CHAPTER 2 WATER SUPPLY MASTER PLAN FOR EASTERN PROVINCE

In this chapter, methods and results of water supply master plan formulation which is one of the main objectives of this study are presented. From the master plan, 10 sites having high priority are selected as priority projects in the next chapter. Since many of the existing water supply facilities in the target area are deteriorated, rehabilitation of these facilities is also included in the plan.

2.1 Consideration on State of Water Sources

Water sources used for water supply schemes in Eastern Province are groundwater (boreholes and springs) and surface water (rivers and lakes). The figure below shows their characteristics in water use and topographical heights.

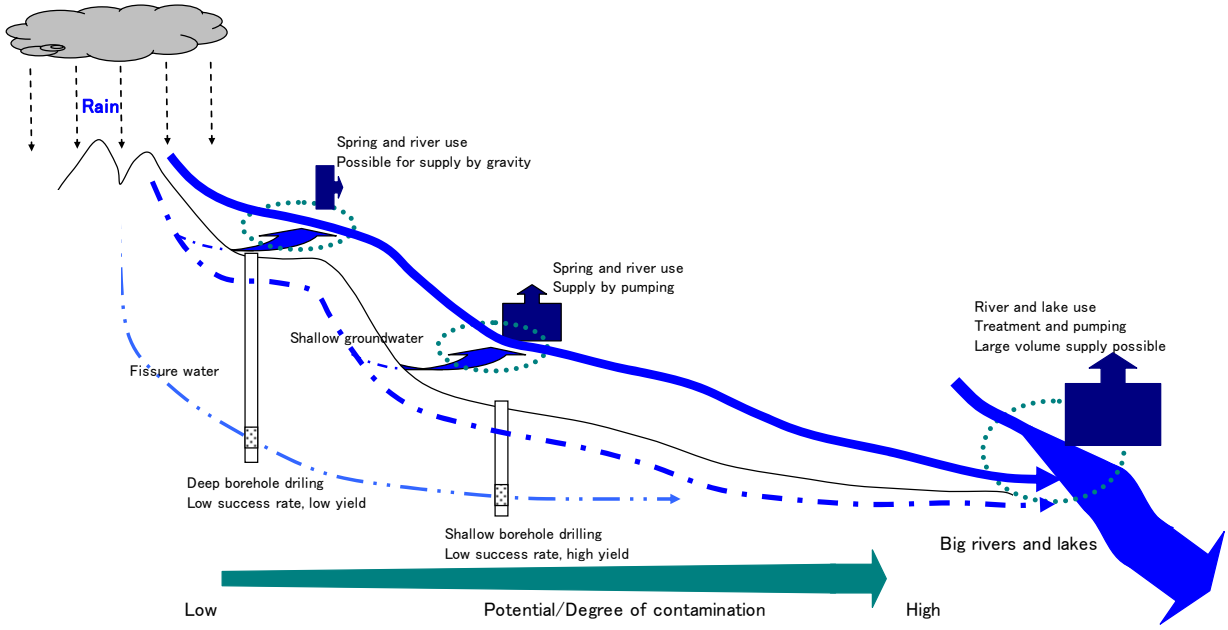


Figure 2-1 Cross Section of Water Use Model

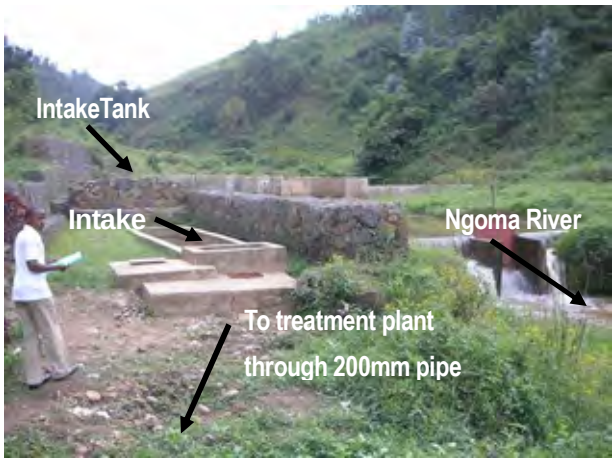
Water supply areas and assumed intake rates for these water sources according to inquiries are summarized in Table 2-1.

