the whole text.

I will therefore like to thank the Japanese Government for their invaluable contributions in the development of the water sector in Nigeria over the years and the JICA Study Team that executed the project for the Review and Update of the Nigeria National Water Resources Master Plan. On our part, the government of Nigeria is determined to pursue those programmes identified in the Master Plan so as to attain the set targets.

Once again, I wish to express my sincere appreciation to JICA and all Members of the Study Team for their dedication and hard work towards making this project possible.

Mrs Sarah Reng Ochekpe
Honorable Minister of Water Resources.

CHAPTER 1 INTRODUCTION

1.1 Background of Review and Update of National Water Resources Master Plan 1995

In Nigeria, the government has led the process of water resources development since the 1970s. The Federal Ministry of Water Resources and Rural Development (FMWRRD) as it was then known undertook the formulation of National Water Resources Master Plan with the assistance of the Food and Agriculture Organization (FAO), aiming at efficient management and development of water resources. However, due to lack of funds, this work was not concluded; coming up with only a draft report. In order to complete the master plan, FMWRRD requested the Japanese government to conduct a study on the water resources master plan. Accepting the request from the Nigerian government, Japan International Cooperation Agency (JICA) raised a team of consultants to come to Nigeria. The study was conducted over a period of three years from end of March 1992 to end of March 1995. The Master Plan studied and came up with results of current status and problems related to water resources in the country. It recommended and mapped out the plans for water source development, water supply, irrigation etc.

In recent times, water shortage has become more serious mainly in the northern part of the country because of increasing need for irrigation, water supply, energy generation etc. as result of population growth and economic development. Therefore, adequate development and management of water resources became a critical necessity to meet these needs and prevent environmental damage.

With this background, the Government of Nigeria requested for technical cooperation from Government of Japan to review and revise the Master Plan for the promotion of optimum water resources management. (the Project). In response to this request, JICA raised a Project Team to implement the Project (the JICA Project Team) consisting of consultants and commenced the Project in August 2011 till date, based on the Scope of Work signed and agreed between the Federal Ministry of Water Resources (FMWR) and JICA in March 2011.

1.2 Objective of the Project

The objective of the project is formulation of the Master Plan on Water Resources Development and Management for Nigeria spanning 2014-2030 (hereinafter referred to as M/P2013).In addition, a Draft Catchment Management Plan (CMP) will be formulated for two priority hydrological areas. This is expected to lead to the establishment of Catchment Management Office in each of the two hydrological areas. This would subsequently be replicated in the remaining hydrological areas across the country.

1.3 Justification

Fifteen years have elapsed since the formulation of the M/P1995 and the following challenges and issues have emerged:

1) Water demand is increasing as a result of population growth and economic development.
2) It is usual that river flow may decrease in the dry season. In recent years, however, some rivers dry up completely between December and January. Groundwater sources also dry up more than before in dry season mainly in northern part of the country. Actual water resources potential shows considerable difference from what was assessed in the M/P1995.
3) With the impact of Climate Change, the frequency of extreme weather events is increasing and the damages caused by water shortage or heavy rains etc. are on the increase. Therefore it is necessary to incorporate new approaches such as forecast/mitigation of natural disaster into management and development of water resources.
4) In addition to the establishment of Nigeria Integrated Water Resources Management Commission (NIWRMC) which will take responsibility for water-resources management at the national level, the Catchment Management Office (CMO) will be established under NIWRMC

in eight hydrological areas. Catchment Management Plan will therefore be formulated on the basis of coordination and agreement between stakeholders for better allocation of water resources.

With the above background, the project has commenced in August 2011 in order to revise the M/P1995 for the promotion of optimum water resources management in Nigeria.

1.4 Goals

This project is aimed at achieving the following goals:

- Formulation of National Water Resources Master Plan 2013 (M/P2013)
- Establishment of an Integrated Water Resources Management (IWRM) system with a view to harmonize & optimize the goals of the following sub-sectors:
  - ✓ Urban & rural Water Supply
  - ✓ Irrigation
  - ✓ Livestock & Freshwater Aquaculture
  - ✓ Power Generation
  - ✓ Flood & Erosion Control
  - ✓ Internal Navigation

1.5 Evaluation of Water Resources Potential

The basis of estimation of water resources potential of the country is the output of long-term rainfall-runoff model with the input data of precipitation and air temperature for 40 years from 1970 to 2009; among other factors that were considered. The total water resources potential inclusive of inflow from neighboring countries is estimated at 375 BCM/year. Out of this volume, 88BCM/year comes from neighboring countries. This indicates that almost 24% of surface water in Nigeria is form neighboring countries. In addition to this, total groundwater resources potential is estimated at 156BCM/year on the basis of estimated groundwater recharge.

It is noteworthy that the country's current total raw water storage capacity is more than the estimated total surface water demand in 2030. It is therefore imperative that this project consider in detail how the current and future challenges in the water sector are addressed in light of this fact.

1.6 Planning Parameters

The planning parameters adopted in terms of population figures was the estimated population used by FMWR as sourced from the National Bureau of Statistics (NBS) which the median scenario of the United Nations World Population Prospects as revised in 2010 bore similarity with. Other indices considered in the Plan included the GDP growth rates published by the NBS in the Revised Economic Outlook for 2012 – 2015. Other parameters are sub-sector specific in water resources.

Similarly, climatic factors that determine water resources potential are considered as environmental conditions in the formulation of Water Sector M/P2013.

1.7 Strategies

The National Water Resources Master Plan 2013 (M/P2013) is developed around nine (9) strategic issues, namely:

1) Water Resources Management & Development in consideration of Uneven Distribution of Water Resources and Demand
2) Addressing Increasing Municipal Water Demand on the premise of current Low Operation Rate of Water Supply Facilities
3) Promotion of sound and self-reliant Irrigation Development
4) Effective Utilization of existing water source facilities in view of contemporary needs
5) Enhancement of water-related Data/Information and its uniform management

6) Consideration of increasing risks to water resources
7) Active involvement of water resources administrator in the management of important rivers and flood plains
8) Water Quality monitoring to secure clean and safe water
9) Institutional Development & Strengthening of Water Resources Development

1.8 Implementation Program

The M/P2013 implementation schedule is classified into 3 stages. Accordingly, the timelines are as follows:

1st Stage: 2014 – 2020
2nd Stage: 2021 – 2025
3rd Stage: 2026 – 2030

1.9 Framework of National Water Resources Master Plan 2013

The framework of the National Water Resources Master Plan 2013 (M/P2013) consists of four major components, namely:

- Integrated Water Resources Management (IWRM)
- Water Sources Development Plan (WSDP)
- Water Sub-sector Development Plan (WSSP)
- Water Resources Management Plan (WRMP)

1.10 Key Performance Indicators & Expected Outcomes

The Water Sector M/P2013 envisages certain achievements and targets that broadly result in 13 outputs and 6 outcomes; while there are some Key Performance Indicators (KPIs) and expected outcomes that are specific to the various sub-sectors in water resources.

The overarching goal is to achieve an Integrated Water Resources Management (IWRM) system in the country, which will be through the establishment of Catchment Management Office (CMO) in two Hydrological Areas (HA), namely, HA 1 & HA 6. This, it must be stated, is the first step towards realization of the country's aspirations in the water sector. The realization of the aspiration is the major expected outcomes of 100% access to clean, safe drinking water for the populace; supply of adequate irrigation water to meet the country's agricultural goal of self-sufficiency in food production; increased generation of electricity through hydropower; and achievement of zero loss of life and property to perennial floods.

1.11 Plan Budget

The budget to actualize the Water Sector M/P2013 has been determined. However, the funding plan or the modalities for securing the funds was not identified.

1.12 Appendix

This master plan, like its predecessor, was developed on the basis of detailed scientific and geophysical study of the project area. These details are reflected in many tables, graphs, charts, and maps etc. that are not required in a policy document such as this. This requirement has been observed in this plan document.

However, some details were considered to be necessary input and have therefore been included; while in order not to overload the main text, others have been put in the Appendix at the end of each chapter to which they relate.

CHAPTER 2 OVERVIEW OF NATONAL WATER RESOURCES MASTER PLAN 2013

2.1 National Water Resources Master Plan 1995

In addition to the foregoing background and outline, an overview of M/P1995 is presented to provide the rationale for the conceptual framework of the M/P2013.

Based on the projects proposed in M/P1995 and its overall level of implementation, the review and update, M/P2013, was prepared with the following underlying consideration:

(1) National Policies and Basic Strategies of National Water Resources Master Plan

The M/P1995 took into account water policies specified in the National Development Plan, 1992 (NPC), namely:

- Expansion of irrigated agriculture to meet the growing food demand due to population growth,
- Provision of facilities to supply safe and clean domestic water, and
- Preservation of the quality of water environment.

The strategies of M/P1995 were developed along these policies. These policies are still important and are therefore retained by the revised plan in line with the latest national development plans (Nigeria Vision 20: 2020, Water Sector Roadmap etc.).

(2) Evaluation of Water Resources Potential

In M/P1995, the water resources potential was evaluated by using the observed flow and rainfall readings of the 1970s and 1980s. This was the first time a comprehensive evaluation of water resources of the country would be done. However, it has several drawbacks from the viewpoint of appropriate water resources management. For example, regarding the evaluation of surface water potential:

- Evaluation period of the data was short
- Potential was evaluated only on averages while drought was not included
- There was no consideration for flood discharge.

The formulation of M/P2013 utilized long-term data (long-term rainfall data available). Evaluation would clarify the flow regime, flood discharge and probability of flow. Regarding the evaluation of groundwater potential, evaluation would take into account not only meteorological conditions but also hydrogeological conditions of the areas.

(3) Demand Projection, Implementation of Water Resources Development Plan and Water Sub-sector Development Plan

The M/P1995 showed water volume required for achieving the targets of the national plan, but the process of determining total demand which is the basis of development plan for water supply and irrigation was not clear. Demand options should be compared based on various development scenarios. Water source development projects (for surface and groundwater), water supply projects and irrigation projects did not progress as planned. The delay affected both rehabilitation of existing projects and proposed new facilities. Although it was pointed out that the projects were delayed due to budget shortfall, there were also problems related to operational system. There was also insufficient consideration in M/P1995 of other sub-sectors beyond water supply and irrigation; whereas the jurisdiction of those sub-sectors belongs to other ministries.

In recent years, the demands for flood/erosion control and small scale hydropower generation are increasing. In formulation of M/P2013 therefore, discussion of these new demands is deepened from the viewpoint of Integrated Water Resources Management (IWRM).

(4) Implementation of Water Resources Management Plan

M/P1995 proposed the foundation for monitoring system to observe the quantity and quality of water resources elements (climate, surface water and groundwater) but its implementation is delayed and persists till date. Since monitoring of water resources is the cornerstone of water resources management, in the formulation of M/P2013, the method of early realization of water resources monitoring system was examined.

New organizations such as NIHSA and NIWRMC were established changing the form but taking over the mode of the organization proposed in M/P1995. NIWRMC was established to be responsible for water resources management. M/P1995 did not mention the contents of water resources management. M/P2013 discussed the contents of water resources management that NIWRMC should carry out. Also, these new organizations have important roles to play together with existing ones. One of the challenges to be addressed in this regard is capacity development (CD). In addition, the revised M/P would discuss current challenges such as water resources information management, risk management (including drought, flood, cross boundary water), administration of water rights, conservation of the water environment, promotion of PPP, effective application of monitoring and evaluation (M&E) etc. M/P2013 would propose the practical measures to realize all these.

(5) Observation

The M/P1995 outlined the strategies to achieve the set targets. However, implementation of the proposed projects did not proceed as scheduled even after 20 years since the plan. This has made the achievement of the goals set for the water sector more challenging; and to achieve by 2020 as envisaged in NV20:2020. There are many posers to consider for this situation, some being:

1) Is it correct demand projection? (water supply unit rate, irrigation scale, cropping pattern, combination with irrigation and rain-fed agriculture etc.)
2) Is it weak implementation structure? (deficient regulatory & operational system, lack of human capacity, insufficient participation of relevant stakeholders etc.)
3) Is it lack of budget? (unsuitable project environment such as consensus building, poor project justification note, lack of lobbying for budget appropriation etc.).

In the preparation of M/P2013, measures to resolve these issues were examined.

2.2 National Water Resources Master Plan 1995 updated as M/P2013

(1) Framework of National Water Resources Master Plan 2013

Following from the ineffective implementation of Water Sector M/P1995 due to several reasons, it became imperative to do a review of it in light of emerging new realities, as it had become clearly outdated 20 years after its conception. The review and update is the current M/P2013.

As mentioned in the previous section, the national plans such as Nigeria Vision 20: 2020, Water Sector Roadmap informed the key policy thrust in the M/P2013. Accordingly, its goals are targeted to improve current situation in the water sector and address:

- Low rate of access to safe and clean water and sanitation facilities
- Low contribution of irrigation to national food security, and
- Insufficient utilization of hydropower as renewable source of energy.

The revised M/P involved evaluation of water resources potential and demand projection on the basis of the philosophy of integrating development, utilization and management of water resources. In formal terms, this is integrated water resources management (IWRM). The M/P2013 was prepared in this format.

(2) Definition

National Water Resources Master Plan (M/P2013)

The revised draft National Water Resources Master Plan (M/P2013) was prepared by JICA Project Team in collaboration with the Nigerian Counterpart Team based on available data and information and guided by the philosophy of IWRM. The main components of the plan are: (i) Water Sources Development Plan; (ii) Water Sub-sector Development Plan and; (iii) Water Resources Management Plan.

Integrated Water Resources Management (IWRM)

Integrated Water Resources Management (IWRM) is recognized globally as an effective method for the development and management of water resources. It is a process which promotes the coordinated development and management of water, land and related resources in order to maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment. IWRM is targeted at the following three integrations:

- Integrated consideration of the natural world: to consider, in an integrated manner, any form and stage of water in natural water cycle such as water resources & land resources, water quantity & quality, surface water & groundwater and so on. → Evaluation of Water Resources
- Integrated consideration of the various sectors related to water: to consider, in an integrated manner, various sectors which conventionally have been managed separately. (water for ideal rivers, flood control, water supply and sewerage, irrigation, industry and environment) → Clarification and Projection of Water Demand
- Participation of various stakeholders: to apply participatory approach to stakeholders at all levels including central government, local government, private sectors, NGO and residents → Consensus of Stakeholders

Water Sources Development Plan (WSDP)

Water Sources Development Plan (WSDP) adopts the approach of water resources development (such as dam/reservoir, intake facility, channel, well etc.) in meeting the needs of water users, on the basis of evaluation of water resources potential and projection of users' demand. WSDP plans physical infrastructures and operation systems. It targets new projects for water resources development. If the new water is developed by a change or remodeling of existing facility and system, this re-development is within the scope of WSDP. Also WSDP plans the mitigation measures for flood disaster. Target water resources are conventional ones such as surface and groundwater. But in semi-arid areas, non-conventional sources such as desalinated sea water and reclaimed waste water are targets of development.

Water Sub-sector Development Plan (WSSP)

Water Sub-sector Development (WSSP) is the approach of utilization of facilities and systems to meet demands of such sub-sectors as water supply, irrigation, hydropower generation etc. This plan is referred to as Sector Development Plan, such as water supply, irrigation development etc.

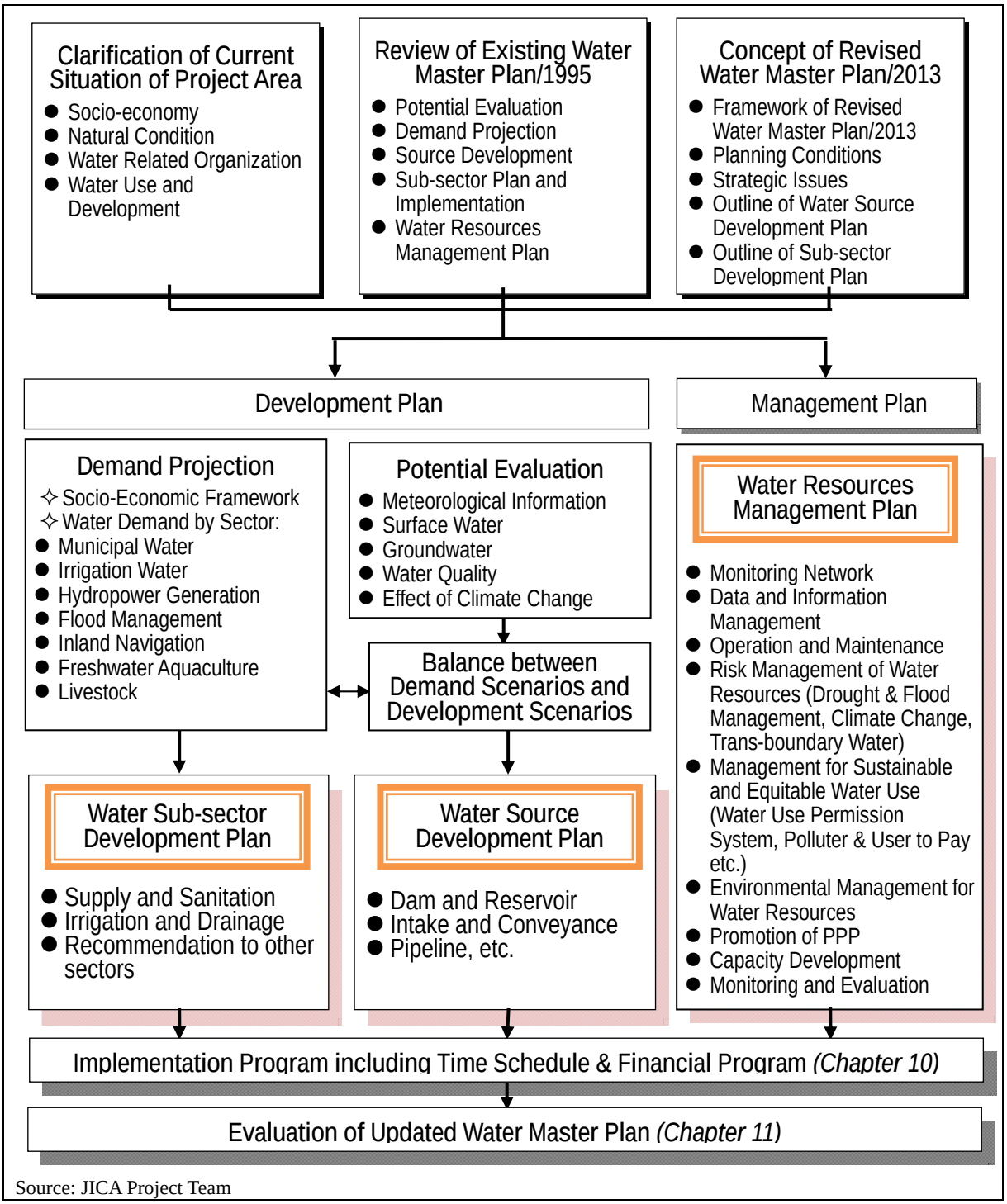
Water Resources Management Plan (WRMP)

Water Resources Management Plan (WRMP) is the approach of proper delivery of water services to meet water user's needs such as water supply, irrigation, hydropower, flood control and environmental protection, on the basis of sufficiency, efficiency, equitability and sustainability, by using facilities and operation systems established by WSDP and WSSP in a harmonious manner. A principle of water resources management is to monitor facilities and systems on a routine basis. A very important capability in this regard is weather & climate prediction (evaluation) for effective operation. It is important to have capacity to maintain, repair and improve the facilities and systems for water resources development / utilization / management. Also, WRMP includes the activity plans to support and improve technology and human resources.

(3) Content of National Water Resources Master Plan 2013

Figure 1 shows the contents of the M/P2013 including its three main components:

1) Water Sources Development Plan,
2) Water Sector Development Plan
3) Water Resources Management Plan.



Source: JICA Project Team

Figure 1 Contents of M/P2013

(4) Planning Conditions

In principle, the planning conditions shown in Table 1 were considered in the formulation of the M/P2013.

Table 1 Planning Conditions

Items	Planning Condition
Flow and Climate Condition	1) Future climate condition is never certain. Therefore, the planning will be based on the existing climate and runoff conditions. 2) As a basic condition of the climate, the existing climate condition (40years: 1970-2009) is applied. Based on the existing runoff condition as well as the existing climate condition, the alternative options for water uses and water resources development will be examined.
Climate Change Impact	1) The possible climate change impact on water resources and water demand will be treated as a risk factor which we cannot control as is the case of uncertainty associated with trans-boundary water. The sensitivity of the risk factor may be analyzed. 2) For the climate change scenario, the scenario based on the output of GCM would be applied.
Trans-boundary Water	1) There are large amount of inflow through the Niger River, Benue River and its tributaries, and Cross River. These inflows may be affected by water resources development and use in the neighboring countries, which is a risk factor that is not controlled. The risk factor may be examined by sensitivity analysis, if necessary. 2) Especially, i) Operation of Lagdo dam on the Benue River, ii) Operation of Kainji dam (under construction) in the upper Niger River will be carefully examined. The regulated water by those dams is not considered as a usable water source unless the minimum flow is set, by the assumption that the regulated water is basically utilized in the upstream countries.
Target Safety Level for Surface Water Development	1) The following target safety level for surface water development will be applied. a) Municipal Water Supply= 90% yearly dependable (1/10 years safety level: Lack of water once in 10years can be accepted.) b) Irrigation Water Supply= 80% yearly dependable (1/5 years safety level: Lack of water once in 5years can be accepted.) c) Other Water Supply = 80% yearly dependable (1/5 years safety level: Lack of water once in 5years can be accepted.) It is noted that municipal water supply includes domestic, industrial and commercial water supply system.
Priority of Water Use	1) The following principles are considered, when the surface water resources development is planned. a) The highest priority is given to domestic water use, without compromising health and quality of the environment. b) The second priority is given to irrigation water use in order to assure food security. 2) Based upon the above-mentioned principles, the following priority order of consumptive water use will be applied, when surface water resources development is planned. 1st priority: Minimum stream flow requirement 2nd priority: Municipal water supply 3rd priority: Irrigation water supply 4th priority : Other water supply, if any When the hydropower component that is non-consumptive water use is included in the water resources development, the optimum use of hydropower will be considered, under the above-mentioned priority order. 3) For actual operation during extreme event such as drought or flood conditions, the priority should be discussed among stakeholders case by case. This is a part of risk management of water resources. To do so, the master plan may recommend the establishment of the committee of water use in each HA.
Minimum Stream Flow Requirement	1) Q_{97DS}90%Y (90% yearly dependable 97percentaile daily flow for a single year), which has been estimated in the present project and may represent the drought condition according to the flow regime in each area in Nigeria, will be applied as the minimum stream flow requirement, when the surface water resources development is planned in the present project. 2) In the future, when more data for river discharge as well as river conditions will be accumulated, more details to set appropriate minimum stream flow requirement should be discussed among stakeholders.
Groundwater Development	1) Basically, groundwater use that exceeds safe yield should not be planned.

