2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

The design policy of this Project related to the contents of the Japanese Assistance is as follows:

2-2-1-1 Basic Policy

(1) Scope of the Assistance

1) The maximum of 15 sites will be selected from the requested 30 sites in four regions.

2) Relevance of the use of solar-powered pumping systems will be examined by comparing solar power generation as a power source with diesel power generation and national electric power supply and taking into account the fact that villagers are to operate and maintain the systems.

3) Relevance of construction of the piped water supply facilities assumed for the Project will be examined from the viewpoints of hydrogeological conditions and operation and maintenance of the facilities. The sites where the examination has found relevance of water supply facilities with hand pumps will be excluded from the Project.

4) The scales of the water supply facilities will be those appropriate for the design populations served with water supply in 2020, the Project target year.

5) Equipment for water quality analysis and a video camera have been excluded from the equipment plan. Relevance of and necessity for the other equipment will be examined to decide whether it is necessary to procure it.

6) Since operation and maintenance of rural water supply facilities is considered principally as responsibility of the people benefiting from the facilities in The Gambia, there is a need for assistance in development of and awareness creation among the residents on the operation and maintenance system for the water supply facilities to be constructed in the Project and hygiene education. Therefore, implementation of Soft Component in the Project will be considered.

(2) Site Selection

1) Site for construction of water supply facilities

① Among the 30 sites for construction of water supply facilities in the original request, 15 remain for further consideration after having excluded the sites where other donors had projects and the sites located in dangerous areas near the border with Senegal in the process of confirmation and discussion with The Gambian government. By adding five

supplementary sites to the remaining 15 sites, a survey will be conducted in 20 sites to select 15 project sites. Attention will be paid to the following points in the survey:

② The criteria to evaluate relevance of the proposed sites have been established as shown in Table 2-5 below (nine criteria). These criteria will be used for comprehensive evaluation of the proposed sites and selection of the construction sites.

Table 2-5 Evaluation and Selection Criteria

Evaluation Criterion	Criteria of Limit
1) Project duplication	Where there already exists a project supported by another donor
2) Beneficiary population	Where the beneficiary population (2009) at a site is less than 500
3) Amount of water supply	Where The Gambian standard for the unit water supply (35 litters/capita/day) has been met.
4) Percentage of population served with water supply	Where the percentage of population served with water supply is more than 81 % (the average percentage in rural areas)
5) Willingness to pay	Where residents have no intention to pay water charges
6) Intention to conclude a contract	Where a representative of a village has no intention to conclude a maintenance contract, which should be concluded between a local OM company and the Village Water Committee
7) Access	Where large vehicles cannot reach a site even in the dry season
8) Result of the pumping test	Where a yield is 5.0 m^3/h or less
9) Results of the water quality analysis	Where water quality does not conform to the Guidelines for Drinking-Water Quality of WHO. However, on the iron concentration, the outcome of the discussions between the residents and the executing agency will be followed.

③ The geophysical prospecting will be conducted at the sites where the confirmation of relevance and prioritization have been made with the examination described in ②, among the 20 survey sites. Based on the result of the prospecting, test drilling was conducted at the 15 priority sites to confirm yield from and water quality of water sources. These data will be used in selecting villages as the Project sites. Fig. 2.1 shows the flowchart of the site selection.

④ A test borehole which has a yield of 5 m^3/hour or more and produces water with appropriate quality with reference to the Guidelines for Drinking-Water Quality of WHO will be considered as a successful borehole and will be used as a water source in the Project.

⑤ If a yield and water quality at a site does not conform to the above-mentioned

standards of the Project, the site concerned will be replaced by a supplementary site in the list of priority sites.

⑥ The supplementary site N-17 consists of two villages, Gidda and Talokoto. Since there are a mini solar-powered water supply facility and public taps installed with assistance from a local NGO at Talokoto, only Gidda will be considered for implementation of the Project.

2) Site for conversion of the existing water supply facilities

① The existing water supply facilities in the three conversion sites were constructed in the previous grant aid project of Japan, "the Project for Rural Water Supply Phase I" (1991 – 1993). The facilities have been operated voluntarily by the villagers for 16 to 18 years after their construction. However, since soaring fuel cost and deterioration of the equipment by aging have made it difficult to operate and maintain them, the villagers request conversion of the diesel-powered facilities to solar-powered ones, which will result in smaller operation and maintenance costs than the diesel-powered facilities. Therefore, the relevance of conversion to the solar-powered facilities will be examined.

② At the three conversion sites, the Project will plan to replace the power units, pumps and part of the auxiliary facilities on the assumption that the use of the existing water sources and water supply facilities will continue.

③ The evaluation of the sites will be implemented following the evaluation criteria in Table 2-5 (nine criteria).

④ The existing facilities were designed to supply to livestock as well as villages. However, through the discussions on DWR, it was decided that the conversion of facilities in the Project would be intended only for the supply of drinking water. Therefore, the existing water supply facilities will meet the demand of the populations as of 2009 in their service areas even without expansion of the facilities. For this reason, the populations as of 2009 will be considered as the beneficiary populations in the service areas of the conversion sites.

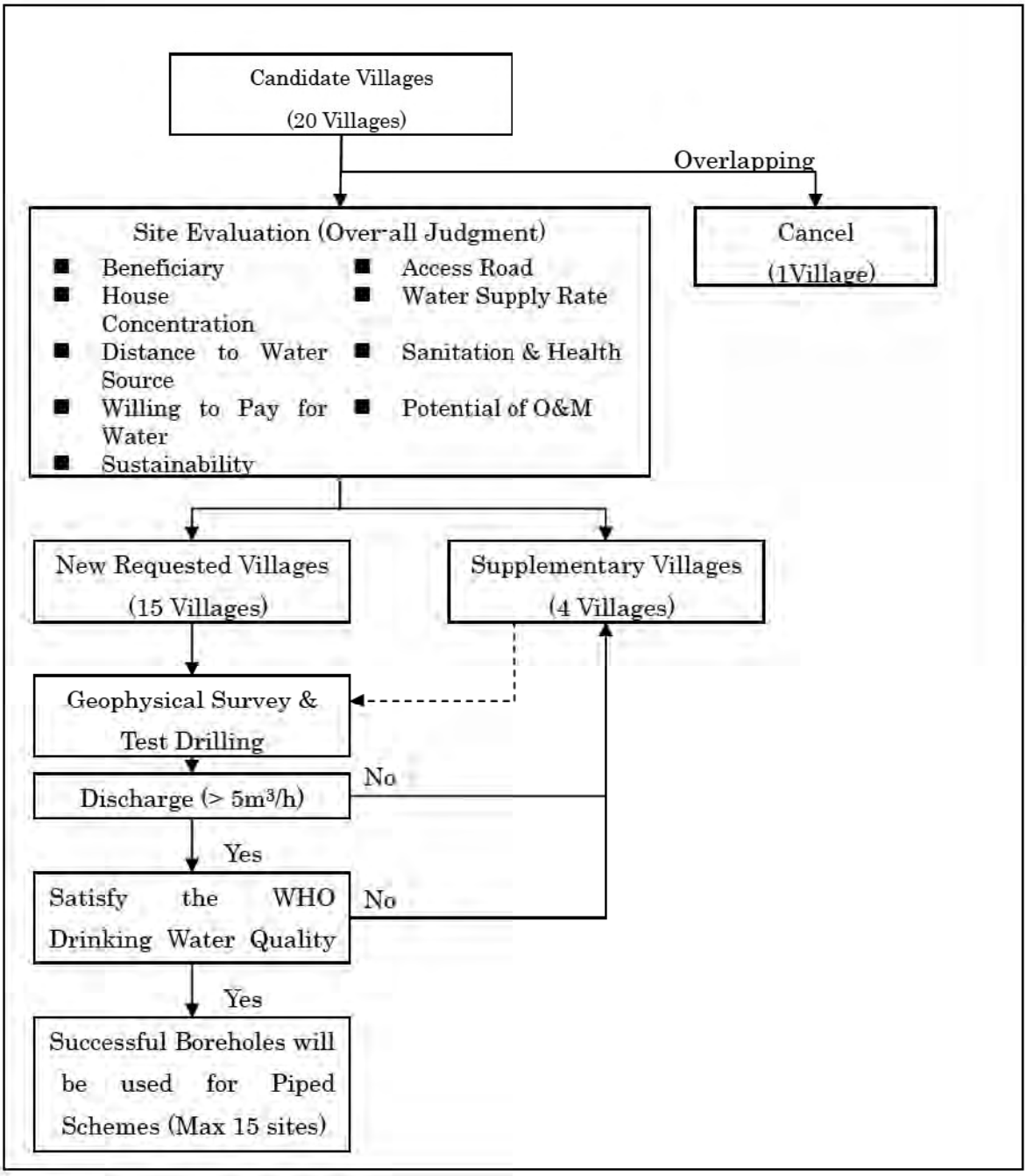

Fig. 2-1 Criteria for the Selection of Project Sites

(3) Procurement of Equipment

The details concerning the equipment in the request (of 2007) were confirmed during the field survey (in May 2009). Table 2-6 below shows the details of the confirmation. Necessity for and relevance of the procurement of the equipment listed in Table 2-6 will be examined.