Table 2-1 Summary of Water Sources for Water Supply

Water Source Type		Supply Area	Intake Rate (m^3/day)
Lake	Muhazi	Rwamagana District	5,700
	Mugesera	Rwamagana District (also, 11,000m^3 intake for Kigali City)	
	Cyohoha Sud	Bugesera Dstrict	
River	Ngoma	Nyagatare District	1,500
	Muvumba	Nyagatare District	
Groundwater	Spring	Nyagatare, Gatsibo, Kayonza, Rwamagana, Ngoma, Kirehe Districts	16,200
	Submersible Pump	Kayonza District	
	Handpump	Nyagatare, Gatsibo, Kayonza, Ngoma Districts	
		Total	23,400

Intake rates of water sources used in Eastern Province at the time of the survey are, about 5,700 m^3/day from lakes, about 1,500m^3/day from rivers and about 16,200m^3/day from groundwater (of this amount, 13,000m^3/day from springs and 3,200m^3/day from boreholes using handpumps and submersible pumps) for a total estimate of about 23,400m^3/day.

These water sources are not distributed evenly around the province but rather limited only in certain areas. Using rivers as water source in Eastern Province is limited to Nyagatare District where only water from the Muvumba River system originating from mountainous areas along the border with the Northern Province can be used. At upstream, water can be taken directly, but at the lowest stream, since the turbidity increases from 24.3NTU to 200 NTU, culvert pipes are used to intake water from the underground flow along the river.



Ngoma River Tovu Intake Point

Muvumba River Downstream Matimba Intake

Springs are concentrated in areas where metamorphic rocks are distributed. This area has topography of rough slopes formed by erosion after being forced up by external metamorphic actions. Also, due to the easily weathered geology, surface soil can be secured and moisture is stored near the surface to flourish plants. Therefore, springs having stable volume of water were being developed for many years in the mountainous western part of Nyagatare and Gatsibo Districts as well as Kayonza, Ngoma and Kirehe Districts.

However, according to inquiries to district offices and local residents, they are reporting that recently spring flow rates are decreasing, but records showing annual flow rate changes are not kept to confirm this situation. Groundwater pumped up by handpumps is being used to complement areas which cannot be covered by piped schemes. The distribution of these existing facilities is shown in Figure 2-2.

If existing water sources and newly developed water sources are added together, the total possible intake rate is about 270,000 m^3/day. For details, refer to Supporting Report.