Source: JICA Project Team

(5) Strategic Socio-Environmental Consideration

The main target of the M/P2013 is to enhance the social welfare and to contribute to Nigeria's economic growth according to the national plans such as "Nigeria Vision 20: 2020", although some negative socio-environmental impacts by implementing the M/P2013 could appear. In order to avoid significant negative socio-environmental impacts, the followings are strategically considered for formulating the M/P2013.

Water Source Development

- Groundwater development is to be less than safe yield so as to secure sustainable usage of groundwater.
- Necessary new dam sites would be proposed on the basis of water balance study utilizing currently available information and data.
- The potential dam and reservoir sites where large town could be inundated would not be selected even though they are economically efficient sites, in order to avoid significant social impact of resettlement.

Water Supply and Sanitation

- New development of water supply facilities would be minimized, by promoting effective use of the existing water supply facilities by means of rehabilitation of the facilities.
- Considering the expected increase in waste water according to the increase of municipal water demand and use, sanitation and waste water management would be more highlighted compared to M/P1995, in order to secure clean and safe water.

Irrigation and Drainage

- Standard cropping pattern for each hydrological area would be proposed, in consideration with precipitation and flow pattern for each hydrological area, so that water resources are efficiently utilized.
- In general, new irrigation scheme would not be proposed in the existing Fadama area, so that the existing small private famers in Fadama area could secure their current practical life style.
- Supplemental irrigation scheme which utilizes rain water efficiently would be promoted in such area where precipitation is high as HA-5 and -7, in order to minimize water source development.

(6) Usage of National Water Resources Master Plan 2013

The M/P2013 deals with nationwide water resources development and management in Nigeria comprehensively. This is definitely beneficial to Federal Ministry of Water Resources (FMWR) as the national institution in charge of water resources development and management. But, many activities of water resources development and management should be carried out at the level of hydrological area or state level, while some of the sub-sectors are under the jurisdiction of other federal ministries or agencies.

Therefore, the M/P2013 is formulated to be used practically as follows:

- Application to catchment management plan for each hydrological area
- Application to sub-sector development plan mainly in water supply, sanitation, irrigation and drainage

(7) Outline of National Water Resources Master Plan 2013

Water Source Development Plan

The water source development plan is proposed on the basis of water balance between water demand and water supply capacity, in consideration uneven distribution of water demand and water resources potential across the country. The basic concept for water source development plan for surface and groundwater is shown in Table 2.

Table 2 Basic Concept on Water Source Development

Source	Basic Concept
Surface Water	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 in order to prepare for the expected increase in the water demand. Preparation of Sufficient Surface Water Source to Address Increasing Water Demand in Consideration of Uneven Distribution of Water Resources in the Country The primary objectives of the surface water resources development is to prepare and supply sufficient volume of surface water in accordance with the expected increasing demand of water users such as municipal water supply and irrigation water supply. The water resources development should consider the unevenly distributed water resources in the country. The following are considered. ● The required water resources development would be proposed by utilizing the proposed dams in M/P1995 as the potential dams as well as 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, demand control such as reduction of planned irrigation area and/or changing the crop should be considered as one of the options for managing the available water, in order to avoid conflict among water users. ● The integrated development with hydropower generation and irrigation components is proposed in order to promote self-reliant project.
Groundwater	Sustainable and efficient groundwater development Issues listed below should be considered in groundwater development ● Amount of groundwater development should be less than the amount of groundwater recharge for sustainable groundwater development ● Aquifer capacity should be taken into account in groundwater development for each region. ● Efficient location of boreholes should be planed for maximum yield from boreholes with minimum drawdown of groundwater level. Rehabilitation and repair of borehole facilities ● Borehole operational rate is currently only 63% in Nigeria. Breakdown of pumps is the main reason of nonoperational boreholes. Broken pumps should be repaired to recover borehole capacity, and borehole maintenance should be strengthened to keep high borehole operational rate. ● Yield of boreholes should be increased by changing pump type from hand pump to motorized pump to meet future groundwater demand with minimum number of boreholes.

Source: JICA Project Team

The basic concept for water source conservation is shown in Table 3.

Table3 Basic Concept on Water Source Conservation

Source	Basic Concept
Surface Water	Conservation of surface water resources would be implemented inside dams and reservoirs as well as in a watershed area. Both activities are related to each other. The former is a part of dam management activities, and will thereby be proposed to be enhanced together with measures for recovering and upgrading functions of existing dams. This is mainly implemented by dam owners. On the other hand, the latter needs cooperation among a wider range of stakeholders in a watershed, which deals with environment management, water quality management, erosion control etc.
Ground-water	Groundwater conservation in quantity and quality is important for sustainable usage of groundwater. It is taking place in many boreholes: i) lowering of groundwater level and drying up of boreholes due to over pumping, ii) deterioration of groundwater quality by sea water intrusion and infiltration of domestic drain and factory pollutant into aquifer. Pumping will be controlled as quantity conservation based on aquifer capacity assessment. On the other hand for quality control, pumping will be controlled against sea water intrusion, and pollutant discharge will be controlled against pollutant infiltration based on water quality standard. Guideline for these measures will be prepared, and technical transfer is necessary for NIWRMC, CMO, NIHSA, which are in charge of groundwater management and conservation.

Source: JICA Project Team

Water Sub-Sector Development Plan

The basic concept of sub-sector development plan related to water resources development has been prepared for the following sub-sectors which are under jurisdiction of FMWR; Water Supply and Sanitation, and Irrigation and Drainage. For the other sub-sectors such as hydropower generation, flood and erosion control, inland transportation, inland fishery, livestock, recommendations are provided.

Table 4 shows the basic concept of the sub-sectors.

Water Resources Management Plan

Water Resources Management Plan (WRMP) shows the approach of proper delivery of water services meeting water user's needs on the basis of sufficiency, efficiency, equitability and sustainability, by using facilities and operation systems to be established by WSDP and WSSP.

Water Resources Management Plan (WRMP) is established based on the following strategies:

Strategy-1 Operation and maintenance for quantitative and qualitative provision of water resources
Strategy-2 Regulation and conservation of water resources from quantitative and qualitative point of view
Strategy-3 Coordination among organizations and mediation between users
Strategy-4 Facilitation and improvement of water resources development / utilization / management

In order to realize appropriate water resources management, the M/P2013 proposes the measures by which the following would be undertaken:

- Establishment of organizations & institutions for public water services
- Development of water resources facilities, their operation & maintenance
- Hydrological monitoring
- Data & information management of water resources
- Flood plains control
- Consideration of risks caused by climate change and trans-boundary water
- Water allocation and regulation
- Water environment conservation
- Public relation on water resources
- Public-Private Partnership
- Human resource development, and
- Monitoring and Evaluation

Table 4 Basic Concept on Sub-Sector Development

Subsector	Basic Concept
Water Supply and Sanitation	● Water supply plan of New infrastructure, upgrading, rehabilitation and expansion of existing infrastructure, to respond to increase in water demand ● Water supply plan in consideration of optimum and sustainable utilization of water resources (surface water and groundwater) and areal demand distribution ● Sanitation plan considering criteria on standard sanitation facilities in accordance with settlement classification
Irrigation and Drainage	● To complete early on-going public irrigation schemes ● To implement rehabilitation and expansion of public irrigation schemes which FMWR identifies as high priority ● To develop new water resource for high priority public irrigation schemes ● To utilize existing dams for public irrigation schemes and expand its system developed area ● To develop new proposed irrigated farmland ● To formulate effective structure for operation and maintenance to run schemes
Hydropower generation	● On the basis of the updated results for the water resources potential, the potential sites for hydropower generation would be examined at conceptual level. The recommendation would be provided for future development of hydropower generation from the view point of water resources management. ● Necessity of coordination among water users when hydropower plant is installed in a multi-purpose dam managed by FMWR would be examined at conceptual level. Recommendation would be provided.
Flood and Erosion Control	● Strategies related to water resources are as follows: - Proper development and management of floodplain along Niger and Benue Rivers, - Implementation of flood control project in urban centers and developing flood warning system as a disaster management, and - Implementation of erosion control project. ● Considering the strategies shown above, the concepts of dealing with the sector are as follows: - The role of FMWR on the flood and erosion control would be examined from the view point of water resources management. The items related to flood and erosion control to be done by FMWR would be proposed.
Inland Transportation	● National strategies on the sector are as follows: - Operation and Maintenance of inland navigation route, and - Securing enough investment for developing inland navigation as a part of integrated transportation system. ● Considering the strategies shown above, the concepts of dealing with the sector are as follows: - Recommendations would be made on the necessary measures in flood plain management for the purpose of navigation management.
Inland Fishery	● Water demand of freshwater aquaculture would be estimated and its water balance with water supply capacity would be checked. Recommendation on necessary coordination with other water users would be provided.
Livestock	● Water demand of livestock would be estimated and its water balance with water supply capacity would be checked. Recommendation on necessary coordination with other water users would be provided.

Source: JICA Project Team

CHAPTER 3 PROJECTION OF FUTURE WATER DEMAND

3.1 Planning Parameters & Condition

The planning socio-economic parameters and conditions considered in the formulation of M/P2013 are outlined below:

(1) Population

The long-term projection of population is indispensable for formulating the future framework of socio-economic structure in the project area. The population projection up to 2030 was done based on the following data:

- Census Population of 1991 and 2006
- Estimated Population of 2010 by the United Nations

The 2010 Revision of World Population Prospects by the United Nations projected 3 different scenarios for future population of Nigeria, as presented in Table 5. The median, case-2, is similar to the estimated population utilized by FMWR. Accordingly, based on case-2, JICA Project Team projected the state-wise and HA-wise future population up to the target year 2030 as shown in Table 6.

Table 5 Projected Population of Nigeria by United Nations (in millions)

Population		2010	2015	2020	2025	2030	2050
Case-1 High	Population	158.4	181.1	207.6	237.1	269.2	433.2
	(Growth Rate)	-	(2.72%)	(2.77%)	(2.69%)	(2.58%)	(2.41%)
Case-2 Median	Population	158.4	179.7	203.8	229.7	257.8	389.6
	(Growth Rate)	-	(2.56%)	(2.55%)	(2.42%)	(2.33%)	(2.09%)
Case-3 Low	Population	158.4	178.4	200.0	222.4	246.3	348.3
	(Growth Rate)	-	(2.41%)	(2.31%)	(2.15%)	(2.06%)	(1.75%)

Source: "The 2010 Revision of World Population Prospects" by United Nations

Table 6 Census and Projected Population (in thousands)

Region		Census [1]		Estimate [2]	Projection [2]			
		1991	2006	2010	2015	2020	2025	2030
Nigeria		88,992	140,432	158,423	179,791	203,869	229,796	257,815
Growth Rate		-	3.18%	3.06%	2.56%	2.55%	2.42%	2.33%
State-wise [3]								
1	Abia	1,914	2,845	3,157	3,519	3,918	4,334	4,771
2	Adamawa	2,102	3,179	3,543	3,968	4,436	4,930	5,450
3	Akwa Ibom	2,410	3,902	4,427	5,049	5,749	6,500	7,305
4	Anambra	2,796	4,178	4,642	5,180	5,774	6,396	7,050
5	Bauchi	2,862	4,653	5,284	6,034	6,878	7,783	8,756
6	Bayelsa	1,122	1,704	1,902	2,133	2,388	2,656	2,940
7	Benue	2,753	4,254	4,767	5,370	6,038	6,746	7,497
8	Borno	2,536	4,171	4,751	5,442	6,222	7,062	7,966
9	Cross River	1,911	2,893	3,225	3,612	4,040	4,490	4,965
10	Delta	2,590	4,112	4,641	5,266	5,965	6,710	7,505
11	Ebonyi	1,454	2,177	2,420	2,703	3,014	3,341	3,684
12	Edo	2,172	3,233	3,589	4,002	4,456	4,932	5,432
13	Ekiti	1,536	2,399	2,696	3,046	3,435	3,848	4,288
14	Enugu	2,125	3,268	3,658	4,115	4,621	5,157	5,724
15	Gombe	1,489	2,365	2,670	3,029	3,431	3,860	4,318
16	Imo	2,486	3,927	4,427	5,017	5,675	6,377	7,124
17	Jigawa	2,876	4,361	4,864	5,451	6,100	6,783	7,504
18	Kaduna	3,936	6,114	6,861	7,739	8,715	9,750	10,849
19	Kano	5,810	9,401	10,663	12,160	13,843	15,646	17,581
20	Katsina	3,753	5,802	6,503	7,326	8,239	9,205	10,231
21	Kebbi	2,068	3,257	3,668	4,152	4,692	5,267	5,880
22	Kogi	2,148	3,314	3,713	4,181	4,699	5,248	5,831
23	Kwara	1,548	2,365	2,643	2,968	3,327	3,707	4,108
24	Lagos	5,725	9,114	10,293	11,687	13,247	14,912	16,690
25	Nassarawa	1,208	1,869	2,096	2,362	2,657	2,970	3,302
26	Niger	2,422	3,955	4,496	5,141	5,866	6,646	7,484
27	Ogun	2,334	3,751	4,247	4,835	5,495	6,200	6,955
28	Ondo	2,250	3,461	3,875	4,359	4,896	5,464	6,066

Region		Census [1]		Estimate [2]	Projection [2]			
		1991	2006	2010	2015	2020	2025	2030
29	Osun	2,158	3,417	3,854	4,369	4,946	5,559	6,214
30	Oyo	3,453	5,581	6,328	7,215	8,211	9,278	10,423
31	Plateau	2,105	3,207	3,581	4,018	4,501	5,011	5,550
32	Rivers	3,188	5,199	5,908	6,752	7,703	8,723	9,821
33	Sokoto	2,397	3,703	4,150	4,674	5,255	5,871	6,524
34	Taraba	1,512	2,295	2,560	2,869	3,211	3,572	3,952
35	Yobe	1,400	2,321	2,650	3,042	3,486	3,964	4,481
36	Zamfara	2,073	3,279	3,697	4,190	4,742	5,329	5,955
37	FCT (Abuja)	372	1,406	1,974	2,816	3,998	5,569	7,639
	HA-wise [3]							
1	Niger North	-	15,252	17,142	19,361	21,829	24,448	27,231
2	Niger Central	-	14,802	17,018	19,779	23,064	26,828	31,171
3	Upper Benue	-	10,866	12,220	13,807	15,565	17,427	19,398
4	Lower Benue	-	7,299	8,301	9,513	10,909	12,454	14,173
5	Niger South	-	17,504	19,644	22,161	24,959	27,924	31,078
6	Western Littoral	-	31,864	35,910	40,690	46,036	51,735	57,821
7	Eastern Littoral	-	18,578	20,803	23,410	26,302	29,359	32,593
8	Lake Chad	-	24,267	27,385	31,070	35,205	39,621	44,350

Note: A figure of the Case-2 (median growth) set out in Table 5 is applied for projection from 2015.
Source: 1) NPC - Census, 2) United Nations - Estimate and Projection of Nigeria, and 3) JICA Project Team - State-wise and HA-wise estimate and projection on the basis of the projection on Nigeria by the United Nations

(2) Growth of Industry

An annual growth rate of 8.5% is applied for the manufacturing sector GDP in terms of industrial water demand projection based on the following criteria:

- NBS estimates the averaged GDP growth rate of 7.3% in “Revised Economic Outlook for 2012 – 2015, September 2012”.
- The GDP growth rate of the manufacturing sector has generally recorded higher than that of the nation’s GDP.
- The real growth rate of the manufacturing sector was 8.4% on average over the period between 2006 and 2011.

3.2 Municipal Water

(1) Domestic Water

Domestic water consists of drinking, cooking, bathing, flushing and washing water, and also other water usage in daily life. It typically grows not only by increase in population served but also by changes in lifestyle due to improvement in living standards.

Daily average domestic water consumption is calculated by multiplying population served by per capita consumption (lit/cap/day).

(2) Categorization of Settlement & Categorization of Water Demand Projection

Categorization of settlement by population size, consisting of three categories for water supply planning, has been defined by the Federal Ministry of Water Resources (FMWR). This project conforms to this categorization shown in the Table 7. The per capita consumption of domestic water based on this categorization is applied in water demand projection.

However, water demand projection by settlement category based only on population size may lead to inaccuracy because there is mixture of various water supply schemes, various living or water usage situations, and various income groups within a settlement category. In the process of water demand projection, the project included an additional category shown in Table 7 and allocated population based on referenced indicators such as household using flush toilet.

Table 7 Categorization of Settlement & Categorization of Water Demand Projection

Population Size		Settlement Category	Typical Water Supply Scheme	Category of Water Demand Projection
1	More than 20,000	Urban	Surface water, piped supply, house or yard connection	Urbanized water usage (referenced indicator: household using flush toilet)
2	5,000 to 20,000	Semi-Urban or Small Town	Surface or groundwater, small scale piped supply, communal standpipes, house or yard connection	Semi-urbanized water usage (except 1 above and 3 below)
3	Less than 5,000	Rural	Ground water, 250m radius, 250-500 persons per point	Rural water usage (referenced indicator: household using hand pump)

Source: JICA Project Team

(3) Water Supply Coverage

National water supply coverage of 75% in 2015 as midterm goal and 100% in 2025 as long-term goal specified in the Sector Roadmap 2011 by FMWR were considered as guidepost. Water supply coverage in each target year was set for the above settlement categories based on projected population size and socioeconomic conditions as outlined above.

In this regard, it utilizes the water supply coverage by settlement category at the state level, published by the results of Core Welfare Indicators Questionnaire Survey (CWIQS), 2006 in order to estimate present water demand, and then applies them respectively as an average to the local government areas across the board in each State.

Summation of water consumption by LGA on the basis of the above supply coverage and attainment of 100% in 2025 with constant improvement of supply coverage resulted in national water supply coverage of 56% in 2010, 71% in 2015 and 85% in 2020 as each target coverage. Refer to Table 8.

Table 8 National Water Supply Coverage by Settlement Category in Target Years

Target Year	National Water Supply Coverage			
	Nationwide	Urban	Semi-Urban, Small Town	Rural
2010 (Current) Estimated by this Project	56%	72%	51%	40%
2015	71%	81%	68%	60%
2020	85%	91%	84%	80%
2025	100%	100%	100%	100%
2030	100%	100%	100%	100%

Source: JICA Project Team

(4) Population Served

Based on the above coverage, the study estimated the population served as shown in Table 9.

Table 9 Population Served

	Population Served (1,000 persons)				
	2010	2015	2020	2025	2030
Nationwide	79,848	120,287	170,100	229,796	257,815

Source: JICA Project Team

(5) Per Capita Consumption of Domestic Water

Current water supply coverage and the rate of growth of water demand due to increasing population are used in the estimations; and in addition to these, per capita consumption is considered due to improvement in living standards, as earlier explained. The project applied current per capita consumption shown in Table 10 and extrapolated till 2030.

Table 10 Per Capita Consumption of Domestic Water

Settlement (Water Supply) Category		Category of Water Demand Projection	Per Capita Consumption
1	Urban	Urbanized water usage	120 lit/cap/day
2	Semi-Urban or Small Town	Semi-urbanized water usage	60 lit/cap/day
3	Rural	Ruralized water usage	30 lit/cap/day

Source: Federal Ministry of Water Resources (FMWR)

(6) Commercial Water

Commercial water is defined as water for public and private institutions, stores and shops, accommodation facilities, hospitals and clinics, educational institutions, urban greening, etc. It typically grows by not only growth of urban activities but also as a result of improvement in facilities and equipment of institutions.

Daily average commercial water consumption is calculated at the ratio of 10% of daily average domestic water consumption across the board at the State level except 20% for Kano, Lagos States and the FCT Abuja. These ratios referred to instances from Japan, the Philippines (Manila), Colombia (Bogota), Indonesia (Bali) and Brazil (Sergipe) because applicable data for Nigeria have not been confirmed.

(7) Industrial Water

Industrial water is defined as water used for processing raw materials, treatment, coolant, cleaning, etc. It typically grows by growth in socioeconomic activities.

Daily average industrial water consumption in 2010 was calculated at the ratio of 1.25% of daily average domestic water consumption in the Northern area, 2.5% in the Southern area and 5.0% in Kano and Lagos States. Up to 2030 daily average industrial water consumption is estimated to increase at an annual rate of 8.5% of the GDP growth rate.

As in the case of commercial water, these ratios for calculation of the water consumption in 2010 were referred to instances from Japan, the Philippines (Manila), Colombia (Bogota), Indonesia (Bali) and Brazil (Sergipe), because applicable data for Nigeria have not been confirmed.

(8) Water Loss

Water loss is defined as total volume of water leakage from pumping equipment, reservoirs and pipelines, and also unaccounted water due to illegal connections, that is, technically known as unaccounted for water (UFW). But most of State Water Agencies cannot figure out water loss ratio accurately because flat rate tariff is much more common in urban, semi-urban and small town water supplies in the country, which means near absence of water meter installation. Furthermore poor data management of existing facilities causes difficulty of status analysis. In view of these facts, 30% water loss rate was applied across the board except for rural water supply.

(9) Result of Water Demand Projection

The result shows that water demand based on the above basic conditions will nearly triple between 2010 and 2030. Refer to Table 11.

Table 11 Water Demand Projection

	Water Demand (Million Liter per Day : MLD)					2030/2010
	2010	2015	2020	2025	2030	Ratio
Nationwide	8,254	11,666	15,890	20,994	23,876	2.9

Source: JICA Project Team

(10) Sensitivity Analysis on Water Demand Projection

The master plan did sensitivity analysis for water demand with a view to achieving the 100% target set. It worked around the constraints of lack of information on the amount of current water loss as a result of leakages, “illegal” use, existing distribution network; all of which are issues in operation and maintenance.

3.3 Irrigation Water

(1) Development of Agriculture & Irrigation

Major crops produced in Nigeria are rice, cassava, yam, maize, sorghum, millet, groundnut, etc. The country is self-sufficient in most basic staples such as cassava, yam, etc. but the country is still heavily dependent on import of agricultural commodities and processed food particularly rice, wheat, sugar, livestock products and fish. Rice and cassava are especially identified as strategic crops to the nation. The potential irrigable area in the country is estimated at 3.14 million hectares but irrigated paddy farmland is about 48,000 hectares. It is necessary to expand irrigable farmland and rain-fed paddy for food security; accelerate the rehabilitation and expansion of existing public irrigation schemes and development of new irrigated farmlands.