Table 2-6 Discussions of Procurement of Equipment

Equipment Requested (2007)	Qt	Qt	Discussions of Procurement (May 2009)
1) Pick-up truck	3	2	1) Number of pick - up trucks will be examined based on the necessity of pumping test, geophysical survey equipment, borehole logging equipment and GPS for field activities, taking into account the past experiences and the future plan of activities. 2) Pumping test equipment will be also examined the necessity to be procured by DWR for the project
2) Cargo truck	1	0	
3) Station wagon, 4 wheel drive	1	0	
4) Compressor mounted on truck	1	1	
5) Pumping test generator	1	1	
6) High capacity submersible pump for pumping test	1	1	
7) Water quality analysis equipment	1	0	1) not to be procured the project
8) Video	1	0	1) not to be procured the project
9) Geophysical resistivity survey equipment	1	1	1) Geophysical and logging equipments will be considered the meaning of necessity of DWR.
10) Borehole logging equipment	1	1	
11) GPS	1	1	
12) Spare parts on the above	1	1	1) Spare parts on the above

* The letter of request was submitted by DWR on September 2009 namely 1) Water quality monitoring vehicle 2) Groundwater monitoring vehicle including geophysical survey and, 3) Project operation and maintenance vehicle.

(4) Soft Component (Technical Assistance) Plan

Sustainable supply of safe and stable water from the facilities to be constructed in the Project to the villagers in the Project area will require establishment of a tripartite operation and maintenance system consisting of "residents – private OM companies - administrative agency". There is a need to consider implementation of Soft Component for establishment of this system and implementation of sustainable operation and maintenance of the water supply facilities under agreements with private OM companies for the villages in the Project area.

2-2-1-2 Policies on Natural Environmental Conditions

(1) Climate and Precipitation

The Project area is located in the southern edge of the dry Sahel. Meteorologically, the area is in the tropical savannah climate zone and has distinct rainy and dry seasons and the average annual precipitation of 600 - 850 mm. The rainy season is from June to October. In the period of the heaviest rain from July to September, implementation of the work may become difficult because unpaved access roads may be submerged in water. Therefore, the possibility

of poor access to the Project sites in poor climatic conditions should be taken into account in the preparation of the implementation schedule of the Project.

(2) Hydrogeology

The Project area is located in a flat area with an elevation of 50m or less along The Gambia River. Villages in the Project area have traditional hand-dug shallow wells with depths of 10 to 40 meters and shallow well facilities equipped with hand pumps. In many villages, drop in groundwater levels in the dry season makes it difficult to fetch water from these wells. In villages near The Gambia River, there is a concern over saline-water intrusion into the groundwater caused by the seawater running up the river at high tides.

The current geological and hydrogeological conditions suggest high groundwater potential in the Project area. The data on the existing boreholes suggest a possibility of stable supply of safe groundwater from 70 - 100m in depth. Aquifers are found in Tertiary and Mesozoic sandstones and confined groundwater in these aquifers are expected to be of good quality in general. During the survey, after conducting geophysical prospecting in Project sites, test drilling survey will be conducted at a promising location identified in the prospecting. The test boreholes will be judged for suitability as a water source in the Project by yield and water quality and, if judged suitable, will be used as production wells.

If test drilling survey could not be completed during the field survey, production wells will be drilled in such sites during the facility construction period. In such cases, the success rate of drilling boreholes and average drilling depth will be estimated from the data of the field reconnaissance and geophysical prospecting and the results of analysis of the existing data.

(3) Water Quality

The standards for water quality of The Gambia are shown in Table 2-7 below. The Gambian standards provide water quality items specific to the country, whose standard values follow the guideline values of WHO Drinking Water Guidelines in general. In the Project, The Gambian standards will be followed. However, for those items to which The Gambian standards do not provide standard values, WHO Drinking Water Guideline values will be used for judgment of compliance.

As problems specific to The Gambia, there are concerns over the effects of iron concentration, salinity and free carbonic acid. Table 2-8 below summarizes the policies to overcome the problems.

Table 2-7 The Gambian Water Quality Standard and WHO Drinking Water Quality Guideline (mg/l)

Item	The Gambia	WHO	Item	The Gambia	WHO	Item	The Gambia	WHO
1. TDS	1,000	1,000	8. Calcium	250	-	15. Nitrate	10	50
2. Turbidity	-	-	9. Iron (Fe)	0.3	0.3	16. Nitrite	0.03	3
3. Alkalinity	-	-	10. Ammonia	0.5	1.5	17. Fluoride	1.5	1.5
4. Arsenic	-	0.01	11. Magnesium	150	0.1	18. Calcium	250	-
5. Sodium (Na)	150	200	12. Copper	-	1	19. COD	-	-
6. Potassium	NS	-	13. Chloride	250	250	20. Coliform	0/100ml	0/100ml
7. Magnesium	150	0	14. Sulphate	250	250	21.Electric Conductivity	1,300 µS/cm	-

Table 2-8 Policies on Water Quality Specific to The Gambia

Water Quality Item	Details of Policies against the Concerns
Iron ion	High concentration of iron in groundwater is found in some parts of The Gambia. The Guidelines for Drinking-Water Quality of WHO provide the guideline value of 0.3 mg/l for iron concentration. However, since iron does not affect people's health, suitability of water with high iron concentration as a water source in the Project is to be concluded through the discussions with the area residents and the executing agency of DWR.
Free carbonic acid	Groundwater in The Gambia tends to have low pH and contain free carbonic acid. However, measurements of these items approach the standard values as a result of water spraying and aeration at the pumping stage. Therefore, consideration is to be given to the structure of the facilities at distribution reservoirs.
Salinity	Seawater intrusion has been confirmed at a point 200 km upstream from the estuary along The Gambia River. Signs of salinity in the groundwater at the Project sites will be examined with electrical prospecting and two-dimensional prospecting, and water sources suitable as sources of drinking water will be selected by carrying out sampling in the test drilling boreholes.

2-2-1-3 Policies on Socio-economic Conditions

(1) Economic Burden on the Residents

Sufficient supply of safe drinking water has not been guaranteed in the villages in the Project area. For this reason, construction of water supply facilities has been requested. To ensure supply of safe drinking water, the constructed water supply facilities will have to be operated sustainable, which will require residents to operate and maintain the facilities at their expense and to have responsibility by collecting water rates to pay necessary expenses. In the Survey,

it will be confirmed whether the villagers have intention to accept the responsibility to operate and maintain the new water supply facilities and willingness to pay the maintenance costs.

Villagers in the Project area are mainly engaged in agriculture. In the season when they are not much engaged in agriculture, they earn cash income from temporary jobs in urban areas, sales of vegetables and food items at local markets and manufacturing and sales of handicrafts. For the selection of the project sites, evaluation will be carried out on necessity for contribution from the residents and intention to make payment for the guarantee of supply of safe drinking water, capacity in the operation and maintenance and the levels of their incomes.

(2) Cultural and Religious Tradition

Since Islam is the major religion in The Gambia, sufficient consideration will have to be given to Islamic religious events such as Ramadan and the male-dominant decision-making process. Meanwhile, in villages where women's groups have been formed, there are signs of women's participation in social and economic activities. In the activities related to improvement of water supply and sanitation at the village level, it is mainly women who understand the role of and participate in the activities. Therefore, in the Project, Village Water Committees will be established and organized through the "Soft Component" activities, while paying attention to traditional practices of villages as mentioned above and giving consideration to women's status.

In the past, traditional leaders such as chiefs and village heads governed and made decisions in Gambian villages. At present, these leaders still have significant influence on villagers. Establishment of a system for maintenance of the water supply facilities with the basic principle of community participation depends on understanding and support of these leaders who have influence on villagers. Therefore, explanatory meetings will be held continuously, as a gesture of respect to these social norms in the traditional society, to win the understanding for the Project.

(3) Health and Sanitation

Forty(40) percent of the respondent households had members who had had diarrhea within two weeks before this social survey. Approximately 80 % of those who had diarrhea were children under seven including infants. While approximately 90 % of the households recognized diarrhea as a water-borne diseases, *ca.* 60% of the households considered quality of the water from the existing water source "good" and few households recognized use of the existing water sources confirmed to have been contaminated with plate count and coliform bacteria as a cause of diarrhea. Therefore, it is necessary to explain to the people the adverse effects of use of unsanitary water on health and, while monitoring the progress of awareness creation in sanitation, importance of use of the safe water to be provided by the new water facilities.