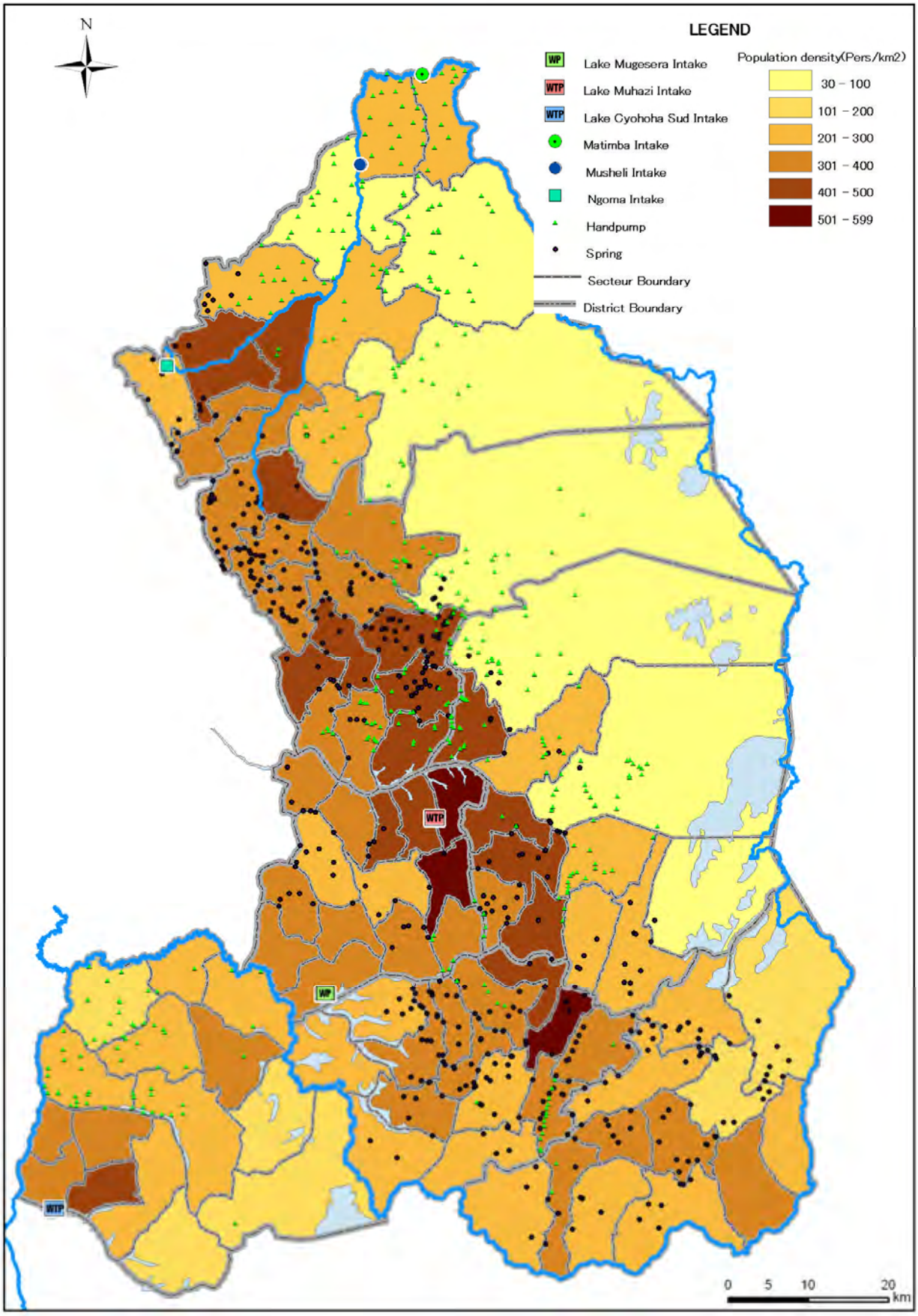


Figure 2-2 Location Map of Existing Water Sources

From the past, springs found at high altitudes were used as water sources for gravity schemes. However at high altitudes, since the catchment area inevitably becomes small and spring flow rates are limited, many small scale schemes were constructed one after another. Recently, along with the population growth, imidugudu are spreading also to lower elevations into areas where habitation was previously unsuitable. As a consequence, since water sources need to be found at lower altitudes and intake amount is increased, gravity schemes can no longer cope with this situation and therefore, pumped water supply schemes are becoming the main type of water schemes. This trend becomes more apparent as the target year approaches and small scale water sources in high areas must be transferred to large scale sources in low areas. Although water sources for this study are focused on springs, in areas where spring development and securing water sources are difficult, water from rivers and lakes will be developed and transported to necessary areas. Also, in areas where piped schemes cannot be reached, existing boreholes will be rehabilitated for continued use.

2.2 Design Criteria

The following criteria, which include unit supply rate and fetching distance as conditions stipulated for achieving accessibility to safe water within the EDPRS, are applied for this study, and these were agreed by relevant concerns.