Key ingredients of Nigerian agricultural and irrigation policies are (a) enhanced agricultural productivity, (b) expanded irrigated farmland, and (c) internal reform of irrigated farming. The main features of irrigated farming in this master plan based on Nigerian development policies for agriculture and irrigation sectors are as follows:

- Completion of ongoing schemes for irrigation development and rehabilitation,
- Development of new irrigated farmlands,
- Increased rice production,
- Expansion of rain-fed farmlands, growth of crop production and
- Creation of employment opportunity

(2) Current Irrigation Water Demand

The overall water demand is 872MCM in the wet season and 1,054MCM in the dry season, and the total amount is 1,926MCM year-round. The total amount corresponds approximately to 0.7% of Nigeria's surface water abundance of 286,600MCM. Refer to Table 12.

Table 12 Current Irrigation Water Demand

Water Source	Type	Area (ha)	Wet Season (MCM)	Dry Season (MCM)	Total (MCM)
Surface Water	Irrigation scheme[1)]	142,106	741	345	1,086
Sub-surface Flow	Fadama, partial Small-scale private irrigation	93,000	0	361	361
Groundwater	Small-scale private irrigation	90,000	131	348	479
Total		829,252	2,052	4,193	6,245

Source: JICA Project Team

(3) Future Irrigation Water Demand

The overall water demand is 2,052MCM in the wet season and 4,193MCM in the dry season, and the total amount is 6,245MCM year-round. The total amount corresponds approximately to 2.6% of Nigeria's surface water abundance of 286,600MCM. Refer to Table 13.

Table 13 Irrigation Water Demand

Water Source	Type	Area (ha)	Wet Season (MCM)	Dry Season (MCM)	Total (MCM)
Surface Water	Irrigation scheme[1)]	494,252	1,720	2,712	4,432
Sub-surface Flow	Fadama, partial Small-scale private irrigation	139,000	0	617	617
Groundwater	Small-scale private irrigation	196,000	332	864	1,196
Total		829,252	2,052	4,193	6,245

Source: JICA Project Team

3.4 Other Sub-Sectors

(1) Livestock

Dependence of livestock on surface water is greater in the southern part of the country than in the northern part where larger herds of livestock rely on groundwater and remaining water in fadama. The method of estimating annual water demand of livestock was based on the text of FAO livestock guideline for African region. The projected water demand of livestock in 2030 amounts to 320.8 MCM, as against 232.8 MCM in 2010.

(2) Freshwater Aquaculture

This sub-sector has been recording fast supported by policy orientation with the application of subsidy for private facility development, propelled by rapid growth of domestic demand for fish. The southern states in HA-5 and HA-6 are centers of this activity because many feed mills and fingerling hatcheries are available for fish farming.

The method for projecting future water demand for this subsector was based on the data in the "Inventory of Private and Government Fish Farms", summarized by the fishery department of MFARD in 2007. Here 6,126 ha were identified as the size of fresh inland water area as at 2007. Fish yield per ha is calculated to grow from 1.4 t/ha in 2007 to 8.6 t/ha in 2030, and the water surface area required for producing future annual demand projected for 2030 is estimated at 38,880ha assuming this future yield. Water demand for inland fish farming will therefore increase from 727.8 MCM in 2007 to 1,166.1 MCM in 2030.

(3) Hydropower Generation

In Nigeria, stable supply of electricity is a major element for development. The hydropower generation can contribute to it significantly. It is therefore a major user of water resources in the country.

However, water use for hydropower generation is non-depleting, so total water quantity is not reduced by it. Nonetheless, the flow regime may be altered in case of hydropower generation with storage dam. The optimum utilization of water for hydropower generation is desired under the condition that it would not inhibit water use such as municipal and irrigation in downstream reach.

(4) Flood Control

Flood refers to rainwater stagnation or overflow from river channels in areas that are usually dry. Flood control means control of flood water by storing rain and river water in ponds and reservoirs and/or let a river water flow downstream safely through man-made channels.

In flood control, water intake and consumptive uses of water are not common, so quantitative evaluation of water demand is not conducted.

However, flood control measures such as flood storage in multipurpose dam reservoirs and rain water harvesting in arid areas can contribute to water resources development. They should therefore be considered in Nigeria in the future.

(5) Inland Water Navigation

Inland Water Navigation is becoming more important as a matter of policy to achieve intermodal transportation system in the country. However, since inland water navigation is under jurisdiction of NIWA in Federal Ministry of Transport, information on this sub-sector is limited that the water demand such as discharge in navigation routes are not addressed. So the operation and maintenance of major rivers having navigation routes will be significant in Nigeria. Water demand for inland water navigation should be evaluated comprehensively such as river discharge for each river section in normal times when local water demands of other sub-sectors along the rivers are studied in details.

(6) Minimum Stream Flow Requirement

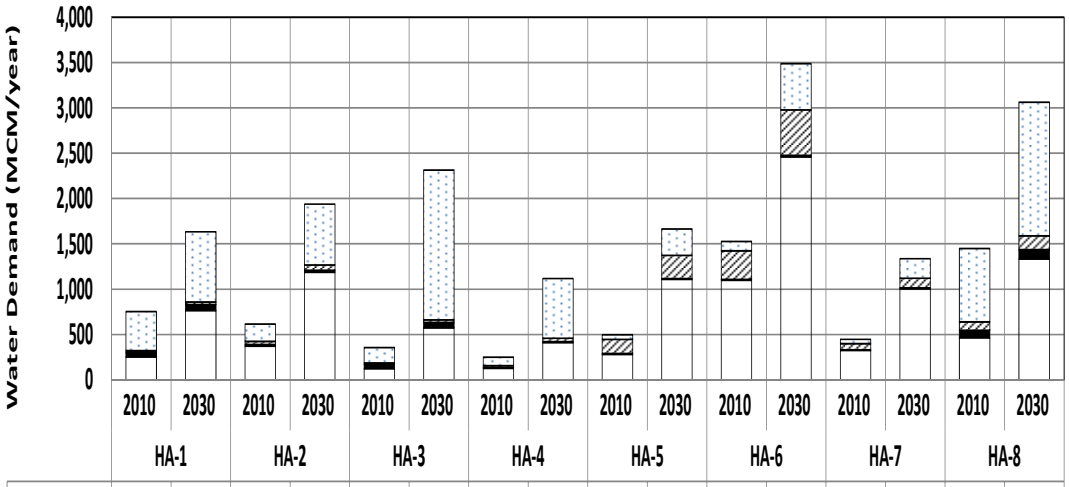
Aside from the water demand shown in the previous sections, the minimum stream flow requirement should be observed as a higher priority in order to protect the environment of the water body and for other important reasons. There is no authorized method to determine the minimum stream flow requirement in Nigeria at the moment.

It should be noted that the minimum stream flow discussed in the present project could be used as a guide for the overall water resources planning and management. It may require more detail study before a particular project is actually implemented, however. It is desirable that more appropriate minimum stream flow requirement for each of the rivers be set based on discussion among stakeholders, when more reliable data of river conditions such as river discharge will be available.

3.8 Water Demand Structure

Figure 2 shows the water demand by each sector for each HA. From the figure, the following are noted.

- The present municipal water demand is highest in HA-6, followed by HA-8. This will be kept in the future (2030).
- The present total water demand is highest in HA-6, followed by HA-8. This will be kept in the future (2030).
- The increasing rate of irrigation water demand in HA-3 is much higher than that in other HAs.
- The increasing rate of irrigation water demand in HA-3 is much larger than that in other HAs.



	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030	2010	2030
	HA-1		HA-2		HA-3		HA-4		HA-5		HA-6		HA-7		HA-8	
Irrigation	431	775	191	672	169	1,650	94	661	48	293	103	508	49	215	808	1,473
AuqaCulture	18	29	36	57	17	28	22	36	158	254	315	505	67	107	94	151
Livestock	49	64	18	24	46	59	8	10	8	11	11	14	7	9	81	105
Municipal	254	766	371	1,186	125	576	127	411	281	1,108	1,099	2,460	325	1,004	464	1,333

Source: JICA Project Team

Figure 2 Water Demand by Sectors and by HAs

CHAPTER 4 EVALUATION OF WATER RESOURCES POTENTIAL

The evaluation of the water resources potential consisted of detailed scientific, climatic and geophysical analysis. However, the summary is as indicated in Table 14. The basis of estimation of the water resources potential is as follows.

- The output of long-term rainfall-runoff model with the input data of precipitation and air temperature for 40 years from 1970 to 2009 is used.
- The long-term rainfall-runoff model is setup based on the available observed discharge data at main hydrological stations, which covers the catchment area of rivers flowing into Nigeria except the upper Niger River as well as the territory of Nigeria.

The average precipitation over the country is about 1,150mm. Only 24% of the precipitation becomes runoff and the rest are lost as evapotranspiration and/or others. Total internal generation of the runoff is 244BCM/year and the surface water resources potential is estimated at about 333BCM/year. The total water resources potential can be evaluated by adding the component that is lost without becoming surface runoff among recharge. The internal generation of total water resources potential is estimated at 287BCM/year and the total water resources potential with inflow from neighboring countries is estimated at 375BCM/year. Out of this amount 88BCM/year of water comes from neighboring countries, which roughly indicates that almost 24% of surface water resources in Nigeria relies on neighboring countries. The total groundwater resources potential is estimated at 156BCM/year as a renewable source on the basis of the estimated groundwater recharge.

Table 14 Estimated Water Resources Potential

		HA-1	HA-2	HA-3	HA-4	HA-5	HA-6	HA-7	HA-8	Total
Total Water Resources Potential [1)]										
Including inflow from outside Nigeria	(BCM /year)	37.4	40.9	60.2	47.9	50.7	43.7	84.0	10.3	375.1
Only internal generation in Nigeria	(BCM /year)	10.7	40.3	37.9	32.8	50.7	43.6	60.3	10.3	286.6
Surface Water Resources Potential										
Including inflow from outside Nigeria	(BCM /year)	35.1	32.3	56.4	46.0	40.1	35.7	79.9	7.2	332.7
Only internal generation in Nigeria	(BCM /year)	8.4	31.7	34.1	30.9	40.1	35.6	56.2	7.2	244.2
Groundwater Resources Potential										
Groundwater Recharge	(BCM /year)	35.1	32.3	56.4	46.0	40.1	35.7	79.9	7.2	332.7
Runoff Condition（Only internal generation in Nigeria）										
Precipitation (P)	(mm/ year)	767	1,170	1,055	1,341	2,132	1,540	2,106	609	1,148
Total Runoff (RO)	(mm/ year)	62	205	218	415	744	359	978	40	268
Groundwater Recharge (GRE)	(mm/ year)	37	132	123	250	592	236	570	24	171
Loss of Recharge (LOS)	(mm/ year)	18	56	24	25	197	80	72	17	47
Runoff Rate (RO/P)	(%)	8.1	17.5	20.7	30.9	34.9	23.3	46.4	6.6	23.4
Recharge Rate (GRE/P)	(%)	4.8	11.3	11.7	18.7	27.7	15.3	27.1	3.9	14.9
Loss Rate (LOS/P)	(%)	2.3	4.8	2.3	1.9	9.2	5.2	3.4	2.9	4.1
Total Water Res. Rate ((RO+LOS)/P)	(%)	10.4	22.3	22.9	32.8	44.1	28.5	49.8	9.5	27.4

Source: JICA Project Team

CHAPTER 5 STRATEGIES

Following from the study done on the project, the strategic issues on water resources in Nigeria were identified. Accordingly, the following strategic issues were taken into account in formulating the M/P2013:

- Water Resources Management and Development in Consideration of Uneven Distribution of Water Resources and Demand
- Addressing Increasing Municipal Water Demand on the Premises of Current Low Operation Rate of Water Supply Facilities
- Promotion of Sound and Self-reliant Irrigation Development
- Effective Utilization of Existing Water Source Facilities in View of Contemporary Needs
- Enhancement of Water-related Data/Information Gathering and Its Uniform Management
- Consideration of Increasing Risk on Water Resources
- Active Involvement of Water Resources Administrator in the Management of Important Rivers and Flood Plains
- Water Quality Monitoring to Secure Clean and Safe Water
- Institutional Development & Strengthening of Water Resources Management

Strategic Issue-1: Water Resources Management and Development in Consideration of Uneven Distribution of Water Resources and Demand

The hydrological condition in Nigeria varies very much from region to region, resulting in uneven distribution of water resources across the country. The internal generation of water resources potential in the northern area such as HA-1 and 8 is less than 10 BCM /year, whereas in the southern area such as HA-5, 6 & 7 it is more than 50 BCM /year. Similarly, the population is unevenly distributed. The water resources potential per person (only internal generation) by hydrological areas differs more than ten times, although the average is 1,800m3/year/person in 2010 and 1,100m3/year/person in 2030, respectively. Those in HA-1 and 8 are especially low. It is necessary to consider these unevenly distributed water resources for effective and sustainable water use. The water resources management and development plan would be formulated based upon the water balance between supply capacity of water source and water demand. The water resources potential has been examined at the unit of SHA on the basis of the results of rainfall-runoff model in the master plan, which is utilized in the water balance study.

Strategic Issue-2: Addressing Increasing Municipal Water Demand on the Premises of Current Low Operation Rate of Water Supply Facilities

The current (2010) population of 150 million in Nigeria is expected to reach to 250 million by 2030 that is the target year of the updated master plan. It is the objective in the water sector to provide adequate volume of water to meet the demands of the increasing population.

The target for municipal water supply is set at 100% coverage in 2030 in Vision 20:2020, which is the country's national development plan, as well as the existing Water Sector Road map. The municipal water demand of 3.1BCM/year in 2010 would need to increase to 9.0BCM/year in 2030. This means that almost three times the current volume of water would be required in 2030.

On the other hand, the existing water supply facilities are not fully utilized; the average operation rates of water purification plant and production wells are 46% and 63% of their design capacity, respectively. This is one of the major reasons for the low coverage (about 50% on average) of municipal water supply. In order to improve the coverage of municipal water supply therefore, it is necessary to increase the operation rate of existing facilities as well as secure high operation rate for new facilities.

The first priority to improve the coverage of municipal water supply is to increase the operation rate of existing facilities through rehabilitation. The next step is to build new water infrastructures.

Strategic Issue-3: Promotion of Sound and Self-reliant Irrigation Development

Nigeria Vision 20:2020, the national development plan, targets the expansion of irrigation area in order to secure stable food supply. However, the developed irrigation area and the actually irrigated area are 130,000ha and 70,000ha, respectively, although the planned irrigation area is 440,000ha. The low operation rate of developed irrigation area could be caused by high operation and maintenance cost as well as deterioration of facilities, especially for the scheme that requires components such as pumps.

It is necessary to propose new schemes that are more economically efficient and self-reliant, instead of further developing existing schemes that have low efficiency, as a way to increase the effectiveness of irrigated areas. For example, gravity schemes which do not require pump and integrated schemes with hydropower generation that can supply energy internally within a project would be considered for the new schemes.

Critical ones among existing schemes would be selected for rehabilitation and expansion. Thereafter, new schemes would be introduced to further increase the irrigation coverage. Although most agricultural production in Nigeria relies on rain-fed cultivation, the irrigation area of about 500,000ha in 2030 can secure 100% self-sufficiency in production when combined with improvement of rain-fed cultivation. This aligns with existing policy on rice production.

Strategic Issue-4: Effective Utilization of Existing Water Source Facilities in View of Contemporary Needs

In Nigeria total storage capacity for the confirmed existing 170 dams in the country is 37.4billion m3. Among the total storage capacity of 37.4BCM, 25.8BCM is associated with large hydropower dams such as Kainji, Jebba and Shiroro. The remaining storage of 11.6BCM is mainly used for irrigation and municipal water supply. The total storage capacity is much larger than the expected total surface water demand in 2030. However, because the water supply and demand do not always match well at the local level, there would be excess volume of water in some places and lack of water in some other places. Unfortunately, the distance between these water sources is usually far. It is therefore difficult to utilize the excess water for the place where the demand is higher than the capacity in many cases. This therefore requires solving the problem locally.

The challenge is to determine how the excess volume of water is effectively utilized to meet contemporary needs; especially as it is expected that existing dams have excess volume even if the water demand in 2030 is considered. For example, part of the excess volume can be converted for flood control purpose if there is problem of flooding at downstream of the dam; or part of the excess volume may be converted for increasing hydropower generation; or enhancing river and flood plain environment. Making available stable supply of electricity is a major development issue in Nigeria, so conversion for hydropower generation would be a most ideal solution. The optimum utilization of the excess volume of water in existing dams would therefore be promoted in this master plan. This would be done during formulation of the Catchment Management Plan for each hydrological area.

Strategic Issue-5: Enhancement of Water-related Data/Information Gathering and Its Uniform Management

Currently water-related data/information on the operation of dams, water purification plants, irrigation schemes and production wells etc. is not uniformly managed. This makes it difficult to grasp rapidly and correctly the existing condition of water resources facilities in the country. It also serves as impediment to planning and design of any kind for water resources projects, leading to inefficiency and much waste. Furthermore, important meteorological and hydrological as well as water use data are also not managed uniformly. It also hampers daily operation of water resources facilities.

It is the important issue to establish the framework for periodical collection and uniform management of water-related data/information and to sustain its system. The cost of investment in enhancing water-related

data/information is usually much less expensive compared to investment in large scale water infrastructure projects. All stakeholders should recognize that this relatively small investment would finally benefit all water-related projects. Adequate investment in the water-related data/information should therefore be secured.

The strategy would be to enhance the capacity of FMWR and relevant agencies for periodic collection and uniform management of water-related data/information as well as promote awareness on the importance of basic water-related data/information.

Strategic Issue-6: Consideration of Increasing Risk on Water Resources

It is possible that changes in water resources associated with climate change can increase flood hazard as well as lower safety level of water supply. Although the future tendency on climate condition in the world can be predicted nowadays, the predictions by different climate models at the local level are still widely divergent. This makes it difficult to assess future conditions. However, the possibility of changes in water resources due to climate change cannot be ignored, because it is almost certain that changes would occur in the future. This kind of uncertainty would be treated as a risk factor and it is important to find ways of coping with the risk.

Besides, trans-boundary water which flow into Nigeria from upstream countries is also uncertain, because it is influenced by water resources development and management in those upstream countries. It should therefore be treated as a risk factor.

Identification of risk and the coping strategy for it is important. In order to identify the risk correctly, the enhancement of fundamental data/information including proper communication with neighboring countries should be promoted. As for coping with the risk, the following should be considered;

- Establishment of flexible implementation structure which can adapt to future changes, and
- Enhancement of emergency response for flood and drought conditions.

It should be noted that both rely on the availability of fundamental water-related data/information.

Strategic Issue-7: Active Involvement of Water Resources Administrator in the Management of Important Rivers and Flood Plains

Although rivers and flood plains are the places where water is located, their management body is not clearly defined. There was devastating damages on such rivers and flood plains during the large scale flooding along the Niger and Benue Rivers in 2012. In of the importance of proper management of rivers and flood plains where flood often disturb human activity with increasing frequency, it is necessary for a water resources administrator to be instituted to regulate river flow through operation of reservoirs and other river bodies.

The strategy is start with rivers on which large scale dams are located and engage in active data/information gathering for the purpose of correctly predicting of flood situations, control of low flow condition, dissemination of timely information etc. All of these are possible through intensive monitoring of the rivers and meteorological data gathering. It is therefore necessary to establish a robust monitoring system for this purpose.

Strategic Issue-8: Water Quality Monitoring to Secure Clean and Safe Water

It is important to ensure clean and safe water through proper water environmental management, in addition to water quantity conservation and development. However, because information on current water quality condition for both surface and groundwater is not available, it is difficult to assess the water quality for existing and future conditions and to consequently take decisions on them.

In order to have proper water environment management, the condition of water quality and quantity in terms of various water uses should be adequately studied by FMWR as the water resources administrator. The capacity of FMWR on water quality monitoring should therefore be enhanced.

Strategic Issue-9: Institutional Development & Strengthening of Water Resources Management

The FMWR has statutory responsibility mainly in water sub-sectors like water supply & sanitation, irrigation & drainage. Other sub-sectors such as hydro-electric power generation, flood control, inland water transportation, fisheries/aquaculture/livestock etc. are undertaken by Federal Ministry of Power, Federal Ministry of Environment etc. In addition, even in a single sub-sector, roles and responsibilities are further compartmentalized in most institutions. A major challenge in current water resources management is lack of adequate coordination and cooperation among statutory bodies, inconsistency of policies and strategies and perennial funding problem.

Under this circumstance, it is necessary to establish and strengthen a management system to be guided not at the administrative boundaries but at river basin level as the most appropriate unit, on the basis of a general principle of IWRM. An important foundation for this new institutional arrangement is the completion and implementation of the National Water Policy and promulgation into law the National Water Resources Bill. In addition, the enactment of the Bill to Establish NIWRMC which is now in process is urgently required. This bill is still awaiting Presidential assent.

Taking the current situation and issues with regard to the water resources management into account, development and strengthening of institutional framework should be promoted. In this regard, the following policy thrust should be pursued.

- Cooperative Institutional Arrangement
- Participatory Management Administration
- Fair Regulatory Framework
- Decentralization and Coordination

CHAPTER 6 WATER BALANCE BETWEEN DEMAND & SUPPLY

6.1 Overall Water Balance between Total Water Demand and Water Resources Potential

As shown in Chapter 3, the existing total water demand is estimated at 5.93BCM/year. It is expected to increase to 16.59BCM/year by 2030.

The water use rate varies from HA to HA. The rate in HA-8 in 2010 is 14%, which is much higher than the other HAs. In 2030, the water use rate in HA-8 may reach to about 30%, whereas the ratio in other HAs may be less than 10%.

The total water demand in 2030 is still much less than the total water resources potential. It should also be noted that the current usable water with stable supply to meet current demand is also much smaller than the surface water resources potential. Furthermore, water demand and water resources are unevenly distributed. This imposes the necessity that water resources development should be addressed at the local level; at least as a starting point from where other longer range solutions could be undertaken with time.

6.2 Procedure for Water Balance Study

The current demarcation of water source in Nigeria is estimated at 40% for groundwater and 60% for surface water. The share of groundwater in municipal water supply is high. This nature would be kept even in 2030, although the usage of surface water would increase in urban areas too. Considering this situation, the sustainability of groundwater use would be firstly examined. Then, the water balance for both groundwater and surface water would be studied.