Meanwhile, the survey found that laundry and domestic wastewater was disposed of and water points for livestock and rubbish pits had been established near the existing water supply facilities at the Project sites. This observation suggests inappropriate protection of environment and inappropriate maintenance of sanitary conditions around the water sources. As people fetch water in open containers, drinking water is being transported while exposed to the open air at present. Since unsanitary conditions around water sources and inappropriate handling of drinking water can cause water-borne diseases, awareness creation activities related to improvement of environmental and sanitary conditions around the water supply facilities and concept of hygiene and assistance to sanitation education will be implemented as part of the "Soft Component." With implementation of these activities, awareness of the people on safe ways to handle water, health and sanitation is to be raised.

2-2-1-4 Policies on New Water Sources for the Water Supply Facilities

At eleven (11) construction sites, the boreholes completed in the test drilling survey will be used as the production wells. At the remaining four(4) sites, production wells will be drilled while the Project is being implemented. Field reconnaissance and geophysical prospecting for the four sites have already been completed and their prospecting results suggest existence of promising aquifers at the sites.

2-2-1-5 Policies on Construction and Procurement Situations

(1) Approval/Permission Systems Relevant to the Implementation of the Project

In accordance with the rule of public facility construction in The Gambia, when installing water pipelines underground across a paved road, an application for the work will be submitted to the National Road Agency (NRA) prior to the work. The work concerned will be implemented as a outsourcing work by NRA.

(2) Quality of Locally Available Materials and Equipment and Ease of Procurement

Main construction materials (reinforcing bars, cement, piping materials, forms, etc.) can be procured in The Gambia. Although it is difficult to procure locally produced aggregate, aggregate imported from Senegal and other neighbouring countries can be procured in the capital, Banjul.

2-2-1-6 Policies on Employment of Local Contractors

A Gambian company will be employed to construct boreholes for the Project, since the capability and technical level of the local company have been confirmed in the test drilling survey for the Project. There are local construction companies with experience in water supply projects. However, their experience is only in small-scale works corresponding to the work at one project

site. Moreover, poor workmanship was detected and repair work was required when a Gambian-owned construction company implemented work in a grant aid project of Japan in the past under a local subcontract. From the above-mentioned reasons, a Japanese company will employ local workers and implement the work directly in the Project. A Japanese technician in the concrete work will be dispatched to the concrete work in the reservoir construction.

2-2-1-7 Policies on Operation and Maintenance

A system of operation and maintenance (O&M system) by villagers led by the Village Water Committee will be established at each village in the Project for the operation and maintenance of the water supply facility to be constructed or converted in the Project. The organization of Village Water Committees has been a norm in the rural water supply system of The Gambia.

Although domestic conditions for transfer to a decentralization system have been created gradually, it is considered difficult for the local governments to provide support to the operation and management of the water supply facilities at present because of their limited capacity such as shortage of financial and human resources.

Therefore, the conventional DWR (the executing agency of the Project) led activities for the establishment of O&M system at the community level will be implemented in the Project. However, such activities will be implemented in cooperation with local governments as activities of technical assistance (Soft Component) in the operation and maintenance of the facilities and operation of organizations by villagers.

In The Gambia, a system in which local residents and a private O&M company conclude a maintenance agreement for a solar-powered water supply facility, under which the private company provides maintenance and repair services, under the supervision of the administrative agency has been established and has been working well. This operation and maintenance system is essential because, in this system, private companies complement the limitation of the administration in the support service to the operation and maintenance in the rural water supply projects. However, the current system does not have strong legal force in certain areas and this system of consignment agreements with private companies is based on mutual trust among the parties concerned. Therefore, Soft Component activities will be required for reconfirmation of the roles of and trust between the parties concerned and establishment of a comprehensive operation and maintenance system.

2-2-1-8 Policies on Establishment of Design Standards for Facilities and Equipment

Since The Gambia does not have its own standardized facility design criteria each donor and international organization adopt their own design criteria for their projects in The Gambia. Therefore, for this Project, facilities will be designed mainly in accordance with "Design Criteria for Water Supply Facilities (Japan Water Works Association)" with consideration to those various

specifications adopted in The Gambia.

Even if the Japanese criteria have been followed, attention will be paid to adapt them to the actual conditions in The Gambia and the purpose of this Project.

2-2-1-9 Policies on Implementation Methods and Period

Since the average daily temperature exceeds 25°C all through the year in The Gambia, the hot-weather concreting will be adopted as the standard method in the concrete work. A Japanese technician will station at a site to supervise the concrete work, in which strict quality control is required, from casting through the period of curing. Since The Gambia does not have clearly stated criteria on work implementation and quality control, "Design Criteria for Water Supply Facilities" and "Standard Specification for Concrete Structures" of Japan will be followed in the facility design and construction and the concrete work, respectively.

The earthwork in the Project will consist mainly of the underground piping work and the foundation work for the reservoir construction. Many water supply pipelines will have to be installed in residential areas in villages, where there is little space. Such work requires small backhoes, which are not available locally. Meanwhile, it is possible to install buried pipelines along national highways mechanically with large backhoes. However, only a very limited number of such machinery is owned by local contractors. In the Project, such local constraints will be overcome effectively with measures, which are unlikely to prolong the work period significantly and enables the work to progress as planned according to the work schedule. Possibility of manual implementation will be considered thoroughly in the plan.

2-2-2 Basic Plan (Construction Plan/Equipment Plan)

2-2-2-1 Overall Plan

(1) Selection of the Sites for Construction and Conversion of Water Supply Facilities

1) Confirmation of relevance of the sites and selection of the priority sites

To confirm relevance of the 20 construction sites and 3 conversion sites in the request for the Project, each site will be evaluated individually for the six(6) exclusion criteria described below. If a site falls into any one of these criteria, such a site will be excluded from the survey.

① A total population, or the beneficiary population, at a survey site is 500 or less.
② A site is inaccessible by large vehicles.
③ Water consumption is at 35l/capita/day or more. (A site where the design unit water supply has already been met will be excluded.)
④ The percentage of population served with safe water supply is 64% or above (at or above the national average in rural areas).
⑤ People have no intention to pay water charges.

⑥ People have no intention to conclude a maintenance agreement with a private O&M company.

Table 2-9 shows the result of the evaluation. No site among the 23 survey sites has met any of the above-mentioned exclusion criteria and, thus, all the sites are considered relevant sites. However, Priority Site N-02 has been excluded from the Survey because duplication with another project has been found at the site.

Table 2-9 The Evaluation of Exclusion Criteria for Candidate Sites

Item	No	Project Overlapping	① Beneficiary more than 500	② Access Road	③ Water Supply (ℓ/capita)	④ Water Supply Rate (%)	⑤ Willing to Pay	⑥ Intention to Contract	Evaluation
Priority 15 sites	N-01	-	○	○	0	0	○	○	◎
	N-02	**NAWEC**	-	-	-	-	-	-	※
	N-03	-	○	○	0	0	○	○	◎
	N-04	-	○	○	4.25	12	○	○	◎
	N-05	-	○	○	0	0	○	○	◎
	N-06	-	○	○	0	0	○	○	◎
	N-07	-	○	○	2.42	7	○	○	◎
	N-08	-	○	○	5.31	15	○	○	◎
	N-09	-	○	○	5.40	15	○	○	◎
	N-10	-	○	○	0	0	○	○	◎
	N-11	-	○	○	0	0	○	○	◎
	N-12	-	○	○	0	0	○	○	◎
	N-13	-	○	○	0	0	○	○	◎
	N-14	-	○	○	0	0	○	○	◎
	N-15	-	○	○	0	0	○	○	◎
Supplementary	N-16	-	○	○	0	0	○	○	◎
	N-17	-	○	○	5.16	15	○	○	◎
	N-18	-	○	○	8.03	23	○	○	◎
	N-19	-	○	○	0	0	○	○	◎
	N-20	-	○	○	0	0	○	○	◎
Rehabilitation	R-01	-	○	○	0	0	○	○	◎
	R-02	-	○	○	2.15	6	○	○	◎
	R-03	-	○	○	6.38	18	○	○	◎

◎:Excellent, ○:Positive, ※:Negative, - : Nothing concerned

In accordance with "2-2-1-1 Design Policy" mentioned above, each candidate Project site thus evaluated will be examined for its priority in terms of necessity, urgency and sustainability of the water supply facilities. Table 2-10 below shows the ten (10) evaluation criteria and evaluation standards.

The results of the field survey, the priority order proposed by the recipient government and the outcome of the discussions with the recipient government will used for deciding the priority order among the candidate Project sites. The top 15 sites in the order will be considered as the priority sites.