Table 2-2 Design Criteria for this Study

Parameter	Criteria for this Study	Out of Scope	Consideration
Water Supply Target	Domestic water for rural residents (drinking, cooking, etc.)	Industrial use, livestock watering, large scale irrigation and other large consumers	Living environment of rural residents is given priority
Target Water Sources	Spring, groundwater from borehole, surface water (lakes and rivers)	Rainwater, valley dams*[1]	Determined from water quality and quantity
Unit Water Supply Rate	20 liters/capita/day*[2]		Refer to 2.3.3
Distance to Fetch Water	Maximum 500m*[2]		
Water Quality	WHO Guidelines for Drinking Water Quality		Rwanda does not have its own standards, but base their standards on WHO

*[1] Valley dams are naturally made or man-made water retention basins in valleys for livestock watering.
*[2] These are conditions for rate of accessibility to safe water in rural areas within the EDPRS.
N.B.: Refer to Supporting Report for recommendations on livestock watering and rainwater use which are out of scope for this study.

Target years for this study were set as 2020 for the master plan and 2015 for the priority projects[1]. Although the priority projects will be planned for 2015, to handle the population growth after this year, a plan for additional public tap stand extensions to be included in the master plan was agreed by the Rwandan side.

2.3 Water Supply Service Extent and Scale for Planning

2.3.1 Design Service Population

According to NISR and international organizations, population growth rate predictions for the whole country of Rwanda are as follows.

Table 2-3 Rwanda Population Growth Predictions

(unit: %/year)

Organization	2007	2009	2012	2017	2022
NISR*[1]	2.76	2.60	2.86	2.74	2.50
UN*[2]	2.71	2.70	2.59	2.29	2.00
WB*[3]	2.50	-	-	-	-

Source: *[1] Letter from Acting Director General of NISR No. 459/2009/10/INSR
*[2]United Nations World Population Prospects (2008 Revision)
*[3]World Bank World Development Indicators (January 2009)

Although information on population growth rate predictions for Eastern Province alone is not available, the 2002 National Census Report of NISR gives information for former Umutara and Kibungo Provinces (includes 6 districts, excluding Bugesera District, of the present Eastern Province) on population growth predictions from 2007 to 2020 as follows. NISR information gives only population predictions and therefore, population growth rates were calculated for each year group as shown below.

Table 2-4 Population Predictions and Growth Rates of Target Area

Item		2007	2012	2017	2020
Population Prediction (persons)	Former Umutara Province	478,822	539,167	598,807	632,026
	Former Kibungo Province	797,517	898,028	997,362	1,052,691
	Total	1,276,339	1,437,195	1,596,169	1,684,717
Population Growth Rate (%)		2.40	2.12	1.82	

Source: 3eme Recensement General de la Population et de l'Habitat du Rwanda : Perspectives et Projections Demographiques, NISR, 2002

[1] Agreements were received from the Rwandan side through the minutes for preliminary mission of this study as well as that for the Inception Report.

Future population growth rates for the whole country show decreasing trends and in consideration that the resettlement policy in Eastern Province is almost at completion, the adoption of the above population growth predictions was discussed with the Rwandan side. Based on the above table, population predications for each district are as follows, and these populations will be used as design water supply populations.

Table 2-5 Target Area Population (persons)

Target District	2008*	2015 Priority Project Target Year	2020 Master Plan Target Year
Nyagatare	329,101	385,355	424,211
Gatsibo	350,410	410,307	451,679
Kayonza	258,606	302,810	333,344
Rwamagana	255,653	299,352	329,537
Ngoma	277,144	324,517	357,239
Kirehe	278,712	326,353	359,260
Bugesera	294,014	344,271	378,985
Eastern Province	2,043,640	2,392,965	2,634,255

*From Table 2-6

Presently, the population which can access safe water in Eastern Province is 53% (refer to Table 2-6) of the total population, or about 1.1 million persons, and water supply plans are required for about 1.5 million persons in 2020. The 2008 service populations and design service populations for each secteur are listed in Table 2-6 (1) and (2).