6.3 Results of Water Balance Study

(1) Water Source for Municipal Water Supply

As the results of the water balance study for the relatively large scale water purification plants, it is evaluated that some water sources could experience the deficit for supplying necessary water volume for 2030 with 90% yearly dependability. The estimated total deficit is about 277MCM/year. The recommended measures against those deficits are proposed on the basis of the results of the water balance study.

(2) Water Source for Irrigation Water Supply

As the results of the water balance study for the existing large irrigation schemes whose planned area is more than 500ha (54 schemes with 125,000ha in total planned area), it is evaluated that the irrigable area in terms of stable water supply with 80% yearly dependability under the proposed standard cropping patterns is about 38,000ha, which is about 30% of the total planned area. The irrigation development plan as well as surface water development plan refers the evaluated results.

(3) Excess Storage Volume in Significant Dams

It was established that there could be excess storage volume in some significant dams, even if the demand for irrigation and municipal water supply in 2030 is considered. The total excess storage volume is estimated at 5.3BCM against the total effective storage volume of 9.8BCM. The excess storage volume can be utilized for several different purposes such as irrigation, municipal water supply, enhancement of firm energy of hydropower generation, reduction of peak flood discharge and enhancement of river environment. It is necessary to discuss how to use the excess storage volume by stakeholders in each hydrological area. It would be one of the important topics during formulation of the CMP.

CHAPTER 7 WATER SOURCES DEVELOPMENT PLAN

7.1 Groundwater Development Plan

(1) Merit of Groundwater Use in Nigeria

Merit of groundwater resources should be considered as mentioned below:

- Groundwater is stored in aquifer, which is widely distributed across Nigeria.
- Groundwater can be used even in dry season. On this point, groundwater is superior to surface water and rain-harvested water.
- Cost of groundwater development and usage is lower than cost of surface water in case where amount of groundwater development is small. Therefore, groundwater is suitable for rural water supply and small town water supply, which does not require large investment.
- Generally, groundwater has better water quality than surface water and does not need high level treatment even for drinking.

(2) Issues in groundwater usage

According to survey by FMWR on water supply infrastructure in 2006, 37% of existing boreholes are currently not used. Breakdown of hand pumps and motorized pump is the main reason for this. Users' organizations are in charge of maintenance of pumps for small town and rural water supply. However, most of the users' organizations are not functioning. As a result, many broken down pumps are left non-operative without being repaired. This situation must be improved upon.

(3) Optimum Method of Groundwater Development

Optimum groundwater development was examined based on groundwater recharge using borehole field theory. The amount of newly available groundwater was calculated for 6 aquifer types based on groundwater recharge, number of boreholes and distance between boreholes within borehole field.

7.2 Surface Water Development

(1) Proposed Project for Surface Water Development

The following projects were identified for development of surface water in the master plan:

Project 1-1: Capacity Development on Dam Management

The direction of improvement of dam management was discussed in Chapter 9 as one of the important elements of water resources management. This project is to enhance the capacity of the dam department in 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.

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 of reservoir operation etc. 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 dams which may threaten the downstream areas. The rehabilitation would be implemented case by case up to 2030. The conditions should be studied in detail for individual dam and the countermeasures implemented as required in each case.

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

This project is to provide stable water source for municipal water supply in those water sources 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 conducted, the surface water source development projects (23dams/weir) are proposed. The total storage capacity of the proposed dams is 381MCM.

Project 2-2: Surface Water Development for Irrigation

This project is to secure the required 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, the surface water source development projects (21 dams) are proposed. The total storage capacity of the proposed dams is 969MCM.

Project 2-3: Integrated Surface Water Development

Three project sites along the Benue River are proposed. The total storage volume of the proposed dams is 960MCM. 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.

This is an integrated project to combine hydropower generation and irrigation development. The energy required for pumping irrigation water is provided internally by the power generated in the project; this is to secure self-reliance and sustainability of the project.

(2) Potential Sites for Surface Water Source Development

In addition to the proposed dam sites in M/P1995, i) candidate sites for large scale dam (water depth is more than 30m), 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.

Among these potential sites, new dam sites are selected in consideration with needs on urban water supply, irrigation development as well as efficiency and socio-environmental impact.

(3) Possibility of Hydropower Generation in Surface Water Source Development Projects for Municipal Water Supply and Irrigation Development

The dam operation for water source development projects for municipal water supply and irrigation development basically follows the demands of municipal and irrigation water users. So, even if hydropower equipment is installed, its operation should follow the releases based on the requirements of other water users. How much energy can be generated in this case is 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).

As a result, the total installed capacity and generated energy could be 4MW and 24GWh, respectively. It is recommended that more detailed study be conducted when each project is to be implemented.

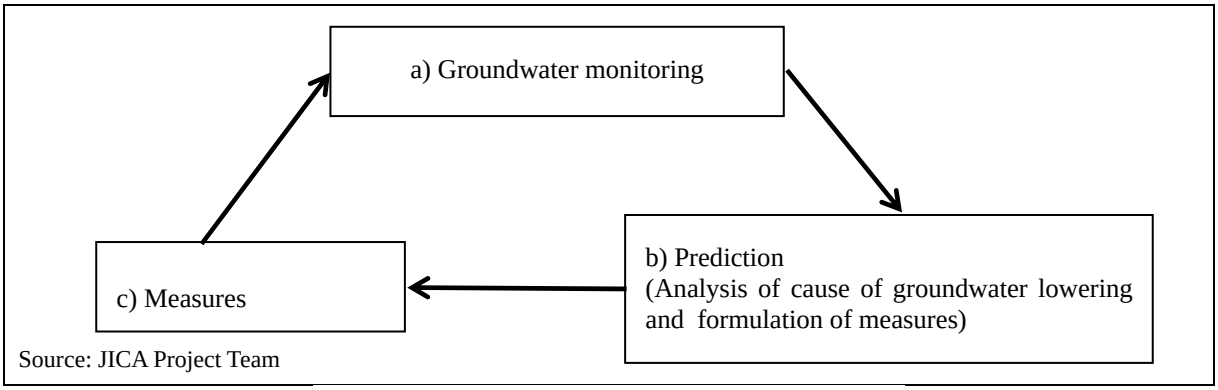
7.3 Water Resources Conservation Plan

(1) Conservation of Groundwater

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

Quantity Conservation

When groundwater is extracted more than groundwater recharge, lowering of regional groundwater level 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 shown in Figure 1. NIWRMC and CMO should take responsibility for implementing the cycle below.



Source: JICA Project Team

Figure 3 Concept of Groundwater Management

Quality Conservation

Groundwater will be contaminated when contaminated surface water infiltrate into the aquifer. When sea water has intruded into aquifer, groundwater will become salty. Type of groundwater contamination is shown in Table 15.

Table 15 Type of Groundwater Contamination and Measures against It

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

Method of Groundwater Management for Conservation

The method of groundwater management for conservation should be formulated based on local hydrogeological characteristics and water use conditions. 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 the country following the standard method shown below:

(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 4 Method for Groundwater Management and Development

Groundwater management plan should take into account the scale of target aquifer. The scale of aquifer can be classified as a) Large, b) Medium, c) Small, d) local, and the management method should be decided according to above classification as shown in Table -16.

Table 16 Groundwater Management Plan and Responsible Organization

Scale of Area		Responsible organization
a) Large	Multiple-Catchment level	•NIWRMC
b) Medium	Catchment level	•CMO NIHSA
c) Small	LGA level	•State Government
d) Local	Community level	•LGA

Source：JICA Project Team

Institutional Issues in Groundwater Management

Institutional improvement is necessary to resolve issues above. NIWRMC should implement activities below.

- Registration of borehole
- Permissible groundwater level
- Formulation of Groundwater management manual
- Information sharing among organizations in charge of groundwater management and groundwater users.
- Registration system of borehole drilling company

(2) Conservation of Surface Water Source

Issues on Conservation of Surface Water Source

The following table summarizes the issues in conservation of surface water source.

Table 17 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 no collaboration among 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 the activities of mining at artisanal and small-scale levels are very common. 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 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 countermeasures in the country, however, because of lack of fund this is not sustainable.	Risk assessment should be done 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 areas related to people's living condition such as keeping of transportation route, protection of residential areas and mitigating soil erosion into drainage. Little attention is paid to watershed conservation in which it takes a long time before taking action.	• Environmental education and awareness campaign on water resources protection • Risk assessment should be done nationwide in order to prioritize the critical projects to be implemented among the wide range of watershed.
Dams/Reservoirs	
The presence of aquatic plants in dams and reservoirs is of great concern that must be addressed. It is considered a nuisance since it interferes in the normal operation of dams. The introduction of nutrients such as P and N promotes the proliferation of this nuisance.	Aquatic plant control program was implemented by FME for many dams until 2011. A continuation of that program is under preparation by FME. It is proposed to make a joint-work between FME and FMWR for the recovery of affected dams from aquatic plants
Surveyed dams in this Study present problem of sedimentation and this has direct effect on their storage capacity.	Actions to control sedimentation effectively are necessary to be implemented such as: • Risk assessment to be done nationwide in order to prioritize the critical projects to be implemented among wide range of watershed size. • Economic comparison between dredging of reservoir and soil erosion countermeasures in each watershed

Source: JICA Project Team

Proposed Mechanism for Conservation of Surface Water Source

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

It is proposed that NIWRMC be responsible for coordinating the activities of various stakeholders through formulation and implementation of Catchment Management Plan in each hydrological area. The workable mechanism for cooperation among stakeholders in a catchment area should be explored during the formulation of the draft Catchment Management Plan.

CHAPTER 8 WATER SUB-SECTORS DEVELOPMENT PLAN

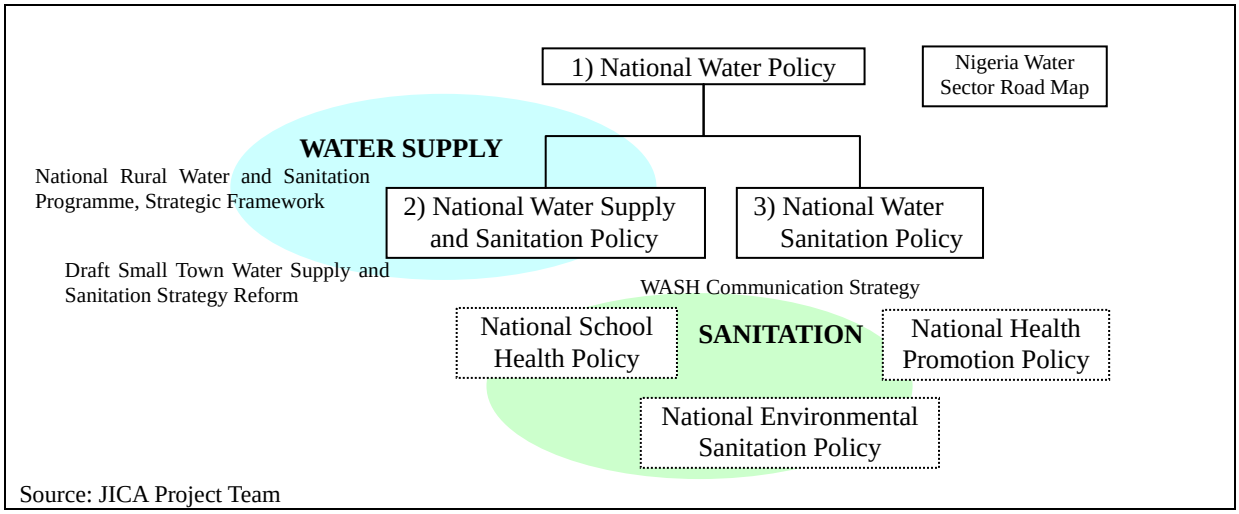
8.1 Water Supply and Sanitation Development Plan

The existing water supply infrastructures in Nigeria have not been optimally utilized as designed. This is evident from low production efficiency or operating rate of the facilities, such as 45.2% of surface water (water treatment works production-based) and 54.3% of groundwater (borehole number-based). This project observes that this fact is a major cause of low water supply coverage of 51.4% at the national level, as estimated by this study. Indeed, improvement of production efficiency or the operating rate of existing facilities in a sustainable manner through appropriate operation and maintenance are keys to boosting water supply coverage in the country.

In order to meet the increase in water demand in the future, this project plans to improve upon the low production efficiency of existing facilities using surface water in the short term and the operating rate of existing facilities using groundwater in the entire period. This would then be complemented by development of new facilities as required. Accordingly, the development plan of this master plan consists of rehabilitation of existing facilities and construction of new water projects; which would include expansion where necessary.

(1) Sector-Related Policies, Strategies and Documents

Figure 6 shows association chart of policies, strategies and documents relevant to the water and sanitation sector.



Source: JICA Project Team

Figure 6 Association Chart of Sector-Related Policies, Strategies and Documents

(2) Nationwide Water Supply and Sanitation Coverage

Water supply and sanitation coverage figures vary in existing policies, studies and other official documents. According to the Water Sector Roadmap 2011, the Federal Ministry of Water Resources (FMWR) accepted the coverage calculated by WHO/UNICEF Joint Monitoring Program (JMP) in 2008 as the latest coverage.

This project on the other hand utilizes the results of the Core Welfare Indicators Questionnaire Survey (CWIQ), 2006 for water demand projection; because it shows water supply coverage according to water supply category at the state level, and its nationwide coverage do not differ much from JMP, 2008

As a result of summation of population served by Local Government Area (LGA), nationwide water supply coverage estimated by this project is 56.2%, and 72.2% for urban and 39.9% for rural (51.3% for semi-urban/small-town); and these are adopted as the baseline values in this project.

As for Sanitation, this Project applies the results of National Demographic and Health Survey (NDHS) as baseline values, because it shows sanitation coverage at the state level.

(3) Urban Water Supply

Urban water supply is defined as water supply for 20,000 population size or more. This means that it is not only Abuja municipal area of the Federal Capital Territory (FCT) and 36 state capitals that are considered but also other local high-populated cities across the country.

Water supply services are carried out by the State Water Agency (SWA) known more commonly as State Water Board or Corporation, established by each State including FCT Abuja. Water is normally abstracted from river or dam as the water source, treated and distributed, but some cities rely on groundwater. Water service level is typical house or yard connections and some public standpipes. On the whole, most facilities and equipment have deteriorated and actually operate below their designed capacity due to age and inadequate maintenance. Asbestos pipes are mainly used for reticulation, and unaccounted for water (UFW) is very high as a result of loss and illegal connection. Furthermore, intermittent water supply is frequent due to unreliable power supply, so the operational cost is high as a result of the use of generators to power water supply. This is a major problem. To make up for inadequate water supply by government authorities, overvalued water by private water vendors is popular nationwide, and many households and private estates have their own boreholes.

Although in principle state water agencies (SWAs) should be financially independent with water tariff collection from water consumers, unmetered tariff system, low priced water and high non- revenue water (NRW) have resulted in insufficient operating revenue. Consequently, there are several structural problems with habitual reliance on subsidies from state governments.

(4) Semi-urban and Small Town Water Supply

Semi-urban and small town water supply refers to water supply to between 5,000 and 20,000 population size. Nationwide, there is a great number of semi-urban and small towns in which a lot of people reside; and for this project it is estimated that 45% of municipal water demand is from this category.

Prior to 2000, most water supply services in semi-urban or small towns were provided virtually as a social service without any tariff collection by state water agencies or the state governments. This led to non-sustainability of service, ineffective operation and maintenance, insufficient funding, lack of ownership etc. Water is normally abstracted from groundwater and pumped up to elevated tank by motorized pump, and then distributed by gravity to end-consumers through standpipes or household/yard connections.

Against such a background, water supply services were categorized to include semi-urban and small town water supply by the National Water Supply and Sanitation Policy, 2000. Meanwhile, Small Town Water Supply and Sanitation Projects (STWSSP) have been implemented as a pilot project in some states with assistance of the World Bank and European Union. Under these projects, Small Town Water Supply and Sanitation Agencies (STWSSA) were established in the states for improvement of water supply in semi-urban and small towns; as well as Water Consumer Association (WCA) for community-based operation and maintenance with tariff collection.

(5) Rural Water Supply

Rural water supply refers to water supply for less than 5,000 population size, which generally reside in rural villages.

Local Government Area (LGA) Councils are in charge of rural water supply in principle, but actually are not capable to implement projects or operate and maintain facilities due to constraints such as lack of human resources, funds, equipment and skills; except in a few LGA councils. To make up for the inadequate capacity of LGA councils, Rural Water Supply and Sanitation Agencies (RUWASSAs) or Water and Sanitation (WATSAN) Projects under state governments and the State Ministry of Water Resources have taken their place. Water supply facilities are typically boreholes equipped with hand pump, while some small piped water supply facilities using motorized pump and elevated tank are also popular nationwide.

Community-based organizations usually have responsibility for daily operation and maintenance, such

as Water and Sanitation (WATSAN) Committee or Water Sanitation and Hygiene Committee (WASHCOM), but regular collection of usage fees to finance the cost of operation and maintenance is rare; so RUWASSA or state ministry have supported communities financially and technically. However, facilities have often been neglected because the support is not disbursed timely due to lack of funds and other reasons.

(6) Water Supply Facilities using Surface Water

Table 18 shows summary of existing public water supply facilities using surface or subsurface water, mostly treatment facilities verified by this project. To a greater or lesser, there are more than 240 treatment facilities or equivalent of surface or subsurface water in Nigeria. The proportion of actual production to designed capacity is 45.2% nationwide. This indicates inefficiency in facility operation. This inefficiency is mainly due to erratic power supply, aging facilities and equipment, malfunctioning equipment such as pump due to non-maintenance, and also oversize design resulting from excess estimate of water demand.

Table 18 Existing Water Treatment Facility of Surface Water

	Number of Water Treatment Facility※1			Capacity/Production (LCD)※2		
	Surface	Subsurface	Total	Design	Present	Efficiency
Nationwide	**225**	**18**	**243**	**4,239.8**	**1,915.8**	**45.2%**

*1: As of 2010. Simplified treatment facilities and chlorination only are included. *2: As of 2012.
Source: JICA Project Team

(7) Water Supply Facilities using Groundwater

Table 19 shows the number and operation rate of existing boreholes by state through detail check and summary of data obtained from the National Water Supply and Sanitation Baseline Survey (NWSSBS), 2006 by the Federal Ministry of Water Resources. From it, the total number of boreholes is about 38,000, and operating ratio is 54.3% nationwide.

Table 19 Number and Operating Ratio of Existing Boreholes by State in 2006

	Hand pump			Motorized Pump			Total		
	No.	Function	(%)	No.	Function	(%)	No.	Function	(%)
Nationwide	**25,470**	**14,748**	**57.9%**	**12,421**	**5,836**	**47.0%**	**37,891**	**20,584**	**54.3%**

Source: National Water Supply and Sanitation Baseline Survey (NWSSBS), 2006. Reanalyzed by JICA Project Team

(8) Current Status of Sanitation

Table 20 shows both sanitation coverage and sewerage coverage, sourced from National Demographic and Health Survey (NDHS), 2008 and Multiple Indicator Cluster Survey (MICS), 2007. Sewerage systems with proper treatment exist only in a part of major metropolis such as Abuja and Lagos.

Table 20 Sanitation and Sewerage Coverage by State in 2008 and 2007

	Sanitation (NDHS,2008)	Sewerage (MICS,2007)
Nationwide	**27.0 %**	**3.9 %**

Source: National Demographic and Health Survey (NDHS), 2008 Multiple Indicator Cluster Survey (MICS), 2007

(9) Basic Conditions of Plan

In view of the above current status, this project will make the water supply and sanitation development plan based on the following design criteria:

Per Capita Consumption

The National Water Supply and Sanitation Policy, 2000 defines standard per capita consumption according to category of water supply and settlement type based on population size, as shown in Table 21. This project conforms to this standard per capita consumption for sector development plan as well as basic conditions for water demand projection.

Table 21 Per Capita Consumption by Water Supply Category

	Water Supply Type	Per Capita Consumption (lit/cap/day)
1	Urban	120
2	Semi-Urban / Small Town	60
3	Rural	30

Source: Federal Ministry of Water Resources (FMWR)

Designed Capacity and Yield of Water Sources

To make up a development plan of water supply against growing water demand in the future, capacity or yield of water source should be specified. For water supply facilities using surface water, water demand within available capacity of water source corresponds to designed capacity by considering surface water potential. For water supply facilities using groundwater, designed yield is subject to hydrological features and pumping capacity.

Rehabilitation Scheme for Existing Facilities

For existing water supply facilities using surface water, this project assumes that all the facilities have production efficiency of 45.2% across the board in 2010, the baseline year of the project, which was obtained from nationwide efficiency of 2012, and also that the efficiency will be improved to 80% by 2020 through rehabilitation and be sustained until 2030. This water volume to be obtained through rehabilitation scheme is required development in both hydrological balance and facility planning.

On the other hand, as to existing water supply facilities using groundwater, the volume to be rehabilitated to the maximum extent possible is through rehabilitation scheme, based on results of the previous chapter but varying from state to state. This water volume to be reactivated by rehabilitation scheme becomes the required development in both hydrological balance and facility planning.

New Schemes

As to the water supply facilities using surface water to be newly constructed, this project assumes that water development is 80% of design capacity, as production efficiency, for newly planned water treatment plants and this is sustained until 2030. On the other hand, for water supply facilities using groundwater for new construction, the remaining balance of groundwater development after deduction of groundwater development by rehabilitation scheme is covered by new construction in hydrological balance. Water development in facility planning is 125% (inverse of production efficiency at 80%) of water development in hydrological balance.

Sanitation Service Level

The National Water Sanitation Policy, 2004 defines standard sanitation service level guaranteed for all citizens according to settlement category based on population as well as water supply, as shown in Table 22. This project conforms to this standard sanitation level for sector development plan.

Table 22 Standard Sanitation Service Level

Category		Population	Service Level(at least)	Remarks
Urban	Urban	20,000 <	Pour-Flush Toilet	each household, using suitable and affordable water conveyance systems
	Semi-Urban / Small Town	5,000 - 20,000	San Plat Latrine or equivalent	each household, improved latrine slab and superstructure harmonizing with surroundings
Rural		< 5,000	Upgraded Pit Latrine	each household, reduction of flies and odour, etc.

Source: Federal Ministry of Water Resources (FMWR)

8.2 Irrigation and Drainage Plan

The operation and management of public irrigation schemes is mainly done by RBDAs and the state governments; some farmers groups have also been supporting the maintenance of irrigation facilities. However, irrigation infrastructure are dilapidated in most of the schemes with many pumps in need of repair/replacement and conveyance structures damaged or deteriorated, with many weed infested and silted up.