Table 2-10 Criteria and Description of the Priority Evaluation Standards for the Candidate Project Sites

Criterion	Evaluation standards		Point	Weight factor
1. Beneficiary population (Cost performance)	To have greater beneficiary effect from the construction of water supply facilities, priority is given to a site with a large population.	A. 2,000 or more B. 1,000 or more and less than 2,000 C. 500 or more and less than 1,000 D. less than 500	4 3 2 1	×3
2. Access	A site is accessible by large vehicles and a drilling rig.	A. Accessible throughout the year B. Rather difficult in the rainy season C. Inaccessible in the rainy season D. Difficult to access at the moment	4 3 2 1	×3
3. Village structure and population density	Population density is used as a criterion in the evaluation of housing patterns in the villages as the village structure affects the cost of pipeline installation for piped water supply facilities and it is affected by population density.	A. Density of 1,000 people or more B. Density of 500 people or more and less than 1,000 people C. Density of 300 people or more and less than 500 people D. Density of less than 300 people	4 3 2 1	×1
4. Current ratio of population served with water supply (quantity and quality of water)	The ratio to the design unit water supply (35l/day/person) of *per-capita per-diem* consumption of domestic water derived from existing water sources, which is safe in terms of water quality*, at each household is low. *Water quality is evaluated with simplified analyses (on plate count and coli form bacteria), etc.	A. Less than 20% B. 20% or more and less than 50% C. 50% or more and less than 80% D. 80% or more	4 3 2 1	×3
5. Distance to a water source	Average distance from households to an existing source of water used for drinking and domestic use is long.	A. 1 km or more B. Less than 1km (with problem in water quality) C. Within 0.5 km (with problem in water quality) D. Less than 0.5km	4 3 2 1	×1
6. Health and sanitary environment	Proportion of households whose members had diarrhea or other diseases within two weeks before the household survey is high.	A. 60 % or more B. 40% or more and less than 60 % C. 20% or more and less than 40 %	4 3 2	×1

Criterion	Evaluation standards		Point	Weight factor
		D. Less than 20 %	1	
7. Willingness to pay	The amount households intend to pay for the cost of operation and maintenance of solar-powered pumping facilities is high.	A. 50 GMD/month or more B. 20 GMD/month or more and less than 50 GMD/month C. 10 GMD/month or more and less than 20 GMD/month D. Less than 10 GMD/month	4 3 2 1	×2
8. Maintenance capability	A water committee exists and the maintenance fees are collected regularly.	A. Maintenance fees are collected regularly. B. Maintenance fees are collected at the time of facility breakdown. C. There is no committee. Fees are collected at the time of facility breakdown. D. There is no Committee and maintenance fees are not collected.	4 3 2 1	×2
9. Sustainability	Proportion of the payment of the fees for the operation and maintenance of a solar- powered water supply facility (the management contract fees and contribution to conversion of facilities such as pipelines) to the average monthly income of a household.	1. Less than 4 % 1. 4 % or more and less than 8 % 2. 8% or more and less than 10% 3. 10 % or more	4 3 2 1	×2
10. Priority of the Executing Agency	The executing agency gives a site high priority.	A. Priority ranks 1st to 15th places B. Priority ranks R1 to R3 places C. Supplementary sites: from 16th to 20th places.	4 3 2	×1

① The comprehensive evaluation of each site was obtained as the sum of a point in each of the 10 criteria multiplied by the weight factor of the criterion. Table 2-11 below shows the comprehensive evaluation and the priority order derived from the comprehensive evaluation. The 15 sites with high priority correspond well with the priority order of the executing agency. During the second-phase field survey, yields and water quality of the water sources will be evaluated by conducting geophysical exploration and test drilling survey to select a maximum of 15 project implementation sites.

② At the stage of evaluation, existence of a mini solar powered water supply facility constructed by an NGO was confirmed at one of the two villages in a supplementary site N-17, Talokoto. Therefore, Talokoto was excluded from the survey and only Gidda was considered as a candidate site.

Table 2-11 Evaluation for Priority Candidate Survey Sites

No.	Village Name	Nos of Villages	Evaluation point x Weight factor										Marks	Priority
			1	2	3	4	5	6	7	8	9	10		
N-1	Kabocorr, Tampapo & Killing	3	B	A	C	A	D	B	A	B	A	A	65	**6**
N-2	Berending	1	Overlapping the NAWEC Project										Cancelled	
N-3	Kekuta Kunda Complex	4	B	A	C	A	B	B	A	B	A	A	67	**4**
N-4	Kerr Katim Wolof + Fula	2	C	B	B	A	A	B	A	B	A	A	63	**10**
N-5	Madina Kaif (Sancha)	1	B	C	A	A	A	B	A	B	A	A	64	**9**
N-6	Dongoroba	1	B	A	A	A	C	B	A	A	A	A	70	**1**
N-7	Ballangharr Complex (Kerr Ndery, Mbentenki, Hoi)	7	B	A	A	A	B	C	A	B	A	A	68	**2**
N-8	Jimbala Complex	3	B	C	B	A	D	B	C	B	A	A	56	**15**
N-9	Fass	1	B	A	A	A	D	A	A	B	A	A	68	**2**
N-10	Kuntaur Fula Kunda & Jakaba	2	B	A	B	A	D	C	C	A	A	A	63	**10**
N-11	Kerewan Samba Sira	2	B	A	A	A	D	B	C	B	A	A	63	**10**
N-12	Fula Bantang & Sinchu Sora	2	B	A	B	A	D	B	A	B	A	A	66	**5**
N-13	Jissadi	4	B	C	C	A	D	C	B	B	A	A	56	**15**
N-14	Sotokoi	1	B	B	A	A	A	B	B	B	A	A	65	**6**
N-15	Maka and Njie Kunda	2	B	C	B	A	B	A	A	B	A	A	63	**10**
N-16	Lamin Koto + Badala+ Sotokoi	3	B	A	B	A	B	B	A	B	A	B	65	**6**
N-17	Gidda	2	B	A	C	A	D	B	C	C	A	C	55	**16**
N-18	Kerr Mama	1	C	C	C	B	D	C	A	B	A	C	52	**19**
N-19	Kerr Cherno	1	C	C	B	A	D	C	A	B	A	C	54	**17**
N-20	Banta Killing	1	C	C	B	A	D	B	B	B	B	C	51	**18**

③ As discussed in M/D, test drilling survey will be conducted at the top 15 sites in the priority order.

④ The sites for conversion of the existing facilities have been given priority rankings separate from the trial boring survey sites. However, since the evaluation has shown that these sites require safe drinking water urgently, they have been included in the survey sites for the water supply project.

2) Selection based on the hydrogeological survey

① At the 15 candidate Project priority sites, the results of the analysis of the geophysical prospecting were used for deciding the points of test drilling survey and the survey was conducted. Tables 2-12 and 2-13, show the hydrogeological conditions and the results of water quality analysis at the exploratory wells, respectively.

② The sites where test boreholes have satisfied the pre-determined standards for the yield and water quality will be selected as the final Project sites for construction of water supply facilities.

③ Water quality of the test boreholes at three sites among the 15 priority sites has not conformed to the Guidelines for Drinking-Water Quality of WHO, while yields are sufficient. Therefore, these three sites have eventually been excluded from the list of the priority sites. Table 2-14 and 2-15 show the results of the evaluation and reasons for exclusion, respectively.

④ Because of the exclusion of the three sites for the reason of poor water quality from the priority sites, three supplementary sites among the four will be selected as new Project sites. At these sites, test drilling survey was not conducted during the field survey. Therefore, borehole construction at these sites will be conducted during the period of facility construction.

Table 2-12 Hydrgeological Evaluation of Test Drilling Sites in The Gambia

Site No.	Village Name	Drilling	Well Dia. (mm)	Total Depth (m)	Completion (m)	Discharge (m^3/hr)	SWL (m)	PWL (m)	Drawdown (m)	S.C. (m^3/hr/m)	Installation (m)	Aquifer and Depth (m)	
N-1	Kabocorr Tampapo & Killing	2009	152	63.00	53.00	24.7	23.58	30.34	6.76	3.65	38.2	Sand/Silt	33～51
N-3	Kekuta Kunda Complex	2009	152	87.00	82.50	18.8	12.52	13.22	0.70	26.86	Cancel	Fine Sand	60～80
N-4	Kerr Katim Wolof + Fula	2009	152	81.00	79.00	15.2	27.73	28.32	0.59	25.78	38.1	Sands	54～76
N-5	Madina Kaif	2009	152	77.00	75.80	21.4	39.20	42.24	3.04	7.04	51.0	Fine Sand	58～69
N-6	Dongoroba	2009	152	87.00	86.15	30.5	19.59	22.70	3.11	9.81	Cancel	Fine Sand	60～85
N-7	Ballangharr Complex	2009	152	81.0	79.00	16.5	20.55	21.40	0.85	19.41	31.8	Fine Sand	60～76
N-9	Fass	2009	152	90.00	82.00	8.0	25.17	45.34	20.17	0.40	61.9	Sand/Silt	62～79
N-10	Kuntaur Fula Kunda & Jakaba	2009	152	84.00	81.00	34.4	10.65	12.52	1.87	18.40	Cancel	Fine Sand	57～78
N-11	Kerewan Sambia Sira	2009	152	75.0	71.75	34.4	9.49	10.52	1.03	33.40	20.6	Fine Sand	43～69
N-12	Fula Bantang & Sinchu Sora	2009	152	78.0	74.6	30.5	7.34	8.90	1.56	19.55	17.9	Sand	57～72
N-13	Jissadi	2009	152	87.0	86.0	30.5	13.5	17.37	3.87	7.88	25.4	Fine Sand	60～84
N-14	Sotokoi	2009	152	72.0	69.55	30.5	9.21	12.0	2.79	10.93	19.2	Fine Sand	43～67
N-15	Maka & Njie Kunda	2009	152	84.0	80.0	30.5	22.34	24.32	1.98	15.4	34.5	Sands	53～77
N-16	Lamin Koto + Badala + Sotokoi	2009	152	84.0	83.0	34.4	12.98	15.43	2.45	14.04	23.8	Fine Sand	60～80
R-01	Toniataba	1993	152	92.0	-	15.6	9.93	13.94	4.01	3.89	22.6	Sands	40～60
R-02	Bureng	1987	152	56.0	(52.6)	6.2	7.30	8.40	1.10	5.60	19.2	Pebble	45～55
R-03	Barrow Kunda	1993	152	101.0	-	18.0	18.83	20.99	2.69	6.69	35.0	S/ Peb	68～92