2.3.2 Design Service Area

Water service target for the planning in this study will be the residents of the present imidugudu areas and future planned imidugudu areas. The areas where houses are widely scattered along the valleys and those without any plans for housing will not be included in the planning. Also, the Akagera National Park (a natural conservation zone and housing prohibited zone) stretching across 3 districts (Nyagatare, Gatibo and Kayonza) in the north-eastern part of Eastern Province, and the wetlands of Rweru Secteur (Ramsar Registered zone and housing prohibited zone) located in Bugesera District, the south-western part of the province, as well as housing prohibited areas along rivers, and areas along steep slopes and valley floors which are not to be included in imidugudu planning according to the organic law will also be out of scope for the master plan.

Table 2-6 (1) Design Service Populations by Secteur (persons)

Dist.	Secteur Code	Secteur Name	Population		Coverage Rate (2008)	Served Pop. (2008)	Unserved Pop, (2008)	Increased Pop. (2020)	Beneficiary Pop. (2020)
			2008 (A)	2020 (B)	C	D=A*C	E=A-D	F=B-A	G=E+F
Nyagatare	Ny01	Gatunda	22,566	29,088	75%	16,925	5,641	6,522	12,163
	Ny02	Karama	24,577	31,680	70%	17,204	7,373	7,103	14,476
	Ny03	Karangazi	26,608	34,298	25%	6,652	19,956	7,690	27,646
	Ny04	Katabagemu	30,195	38,921	45%	13,588	16,607	8,726	25,333
	Ny05	Kiyombe	16,659	21,473	80%	13,327	3,332	4,814	8,146
	Ny06	Matimba	17,538	22,606	35%	6,138	11,400	5,068	16,468
	Ny07	Mimuli	22,389	28,859	66%	14,777	7,612	6,470	14,082
	Ny08	Mukama	19,796	25,517	70%	13,857	5,939	5,721	11,660
	Ny09	Musheri	23,598	30,418	25%	5,900	17,699	6,820	24,518
	Ny10	Nyagatare	32,321	41,662	40%	12,928	19,393	9,341	28,734
	Ny11	Rukomo	25,516	32,890	65%	16,585	8,931	7,374	16,305
	Ny12	Rwempasha	13,671	17,622	20%	2,734	10,937	3,951	14,888
	Ny13	Rwimiyaga	28,784	37,103	20%	5,757	23,027	8,319	31,346
	Ny14	Tabagwe	24,883	32,074	50%	12,442	12,442	7,191	19,632
	Sub-total		329,101	424,211	48%(Ave.)	158,814	170,289	95,110	265,397
Gatsibo	Ga01	Gasange	15,816	20,387	29%	4,587	11,229	4,571	15,800
	Ga02	Gatsibo	23,383	30,141	79%	18,473	4,910	6,758	11,668
	Ga03	Gitoki	27,151	34,998	68%	18,463	8,688	7,847	16,535
	Ga04	Kabarore	38,020	49,008	35%	13,307	24,713	10,988	35,701