The promotion of irrigation sector should be done in accordance with national development policy, regional features such as climate, hydrology, terrain and habitat, economic efficiency, and situation of existing public irrigation schemes.

The existing and proposed public irrigation schemes are categorized as follows;

(1) Completion with No Extension Scheme

Out of existing public irrigation scheme in 303 sites, there are 183 already completed or suspended, and which have no extension plan in future. Subject to the proposed cropping pattern and safety level for water supply (1/5 years safety level), future irrigation area is evaluated by irrigation scheme. The system developed area of 44,688ha developed so far by FMWR is evaluated at 39,153ha due to lack of water potential against water demand for irrigation.

(2) Extension Scheme

According to the Master Plan for Irrigation & Dam Development for 2009 – 2020 (FMAWR), the number of irrigation scheme for only rehabilitation and expansion with partial rehabilitation are 37 sites and 45 sites respectively. According to the surface water potential evaluation, the scheme for rehabilitation only have plenty amount of water, and so it is possible to expand the system development area up to the planned irrigation areas. To expand the irrigated farmlands it is recommended to expand the development to 37 schemes not only for rehabilitation but the planned irrigation areas.

(3) Supplementary Irrigation Scheme

Economical irrigation development is possible utilizing regional characteristics of HAs-5/7. The southern region is located in the tropical rainforest with rain-fed rice cultivation widespread in the region. However, it is necessary ensure enough water in the initial stage of rice cultivation and then have reserve water resources during unstable rainfall conditions. Accordingly, land reclamation and supplementary irrigation facilities are planned utilizing farm ponds and groundwater. In this case, irrigation water is for only rainy season because of small scale of water resources. However, it is necessary to increase rice yield from effective use of irrigation system. The cost of irrigation development by this method is minimal compared with other development options. Also, this method is applied as small scale irrigation scheme by local governments.

The available farmlands in HA-5 and HA-7 are vast. The terrain is flat and soil suitable for rice cultivation in the area, so this development method is easy to apply to all over the place. New development areas are 19,000 ha for HA-5 and 29,000 ha for HA-7 corresponding to the irrigation areas not considered in the dam irrigation scheme below.

(4) Dam Irrigation Scheme

Nigerian agriculture depend on rain-fed cultivation nationwide, however it is imperative to enhance irrigated agriculture emphatically for national food security. Possible merit expected from irrigation in the case of converting rain-fed cultivation into irrigated one include 1) yield improvement by avoiding drought damages, 2) extension of cropping period from only wet season to throughout the year. New proposed irrigation scheme development is planned to irrigate farmlands throughout the whole year downstream of the dam. Location of medium scale dam will be selected considering economy, possibility of suitable irrigation area at downstream of dam, dam efficiency, avoidance of competition among water supply and existing irrigation scheme, and resettlement. The total number of sites for new proposed irrigation schemes attached to dams are 17 having 80,900ha.

(5) Integrated Irrigation Scheme

The long term target of irrigation sector in Nigeria is to convert the irrigable potential area of 3.14 million hectares in the country to irrigated farmlands. This will involve development of large scale irrigation schemes that will include pumping operation which utilizes electricity generated by the hydropower plants in the multi-purpose medium and large scale dams constructed on the tributaries of River Benue, and elsewhere. This development takes a long period to complete the construction. Therefore, considering ease, cost of management and maintenance, immediate utilization; private

small scale irrigated farming should be undertaken as an immediate option for irrigation development. This should be put in place while construction of large integrated public dam projects is going on.

8.3 Recommendation for Other Sub-Sectors

(1) Hydropower Generation

Considering the large environmental and social impacts of constructing large-scale hydroelectric station, as well as the lack of suitable dam sites with big capacities, a more practical choice for the proposed dam sites would be to install small hydropower stations that are driven by water used primarily for irrigation purposes.

With regard to the large-scale hydroelectric dam projects being planned by the Federal Ministry of Power (FMP), it is important for FMWRRD as the administrator of the river environment to provide FMP appropriate guidance on a continuing basis such as, for instance, checking the existence of low-flow sections and, if necessary, discharge water to secure predetermined minimum flow level.

Evaluating Hydroelectric Potential of Irrigation Waterways

The hydroelectric potential of each dam site based on the flow regime and dam height of each site were identified based on survey, to examine the possible introduction of hydropower plants. As a result, it was discovered that HA-2 and HA-3 have good potentials, as these areas are blessed with good stream flows and other topographic advantages.

Installation of Low-Head Hydroelectric Stations

While dam-type hydroelectric stations have the advantage of relatively large output, they also have shortcomings such as high construction cost and large impact on the river environment. Low-head hydropower is gaining attention recently as a promising solution to such obstacles, as it generates electricity mostly by the use of river current without relying on a large head and therefore can minimize the alteration of the river environment.

Necessity of Trial Installation

The most important aspect of the maintenance of hydroelectric facilities is the removal of dust from the equipment, as it takes in water directly from the river, which naturally contains dust and debris that need to be removed properly. While the intake gates of dam-type hydropower stations are usually situated lower than the river surface, those of low-head stations are at about the same level as the river, which makes it easier for the debris floating on the river surface to flow into the turbines, causing damage.

For this reason, it is desirable to install a turbine in a relatively small river or canal on a pilot basis to test and check the actual output and removal of debris before full-scale installation.

(2) Flood and Erosion Control Sector

The flood control sector is addressed by the three tiers, namely, Federal, State and Local governments through the framework on environmental and disaster management. FMWR has nationwide hydrological monitoring network and jurisdiction over a lot of the dams. In this sense, FMWR should be involved in management of floodplain along the major rivers, especially for the downstream reaches of the multipurpose dams. At the same time, the hydrological monitoring system of FMWR should be improved upon to monitor more short term phenomenon such as floods. Moreover, FMWR should extensively do flood risk evaluation for the area of floodplain along the major rivers in which irrigation project is/will be implemented or urbanization has/will be progressing.

Regarding erosion control in Nigeria, some State governments as implementing body express their desires for adequate budget allocation from the Federal Government and technical support from Federal agencies in terms of hydrological analysis. NIHSA of FMWR can contribute to this aspect through hydrological monitoring.

(3) Inland Water Navigation

The inland waterways in Nigeria consist of the two major river systems, Rivers Niger and Benue, which form a confluence at Lokoja; and creeks, lagoons, lakes and intra-coastal waters in the delta area to the Atlantic Ocean. They are declared as Federal navigable waterways by the 1997 Decree. All navigable waterways are under the exclusive management, direction and control of NIWA.

The dam operations by FMWR might affect the hydraulic flow of navigable waterways. Also FMWR should contribute to management of floodplain in which large scale irrigation is undertaken along the navigable reach, if there is, in collaboration with NIWA. In this regard, among other things, there should be routine exchange of information among the two organizations, including early warning, disaster information for the riverine urban areas etc. In the management of floodplains in which FMWR is working, it should consider the effect on inland water navigation and share information with NIWA.

(4) Inland Fishery

The Fishery division of the Federal Ministry of Agriculture launched the following policies in order to promote the sector in the Nigerian Fisheries Master Plan 1998.

- Developing and modernizing measures of fishery production, processing, storage, marketing and conservation of resources,
- Improving living standard of fishery communities,
- Enhancing researches on fisheries,
- Consolidating research facilities and developing human resources,
- Promoting private enterprises to participate in and invest in fisheries,
- Organizing viable fisheries cooperatives throughout the country,
- Providing subsidies for purchasing fishing gears,
- Promoting fishermen's access to public financing organizations,
- Implementing model projects for country-wide diffusion of fish farming techniques,
- Consolidating legal frameworks on fisheries,
- Improving fishery processing techniques and adding higher values to fishery products,
- Collecting information on development of fishries subsector.

Inland fishery basically competes with irrigation sector in terms of water use. However, it is possible to carry out fish farming on the field of irrigation in such ways as fish farming in dams and reservoirs for agricultural purpose. In particular, it will be possible for local people to create opportunities of supplementary income sources without competing for water use by agriculture only if they introduce fish farming in lowland rice fields as it is done in Japan and China. In this case, they can utilize abattoirs' wastes and livestock droppings. In this way, the fisheries, irrigation, agriculture and livestock sub-sectors are closely related to each other. It is advisable to hold regular consultations among these sub-sectors on their respective activities in the water resources sector.

(5) Livestock

The Federal Ministry of Agriculture launched the following policies in order to promote livestock industry in National Agriculture and Food Security Strategy 2010-2020.

- Accelerating participation of private sector in livestock industry making use of loans provided by "Nigeria Agricultural Cooperative and Rural Development Bank (NACRDB)" so as to establish large-scale livestock industry,
- Providing animal feeds, vaccination, livestock medicines, information and resources (loans) so that private management of livestock husbandry can be stabilized and quality and quantity of product supply can be maintained,
- Hatcheries of poultry should be consolidated throughout the country under the collaboration between public and private sectors. Besides, technical research should be promoted for realizing economical hatchery enterprises.
- Promoting dairy industry so as to produce milk for domestic consumption and for exports and

- Increasing highly productive grassland and cropping area under fodder crops through the liaison between public and private sectors so as to increase the production of forage crops and hay.

The above policies do not include water resources development and management for promoting livestock industry. In practice, however, animal water in lakes, ponds, rivers, reservoirs, canals etc. is indispensable for livestock maintenance including water spots for seasonal transhumant activities. Also, commercial livestock sub-sector may need means of water supply exclusively provided for livestock. Thus, livestock and irrigation sectors should closely be related. It is therefore necessary to produce efficient use of water resources through communication, coordination and collaboration between them

CHAPTER 9 WATER RESOURCES MANAGEMENT PLAN

9.1 Operation of Dams and Reservoirs

(1) Current Issues

The operation of dams & reservoirs in Nigeria are not optimally managed in terms of water supply for municipal use and irrigation. Clearly defined rules for operating the dams and reservoirs to supply water to users are mostly nonexistent. The amount of water needed for irrigation and municipal uses is supposed to fluctuate depending on current demand of each subsector. If for instance, the population of the service area had reached only 50% of the prediction, the water supply volume or the reservoir capacity would only need to be half the planned volume or capacity.

Conventionally, water from a dam is supplied to users in the form of water rights. Each water user applies for water rights by submitting a rationale for the calculation of present water demand to the river administrator, who, upon rigorous examination of the rationale, will appropriate a certain amount of water to the applicant-user by granting him water rights. The water user will then send a daily request to the dam administrator to supply a certain amount of water within his water rights volume. Upon receiving the request, the dam administrator will determine the supply volume of the day by taking comprehensively into account the day's river flow and reservoir level, as well as river flow forecast, and manipulate the dam to release an appropriate volume of water. Normally, dams during low water regimes are managed by repeating this procedure daily.

(2) Direction for Improvement

These issues relate not only to the relationship between dam administrators and water users but also to organizations and systems; management of water resource data/information; and agencies concerned with water rights; with whom issues need to be discussed and coordinated. In the future, it is important to involve these stakeholders in discussions to explore how to operate the water resource facilities in ways that are compliant with the legal and administrative system in the country.

(3) Safety Management of Dam Structures

Most dams in Nigeria are earth-fill dams. In ensuring the safety of fill dams, great attention needs to be paid to piping, which is caused by deformation or damage in the dam structures.

Cracks should be repaired after examining the safety status and determining the appropriate corrective measures. It is also important to point out that transportation means, an administrative vehicle, for patrolling and managing the dam structures are needed, as many of the dams in Nigeria have long crests. In addition to dam structures, other dam-related facilities will need safety management.

In view of the above, safety management of these facilities, including spillway facilities, backup power systems for outages, and hydrologic equipment, need to be studied extensively along with dam structures, especially with regard to high-priority dams.

(4) Safety Management of Reservoirs

The subcontracted survey could not obtain data regarding yearly sedimentation or hydrological observation. It is likely that periodic measurements are not taken at these dams. According to the personnel of each dam interviewed, the greatest concerns were aquatic grass and hyacinth followed by sedimentation. Aquatic grass and other weeds are probably caused by eutrophication of reservoir water, against which various measures need to be implemented to improve both stored and inflow waters. At any rate, it is important to measure and accumulate data on the water quality of dam lakes, as they provide important information for examining possible improvement measures.

(5) Safety Management of Dam Reservoir Operation

As described in the earlier section that examined the reservoir operation, records at Shiroro and Kainji, dams in Nigeria tend to give priority to storing (replenishing) water during rainy season, as they need to do so in order to supply water during dry season. This is more or less inevitable because they have the responsibility to store enough water in preparation for the long dry season. In their current low-

water-level operation, they are opening and closing valves by relying on intuitive judgment without regard to the yearly flow regime, which is not desirable.

Ideally, it is important to maintain a proper reservoir water level by controlling discharge in coordination with the discharge operation of other dams while forecasting the yearly flow regime to a certain degree.

To implement such advanced high-water/low-water operations as described above, effective operation manuals, which are supported by analysis of long-term actual data, need to be established (as part of dam management manuals to be drafted in the future). However, none of the dams studied by the subcontracted survey have operation manuals that provide specific instructions as to how to control discharge during the high-water and low-water periods. The urgent task at hand is to draft such dam operation manuals for which, needless to say, long-term data on reservoir water level, inflow, precipitation, and outflow, as well as those of existing dams nearby, if any, are indispensable. It cannot be emphasized enough that the most important aspect of dam safety management is to take and record measurements accurately and diligently on a daily basis upon full understanding of the importance of the above listed data.

9.2 Operation and Maintenance of Groundwater Facilities

Four (4) items are explained below on current situation and issues on operation and maintenance of facilities for groundwater management and development.

- Aquifer management
- Operation and management of borehole facilities
- Pumping capacity of boreholes
- Borehole construction system

(1) Operation and Maintenance of Borehole Facilities

There are about 65,000 boreholes currently in Nigeria, and most of those boreholes are for water supply for rural and small urban/towns. Most of the boreholes are operated and managed by communities. However, only one fifth of the entire rural communities in Nigeria might have special organizations for operation and maintenance of water supply facilities. As a result, boreholes are left non-operational without any repair after hand pump have broken down, even though it may just be an item of simple repair. This situation is replicated across the country. This current state of affairs may be improved in the following ways:

- Adequate selection of prioritized community for borehole construction
- Hygiene and sanitation education for communities
- Establishment of a system for water fee collection
- Strengthening of supporting system for LGAs, which are in charge of communities' water supply
- Provision for spare parts

(2) Pumping Capacity of Borehole

There are many boreholes for rural water supply. Boreholes are usually installed with hand pumps. Pumping capacity of hand pump is as small as 10m3/day. Therefore, a huge number of boreholes must be drilled from now on to meet future groundwater demand for boreholes with hand pumps. This requires a huge amount of investment. If hand pump is changed to motorized pump, pumping capacity of borehole will be increased 20 times. It is necessary to use full capacity of aquifer by shifting pump type from hand pump to motorized pump to meet future groundwater demand. Moreover, change of pump type will reduce number of boreholes to be drilled in the future, and the cost of borehole construction will also be reduced thereby.

(3) Borehole Construction System

Many organizations implement borehole construction for rural water supply. They are State Ministry, RUWASSA, RBDA, MDG Office and others. Each of them implements their own projects without

coordination with other organizations. Consequently, many projects turn out to be duplications and inefficient. The issues listed below should be considered for better implementation of borehole projects.

- Abolish independent implementation of borehole construction for rural water supply. Implementation agency should be unified to one organization, State RUWASSA.
- Implementation agency should formulate long term plan for borehole construction for efficient operations.

For more efficient groundwater development, the issues listed below should be considered.

- Improve technical and institutional capacity of State Agency.
- Strengthen capacity and function of State Agency as main responsible organization for rural water supply.
- Improve capacity of private drilling companies under direction of State Agency.
- Cooperation with Federal Organizations such as NIWRCM and NIHSA for establishment of i) registration system of private borehole companies, and ii) technical transfer system for new groundwater development.

9.3 Hydrological Monitoring

On the basis of the strategies identified to tackle current challenges in the water sector, the following projects are recommended to be implemented by NIHSA:

Project-1: Improvement of Surface Water Monitoring Network

The monitoring network on surface water should be increased and their capacity enhanced. The existing network has monitoring stations that are categorized into four types.

These monitoring stations are basically different from the monitoring of inflow and outflow of reservoir by dam owners. When dams exist at important points for water management, the monitoring stations should be located at appropriate locations downstream of the dam. The locations of the monitoring stations are tentatively agreed upon as a result of discussions with NIHSA. It should be noted that the details of the final location is to be confirmed by field survey.

Project-2: Enhancement of Data Management Capacity in NIHSA

This project is to enhance the capacity for data management of hydrological monitoring. It is proposed to be implemented in two phases.

Phase-1 is proposed to be implemented in three years (2014-2016) to enhance capacity in the following areas:

- Preparation of manual for data management
- Preparation of database for hydrological monitoring
- Collection and storage of hydrological data including integration of hydrological monitoring data and dam operation data
- Quality management of hydrological data
- Preparation and improvement of rating curves as well as discharge measurement
- Introduction of hydrological modeling as one of the checking process for quality of hydrological data
- Dissemination of hydrological information

In phase-2, the activities conducted in Phase-1 will be expanded continuously by NIHSA in a more proactive manner. This is to promote active usage of hydrological data. The project duration would be 14years, 2017-2030.

Project-3: Establishment of Hydrological Modeling Center within NIHSA

In order to make use of hydrological monitoring data and assure high quality of those data, it is proposed that Government should establish Hydrological Modeling Center within NIHSA.

The objective of the Hydrological Modeling Center is to enhance the proper usage of hydrological

information and to realize the best mixture between monitored hydrological information and hydrological modeling activity, and based on that, to disseminate the selected hydrological information. The project implementation period should be set to about 3 years as the most urgent project for the establishment of Hydrological Modeling Center and the consolidation of related activities.

Project-4: Enhancement of Awareness on the Importance of Hydrological Monitoring

This project is to promote awareness on the importance of hydrological monitoring by NIHSA staff. The activities by NIHSA would be widely disseminated to the public through regular seminars and workshops. Furthermore, lectures as part of school curricula and so on by NIHSA staff are promoted. These should be expanded to base flow work in NIHSA.

9.4 Groundwater Monitoring

(1) Current Groundwater Monitoring

NIHSA is in charge of groundwater monitoring. NIHSA has installed groundwater automatic recorders into 11 boreholes and is implementing groundwater level observation. These boreholes are drilled in sedimentary rock areas, and depths of boreholes are 80m to 100m observing confined groundwater level. The purpose of monitoring is to know the groundwater fluctuation in aquifers that are the main water sources for urban water supply. Data accumulation is still not enough to analyze the tendency of long term groundwater fluctuation. It is expected that this monitoring should be continued and new monitoring boreholes should also be established.

Lowering of groundwater level may be taking place as a result of over-pumping in both northern and southern part of Nigeria. In particular, land subsidence and sea water intrusion will take place in the southern part of the country. Large cities along the Gulf of Guinea are using groundwater as main water sources, where it was pointed out that sea water intrusion into boreholes is taking place. Groundwater monitoring work should be strengthened as urgent necessity. It is to drill new deep monitoring boreholes of depth of 300 to 600m to survey geological structure of deep part of the ground for new groundwater development and resolution of environmental problems.

NIHSA and NIWRCM are in charge of groundwater monitoring at the Federal level. They should implement technical transfer to State Agencies such as the Water Boards and RUWASSA. For this purpose, their responsibilities must be clarified and institutional and technical capacity improved.

(2) NIHSA

NIHSA should establish database by collecting data on borehole drilling and geophysical survey from State Agencies in charge of borehole construction. NIHSA will assess groundwater development potential to identify adequate amount of groundwater to be developed. When a risk in groundwater environment is detected through groundwater monitoring, they will analyze and consider measures against it.

(3) NIWRMC

NIWRMC is expected to issue: (i) water right for groundwater development and (ii) borehole registration based on result of assessment of groundwater development. Moreover, NIWRMC will propose measures against groundwater environmental problems, such as pumping control, based on result of monitoring/ analysis/prediction by NIHSA.

(4) State Agencies

The State agencies are in charge of groundwater development for water supply to urban and rural areas. However, they do not implement groundwater monitoring and cannot assess and manage groundwater resources. Such activities are currently implemented by NIHSA and NIWRMC. However, NIHSA and NIWRMC have limitation in terms of budget and manpower, and so cannot cover the entire country by their monitoring network with high accuracy.

Therefore, it is expected that State Agencies should implement groundwater monitoring, receiving

technical training from NIHSA and NIWRMC, to make effective use of the monitoring result for groundwater development and management in cooperation with NIHSA and NIWRMC.

9.5 Data and Information Management

The detailed collection of routine hydrological data over a long period of time and their analysis provide very useful information for sustainable development of water resources. In order to acquire useable data, it is necessary to observe hydrological phenomenon in a consistent manner for a long time. Therefore, it is very important to manage observation, collection, and archiving of data to implement sustainable water resources development. However, there are very few organizations in Nigeria that could keep observing and archiving data in a consistent manner over a long time. Therefore, it is difficult to find reliable data which covers the whole country.

Nonetheless, continuous efforts should be made towards overcoming this challenge through adequate budgetary provision to agencies whose functions are to gather and establish hydrological database. In this regard, it is recommended that in order to improve quality of data a redundancy factor should be added to the process especially at important observation points. By adding redundancy, this will improve continuity and validity of the data. It is also recommended that a monitoring mechanism to help in understanding and directing progress of data collection and archiving should be included. The focal agencies should show commitment to building these databases by utilizing the recommended mechanism.

9.6 Management of Floodplains in Nigeria

(1) Current Situation

The rapid growth in urban population has led to increasing encroachment on floodplains which causes inundation along river banks, flooding and erosion problems. These always result in serious loss of lives and properties almost on a yearly basis. Inundation of floodplains in the country has therefore constituted a perennial problem. The irony is that the vast floodplains of the Niger and Benue rivers have great potential for irrigation farming; which has so far not been utilized. There are however, remedial actions which government at each level should be undertaking to demarcate floodplains in riverine areas, floodplains near urban centers, and floodplains along the major rivers. These actions and other related mitigation measures required to address these challenges are what the master plan would proffer.

(2) Issues

The management of floodplains consists of mitigation of flood damage, promotion of safe river usage as in normal time, promotion of appropriate land and resource use, in response to various river regimes such as water level, discharge and velocity. The management of floodplains should be prioritized among national policies incorporating environmental management of urban areas. For small floodplain in urban areas, State governments and FME are in charge as part of their mandate on environmental administration. Adequate fund for countermeasures and technical support such as hydrological data, planning and design methodology from Federal government are necessary in order to perform this function effectively.