Table 2-13 Water Quality Analysis of Test Boreholes in The Gambia

Parameter		WHO Guideline Values	N-01	N-03	N-04	N-05	N-06	N-07	N-08	N-09	N-10	N-11	N-12	N-13	N-14	N-15	N-16	R-01	R-02	R-03
Temperature	(°)	**Acceptable**	29.8	31.5	30.9	31.2	31.3	30.8		33,5	29	30.6	30.5	31.4	31.7	30.8	32.5		31.6	
Turbidity	(NTU)	**<5**	<5	<5	<5	<5	<5	<5	Project	<5	<5	<5	<5	<5	<5	<5	<5	Project	<5	Project
pH		**6.5 - 8.5**	5.24	5.76	4.60	4.73	5.27	5.15		5.89	4.55	4.17	4.52	4.93	5.16	5.08	6.06		5.14	
A.pH		**6.5 - 8.5**	5.76	6.11	5.09	5.11	5.89	5.92		6.29	5.52	5.47	5.53	5.22	5.33	5.29	6.23		5.76	
Ec	(µs/cm)	**1300**	53.2	331.0	48.3	29.6	86.0	125.6		129.7	65.8	44.4	24.0	117.7	59.1	165.5	50.8		83.6	
TDS	(mg/l)	**1000**	22.60	139.00	20.00	12.00	35.90	52.70		52.10	28.50	18.50	9.70	49.20	24.40	68.50	20		34.6	
Salinity (promile)		**NS**	0.0	0.1	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0		0	
Colour		**Absent**	Abset	Abset	Abset	Abset	Abset	Abset		Abset	Abset	Abset	Abset	Abset	Abset	Abset	Abset		Abset	
Odor		**Normal**	Normal	Normal	Normal	Normal	Normal	Normal		Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal		Normal	
Taste		**Normal**	Normal	Normal	Normal	Normal	Normal	Normal		Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal		Normal	
Suspended Solids	(mg S.S./l)	**NS**	1.0	40.0	3.0	1.0	3.0	0.0		4.0	0.0	0.0	0.0	0.0	0.0	2.0	2		3	
Phosphate	(mg PO_4^{3-}/l)	**NS**	0.10	0.45	0.24	0.00	0.00	0.25		0.17	0.15	0.00	0.00	0.25	0.16	0.00	0.1		0.17	
Nitrate	(mg NO_3-N/l)	**10**	0.5	1	0.9	0.1	0.2	3.8		0.2	0.2	0.2	0.3	0.9	0.9	0.6	0.4		1.2	
Nitrate	(mg NO_3^-/l)	**0.03**	0.000	0.030	0.001	0.000	0.004	0.005		0.006	0.003	0.002	0.004	0.000	0.015	0.000	0.005		0.009	
Total Iron	(mg $Fe^{+2/3}$/l)	**0.3**	0.00	5.28	0.62	0.01	3.00	0.27		0.21	1.84	0.77	0.00	0.00	0.00	0.10	0.08		1.63	
Sodium	(mg Na^+/l)	**150**	5.0	19.2	3.0	1.0	3.0	4.0		3.0	2.0	1.0	0.0	2.0	1.0	2.0	1		8	
Chloride	(mg Cl/l)	**250**	4.0	21.1	6.2	3.3	7.8	63.8		4.8	2.9	3.1	1.4	14.0	4.3	3.8	2.9		48	
Alkalinity	(mg $CaCo_3$/l)	**>20**	9.5	15.5	12.0	6.9	20.7	17.2		42.2	16.4	11.2	6.9	15.5	10.3	48.2	16.4		16.3	
FreeCarbondioxide	(mg Co_2/l)	**NS**	109.0	53.0	602.0	256.0	109.0	243.0		108.0	924.0	1514.0	416.0	364.0	142.5	801.6	28		236	
Hardness	(mg $CaCo_3$/l)	**200**	21.5	294.0	18.6	9.8	130.0	63.8		77.0	31.4	117.7	9.8	47.1	27.5	119.7	20.9		215.8	
Calcium	(mg Ca^{+2}/l)	**200**	6.3	60.0	4.7	2.8	13.8	23.6		22.1	9.8	5.5	3.1	12.6	9.0	31.9	6.5		47.2	
Magnesium	(mg Mg^{+2}/l)	**150**	1.4	34.1	1.7	0.7	15.5	1.2		5.3	1.7	25.3	0.5	3.8	1.2	9.8	1.2		23.8	
Fluoride	(mg F/l)	**1.5**	0.28	0.13	0.20	0.29	0.42	0.70		0.24	0.22	0.18	0.06	0.54	0.18	0.03	0.01		0.3	
Sulfate	(mg SO_4^{-2}/l)	**250**	1.0	6.0	2.0	1.0	6.0	6.0		2.0	2.0	3.0	1.0	3.0	2.0	3.0	1		3	
Manganese	(mg Mn^{+2}/l)	**0.5**	0.1	1.70	0.4	0.1	0.45	0.0		0.1	0.1	0.1	0.0	0.0	0.2	0.0	0.03		0.3	
Potassium	(mg K^+/l)	**150**	0.8	3.4	0.7	0.2	3.3	0.5		4.6	3.7	3.1	0.9	2.3	0.5	0.8	1		1.3	
Copper	(mg Cu^{+2}/l)	**1.0**	0.10	0.83	0.15	0.00	0.08	0.33		0.00	0.00	0.09	0.05	0.00	0.00	0.10	0.21		0.14	
Ammonia	(mg NH_4^+/l)	**0.5**	0.00	0.65	0.00	0.06	0.20	0.07		0.08	0.06	0.01	0.06	0.07	0.00	0.15	0.26		0.06	
Faecal Coliform	(No./100ml)	**nil**	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	
Total Coliform	(No./100ml)	**nil**	0	0	0	0	0	0		0	0	0	0	0	0	0	0		0	
Sanitary Survey		**clean**	Clean	Clean	Clean	Clean	Clean	Clean		Clean	Clean	Clean	Clean	Clean	Clean	Clean	Clean		Clean	

Table 2-14 Final Selection of New Construction 15 Sites

Items	No	Project Overlapping	Beneficiary (2009)	Water supply (ℓ/capita)	Supply rate (%)	Willing to pay ○/×	Intention to contract ○/×	Access ○/×	Pumping test ○/×	Water quality ○/×	Evaluation
Priority Sites	N-01		1,389	0	0	○	○	○	○	○	◎
	N-02	**NAWEC**	-	-	-	-	-	-	-	-	Cancel
	N-03	-	2,337	0	0	○	○	○	○	×	Cancel
	N-04	-	1,200	4.25	12	○	○	○	○	○	◎
	N-05	-	1,661	0	0	○	○	○	○	○	◎
	N-06	-	1,693	0	0	○	○	○	○	×	Cancel
	N-07	-	3,139	2.42	7	○	○	○	○	○	◎
	N-08	-	1,319	5.31	15	○	○	○	Project Implementation		○
	N-09	-	1,296	5.40	15	○	○	○	○	○	◎
	N-10	-	2,271	0	0	○	○	○	○	×	Cancel
	N-11	-	4,341	0	0	○	○	○	○	○	◎
	N-12	-	1,280	0	0	○	○	○	○	○	◎
	N-13	-	1,731	0	0	○	○	○	○	○	◎
	N-14	-	1,079	0	0	○	○	○	○	○	◎
	N-15	-	3,807	0	0	○	○	○	○	○	◎
Supplementary Sites	N-16	-	1,449	0	0	○	○	○	○	○	◎
	N-17	-	1,356	5.16	15	○	○	○	Project Implementation		○
	N-18	-	1,245	8.03	23	○	○	○	Project Implementation		○
	N-19	-	1,819	0	0	○	○	○	Project Implementation		○
	N-20	-	1,261	0	0	○	○	○	Supplementary Site		

Table 2-15 The Reasons for Cancelled Sites

Village of Cancelled Site		Reasons
N-2	Berending	This site is overlapped by the NAWEC project financed by Islamic Development Bank in 2009, therefore it will be cancelled this project.
N-3	Kekuta Kunda Complex	Based on the results of Test Drilling, the three sites of N-03, N-06, N-10 are very high iron contents, and it is not good quality for drinking comparing with the WHO drinking water quality guideline. Therefore these 3 villages will be cancelled from the Project sites.
N-6	Dongoroba	
N-10	Kuntaur Fula Kunda & Jakaba	

Based on the survey results mentioned above, the 15 sites shown in Table 2-14 above have been selected as the Project sites for construction of water supply facilities.