	Ga05	Kageyo	18,625	24,008	53%	9,871	8,754	5,383	14,137
	Ga06	Kiramuruzi	25,319	32,636	78%	19,749	5,570	7,317	12,887
	Ga07	Kiziguro	24,958	32,171	69%	17,221	7,737	7,213	14,950
	Ga08	Muhura	24,463	31,533	75%	18,347	6,116	7,070	13,186
	Ga09	Murambi	23,137	29,824	84%	19,435	3,702	6,687	10,389
	Ga10	Ngarama	26,749	34,479	57%	15,247	11,502	7,730	19,232
	Ga11	Nyagihanga	21,882	28,206	39%	8,534	13,348	6,324	19,672
	Ga12	Remera	22,803	29,393	36%	8,209	14,594	6,590	21,184
	Ga13	Rugarama	30,415	39,205	41%	12,470	17,945	8,790	26,735
	Ga14	Rwimbogo	27,689	35,691	28%	7,753	19,936	8,002	27,938
	Sub-total		350,410	451,679	55%(Ave.)	191,666	158,744	101,270	260,014
Kayonza	Ka01	Gahini	24,662	31,789	80%	19,730	4,932	7,127	12,059
	Ka02	Kabare	29,172	37,603	40%	11,669	17,503	8,431	25,934
	Ka03	Kabarondo	24,148	31,127	60%	14,489	9,659	6,979	16,638
	Ka04	Mukarange	23,790	30,665	20%	4,758	19,032	6,875	25,907
	Ka05	Murama	16,063	20,705	5%	803	15,260	4,642	19,902
	Ka06	Murundi	24,720	31,864	10%	2,472	22,248	7,144	29,392
	Ka07	Mwiri	15,959	20,571	20%	3,192	12,767	4,612	17,379
	Ka08	Ndego	13,846	17,848	100%	13,846	0	4,002	4,002
	Ka09	Nyamirama	24,657	31,783	20%	4,931	19,726	7,126	26,852
	Ka10	Rukara	25,978	33,486	60%	15,587	10,391	7,508	17,899
	Ka11	Ruramira	13,933	17,960	10%	1,393	12,540	4,027	16,567
	Ka12	Rwinkwavu	21,678	27,943	60%	13,007	8,671	6,265	14,936
	Sub-total		258,606	333,344	41%(Ave.)	105,877	152,729	74,738	227,467
Rwamagana	Rw01	Fumbwe	15,494	19,972	12%	1,859	13,635	4,478	18,113
	Rw02	Gahengeri	18,136	23,377	15%	2,720	15,416	5,241	20,657
	Rw03	Gishari	20,601	26,555	94%	19,365	1,236	5,954	7,190
	Rw04	Karenge	19,644	25,321	80%	15,715	3,929	5,677	9,606
	Rw05	Kigabiro	24,743	31,894	97%	24,001	742	7,151	7,893
	Rw06	Muhazi	28,685	36,975	92%	26,390	2,295	8,290	10,585
	Rw07	Munyaga	12,785	16,480	90%	11,507	1,279	3,695	4,973
	Rw08	Munyiginya	14,137	18,223	33%	4,665	9,472	4,086	13,558
	Rw09	Musha	17,688	22,800	20%	3,538	14,150	5,112	19,262
	Rw10	Muyumbu	16,945	21,842	42%	7,117	9,828	4,897	14,725
	Rw11	Mwulire	15,968	20,583	62%	9,900	6,068	4,615	10,683
	Rw12	Nyakariro	17,230	22,209	60%	10,338	6,892	4,979	11,871
	Rw13	Nzige	14,134	18,219	80%	11,307	2,827	4,085	6,912
	Rw14	Rubona	19,463	25,088	30%	5,839	13,624	5,625	19,249
	Sub-total		255,653	329,537	60%(Ave.)	154,261	101,393	73,885	175,277