In terms of mitigation of flood damage, FME is preparing early flood warning system based on rainfall forecast for urban areas. The urgent necessity for early warning system against flooding of major rivers for prevention of natural disasters such as that of 2012 flood would therefore be addressed. To enhance food production, large scale irrigation projects in floodplain of major rivers is recommended. The basic information on such floodplain such as historical change of river bank, river cross section, soil profile and river channel flow capacity would be provided for.

NIWA is in charge of navigation route on major rivers. The management covers the entire breadth of floodplains. The activities to fulfill this mandate would be addressed.

(3) Strategy by FMWR

Considering the above issues, FMWR should start the basic investigation of floodplain of major rivers

such as the Benue, the Niger, the Kaduna and the Sokoto-Rima Rivers which have great potential for large scale irrigation.

By carrying out the proposed basic investigation, it is possible to evaluate the channel stability, inundation frequency of floodplains and urban areas. Further, the evaluation results should be reflected in dam operation, planning and design of large irrigation projects within the floodplains, reference to navigation route management and provision of disaster information for riverine areas and for land use planning.

9.7 Risks Associated with Climate Change and Trans-boundary Water

Both climate change and trans-boundary water are uncertainties that cannot be controlled by any country. However, they are to be prepared for. In this section, the risk to water resources associated with climate change and trans-boundary water is addressed.

(1) Climate Change

On the basis of earlier analyses, the risks associated with climate change are summarized as follows:

- The scenarios for change in precipitation and air temperature in 2050 are set, based on the output from the GCMs.
- The following risks are expected under the scenario set.
  - ✓ The expected change in air temperature could bring about the reduction of annual runoff with about 20%
  - ✓ The response of runoff against the expected change in precipitation is more sensitive in the area with less precipitation. It could mitigate the impact of the expected change in air temperature in the northern area.
  - ✓ The irrigation water demand could increase with about 16% on average compared to base climate condition. The impact could be severer in rainy season than in dry season. The increase of irrigation water demand could be higher in private irrigation schemes which utilize groundwater than public irrigation.
  - ✓ Further lowering of groundwater level with 5 to 20m is expected due to reduction of recharge associated with climate change.
  - ✓ The safety level of municipal water supply and irrigable area with 1/5 safety level could decrease. The significant reduction of irrigable area in terms of safe water source supply may appear in HA-6 and 8, in which both municipal and irrigation water demands are large.
  - ✓ The average generated energy by hydropower plant could become 60-90% of the base case without climate change.

(2) Trans-boundary Water

Lagdo Dam on River Benue

The Lagdo dam was constructed in 1982 on River Benue in Cameroon, about 100km upstream outside the Nigerian border. Its gross storage capacity is 8 billion m^3. The primary purposes of the dam are irrigation and hydropower generation. The average inflow to the dam was estimated at $260m^3/s$.

It was reported that the dam was constructed without due regard to an existing protocol between Nigeria and Cameroon and failed to adopt a mutual operating schedule which is acceptable to the downstream users. The detected main influence on the dam was: (i) siltation of river bed and water intake structure, (ii) loss of Fadama cultivation and fishing lake due to regime change. The regime change could be beneficial for flood control, reclamation and improvement of river condition in dry season to some extent. It is therefore required to operate the dam for mutual benefit of the two countries. It was reported that the sudden release of water from the Lagdo dam during flooding in 2012 worsened the damage around Yola.

Katsina-Ala River and Kashimbilla Dam

The Katsina-Ala River originates in Cameroon. There is a deep maar lake called Lake Nyos at the

most upstream reach of the Katsina-Ala River. The lake was impounded by 50m wide natural dam that is structurally weak and is being eroded. A breach of the natural dam in Lake Nyos is expected within the next 10 years. According to previous report, the eventual failure of the natural dam would cause a destructive dam break flood with maximum of 17,000m^3/s at just downstream of the lake. The estimated hydrograph shows the flood discharge at around 100km downstream of the lake, within the Nigerian border, would be no more than 3,400m^3/s and possibly 1,400m^3/s. The possible collapse of Lake Nyos is a threat to the people who reside along the Katsina-Ala River. A coordinated management of the lake between the two countries is necessary to prepare for the likely dam break. The Kashimbilla dam was designed to be a buffer against such a dam break flood from Lake Nyos. It is a multipurpose dam with storage capacity of 500MCM, and it is still under construction.

Kainji Dam in the Upper Niger River

The construction of the Kainji dam, which is planned to be placed in the Upper Niger River, started in May 2012. The location of Kainji dam is about 197km upstream from Niamey, the capital of Niger. The total storage capacity is 1.6 BCM, and the installation of hydropower generation with 180MW as well as the development of 45,000ha of irrigation area (target year, 2034) is planned. There is also another purpose to provide minimum flow of 120m^3/s throughout the year for improvement of the river environment. The constant release of 120m^3/s will be beneficial for improving the flow condition in the dry season on River Niger. However, when the storage water will be utilized and consumed for irrigation in the future, the total inflow to Nigeria will reduce.

Other Issues related to Trans-boundary Water

About 24% of the total water resources potential in Nigeria relies on trans-boundary water. Most of the trans-boundary water is inflow through the Niger and Benue rivers. As a result, the impact of trans-boundary water would mostly occur along the main course of the Niger and Benue rivers. Regarding the impact of trans-boundary water on electricity generated by Kainji and Jebba hydropower plants which are located on River Niger, it had been established that the reduction rate of energy is almost same as that of inflow to Nigeria when the reduction rate is small. However, the higher the rate of reduction the lower impact on generated power.

In addition to the long-term regime change of inflow, sudden change in flow due to operation of dams in upstream countries should be handled well. In order to cope with sudden change in flow condition, real-time monitoring of flow condition as well as close communication and information exchange with neighboring countries should be established.

(3) Coping Strategy for Risks associated with Climate Change and Trans-boundary Water

The following are recommended as measures to cope with the risks associated with climate change and trans-boundary water.

Reduction of the risk by enhancement of water-related data/information

- Enhancing accuracy of estimation of water resources by promoting refinement of meteorological and hydrological monitoring
- Enhancing accuracy of estimation of water demand by promoting refinement of data/information on water use
- Enhancing communication with neighboring countries and promoting information sharing on water resources
- Preparing flood risk maps along the main course of the Niger and Benue rivers and other important rivers by conducting detailed survey on rivers and flood plains

Promotion of adaptive management

The impact of climate change and trans-boundary water involves uncertainty. When the uncertainty becomes more certain, the plan should be revised accordingly. A flexible implementation structure is required to do this. Proper monitoring & evaluation will be required for the flexible implementation structure.

Enhancement of emergency management against flood and drought

More frequent flood and drought are expected to happen with greater frequency due to effects of climate change and trans-boundary water. The mechanism for determining water allocation during flood and drought through discussion among stakeholders should be established by CMCC in each hydrological area. Furthermore, preparedness and response to flood and drought should be enhanced in collaboration with LEMA, SEMA and NEMA.

Promotion of Water Demand Management

In order to cope with possible future decrease in water resources, the water demand management may, for instance, reduce delivery to municipal water supply and increase water for irrigation. This method can reduce the risk posed to food security during drought condition.

9.8 Water Allocation and Regulation

Although the necessity of obtaining license for water abstraction and use for commercial scale use was stated in Water Resources Act, 1993, the implementation framework for it has not yet been introduced. The current practice for licensing of water abstraction and use is as follows:

- Various State Water Boards/Corporations operate numerous boreholes without explicit license for groundwater abstraction.
- Existing contracts between any State Water Boards/Corporations and an RBDA is deemed to constitute a license for such agency to abstract surface water.

There are several overlapping laws related to the licensing system in water resources. These complicate the situation and have made water resources management difficult. In order to improve on this situation, National Water Resources Bill was drafted based on the: (i) National Water Policy 2004; (ii) Water Resources Strategy 2006; and (iii) Draft National Irrigation Policy and Strategy 2006. It should be noted that the Draft National Water Resources Bill is still under review and modification at this moment.

The Nigeria Integrated Water Resources Management Commission (NIWRMC) was established as the organization responsible for the management of water use permit and regulation. NIWRMC consists of a central coordinating body as well as Catchment Management Offices (CMOs) in eight (8) hydrological areas across the country. NIWRMC has started its activities from 2008 but is still awaiting the legal instrument for its establishment.

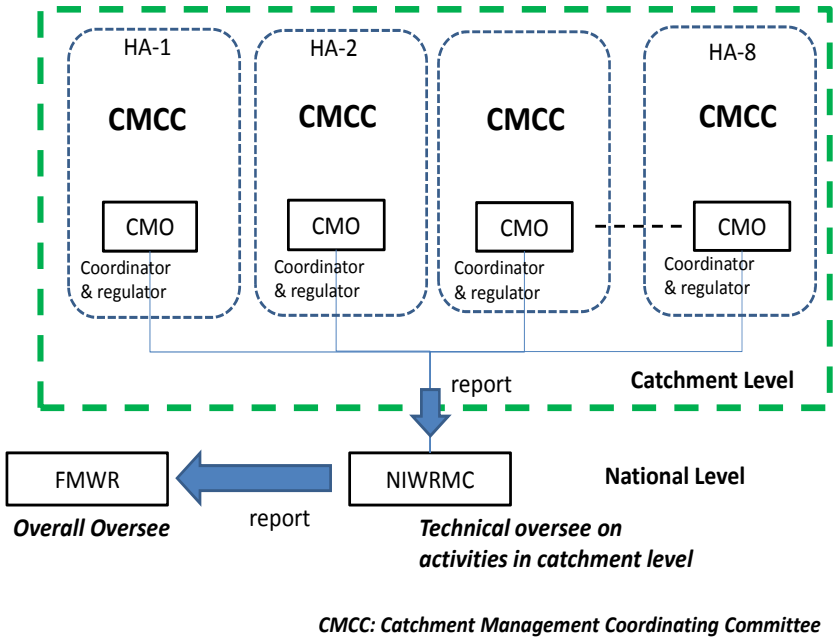
(1) Issues

As mentioned above, although the necessity of obtaining license for water abstraction and use for commercial scale water use is stated in the existing Water Resources Act, the implementation framework for it has not been introduced. Sustainable water resources development and proper water allocation based on equity and environment are secured by implementing proper water use permission and regulation in the country. The main issues are as follows:

- Improvement of law and legislation related to water use permit and regulation
- Capacity building of regulator of water use such as NIWRMC
- Improvement of estimation of water resources in order to allocate water properly
- Enhancement of data/information on water resources facilities and water use, in order to properly implement daily work on water regulation

(2) Proposed Framework for Water Allocation and Regulation

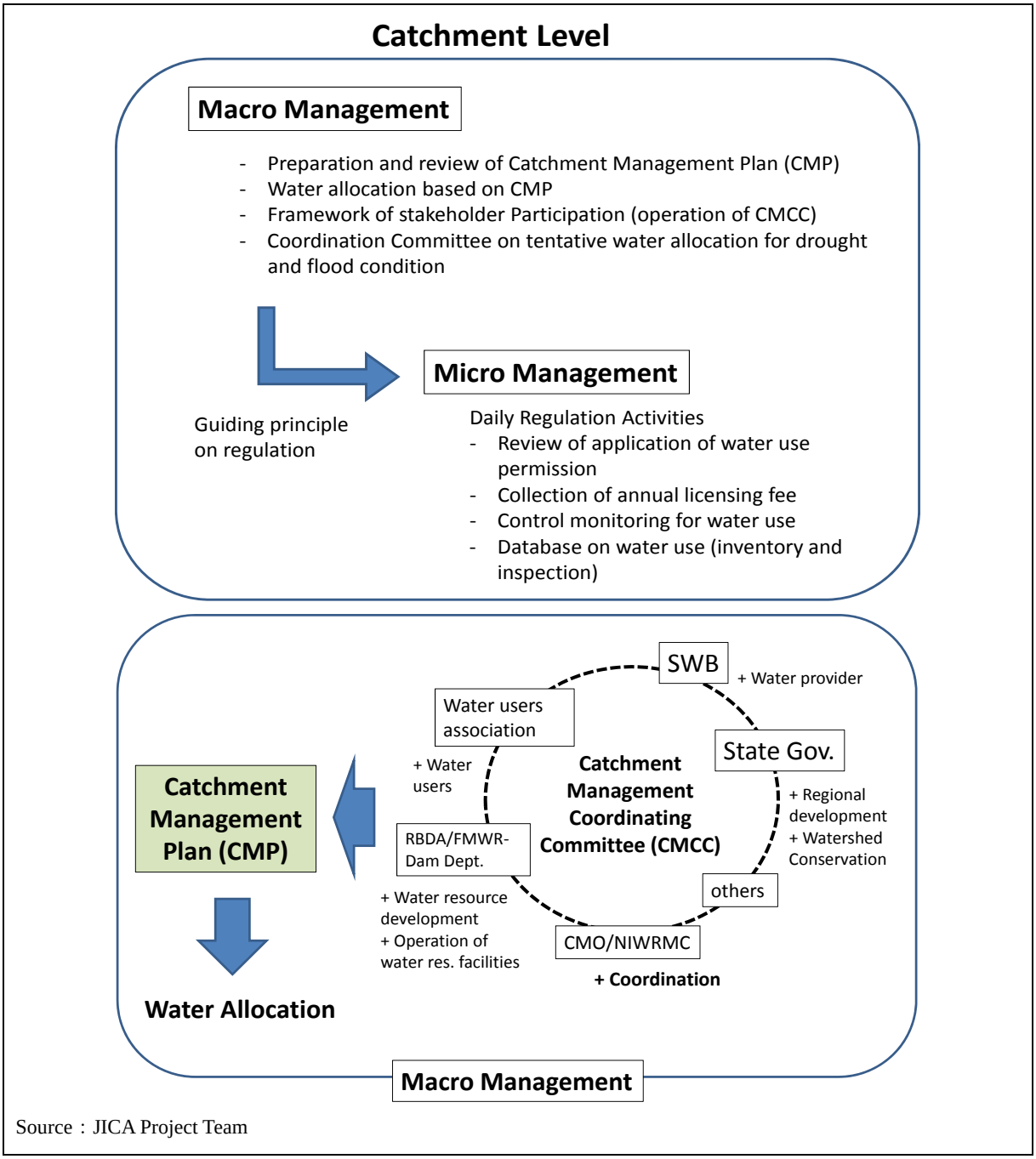
The framework for water resources planning, management and regulation by unit of hydrological area is proposed as shown in Figure 7.



Source：JICA Project Team

Figure 7 Framework for Water Resources Planning, Management and Regulation by Unit of Hydrological Area

The basic unit of water resources management is each of the eight hydrological areas. The Catchment Management Office (CMO), which is the local or field office of NIWRMC for each hydrological area, performs the major role of water resources management in the hydrological area. The headquarters of NIWRMC in Abuja oversees the activities of the CMOs. FMWR further oversees all activities of NIWRMC being the supervising ministry. Accordingly, NIWRMC reports its activities on water resources planning, management and regulation by unit of hydrological area to FMWR and receives advice from FMWR. The framework of the activities of CMO at catchment level is proposed as shown in Figure 8.



Source：JICA Project Team

Figure 8 Framework on Activities of CMO at Catchment Level

The activities of CMO at catchment level can be divided into the following two categories;

- Coordination of stakeholders for macro management; and
- Daily work as regulator of water use for micro management.

The macro and micro management are defined as follows;

Macro Management

- On the basis of the water use and water resources development plans included in the Catchment Management Plan, the water allocation on the scale of the entire hydrological area is managed. It is required that the proper water allocation which should reflect the progress of the implementation of the CMP be considered by monitoring the situation of water use facilities and water resources development facilities from time to time.

- The Catchment Management Plan (CMP) would be formulated by consensus among Catchment Management Coordination Committee (CMCC) that consists of stakeholders in the hydrological area. The CMO as well as NIWRMC play important role to support formulation and revision of CMP from technical point of view and to coordinate stakeholders.
- Coordinating water allocation during drought or flood conditions.

Micro Management

- Based on the water allocation done by macro management, the daily activities for water regulation such as reviewing and approving the application of water use license, collection of license fee, data and information management related to water use permit and control monitoring should be implemented.

It is necessary to note that without the macro management, it is impossible to implement the micro management. The knowledge obtained through the micro management should be reflected in the macro management and vice versa.

The role of CMO for micro management as a regulator of water use include: (1) Reviewing and approving applications for water use license; (2) Collection of license fee; (3) Data and information management related to water use permit and control monitoring.

It should be noted that the license fee for water use which is collected by CMO is different from water charge by SWB, service provider for municipal water supply, and irrigation service charge collected by RBDA from farmers. These charges are collected to recover the cost for construction, operation and maintenance of water resources facilities from water users, whereas the license fee is collected against the opportunity cost of natural flow without any specific water uses. The license fees may be added to the water charges and be shouldered by the end user of water.

It is proposed that the guideline for water pricing including setting water charges and water license fee be prepared by FMWR through NIWRMC. The license fee collected by CMO should be utilized for supporting activities related to water resources management such as organizing CMCC that consists of stakeholders in a hydrological area.

(3) Proposed Projects

With reference to the main issues therefore, the following projects are proposed to be implemented by NIWRMC in order to realize the framework on water allocation and regulation:

Project-1: Formulation of Catchment Management Plan for Eight (8) Hydrological Areas

This project is to formulate Catchment Management Plan for each of the eight hydrological areas. The duration of the project is proposed to be three years from 2014 to 2016. As discussed in the framework on water allocation and regulation, the most fundamental thing to do is to prepare the CMP as a starting point. This is regarded as an important project to drive proper water allocation and regulation in Nigeria.

Project-2: Enhancement of Capacity on Water Use Permit and Regulation

This is to enhance the capacity of NIWRMC and CMO on water use permit and regulation. It is proposed to be implemented in 2014 - 2016, that is 3 years, and the following components would be included.

- Preparation of manual on water use permission and regulation
- Implementation of water use permit and regulation in pilot areas
- Inventory survey on water resources facilities
- Preparation of database for water resources facilities and water use permission
- Water allocation modeling

Project-3: Promotion of Catchment Management for Eight (8) Hydrological Areas

On the basis of the experience in Projects-1 & 2 this project is proposed to promote catchment management for all hydrological areas including operation of water use permit and regulation system.

The duration of the project is 14 years from 2017 to 2030, and the following components would be included.

- Enhancement of human resources in NIWRNC and CMO
- Revision of CMP
- Stakeholder meetings
- Implementation of water use permitting and regulation
- Revision of database on water resources facilities and water use permission

Project-4: Preparation of Guideline for Water Pricing

This project is to examine the cost of water use and consequently to prepare the guideline to set proper water license fee and water charge. It is proposed to be implemented in 2014 – 2016 (3years), and the following components would be included.

- Evaluation of raw water price without water resources development in order to set appropriate water use license fee
- Preparation of guideline to set proper water charge for cost recovery for water resources development by RBDAs etc.

9.9 Proposed Plans for Water Environment Management Improvement

Based on the main problems and issues identified by the JICA team, the following two plans are proposed for the improvement of water environment management in Nigeria.

Project-1: National Drinking Water Quality Monitoring Improvement Plan

<Justification>

The establishment of an effective Water Quality Surveillance Program to cover all basins of the country to analyze water sources and treated water by FMWR is recommended strongly. In this sense, the on-going project for the construction of 6 (six) new Reference Water Quality Laboratories is the most important project of the Ministry towards the improvement of Water Quality Monitoring in the Country.

However, the FMWR needs assistance to replace the current equipment in the old laboratories and to equip the new laboratories whose construction is close to being finalized. In addition, the training of human resources is fundamental for FMWR in order to be able to design a monitoring plan, analysis of samples and the interpretation of results.

<Objective>

The objective of the National Drinking Water Quality Monitoring Improvement Program is to generate scientific data on the water source and drinking water quality in Nigeria to safeguard the health of the population.

<Planning Policy>

The target samples for this program would be the water sources (surface and groundwater) and the treated water consumed by the population and the parameters to be analyzed shall include those necessary to assess the water sources quality and drinking water quality.

<Strategy>

- The Program shall be formulated to strengthen the capability of FMWR and relevant agencies for water sources and drinking water quality monitoring
- The Program shall be formulated to strengthen the involvement of the State Water Boards, River Basin Authorities, environmental associations, etc. and the public in general for a better understanding and cooperation for smooth implementation of the Plan.

<Components>

The components of the program would include:

- Study for the formulation of National Drinking Water Quality Monitoring Improvement Plan
- Provision of equipment for:
  - ✓ Existing laboratories: replacement and provision of equipment for analyzing organic compounds and heavy metals in water.
  - ✓ New laboratories: provision of equipment to analyze all physic-chemical, bacteriological, organic and heavy metal parameters
- Training of Laboratory staff and technicians on water quality monitoring design, analysis of water and assessment of results
- Implementation of the formulated improvement program as a pilot project from which lessons can be learnt for necessary adjustment to be applied in the National Drinking Water Quality Monitoring Improvement Plan

Project-2: Water Quality Monitoring Plan for Important Rivers in Nigeria

<Justification>

Information on water quality of important rivers is necessary to assess their current condition and to determine the trend in the future. Currently, the country lacks such information and this lack of information is the justification for this program.

<Objective>

To assess the water quality condition of important rivers in Nigeria

<Planning Policy>

This Plan will cover main monitoring stations for water quality along important rivers.

<Strategy>

- The parameters to be analyzed will include all those necessary for water quality assessment for different water uses
- The solid database should be prepared for analysis and decision
- Laboratory staff and trained personnel in (a) will take part in this Plan mainly

<Components>

- Study for formulation of the Water Quality Monitoring Plan for important rivers
- Implementation of the formulated Plan for important rivers

9.10 Participatory Approach and Public Relations in Water Resources Sector

The mission of public relations (PR) in water sector is as follows: (i) to establish and promote partnership between the government and civil society in water resources management and (ii) to ensure the responsibilities of the ministry and agencies for transparency and accountability. The functions of public relations are very significant in water resources management to ensure participation of all stakeholders.

(1) Basic Policies

The basic policies for effective and sustaining public relations in water resources sector are discussed below.

- Through PR, demonstrate greater dedication of FMWR, and establish and maintain mutual understanding between the ministry and civil society, ensuring transparency and accountability for all activities of FMWR in water resources development and management
- Through PR, encourage participation of users, planners, decision-makers etc. in water resources management
- Through PR, enlighten and spread education on water, sanitation and hygiene, gender issue, and environmental conservation of communities

(2) Action Plan

Taking into account the basic policies mentioned above, we suggest the following Action Plan below, to be implemented with participation from the Unit of Press and Public Relations, Gender and Human Right, SERVICOM, Anti-Corruption and Transparency, in addition to Dept. of Planning, Research and Statistics, NIWRMC, and NWRI of FMWR as core units in the Action Plan.