(2) Selection of the Sites for Rehabilitation of Existing Water Supply Facilities

The existing water supply facilities at the three rehabilitation sites were constructed in a grant aid project of Japan in 1991 to 1993. The villagers at these sites have managed operation of these facilities voluntarily for 16 to 18 years. However, rise in fuel price and deterioration of power sources has made it difficult to operate and maintain them. Therefore, the Project intends to replace diesel power source by solar power sources and urge participation of private OM companies for financial efficiency of the operation and sustainability of the maintenance.

Table 2-16 Evaluation for Priority Rehabilitation Sites

No.	Village Name	Nos of Village	Evaluation points x Weight factor										Score	Priority
			1	2	3	4	5	6	7	8	9	10		
R-1	TONIATABA	1	B	A	A	A	D	C	B	A	A	B	65	R3
R-2	BURENG	1	B	A	A	A	D	B	A	A	A	B	68	R2
R-3	BARROW KUNDA	1	A	A	A	A	D	C	A	A	A	B	70	R1

Table 2-17 Evaluation for Priority Rehabilitation Survey Sites

No.	Project Overlapping	Beneficiary (2009)	Water supply (ℓ/capita)	Water supply rate (%)	Willing to pay ○/×	Intension to contract ○/×	Access ○/×	Pumping test ○/×	Water quality ○/×	Priority
R-01	-	1,996	0	0	○	○	○	Project Implementation		2
R-02	-	2,331	2.15	6	○	○	○	Project Implementation		3
R-03	-	3,762	6.38	18	○	○	○	Project Implementation		1

Since sufficient intention to pay for the operation and maintenance has been confirmed at the three sites mentioned above, three sites shown in table 2-17 have been selected as the sites for conversion of the existing water supply facilities.

(3) Estimates of the Populations of Villages at the Project Sites for the Piped Water Supply Facilities

DWR has estimated the current populations of the villages at the Survey Sites based on the population statistics of The Gambia (Census 2003) as the basic data and using the national average population growth rate of 2.7%. However, because of the significant discrepancy found between DWR's estimates and the reality in the villages in the Project area, a survey on the populations as of 2009 (Populations at Survey) was conducted with assistance from DWR.

Taking the Populations at Survey and population growth rate of each region into consideration, the populations served with water supply in the Project target year (2020) (design populations served with water supply) and the number of public faucets required were estimated. Table 2-18 below shows the design population to be served with water supply at each site. However, at the conversion sites, since the capacity of the existing facilities is not to be increased, the 3 conversion plan was prepared for the populations at Survey. In the conversion plan for the existing water supply facilities, water for livestock assumed in the first phase will be converted to drinking water to meet the demand of the current populations as of 2009.

Table 2-18 Survey Population by JICA, 2009 and Supply Population in 2020

Item	No	Village Name	Survey Population (2009)	Population Growth Rate (%)	Supply Population (2020)
Priority Sites	N-1	Kabocorr Tampapo & Killing	1,389	5.2	2,426
	N-4	Kerr Katim Wolof + Fula	1,200	1.0	1,339
	N-5	Madina Kaif	1,661	1.0	1,853
	N-7	Ballangharr Complex	3,139	1.5	3,698
	N-8	Jimbala Complex	1,319	1.5	1,554
	N-9	Fass	1,296	1.5	1,527
	N-11	Kerewan Sambia Sira	4,341	2.0	5,397
	N-12	Fula Bantang & Sinchu Sora	1,280	2.0	1,592
	N-13	Jissadi	1,731	2.0	2,152
	N-14	Sotokoi	1,079	2.0	1,342
	N-15	Maka & Njie Kunda	3,807	2.0	4,734
Supplementary Sites	N-16	Lamin Koto, Badala, Sotokoi	1,449	1.5	1,707
	N-17	Gidda	1,356	5.2	2,368
	N-18	Kerr Mama	1,245	1.0	1,389
	N-19	Kerr Cherno	1,819	1.0	2,029
	N-20	Banta Killing	1,261	1.0	1,407
Rehabili-tation Sites	R-01	Toniataba	1,996	-	1,996 (2009)
	R-02	Bureng	2,331	-	2,331 (2009)
	R-03	Barrow Kunda	3,762	-	3,762 (2009)

(4) Examination of the Relevance of Adoption of Solar-powered Pumping Systems

1) The current conditions of solar-powered water supply facilities

The construction of and conversion to solar-powered water supply facilities are the requests for the Project. DWR and residents in rural areas strongly demand adoption of solar-powered pumping system. However, there is a need to examine whether it is possible to adopt such system in The Gambia or not from the viewpoint of sustainability and in economical comparison with other power sources, as well as conformity with the county's master plans and the trends of other donors' assistance.

As shown in Table 2-19 below, 157 solar-powered water supply facilities are in operation in The Gambia. The operation and maintenance system among a local company, the executing agency and Village Water Committee based on a maintenance agreement with the private OM companies has been established. Solar-powered pumping systems are standard for the piped water supply facilities in the country. In the grant aid project of Japan (Phase II in 2004), 20 solar-powered water supply facilities were constructed and four existing water supply facilities were converted to solar-powered facilities. All these facilities are working in good condition. Japan accounts for 15.3 % of donor assistance in the provision of solar-powered water supply facilities in The Gambia.

Table 2-19 The Existing Solar-powered Water Supply Facilities in The Gambia (2009)

Donor	Construction year	Solar Pumping System	Supporting Rate
1.Europe (EU/EDF)	1990－2009	97 systems	61.8%
2.UNDP/UNCDF	1999－2001	10 systems	6.4%
3.Saudi Arabia (SSP project)	2000－2009	15 systems & 11 mini-systems	16.6%
4.Japan (JICA)	**2004－2008**	**24 systems (including conversion 4 systems)**	**15.3%**
Total	1990－2009	157 systems	100%

2) Examination from the viewpoints of the country's master plans, conditions of power distribution, natural conditions and social conditions

The relevance of adoption of solar power generation as power sources of water supply facilities will be examined on the following points:

- Relation between the master plan and this Project
- Conditions of power distribution in the Project area
- Natural conditions (duration of sunshine, solar radiation, etc.) and social conditions

As shown in Table 2-20 below, the results of the examination reveal that The Gambia has the optimal condition to adopt solar power generation in all items including policies, conditions of power supply and natural conditions for the use of solar power generation.

Table 2-20 Examination of the Conditions Necessary for Adoption of Solar-powered Water Supply Facilities

	Examination Item	Verification	Current Conditions in The Gambia and Survey Results
Conditions required for the adoption	1. Relation between the master plans and the Project	(1) The master plans and energy policies relevant to a plan for the use of solar energy and recognition of solar energy system as a renewable energy source	1. As the master plans, The Gambia has a long-term development plan (Vision 2020) and Poverty Reduction Strategy Paper (PRSP 2002) established. These documents state stable supply of drinking water in rural area as an issue of the highest priority for the improvement of the living standards of the people. 2. In accordance with the master plans, the National Energy Policy (2001) and the Action Plan (2002) were formulated to promote use of renewable energy, especially solar energy. At the same time, adoption of solar-powered water supply facilities in the drinking water supply systems in rural areas is considered as a means to ensure supply of drinking water to rural populations and to contribute to poverty reduction through reduction of operation/maintenance cost. Thus, international organizations and bilateral donors have strongly supported the use of solar-powered facilities since the 1990's. Therefore, The Gambia has nearly 20 years of experience in use of solar energy.