Table 2-6 (2) Design Service Populations by Secteur (persons)

Dist.	Secteur Code	Secteur Name	Population		Coverage Rate (2008)	Served Pop. (2008)	Unserved Pop, (2008)	Increased Pop. (2020)	Beneficiary Pop. (2020)
			2008 (A)	2020 (B)	C	D=A*C	E=A-D	F=B-A	G=E+F
Ngoma	Ng01	Gashanda	12,963	16,709	73%	9,463	3,500	3,746	7,246
	Ng02	Jarama	19,663	25,346	73%	14,354	5,309	5,683	10,992
	Ng03	Karembo	12,167	15,683	74%	9,004	3,163	3,516	6,679
	Ng04	Kazo	20,803	26,815	73%	15,186	5,617	6,012	11,629
	Ng05	Kibungo	25,494	32,862	74%	18,866	6,628	7,368	13,996
	Ng06	Mugesera	22,064	28,441	74%	16,327	5,737	6,377	12,114
	Ng07	Murama	19,034	24,535	74%	14,085	4,949	5,501	10,450
	Ng08	Mutenderi	18,389	23,703	74%	13,608	4,781	5,314	10,095
	Ng09	Remera	20,843	26,867	74%	15,424	5,419	6,024	11,443
	Ng10	Rukira	20,817	26,833	73%	15,196	5,621	6,016	11,637
	Ng11	Rukumberi	22,359	28,821	73%	16,322	6,037	6,462	12,499
	Ng12	Rurenge	21,965	28,313	73%	16,034	5,931	6,348	12,279
	Ng13	Sake	20,079	25,882	74%	14,858	5,221	5,803	11,024
	Ng14	Zaza	20,504	26,430	73%	14,968	5,536	5,926	11,462
	Sub-total		277,144	357,239	73%(Ave.)	203,695	73,449	80,096	153,545
Kirehe	Ki01	Gahara	32,389	41,749	28%	9,069	23,320	9,360	32,680
	Ki02	Gatore	22,729	29,298	31%	7,046	15,683	6,569	22,252
	Ki03	Kigarama	25,803	33,260	32%	8,257	17,546	7,457	25,003
	Ki04	Kigina	21,285	27,436	15%	3,193	18,092	6,151	24,243
	Ki05	Kirehe	18,802	24,236	13%	2,444	16,358	5,434	21,792
	Ki06	Mahama	18,322	23,617	17%	3,115	15,207	5,295	20,502
	Ki07	Mpanga	28,008	36,102	24%	6,722	21,286	8,094	29,380
	Ki08	Musaza	21,035	27,114	33%	6,942	14,093	6,079	20,172
	Ki09	Mushikiri	22,436	28,920	5%	1,122	21,314	6,484	27,798
	Ki10	Nasho	22,934	29,562	39%	8,944	13,990	6,628	20,618
	Ki11	Nyamugali	29,976	38,639	29%	8,693	21,283	8,663	29,946
	Ki12	Nyarubuye	14,993	19,326	22%	3,298	11,695	4,333	16,028
	Sub-total		278,712	359,260	25%(Ave.)	68,845	209,867	80,547	290,414
Bugesera	Bu01	Gashora	18,622	24,004	70%	13,035	5,587	5,382	10,969
	Bu02	Juru	20,279	26,140	70%	14,195	6,084	5,861	11,945
	Bu03	Kamabuye	15,190	19,580	70%	10,633	4,557	4,390	8,947
	Bu04	Mareba	20,137	25,957	70%	14,096	6,041	5,820	11,861
	Bu05	Mayange	29,261	37,717	70%	20,483	8,778	8,456	17,234
	Bu06	Musenyi	19,368	24,965	70%	13,558	5,810	5,597	11,407
	Bu07	Mwogo	14,348	18,495	70%	10,044	4,304	4,147	8,451
	Bu08	Ngeruka	26,909	34,686	70%	18,836	8,073	7,777	15,850
	Bu09	Ntarama	11,616	14,973	70%	8,131	3,485	3,357	6,842
	Bu10	Nyamata	23,087	29,759	70%	16,161	6,926	6,672	13,598
	Bu11	Nyarugenge	17,611	22,701	70%	12,328	5,283	5,090	10,373
	Bu12	Rilima	24,393	31,443	70%	17,075	7,318	7,050	14,368
	Bu13	Ruhuha	19,087	24,603	70%	13,361	5,726	5,516	11,242
	Bu14	Rweru	22,596	29,126	70%	15,817	6,779	6,530	13,309
	Bu15	Shyara	11,510	14,836	70%	8,057	3,453	3,326	6,779
	Sub-total		294,014	378,985	70%(Ave.)	205,810	88,204	84,971	173,175
TOTAL		95 Secteurs	2,043,640	2,634,255	53%(Ave.)	1,088,968	954,674	590,617	1,545,289

2.3.3 Design Water Supply Rate

The unit design water supply rate is 20 liters/capita/day (lcd) which is used as design standard of MININFRA and adopted in EDPRS. Since the present average water use rate[2] in Eastern Province is 15 lcd and in consideration that water consumption will increase when water supply facilities are improved, this value is feasible. Also, this is feasible since WHO/UNICEF uses 20 lcd as decision standard for water supply coverage. Based on this unit supply rate, water demands for each area were calculated and used as design supply rates for this study. The water consumption growth rate of the present served population can be adapted since existing water supply schemes are designed according to the Rwandan standard of 20 lcd.