- Strengthen PR, through updating FMWR's quarterly magazine (WATER)
- Strengthen and diversify the tools of PR to include all the media such as newspapers, TV, radios, magazines, etc.
- Strict and efficient management of document files within FMWR (digitalization, etc.)
- Support/Assist in the participatory process of water resources management considering gender equality, empowerment of women, local behavior and practices, etc. at household and community levels.
- Manpower development and capacity building in Press & Public Relations Unit and Gender & Human Rights Unit.

9.11 Public Private Partnership (PPP)

With continuing increase in population it is expected that demand for water infrastructure and water services will continue to grow. Under these circumstances, costs of investment in water infrastructure and provision of water services are bound to get bigger than what only the government can cope with. Hence, Public-Private Partnership (PPP) is now being introduced into water service to procure additional investments from the private sector.

PPP Unit of FMWR was established in 2012 as the focal point for PPP projects for the water sector, and embarked on the process of identification, preparation and procurement of potential PPP projects. PPP Unit has been working closely with Infrastructure Concessionaire Regulatory Commission (ICRC), RBDAs, etc., to develop the market for Nigerian PPP projects in collaboration with international society in addition to the federal and state governments. The potential areas for PPP that attract the private sector have been seriously considered including: agriculture (irrigation), water supply (urban, small town and rural), hydro-power (federal dams), water quality management, aquaculture and horticulture, tourism, etc.

(1) Responsibilities of Government

The government shall take the following responsibilities throughout the PPP project life (from Development Phase, via Procurement Phase to Implementation Phase) .

- Promotion of PPP through awareness creation, roadshows for private sector to join public water services by incentives and preferential treatment for sources of alternative funding
- Creation of sustainable enabling environment (policy, laws, regulations, etc.) to support the PPPs
- Identification and development of bankable projects
- Facilitation of issuance of licenses, permits, etc.
- Provision of incentives to encourage the private sector (tax incentives, viability gap funding, etc.)
- Monitoring and evaluation of PPP projects to ensure delivery of intended value for money

(2) Action Plan

Along with the responsibilities to be taken by the government mentioned above, the following actions are recommended:

- Strengthening of PPP Unit, FMWR
- Capacity development for PPP project preparation and implementation
- Budget allocation for PPP project preparation
- Establishment of Project Delivery Teams and Steering Committee
- Regular Parties/Stakeholders Consultation on the PPP process
- Regular updating of policies and strategies to promote private sector participation

9.12 Human Resources Development (HRD)

Among other concrete ideas to strengthen manpower development and capacity building in M/P1995 and in an official report, the "Nigerian Water Resources Management and Policy" prepared with technical assistance from Commission of European Communities, the EU report commented thus:

- Various engineers, specialists (from younger engineers to middle and top levels) do not have much opportunities to have technical training;
- In order to implement efficient IWRM by basins, HRD in various specialties like economics, community specialist, regional planner, land use, etc. is highly required; and
- NWRI should play an important role in HRD. For instance not only by expanding the training courses but also by increasing the number of places where trainings can be done.

(1) Basic Policy

It is noted that with regard to the needs to "strengthen training to respond to the needs at river basin level", HRD for NIWRMC including its subsidiary Catchment Management Offices (CMOs) and their staff working for the water resources management at river basin and catchment level is one of the most important HRD. Accordingly, the following basic policies for HRD for the M/P2013 are recommended:

- Develop and increase access to training opportunities
- Strengthen training to respond to the needs at river basin level
- Strengthen and enlarge the training functions of all aspects of water resources carried out by NWRI, Dept. of Human Resources, and Dept. of Planning, Research and Statistics under the collaborative system within FMWR

(2) Action Plan

The main points of HRD action plan are stated below.

- Carrying out a periodic survey for HRD to determine current status and capacity so as to adequately plan capacity development towards filling the capacity gap
- Development of staff capacity building for some categories in river basin management and others
- Establishment and coordination of National Water Resources Capacity Building Network (NWRCBNet)

The required and targeted specializations include:

- Groundwater Development Technology (drilling plans)
- Management of operation & maintenance of irrigation schemes
- Dam safety
- Monitoring of hydrological and hydrogeological data
- Collection and management of basic water resources information
- Risk management for flood and drought (flood risk assessment, etc.)
- Authorization and licensing systems for water use and regulation
- Watershed management (water quality monitoring technologies etc.)
- Public Private Partnership (PPP)
- Human Resources (HR)

Considerations:

- HRD Plan consistent with institutional strengthening
- NWRI's initiative in planning, execution and monitoring (evaluation) of HRD Plan
- Introduction of external sources (technologies of advanced countries) for effective HRD
- Early enactment of the National Water Policy, the National Water Resources Bill and NIWRMC Bill as premises of the HRD Plan

9.13 Monitoring and Evaluation System

(1) Monitoring and Evaluation System of NPC

The National Planning Commission (NPC) developed the MDA (Ministry, Department and Agency) Scorecard to implement monitoring and evaluation (M&E) of the performance and contribution of FGN and State Government agencies.

The scorecard defines a consistent format that can be applied to all MDAs, to capture the Key Performance Indicators (KPIs) for Outputs and Outcomes in their strategic sectors. It thereby ascertains the progress against annual targets and the efficiency of their strategy.

A crucial aspect of the results chain is that activities by different agencies or stakeholders can be required to produce a single output. In turn, many outputs from different agencies' or stakeholders' input and activities may feed into a single outcome.

(2) M&E of FMWR

The role and responsibility of FMWR concerning M&E is to determine whether the KPIs of the sub-sectors in water resources are met; monitor and evaluate them periodically and submit reports to NPC every year. The Monitoring & Evaluation Division of the Planning, Research and Statistics Department in FMWR is responsible for this.

CHAPTER 10 ORGANIZATIONS & INSTITUTIONS

(1) Current Issues

The power and functions relating to water resources development and management are executed by various ministries and agencies depending on the water sub-sector. FMWR has the power and functions mainly in such water sub-sectors as water supply & sanitation, irrigation & drainage, in addition to water resources development (surface and groundwater). Other water sub-sectors such as hydro-electric power generation, flood/erosion control, inland transportation, fisheries/aquaculture, livestock, and mining are undertaken by Federal Ministries of Power, Environment, Transport, Agriculture & Rural Development, Mining & Steel Development, respectively.

Under the current institutional arrangement in the water resources sector where the powers and functions are exercised in different institutions mentioned above, causing overlapping or duplications in some institutions, there is a need for adequate coordination and synergy among the ministries and agencies to address the current inefficient implementation of projects and programs.

Water resources development and management in Nigeria is executed at different level of government – federal, state and LGAs. FMWR has responsibility for overseeing protection, use, development, conservation, and management of water resources throughout the country, while, states and LGAs are responsible for provision and regulation of water services, implementation and operation/maintenance of water supply and sanitation schemes.

Planning, management and regulation at river basin unit is a general principle in IWRM. In line with this principle, NIWRMC was established in 2007 as a regulatory body to carry out river basin management including water allocation issues. However, the bill to establish the body is still pending. This lack of legal backing results in difficulties in staff recruitment, budgetary allocation etc. that constrains adequate delivery of the mandate of the institution. As a result, river basin management still depends on RBDAs, even after the establishment of NIWRMC.

On the other hand, RBDAs are provided a broad range of powers and functions for water resources development, such as water supply/allocation, construction/operation/maintenance of water infrastructure and formulation/updating of comprehensive water resources management. However, in most RBDAs, the activities are concentrated on development and operation of public irrigation schemes. It is important to note that in this arrangement, two different functions (water supply and regulatory functions) are being performed by a single institution, leading to conflict of interest and fragmentation in management.

The process of drafting the new National Water Resources Bill for Nigeria started in 2006. A number of important issues in terms of future water resources policies and new institutional arrangements were introduced in the bill, including the principle of adopting river basin as the most appropriate unit for water resources development and management, promotion of public-private partnership in the delivery of water services and development of water resources infrastructure.

(2) Action Plan for Institutional Development

As a result of the foregoing and other studies done, the action plan for institutional development and capacity strengthening recommended are based on the following basic strategies:

- Cooperative Institutional Arrangement
- Participatory Management Administration
- Fair Regulatory Institutional Framework
- Decentralization and Coordination

Cooperative Institutional Arrangement

FMWR is required to evolve a strong collaborative arrangement with other federal ministries and agencies towards effective water resources development and management. This may include promotion of periodic meetings among key stakeholders to address common issues for water resources management. FMWR should also initiate the organization of a framework where all relevant

institutions - such as PRS, NWRI, NIHSA, NIWRMC, RBDAs etc. can work closely with each other. To carry out smoothly a national project like comprehensive water resources development which calls for integration among ministries, agencies, sectors and jurisdictions, it is suggested that task forces be created under FMWR in consultation with other relevant institutions. Planning, Research and Statistics Department of FMWR should act as focal point for this purpose. It should be noted that the water resources bill that is still in process is to replace Water Decree No.101 of 1993 and is required to serve as the legal basis for these activities.

Participatory Management Administration

It is necessary to establish and promote water resources development and management on a participatory basis where all stakeholders including government (federal, state and LGAs), communities, women, NGOs etc. are involved in planning, operation and maintenance of the infrastructure and sharing of their experiences and perspectives. This implies changing the approach of water resources management from top-down to bottom-up approach. The activities in this context will include carrying out some surveys nationwide on public opinion and awareness campaign on water issues. Also, it may be effective to develop and promote, through activities of CMOs in river basin, typical participatory management systems or models best suited to the capacity of the communities. In this regard, FMWR should provide support to sensitization campaigns for people in the communities on water issues such as hygiene, gender issue, women empowerment etc. This would be done in collaboration with other relevant ministries such as Health, Women Affairs etc.

Fair Regulatory Framework

It is essential to establish/strengthen a fair regulatory framework based on the planning, management and regulation of water resources at the river basin level as the most appropriate unit for IWRM. It must be highlighted that regulating the authorization or powers to issue licenses for abstractions and allocation of water is its key function as a water regulatory body. NIWRMC including its subsidiary CMOs are therefore required to deliver seamlessly on the mandate in collaboration with other relevant river basin institutions such as NIHSA and RBDAs. In line with this, it is to update the relevant laws and regulations for water abstraction and allocation such as the RBDA Act, NIWA Establishment Act, etc. Again, the promulgation of NIWRMC bill will form the legal basis for the mandate of the commission.

Decentralization and Coordination

It is considered necessary to transfer the powers and functions of FMWR to state and LGA in a phased manner, where feasible. This is expected to increase the benefits to the people and communities as the development and management of water infrastructure are to be implemented with appropriate technology to match the capacity and meet the purpose of the communities. This in turn will result in an efficient management structure in the water resources sector for the nation as a whole. Transfer of powers and functions are considered in Water Supply/Sanitation sector and Irrigation/Drainage sector. To promote transfer of powers and functions smoothly, capacity building on implementation and management at state and LGA levels is highly required. In this connection, it is essential to strengthen and enlarge the training capacity of NWRI, including establishment of National Water Resources Capacity Building Network (NWRCBNet) under the coordination of NWRI.

CHAPTER 11 IMPLEMENTATION PROGRAM

11.1 List of Projects

The projects that have been identified to deliver on the objectives and the set targets of the M/P2013 are outlined below in Table 23.

Table 23 Outline of Proposed Schemes

Project	Responsible Agency
A. Water Source Development	
A.1 Surface Water Development	
A.1.1 On-going Project	
● On-going Surface water source development	FMWR
A.1.2 New Water Source Development	
● Capacity development of dam management	FMWR
● Rehabilitation of equipment for proper operation of major dams	FMWR
● Rehabilitation of deteriorated dams	FMWR
A.1.3 New Water Source Development	
● Surface water development for municipal water supply	FMWR
● Surface water development for irrigation development	FMWR
● Integrated surface water development	FMWR
A.2 Groundwater Development	
A.2.1 Borehole rehabilitation	
● Urban/small-urban/small town	Water board
● Rural	RUWASAA
A.2.2 New boreholes drilling	
● Urban/small-urban/small town	Water Board
● Rural	RUWASSA
B. Sub-sector Development	
B.1 Water Supply and Sanitation	
B.1.1 Water Supply Rehabilitation Scheme	
● Urban and Semi-Urban / Small Town	FMWR, State Ministries, SWAs, STWSSAs
● Rural	FMWR, State Ministries, RUWASSAs
B.1.2 Water Supply Newl Construction Scheme	
● Urban and Semi-Urban / Small Town	FMWR, State Ministries, SWAs, STWSSAs
● Rural	FMWR, State Ministries, RUWASSAs
B.1.3 Sanitation Scheme	
● Public Toilet	FMWR, state ministries
● Final Septic Disposal Facility / Site	FMWR, FME, FEPA, SEPA
● Sewerage System	MWR, FME, FEPA, SEPA
● Hygiene Promotion	FMWR, state ministries, LGAs
● Domestic Sanitation Facilities	
B.2 Irrigation/Drainage	
B.2.1 Rehabilitation of Existing scheme	FMWR, State
B.2.2 New Irrigation scheme	
● Ongoing Scheme	FMWR
● Extension Scheme	FMWR, State
● Supplementary Irrigation Scheme	FMWR, State
● Dam Irrigation Scheme	FMWR
● Integration Scheme	FMWR
B.3 Hydropower Generation	
B.3.1 Installation in to existing dams	
B.3.2 Installation to newly constructed dams	
C. Water Resources Management	
C.1 Hydrological Monitoring	
● Improvement of Surface Water Monitoring Network	NIHSA
● Improvement of Groundwater Monitoring Network	NIHSA
● Enhancement of Data Management Capacity in NIHSA	NIHSA
● Establishment of Hydrological Modeling Center within NIHSA	NIHSA
● Enhancement of Awareness on Importance of Hydrological Monitoring	NIHSA
C.2 Water Allocation and Regulation	

Project	Responsible Agency
● Formulation of Catchment Management Plan for Eight (8) Hydrological Areas	NIWRMC
● Enhancement of Capacity on Water Use Permitting and Regulation	NIWRMC
● Promotion of Catchment Management for Eight (8) Hydrological Areas	NIWRMC
● Preparation of Guideline for Water Pricing	NIWRMC
C.3 Water Environment Management	
● National Drinking Water Quality Monitoring Improvement Plan	FMWR
● Water Quality Monitoring Plan for Important Rivers of Nigeria	FMWR
C.4 Management of Floodplain	
● Flood Risk Evaluation in Floodplain	FMWR
● Capacity Development for Flood Control for Proposed Irrigation Project in the Benue River Flood plain	FMWR
C.5 Financial Enhancement	
● Accounting Standardization if RBDA	FMWR
C.6 Operation and Maintenance	
● Adequate Measuring of Irrigation Costing of RBDA	FMWR
● Project for Capacity Development of Dam Management	FMWR
C.7 Project Management	
● Project for Capacity Development on Water Project Management	FMWR
● Project for Capacity Development on Water Resources Management	FMWR

Source: JICA Project Team

11.2 Implementation Schedule

Implementation schedule of the proposed projects is shown in Tables 24 to 27. The schedule is decided based on strategies of each sector as explained below:

[A] Water Source Development

(1) Surface Water

On-Going Projects

At the latest, the on-going projects would be completed by 2020.

Utilization of Existing Dams

It is proposed that capacity building on dam management for FMWR and relevant agencies should be undertaken urgently. During the capacity building activity, requisite surveys such as safety management survey and dam body survey should be implemented as much as possible, as preliminary steps towards the rehabilitation of dams. Equally, a high priority will be given to the rehabilitation of equipment for proper operation of major dams.

New Water Source Development

It is projected that by 2025 stable water source for urban water supply would be achieved by which time 100% coverage for municipal water supply is targeted. The water source development for irrigation would be implemented according to the irrigation development plan. For the integrated projects, relatively small scale projects would be implemented as a pilot case, and then the remaining large projects would be implemented by 2030.

(2) Groundwater Development

Groundwater will be developed by new borehole drilling and rehabilitation of nonoperational ones. It is most efficient to develop groundwater to follow increase in demand for it. Therefore, amount of groundwater development, i.e. total yield from new boreholes and rehabilitated boreholes, will be increased in proportion to the growth of demand for groundwater, which can be assumed as linear growth during 2014 to 2030. It means that the number of new boreholes and rehabilitated boreholes is the same every year.

[B] Water Supply and Sanitation

(1) Water supply facilities using surface water

The M/P2013 proposes rehabilitation of existing facilities and construction of new facilities in that order of priority in the 1st stage, and then continue the construction of new facilities according to progress of water sources development in the 2nd and 3rd stages.

(2) Water supply facilities using groundwater

The M/P2013 proposes rehabilitation of existing facilities and construction of new facilities in the entire period from 1st to 3rd stage.

(3) Sanitation

In respect of sanitation, the M/P2013 proposes construction of public toilets in the entire period, construction of final septic disposal facilities and/or sites in the short term, and construction of sewerage systems in the 2nd and 3rd stages.

[C] Irrigation and Drainage

It is proposed that ongoing schemes should be completed by 2025 considering their high priority. Supplementary Irrigation Schemes, which are expected to start earlier due to comparatively small and economic scale of their development, would be completed before 2025. The Extension Schemes and Integration Schemes would be prepared in the 1st Stage and implemented by 2025 due to their large scale. Dam Irrigation Scheme would be implemented by 2030 in line with construction schedule of the irrigation dams. Also Integrated Irrigation Scheme would be implemented by 2030.

[D] Water Resources Management

(1) Hydrological Monitoring

The monitoring network would be improved step by step. As for the hydrological services such as data management and hydrological modeling, the capacity development project would be urgently implemented. Then, the related hydrological services would be continuously implemented. The awareness on importance of hydrology would be promoted continuously for the entire period.

(2) Water Allocation and Regulation

The Catchment Management Plans should be urgently prepared. Simultaneously, capacity development on water use permits and regulation by NIWRMC should be enhanced. Furthermore, guideline for water pricing should be prepared. These should be implemented urgently in the short term. On the basis of these experiences, catchment management for eight (8) hydrological areas would be implemented continuously.

(3) Water Environment Management

The capacity development for water quality monitoring would be implemented first. Thereafter, continuous water quality monitoring for drinking water as well as for important rivers would be implemented.

Figure 24 Implementation Schedule of Water Sources Schemes

Project	1st Stage							2nd Stage					3rd Stage				
	2014-2020							2021-2025					2026-2030				
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1.Surface Water Development																	
1.1 Ono-going Project	XXX	XXX	XXX	XXX	XXX	XXX	XXX										
1.2 Effective Utilization of Existing Dams																	
● Capacity development of dam management	XXX	XXX	XXX														
● Rehabilitation of equipment for proper operation of major dams				XXX	XXX	XXX	XXX										
● Rehabilitation of deteriorated dams				XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
1.3 New Water Source Development																	
● Surface water development for municipal water supply					***	***	***	XXX	XXX	XXX	XXX						
● Surface water development for irrigation development					***	***	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Integrated surface water development	***	***	***	***	***	***	***	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2 Groundwater Development																	
2.1 Rehabilitation of existing boreholes																	
● Urban/small-urban/small town	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Rural	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXDX	XXX	XXX	XXX
2.2 New drilling boreholes																	
● Urban/small-urban/small town	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Rural	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

[Note] ***: Preparation, XXX: Implementation
Source: JICA Project Team

Figure 25 Implementation Schedule of Water Supply and Sanitation Schemes

Project	1st Stage							2nd Stage					3rd Stage				
	2014-2020							2021-2025					2026-2030				
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1 Water Supply Rehabilitation Scheme																	
● Urban and Semi-Urban/Small Town	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Rural	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2 Water Supply Newly Construction Scheme																	
● Urban and Semi-Urban/Small Town	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Rural	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
3 Sanitation Scheme																	
● Public Toilet	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Final Septage Disposal Facility/Site	***	XXX	XXX	XXX	XXX	XXX	XXX										
● Sewerage System							***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Hygiene Promotion	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Domestic Sanitation Facility	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

[Note] ***: Preparation, XXX: Implementation
Source: JICA Project Team

Figure 26 Implementation Schedule of Irrigation and Drainage Schemes

Project	1st Stage							2nd Stage					3rd Stage				
	2014-2020							2021-2025					2026-2030				
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1. Existing Irrigation Scheme																	
1.1 Ongoing Scheme	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XX					
1.2 Extension Scheme		***	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2. New Irrigation scheme																	
2.1 New Irrigation scheme	***	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX					
2.2 Dam Irrigation Scheme					***	***	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2.3 Integration Scheme	***	***	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX

[Note] ***: Preparation, XXX: Implementation
Source: JICA Project Team

Figure 27 Implementation Schedule of Water Resources Management Schemes

Project	1st Stage							2nd Stage					3rd Stage				
	2014-2020							2021-2025					2026-2030				
	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1. Hydrological Monitoring																	
● Improvement of Surface Water Monitoring Network	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Improvement of Groundwater Monitoring Network	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Enhancement of Data Management Capacity in NIHSA	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Establishment of Hydrological Modeling Center within NIHSA	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Enhancement of Awareness on Importance of Hydrological Monitoring	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
2. Water Allocation and Regulation																	
● Formulation of Catchment Management Plan for Eight (8) Hydrological Areas	***	XXX	XXX														
● Enhancement of Capacity on Water Use Permitting and Regulation	***	XXX	XXX														
● Promotion of Catchment Management for Eight (8) Hydrological Areas	***			XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Preparation of Guideline for Water Pricing	***	XXX	XXX														
3. Water Environment Management																	
● National Drinking Water Quality Monitoring Improvement Plan	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
● Water Quality Monitoring Plan for Important Rivers of Nigeria	***	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX	XXX
4. Management of Floodplain																	
● Flood Risk Evaluation in Floodplain	***	XXX	XXX	XXX	XXX	XXX	XXX										
● Capacity Development for Flood Control for Proposed Irrigation Project in the Benue River Flood plain	***	XXX	XXX	XXX	XXX	XXX	XXX										
5. Financial Enhancement																	
● Accounting Standardization if RBDA	***	XXX	XXX	XXX	XXX	XXX	XXX										
6. Operation and Maintenance																	
● Adequate Measuring of Irrigation Costing of RBDA	***	XXX	XXX	XXX	XXX	XXX	XXX										
● Project for Capacity Development of Dam Management	***	XXX	XXX	XXX	XXX	XXX	XXX										
7. Project Management																	
● Project for Capacity Development on Water Project Management	***	XXX	XXX	XXX	XXX	XXX	XXX										
● Project for Capacity Development on Water Resources Management	***	XXX	XXX	XXX	XXX	XXX	XXX										

[Note] ***: Preparation, XXX: Implementation
Source: JICA Project Team

CHAPTER 12 KEY PERFORMANCE INDICATORS & EXPECTED OUTCOMES

The recommended projects and programs identified as measures needed to deliver on the objectives of M/P2013 are expected to result in measurable outputs that would signpost progress towards attainment of set targets. These have been scheduled in Chapter 11 with different timelines for accomplishing each of them. These signposts or milestones by which progress may be measured are 13 outputs. These are the key performance indicators (KPIs). The expected socio-economic benefits derivable from it all are identified as 6 outcomes. Both the outputs and outcomes are shown in Table 28 below.