	Examination item	Verification	Current Conditions in The Gambia and Survey results
Conditions required for the adoption		(2) Intention of the aid-recipient government on power sources in rural drinking water supply	1. The Department of Water Resources (DWR) of the Ministry of Fisheries and Water Resources is the executing agency of the rural drinking water supply. DWR has endorsed solar power as the power source of all the water supply facilities for villages with populations of 1,000 – 5,000. 2. Because national power generation and distribution system in The Gambia is underdeveloped in nation as a whole, adoption of solar energy as power source for the water supply facilities has been strongly promoted since the 1990's. Solar energy has been adopted as power source for all the rural water supply facilities. 3. In accordance with the National Water Policy (2006), the policy on sustainable operation and maintenance of solar-powered water supply facilities and rural drinking water supply facilities was drafted (November 2008) and presented to the parliament for enactment in May 2009.
	Conditions of power distribution in the area concerned	(1) Progress of rural electrification and conditions of power distribution at the Project sites	1. Rural electrification in The Gambia has been slow in progress. Among the 23 candidate construction and conversion sites, only one site was connected to national power supply in 2008. There is no future rural electrification plan for the remaining 22 sites.
	Natural conditions (duration of sunshine, solar radiation, etc.) and social conditions	(1) Average annual and daily duration of sunshine	1. As located in drought-prone Sahel Region, sunshine can be fully utilized in the Project area. Duration of sunshine is 6 – 10 hours per day throughout the year and at least six hours a day of sunshine is guaranteed even in the rainy season.
		(2) Solar radiation suitable for solar power generation	1. Solar radiation of 4.1 kWh/m^2/day is required for solar power generation. The Gambia meets this condition readily because the solar radiation of 5.22 kWh/m^2/day is confirmed.
		(3) Presence/absence of the rainy and dry seasons	1. The Gambia is located in the tropical savannah climate zone and has distinct rainy (June to October) and dry (November to May) seasons. Annual precipitation is small at 600 – 950 mm. Even at the height of the rainy season in August and September, there is no day without sunshine and, after a local heavy rain, there is sunshine sufficient for solar-powered pumping system. Therefore, no problem has been observed in the operation of existing solar-powered water supply facilities in the rainy season.
		(4) The groundwater in the water source boreholes are at such levels as to allow pumping with solar power when taking into account pumping water levels and design yields.	1. The design supply populations are from 1,300 to 5,400. The unit water supply is 35L/capita/day. These figures give the design yields of 56 – 227 m^3/day. 2. Since water source in the Project area are boreholes, confined groundwater is available from them. Static water levels in these boreholes are 7 - 40 m and pumping water levels to ensure design yields are within 43 m. These figures are within the optimal ranges for the solar-powered pumping system.
		(5) Sufficient flat land to install the facilities	1. In each of the villages at the Project sites, a *ca.* 200m^2 piece of flat land required for construction of a water supply facility is available in the vicinity of the water source. At each candidate Project village, an agreement has been reached with the owner of the land concerned on its acquisition by the Project.
		(6) Sizes of the population and area of the villages at Project sites	1. The villages at Project sites have design populations of 1,300 to 5,400 and areas of *ca.* 1 km x I km. Even in the largest village in the Project area, a compound village with the design population served with water supply of *ca.* 5,400 (as of 2020), the water supply area is within a few kilometres from the water source.

(5) Examination of Water Supply Facilities for their Power Sources and OM Costs

A water supply facility can use i) solar power generation, ii) diesel power generation or iii) national electric power supply as its power source. An examination will be carried out on the operation/maintenance costs, including costs for facility renewal, for the three types of facilities. To use the commercial power supply as a power source, a power distribution facility has to be available at the site. Such a facility is available at one of the conversion sites (R-01, Toniataba).

Sustainable operation and maintenance of a water supply facility requires a precondition that residents collect water charges from water users to pay the operation and maintenance cost of the facility. The amount of the operation/maintenance cost at each Project site depends on the population size and the water charge system of the village at the site. Thus, the balance between revenue and expenditure (including expenditure for replacement of equipment) differs from a village to another. Therefore, the three types of facilities will be examined to decide which type has economic advantages over others when the cost for facility replacement was included. As the residents are expected to pay the operation/maintenance costs, a comparative examination of economic advantages of three supplementary power sources will be carried out in the cases of a village with the largest supply population, Kerewan Samba Sira (N-11, current population: 4,341 and population growth rate: 2.0 %), and a village with the smallest supply population, Sotokoi (N-14, current population: 1,079, population growth rate: 2.0 %) on the preconditions described below.

Preconditions and Results of the Examination

a. The current national standard price for the water supplied by solar-powered water supply facilities (2.1 GMD/m^3) will be used as the water rate.
b. The balance of the maintenance cost including equipment replacement cost for the next 20 years will be simulated for the three types of power sources.
c. Figs 2-2 and 2-3 show the results of the simulation. For the facilities powered by diesel generated power and national electric power supply, the balance of the maintenance costs will be in deficit. Thus, it will not possible to operate these facilities sustainable with the current water rate (2.1 GMD/m^3), when taking into account the cost for replacement of equipment (pumps and generators) and other costs.
d. As shown in Fig. 2-2, sustainable operation of the solar-powered facility can be predicted at the largest village in the Project site (with a current population of 4,341) with the current water rate (2.1 GMD/m^3). On the other hand, in case of Fig. 2-3 the balance of the maintenance cost will be in deficit from the ninth year in the smallest village (with a current population of 1,079). Sustainable operation of the facility will require higher water rate.

e. The results of the examination described above show that when the situation where the villagers are to operate and maintain the water supply facilities sustainable is taken into consideration, the solar-powered facility with an established maintenance system including supply of spare parts based on maintenance agreements with private OM companies is most economical and sustainable, followed by the facility powered by the national electric power supply and the diesel-powered facility comes last. This finding has proven economic and technical relevance of adopting the solar power as the power source.

① Simulation of Sustainability for Water Supply Facilities by 3 Types of Power Source

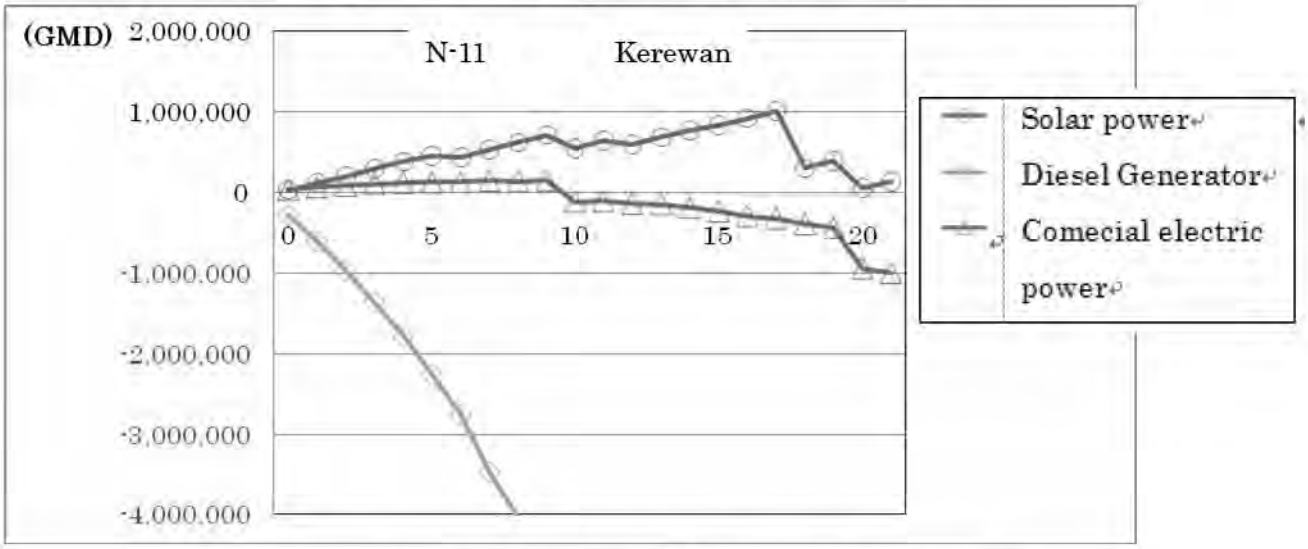

Fig.2-2 Operation and Maintenance Cost by 3 Types of Power Source (1)
(Population 4,341 (in 2009), the Largest Village in the Project Sites,
Population Growth at 2.0%, Water Rate: 2.1 GMD/m^3)

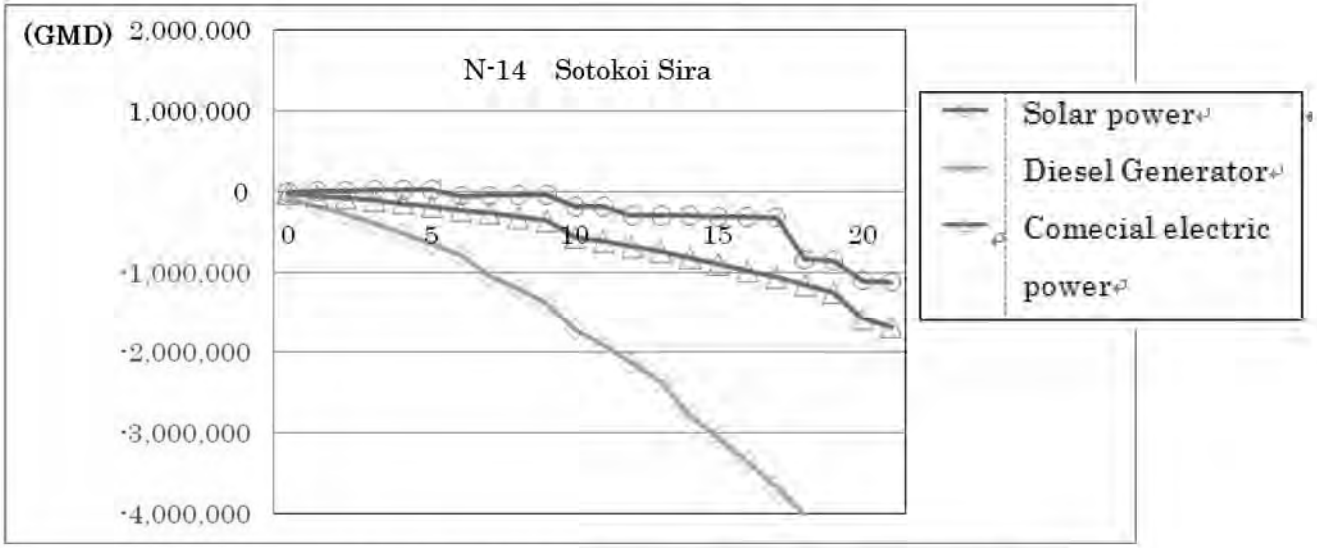

Fig.2-3 Operation and Maintenance Cost by 3 Types of Power Source (2)
(Population 1,079 (in 2009), the Smallest Village in the Project Sites,
Population Growth at 2.0%, Water Rate: 2.1 GMD/m^3)

② Preconditions

1. Solar Pumping System	
● Expenditure	
1. Expense for Operator*	700 GMD/capita/month
2. Local O&M Company for Routine Works	50% of Collected Water Rate
3. Maintenance and Renewal Cost**	
1)Submersible Motor Pump	132,000GMD (F-11)
(Renewal 10 years)	79,000 GMD (F-14)
2)Inverter	
(Renewal 6 years)	74,000GMD (F-11)
3)Solar Panel	59,000GMD (F-14)
(Renewal 50% at 18 years)	
4. Others	11,250GMD/plate
1)Price Escalation for Equipment	4.0%
2)Price Escalation for Fuel	4.4%
・ Income (Water Rate)	2.1 GMD/m^3
* Village population of each 3,000 for 1 operator will be employed.	
** Based on the practices from Phase II, JICA project	

2. Diesel Generator System	
● Expenditure	
1. Expense for Operator*	700 GMD/capita/month
2. Fuel Cost**	6.4 GMD/m^3
3. Maintenance and Renewal Cost***	
1) Submersible Motor Pump	132,000GMD (F-11)
(Renewal 10 years)	79,000 GMD (F-14)
2) Diesel Generator	119,000GMD (F-11)
(Renewal 7 years)	71,000 GMD (F-14)
3)Maintenance Cost	9,700GMD/year
4. Others	
1) Price Escalation for Equipment	4.0%
2) Price Escalation for Fuel	4.4%
・ Income (Water Rate)	2.1 GMD/m^3
* Village population of each 3,000 for 1 operator will be employed.	
** Fuel cost estimated by existing system per 1m3 of pumping.	
*** Based on the practices from Phase II, JICA project	

3. National Electric Power	
● Expenditure	
1. Expense for Operator*	700 GMD/capita/month
2. Electricity 7.58 GMD/kWh	600kWh/m.(F-11), 300kWh/m (F-14)
3. Maintenance and Renewal Cost**	
1) Submersible Motor Pump	132,000GMD (F-11),
(Renewal 10 years)	79,000 GMD (F-14)
2)Maintenance Cost	
4. Others	9,700GMD/年 (F-11 & F-14)
1)Price Escalation for Equipment	4.0%
2) Price Escalation for Fuel	44.0%
・ Expenditure (Water Rate)	2.1 GMD/m^3
* Village population of each 3,000 for 1 operator will be employed.	
** Based on the practices from Phase II, JICA project	

(6) Conscious and Capacity for Operation and Maintenance in Target Sites

As a result of household survey, 97.4% of sample households have willingness to pay for OM cost of constructed water supply facility. It was confirmed by interviewing to community leaders that all target communities understand the "beneficiary-pays principal" and have willingness to pay in accordance with the amount of consumed water.

Regarding the affordability of payment, percentage of OM cost in average monthly income (GMD3200/month) was estimated, assuming planned amount of water (35litter/capita/day) is to be consumed. According to the estimation based on the result of household survey, average OM cost for constructed water supply system is GMD 33/household/month and the percentage in monthly income is 1.0% in average. The largest percentage is 2.4 % in the sites and this is within the ratio recommended by international organization that OM costs for water use should be between 4 and 5% of income. Hence as shown in Table 2-21, it was assessed that all target sites can afford to pay for OM cost of solar water supply system.

Table 2-21 WTP and ATP for OM Cost (Result of Household Survey)

No.	Site	①Num of HH members	②Estimated OM cost per HH (GMD/month)	③Monthly income (GMD)	④Percentage of OM cost in monthly HH income
		(medium)	Planned amount of water supply : 35lit/capita/day O/M cost : D2.1/m3	(medium)	(%)
N-1	Kabocorr Tampapo & Killing	11	24	1,775	1.4%
N-3	Kekuta Kunda Complex	19.5	43	4,700	0.9%
N-4	Kerr Katim Wolof + Fula	24	53	3,080	1.7%
N-5	Madina Kaif (Sancha)	18	40	1,650	2.4%
N-6	Dongoroba	18.5	41	2,000	2.1%
N-7	Ballangharr Complex (Kerr Ndery, Mbentenki, Hoi)	19	42	3,675	1.1%
N-8	Jimbala Complex	12	26	2,997	0.9%
N-9	Fass	18.5	41	3,500	1.2%
N-10	Kuntaur Fula Kunda & Jakaba	15.5	34	3,543	1.0%
N-11	Kerewan Samba Sira	15.5	34	3,150	1.1%
N-12	Fula Bantang & Sinchu Sora	14.5	32	2,650	1.2%
N-13	Jissadi	9	20	1,975	1.0%
N-14	Sotokoi	10.5	23	2,950	0.8%
N-15	Maka & Njie Kunda	21.5	47	2,650	1.8%
N-16	Lamin Koto + Badala + Sotokoi	14	31	3,900	0.8%
N-17	Gidda	8	18	1,850	1.0%
N-18	Kerr Mama	14	31	4,850	0.6%
N-19	Kerr Cherno	21.5	47	4,525	1.0%
N-20	Banta Killing	13.5	30	5,850	0.5%
R-1	Toniataba	12	26	1,975	1.3%
R-2	Bureng	10	22	1,942	1.1%
R-3	Barrow Kunda	13	29	4,400	0.7%
Total		15	33	3,200	1.0%

(7) Overview of the Water Supply Facilities

Based on the results of the examinations mentioned above, the composition of the piped water supply facility has been decided as follows:

1) A water source and a water intake/conveyance facility,

2) A water storage/distribution facility,

3) Pipelines,

4) Water supply facilities and

5) Auxiliary equipment

Table 2-22 below shows the Summary of the Water Supply Facility Plan in the sites for construction and conversion of the water supply facilities.

Table 2-22 Summary of the Water Supply Facility Plan

Facility	Construction Site	Conversion Site
1) Water source and water intake/conveyance		
a) Water source/pumping	Boreholes will be used as water sources. Water will be transmitted by submersible pumps to water storage/distribution facilities. At N-08, N-17, N-18 , N-19, etc. where test drilling survey has not been carried out during the Survey, boreholes will be drilled as part of the facility construction.	At R-01 and R-03, the existing boreholes will be used as the water sources. At R-02, the conditions of the existing borehole will be investigated in the detailed design for its suitability as a water source. Submersible pumps will be replaced with those for solar power generator at the three sites.
b) Power source	Solar power generation will be adopted.	At R-01, the power source will be converted from diesel power generation to national electric power supply available at the site. At R-02 and R-03, the power source will be converted from the diesel power generation to solar power generation.
c) Auxiliary equipment	Required auxiliary equipment such as pressure gauges and water meters will be installed between the water sources and water storage/distribution facilities.	Valves installed on the water conveyance pipes will be replaced.
2) Water distribution facility		
a) Reservoir	Reservoirs to store water transmitted from water sources and to distribute water to distribution facilities will be constructed.	Valves on the distribution pipes will be replaced. Auxiliary equipment (float switches and water gauges) will be replaced.
3) Pipeline		
a) Buried pipeline	Pipelines to connect water sources, water storage/distribution facilities and water supply facilities will be installed.	No work, such as repair, will be implemented.
4) Water supply facility		
a) Public faucets	Public faucets will be installed for the purpose of serving water to the populations.	No work, such as repair, will be implemented.
5) Auxiliary equipment		
a) Valve box	Appropriate numbers of water meters to monitor the amount of water supply at public faucets, valves for maintenance, air valves, spill valves, etc. will be installed at appropriate places.	Water meters to monitor the amount of water supply and valve boxes to house them will be installed.
b) Protection fence	Protection fences will be installed around the water sources and water conveyance facilities.	Protection fences will be installed around the water sources and water conveyance facilities.