The responsibility of monitoring the progress towards set objectives in the water resources sector lies with FMWR. The ministry therefore would be undertaking Monitoring and Evaluation (M&E) of the projects and programs in the sector on regular basis and relay the results to NPC. This function is one of the statutory functions of the PRS Department of FMWR.

Table 28 Achievement and Targets of Outcome and Output KPI

Name of Outcome and Output		Key Performance Indicator (KPI)					
		Baseline	Achieve - ment	Targets			
		2010	2011	2011	2012	2015	2020
＜Outcome＞							
1. Water	% of Population with access to potable water supply	58	60	63	66	100	100
2. Sanitation	1) % of Population with access to improved sanitation facilities	32	46	46	50	70	80
	2) No. of Awareness Campaigns carried out	40	57	n/a	65	85	95
3. Dam	% change in no. of Dam Construction	(88 dams)	0	29.5	31.8	40.1	40.9
4. Irrigation	Size of Irrigated Land (thousands of Ha)	60	96.5	96.5	147.5	275.3	519.4
5. Training & Research	1) No. of Trained Water Prof.	642	689	800	960	1,382	2,304
	2) No. of Research conducted	26	10	21	24	49	111
6. Monitoring	No. of Water Test conducted	1,850	3,050	5,520	8,570	15,640	34,040
<Output＞							
1. Water	1) No. of Urban Water Schemes	2	2	3	111 million Naira	224 million Naira	111 million Naira
	2) No. of Rural Water Schemes	-	93	204			
	3) No. of Small Towns Water Schemes	11	16	28			
	4) No. of Boreholes	710	117	228			
2. Sanitation	No. of Communities having access to improved facilities	695	1,017	1,007	85 million Naira	123 million Naira	163 million Naira
3. Dam	1) Water stored（BCM）	12.9	12.9	13.0	13.4	15.4	15.7
	2) Dams constructed	220	223	223	230	254	283
4. Irrigation	1) Irrigation Schemes	15	21	21	40	45	-
	2) Farmer having access to irrigation land (in thousand)	202.0	236.5	245.0	294.0	800.0	-
5. Training & Research	No. of Training & Research Activities	-	1,099	1,000	1,765	1,795	1,795
6. Monitoring	1) No. of Water Quality Test Lab. constructed	6	6	6	12	17	37
	2) Surface Water Monitoring Station constructed	213	252	253	313	402	482
	3) Groundwater Monitoring Stations constructed	12	20	20	30	52	100

Source：FMWR

CHAPTER 13 PLAN BUDGET

13.1 Cost Estimate

The budget for the intervention projects and programs outlined in the M/P2013 are shown in Tables 29 to 31 in detail. The total cost of the projects for surface water development is N376 billion; N100 billion for groundwater development; N4,117 billion for water supply and sanitation; N1, 531 billion for irrigation & drainage; and N29 billion for water resources management.

Of the total project cost, 8% for water supply development and water resources management, 67% for water supply and sanitation and 25% for irrigation and drainage. Water supply and sanitation cost occupies a large part of the total cost.

Table 29 Project Cost for Water sources Development Schemes

Project	Content (Million Naira)					Total (Millionaire)
	Construction	Equipment	Engineering	Administration	Physical contingency	
1. Surface Water Development	**295,722**	**1,228**	**29,695**	**14,848**	**34,149**	**375,642**
2 Groundwater Development	**79,124**	**0**	**7,912**	**3,957**	**9,099**	**100,092**
Total	**374,846**	**1,228**	**37,607**	**18,805**	**43,248**	**475,734**

Source: JICA Project Team

Table 30 Cost of Sub-sector Development Schemes

Project	Content (Million Naira)					Total (Millionaire)
	Construction	Equipment	Engineering	Administration	Physical contingency	
1. Water Supply and Sanitation	**3,254,770**		**325,477**	**162,738**	**374,298**	**4,117,284**
1.1 Water Supply Rehabilitation	186,282		18,628	9,314	21,422	235,646
1.2 Water Supply New Construction	2,409,720		240,972	120,486	277,118	3,048,296
1.3 Sanitation	658,768		65,877	32,938	75,758	833,342
2. Irrigation and Drainage	**1,180,086**	**30,725**	**121,080**	**60,317**	**139,221**	**1,531,429**
2.1 Rehabilitation of Existing scheme	39,670	568	4,023	2,012	4,627	50,900
2.2 New Irrigation scheme	1,140,416	30,157	117,057	58,305	134,594	1,480,529
Total	**4,465,581**		**446,557**	**223,055**	**513,519**	**5,648,713**

Source: JICA Project Team

Table 31 Cost of Water Resources Management Schemes

Project	Administration		Total (Millionaire)
	Equipment	Administration	
1. Hydrological Monitoring	**10,512**	**13,115**	**23,627**
2. Water Environment Management	**3,700**	**2,009**	**5,709**

Source: JICA Project Team
Remarks: The project cost is for the project which may require considerable cost for equipment as well as operation and maintenance. The cost in the table does not include the cost for foreign experts for capacity development.

13.2 Financial Program for Project Implementation

The financial program for the master plan is shown in Table 32, which was estimated in the previous sections for water sources development, water supply and sanitation and irrigation and drainage.

In water sources development subsector (surface water and groundwater), 30% of the total investment is for the 1st Stage, 31% for the 2nd Stage and 39% for the 3rd Stage. The size of investment is almost the same at every stage though it is a little higher in the 3rd stage.

In water supply and sanitation sector, 45% of the total investment is for the 1st Stage, 34% for the 2nd Stage and 22% for the 3rd Stage. Investment for the 1st Stage is the largest of all the stages for this subsector. Thereafter, the size of investment will gradually reduce.

In irrigation and drainage subsector, 23% of the total investment is for the 1st Stage, 50% for the 2nd Stage and 27% for the 3rd Stage. The investment in the 2nd stage is the largest of all the stages in this subsector.

Table 32 Financial Program of Investment for Water Sources Development Schemes

Project	Investment for each Stage（Billion Naira）			Total （Bil. Naira）
	1st Stage 2014-2020	2ns Stage 2021-2025	3rd Stage 2026-2030	
A. Water Source Development	**144.0**	**146.8**	**184.8**	**475.7**
A.1 Surface Water Development	98.4	108.8	168.4	375.6
A.1.1 On-going Project	98.4	0	0	98.4
A.1.2 New Water Source Development	0	108.8	168.4	277.2
A.2 Groundwater development	45.6	38.0	16.4	100.1
A.2.1 Rehabilitation of existing boreholes	1.4	1.2	1.0	3.6
A.2.2 New drilling boreholes	44.2	36.8	15.4	96.5
B. Water Supply and Sanitation	**1,836.9**	**1,393.5**	**886.9**	**4,117.3**
B.1 Water Supply Rehabilitation Scheme	142.5	49.8	43.3	235.6
B.2 Water Supply New Construction Scheme	1,489.4	994.6	564.3	3,048.3
B.3 Sanitation Scheme	205.0	349.1	279.3	833.3
C. Irrigation and Drainage	**353.8**	**757.6**	**420.0**	**1,531.4**
C.1 Rehabilitation of Existing scheme	14.7	33.8	2.4	50.9
C.2 New Irrigation scheme	339.1	723.8	417.6	1,480.5
Total	**2,334.7**	**2,297.9**	**1,491.7**	**6,124.4**

Source: JICA Project Team

CHAPTER 14 ECONOMIC EVALUATION & CONCLUSION

14.1 Economic Evaluation

An economic evaluation on Water Supply Projects and Irrigation and Drainage Projects proposed in Chapter 11 is carried out in this chapter.

(1) Water Supply Projects

The results of analysis vary from state to state. However, from the national viewpoint, the EIRR exceeds the 10 % of opportunity cost of capital or slightly below it. Accordingly, the Water Supply Projects of the M/P2013 as a whole are judged to be economically feasible.

(2) Irrigation and Drainage Projects

Actually, the results of analysis vary from HA to HA. However, from the national viewpoint, the EIRR exceeds the 10 % of opportunity cost of capital. Accordingly, the Irrigation and Drainage Projects of the M/P2013 as a whole are judged to be economically feasible.

14.2 Financial Consideration

The yearly average budget size of FGN and state governments over the period of 3 years from 2009 to 2011allocated to water supply and irrigation development were N148 billion and N35billion, respectively. Assuming that this relationship is retained into the future, the allocations to the projects of the M/P2013 from the governments are presumed below.

(1) Water Supply Projects

First, the allocated budget to the M/P2013 would be disbursed to the projects that could achieve the highest economic effectiveness, namely rehabilitation projects. Secondly, the remaining amount of the budget would be spent on new development projects. However, it is not possible that the project cost of these new development projects could be financed entirely with this remaining amount. Meanwhile, FGN envisages 100% nationwide coverage for water supply. To attain this national goal, it is suggested that the government should finance the sector budget in order to deliver on the overall objectives and the goals in the water resources sector.

In particular, the state governments play a crucial role in the development of water supply sector in Nigeria, currently bearing more than 80% of the water supply development costs in the country. The M/P2013 requires yearly average amount of N225billion in the 1st stage, N186billion in the 2nd stage and N87billion in the 3rd stage. Besides, a substantial amount of additional budget especially for the 1st and 2nd stage is estimated at N165billion and N68billion respectively. As a result, the state governments have to collaborate closely with FGN on the implementation of this master plan.

(2) Irrigation and Drainage Projects

First, the allocated budget to the M/P2013 would be disbursed to projects that could achieve the highest economic impact, namely the rehabilitation projects and the supplementary irrigation projects. Secondly, the remaining amount of the budget would be spent on new projects. The remaining portion of the budget cannot finance the required number of new projects. In order to achieve the national goal of 100% self-sufficiency in rice production, it is proposed that the government should fund the budget consistently.

14.3 Evaluation of Social and Environmental Impact

(1) List of Projects and Brief Description

The list of projects consists of five (5) sectors which include 93 ongoing and 944 proposed new projects as listed below.

Table 33 Number of Projects under the M/P2013

Sector	Ongoing Projects	Proposed Projects*	Total
1. Dam	32	49	81
2. Municipal Water Supply	28	474	502
3. Irrigation and Drainage	33	109	142
4. Sanitation	-	301	301
5. Water Resources Management & others	-	11	11
Total	93	944	1,037

Note (*): Proposed by JICA Project Team based on existing proposed projects by Nigerian government as well as necessary measures for achieving the target of master plan

Source: JICA Project Team

(2) Categorization of Projects (Screening)

The screening of projects was made based on the Categories List stipulated in the Procedural Guidelines on Environmental Impact Assessment, Decree 86, 1992. The result of the screening is summarized in the table 34 below.

Projects in Category 3 such as capacity development, awareness creation, etc. do not require EIA therefore these projects are not scoped for IEE.

A total number of 355 projects in Category 1 and 443 projects in Category 2 are subject to scoping at IEE study level (total 797) in four (4) Sectors (Dams, Municipal Water Supply, Irrigation and Drainage, and Sanitation). This is in compliance with the Guidelines for EIA and JICA guidelines for environmental and social considerations (ver.2004).

(3) Identification of Potential Impacts and Its Significance

For projects that have been scoped for IEE study, the identification of potential impacts and its significance were made based on scoping matrix. The summary is shown below:

(4) Description of Mitigation Measures against Adverse Impacts

Based on the scoping activities indicated above, the following main mitigation measures were recommended for major adverse impacts in each subsector.

Table 34 Recommended Main Mitigation Measures

Sector	Major Impact	Main Mitigation Measures
Dam	Resettlement	Conduct public consultation with Project affected person (PAPs) and local residents to explain the benefits of the project. For PAPs prepare detail analysis for compensation
	Utilization of Local Resources	Prepare utilization and post utilization plan for those areas from where materials will be extracted for construction of the dam
	Traffic	Control on the number of vehicles/equipment to avoid traffic congestion during construction
	Vector of diseases and HIV/AIDS	Implement medical check-up program
	Flora & Fauna	Plantation of forest to be home of the biodiversity and to compensate for deforestation due to the construction of dams.
Municipal Water Supply	Traffic	Control on the number of vehicles/equipment to avoid traffic congestion during construction.
Irrigation and Drainage	Resettlement	Conduct public consultation with Project affected person (PAPs) and local residents to explain the benefits of the project. For PAPs prepare detail analysis for compensation

Sector	Major Impact	Main Mitigation Measures
	Utilization of Local Resources	Prepare utilization and post utilization plan for those areas from where materials will be extracted for construction of the dam
	Traffic	Control on the number of vehicles/equipment to avoid traffic congestion during construction.
	Vector of diseases and HIV/AIDS	Implement medical check-up program
	Flora & Fauna	Plantation of forest to be home of the biodiversity and to compensate deforestation due to the construction of the dams.
	Water Pollution	● Proper management of chemicals and waste oil from equipment maintenance ● Implement training and education of farmers on the kind of chemicals they can use rationally ● Check that only authorized chemicals are used at the site ● Implement water quality monitoring for existing drinking wells. If affected, construct boreholes for affected people
Sanitation	Social Conflict	Conflicts to get approval from citizens for the location of the facility may arise. It is recommended to conduct public consultation with project affected person to arrive to a beneficial agreement. The Agency should make a compromise to manage properly the facility to obtain the consensus of the population on the Project implementation.
	Offensive Odor	Proper management of the facility

14.4 Conclusion and Recommendations

In general, the projects proposed in the M/P will benefit three main sectors, namely municipal water supply, irrigation/drainage and sanitation. For municipal water supply high positive impacts are expected through the project on current health status of the beneficiary population; as potable water will enhance better hygiene practices in the households. For irrigation/drainage, the socio-economic status of the population will be upgraded through increase in agricultural production and employment opportunities, leading to income generation for households; as well as revenue generation for government. In addition food security will be enhanced. Improvement in sanitation will equally lead to better public health through safe disposal of sewage and excreta.

On the other hand, some adverse impact on the environment is also expected from the project implementation which should be reduced through the proposed mitigation measures. In this case, special attention must be given to the dam sector since this involves huge physical development and often require resettlement of people living around the selected site.

14.4.1 Conclusion

In order to provide water services to meet the demands of water users, FMWR commissioned the M/P2013 to be prepared by JICA. Consequently this master plan was prepared in collaboration with the team of consultants dispatched by JICA (JICA Project Team) and the “Steering Committee”, “Technical Advisory Committee” and “Counterpart Team” raised by FMWR. The master plan is a product of the water vision of Nigeria and the technology of Japan on water resources development and management in the country.

14.4.2 Recommendations

[A] Periodic Review of National Water Resources Master Plan 2013

The M/P2013 was formulated on the basis of evidence of water resources potential based on scientific studies and water demand forecast based on economic growth and population projections up to 2030. In the future, it is necessary to check the water demand forecast and look at the trend in economic and population growth.

In addition, it is necessary to check water resources potential on a regular basis. One of the reasons for this is the issue of trans-boundary water over which the country does not have direct control. About

1/4 (88BCM/Year) out of the amount of water resources in Nigeria (374BCM/Year) enter into Nigeria from outside the countries through the Benue and Niger rivers. The size of inflow into the country would be determined by water resources development in the basins on both rivers outside the country. The other reason is the issue of global climate change. Increases in the frequency of drought and occurrence of floods are anticipated more than ever before around the world. In these situations water resources potential is bound to fluctuate in line with emerging climatic conditions. It is in view of the above scenarios that FMWR is required to carry out periodic review of the water master plan, for example, every five years.

[B] Implementation of Water Resources Development Plan

(1) Water Supply Development Plan

Water Supply Development Plan is a development plan that corresponds to the improvement of water supply rate and new water demand of future population growth (100 million people) to increase to up to 2030. The current water supply rates are: 71% (Urban), 51% (Semi-urban), 40% (Rural) and 56% in the national average. In accordance with the road map of FMWR (2011), the water supply rate in 2025 is planned to achieve 100% of each.

Water supply system is a critical infrastructure in any country. As the investment in water source development facilities (dams and wells), water purification facilities and water distribution networks will be large-scale, investment at government level become essential. Both governments at Federal and State levels should endeavor to implement the projects proposed in the plan in a consistent manner.

(2) Irrigation and Drainage Development Plan

Irrigation and Drainage Plan is a development plan with the aim of 100% self-sufficiency rate in rice production in conjunction with the promotion of rain-fed rice cultivation by 2030. The projects with high investment efficiency have been selected in the development plan. Areas with gravity irrigation system and areas with good development efficiency for water source development have been selected. The investment efficiency for “Supplementary Irrigation Scheme” proposed in the basins of HA5 HA7 with high rainfall amount is particularly high.

In the case of pump irrigation system, the promotion of sound and self-reliant irrigation with hydroelectric power generation using the dam for water resources development is recommendable. The “Integrated Irrigation Scheme” planned for three locations propose multipurpose dam (for irrigation and hydropower generation) and irrigation land reclamation at each location. For the potential of hydroelectric power plant installation at existing dams, future research is needed.

For food security in the country, the promotion of irrigated agriculture with cultivation of improved seeds with high yield and toughness to drought conditions is of particular importance. As urbanization progresses, there is a tendency for demand for rice to increase. Likewise in Nigeria, with continuing urbanization, future demand for rice will increase. In addressing this trend, large-scale projects such as irrigated agriculture, will contribute significantly to the creation of employment opportunities in rural areas and increased food production. From these points of view, planned investment proposed to the Federal Government for irrigation schemes are critical infrastructural requirements.

[C] Involvement in Other Sub-sectors

Also in water resource-related schemes that are under different jurisdiction, involvement of FMWR will become very important in the future. For example, flood management and hydroelectric power generation are important areas where inter-ministerial collaboration is a necessity.

As noted above, the promotion of sound and self-reliant irrigation with hydroelectric power generation component in water resources development is highly recommended. Although the proposed plan often targets small scale hydropower generation plants used to pump irrigation water, multi-purpose dam projects with large-scale hydropower generation and irrigation scheme should be seriously considered. In this regard, collaboration with the Federal Ministry of Power that has jurisdiction over the power sector is important.

Similarly, in the wake of increasing occurrence of floods especially on the Benue and Niger rivers, involvement in flood management by the FMWR has become critical. With enhanced ability for flood management, FMWR will be able to contribute more significantly to flood forecasting and warning system for the purpose of securing timely evacuation of flood plains along disaster prone areas. Also, close collaboration with the Federal Ministry of Environment that has jurisdiction over floods becomes crucial.

Against this background, for water related projects which other ministries have jurisdiction over, FMWR will need to strengthen cooperation with those other ministries for the overall benefit of the country.

[D] Implementation of Water Resources Management Plan

The Water Resources Management Plan shows the methodology of how to provide water services based on the principles of Sufficiency, Efficiency, Fairness, Safety and Sustainability, to water users who expect [Effective Use of Water], [Mitigation of Flood Damages] and [Conservation of Water Quality], in their patronage of water infrastructures. It organizes harmonious ways by which various stakeholders have access to water resources for their use without imperiling the rights of other water users, now and in the future.

It is expected that FMWR would be empowered to implement the projects and action plans that are indicated in the Water Resources Management Plan proposed in the M/P2013. The planned projects and programs are capable of delivering what may be regarded as the best state of water resources management, which is outlined below:

- There is a good plan. There is an appropriate action.
- There are organizations and systems for desirable Water Services.
- Water Services to meet safety and security standards are provided for water users.
- Water Services are never delayed. If there is trouble in delivery system for Water Service, someone restores it immediately.
- Water users pay the price for the right price of Water Services.
- Information relating to Water Services is collected and analyzed. This information is managed and utilized to improve Water Services
- People engaging Water Service study every day with the spirit of self-advancement.
- Water Services are always monitored by water users, and the results of services are evaluated.

[E] Steady and Sound Investment

The water supply projects and irrigation & drainage projects require 2 and 4 times of the current capital expenditures on these 2 sectors by the governments. For the smooth financing and implementation of the projects, efforts to find other sources of funds are therefore important. Some of these other sources are outlined below:

Utilization of Private-sector Funds

FMWR shall promote the introduction of Public-Private Partnership (PPP) and the privatization of the water supply projects and the irrigation projects currently undertaken by the governments in order to decrease government direct capital investment.

Utilization of International Development Partners' (IDPs) Funds

The intensive efforts to get awards such as the "Grant Technical Aid and Grant Financial Aid" or "Soft Loan" from IDPs are to be made for decreasing government direct capital investment. Besides, for realizing actually the investment programs efficiently and concretely, it is also requested to share the related information among all IDPs through means such as stakeholders' meetings and the use of donor's coordination platforms.

Promotion of Users' Pay Principle

Every user of treated water and irrigation water must pay the charge according to the volume they use. However, most of the users actually don't pay this charge. This causes low level of

revenues realized from these projects. So it is crucial to improve revenue collection by educating users on the importance of paying for water services through public awareness campaigns. As a result, incomes from the projects are expected to grow, which could generate the incremental cash flow for new projects and thereby decrease government direct capital investment.

The FGN will realize steadily the objectives of the M/P2013 by considering the above 3 actions which contribute toward decreasing government direct capital investment.

[F] Establishment of Project Promotion Mission Team

A beginning of big job is critical. (The first step is always the hardest)

FMWR is recommended to establish immediately "Project Promotion Mission Team (PMT)" in FMWR to promote and accelerate various action plans and projects proposed in the Water Master Plan 2013.

The team leader of PMT is appointed by the Minister of FMWR. PMT works under the direct control of the Permanent Secretary of FMWR. PMT is time-limited organization of five years. The purpose of PMT is to promote and accelerate the implementation of the various action plans and projects proposed in the Water Master Plan 2013.

PPMT consists of about ten full-time members and will receive support from each Department and Agency of FMWR on the projects. Finally, in view of the required introduction of advanced technology and personnel training, FMWR should ask for technical cooperation from an international development partner.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