Table 2-7 Design Water Supply Rates for Target Area

Target District	Supply Rate of Covered Population in 2008 (m^3/day) A	Total Supply Rate for 2020 (m^3/day) B	Master Plan Design Supply Rate (2020) (m^3/day) C=B-A
Nyagatare	3,176	8,484	5,308
Gatsibo	3,833	9,034	5,201
Kayonza	2,118	6,667	4,549
Rwamagana	3,085	6,591	3,506
Ngoma	4,074	7,145	3,071
Kirehe	1,377	7,185	5,808
Bugesera	4,116	7,580	3,464
Eastern Province	21,779	52,686	30,907

2.4 Water Supply Scheme Construction Plan

A plan for water supply scheme construction was formulated to attain 100% water supply coverage by the year 2020 in Eastern Province. Conditions of candidate water sources and existing water supply facilities in each target district were surveyed and depending on the conditions of water supply schemes, plans for replacement or partial use were included. Also, new water supply schemes were planned for unserved areas. Before commencement of this study, the results of the

[2] Refer to Supporting Report.

national water supply scheme inventory of Rwanda were planned to be used for the study, but since data reliability was very low, a separate survey on water sources and existing water supply schemes was carried out[3].

All candidate water sources in the target area were surveyed as much as possible to select the optimum water sources. Presently, springs, surface waters and groundwater are being used as water sources for water schemes in Eastern Province, but springs are used the most. In consideration that water sources in Eastern Province are not distributed evenly, for areas where water sources are not available, water transmission from a long distance was considered. Furthermore, for existing handpump schemes, reusable boreholes will be cleaned and pumping tests will be carried out, and handpumps will be replaced.

Water supply scheme construction was planned as follows. First, field reconnaissance results and aerial photos were used to identify population distribution from locations of houses. Then from determination on the possible extents of coverage by existing water supply schemes and identification of areas not covered by water schemes, new water supply plans were formulated. Also, for piped schemes, if the water source is located above the supply area, then a gravity type scheme is planned, and if the water source is below the supply area, then the plan needs to be a pumped type scheme. Refer to Drawings for the map showing available water sources and existing water supply schemes, and locations of water supply schemes which make up the plan for each district are listed in Table 2-8 (1) to (7). The design water supply rates were calculated by allocating water points (public tap stands and handpumps) within 500m from houses in the service area and assuming 20 lcd for the design water supply population of each water point.

[3] The inventory survey was carried out through data collection using questionnaires sent to each secteur, but the collection rate was very low and reliability was very low. Therefore, the master plan study team had to change their original schedule and conducted a separate water source and existing water supply scheme survey on their own. As a result of the additional survey, existing and candidate water sources were categorized into springs, rivers, lakes and groundwater to prepare a "water source table of Eastern Province". Also, for existing water supply schemes, upon categorizing piped schemes and handpumps, an "existing water scheme table of Eastern Province" which can be used as fundamental database for water schemes was prepared. (These 2 tables are included in the Databook) However, since preparation was based on minimum requirements of location information on the surface and inquiry surveys within a limited timeframe, we recommend staffs in charge at each secteur and cell to revise the database through resurveys of all water sources and water schemes. Also, the database information needs to be updated periodically such as every year.

Table 2-8 (1) Facilities to be Constructed for Each Target District

Nyagatare District **Total Population: 424,211 persons (2020) Design Service Population: 265,397 pers. (2020) Design Supply Rate: 5,308 m^3/day**

Piped Scheme												Total 265,397	Total 5,308
Master Plan Code	Source Name	Source Type	Served Secteurs	Works	Scheme Type	Receiving Tank (m^3)	Transmission Facility	Transmission Main (km)	Distribution Tank (m^3)	Public Tap Stands	Distribution Pipeline (km)	Design Service Population (pers)	Design Supply Rate (m^3/day)
NyPs01	Kiyombe	Spring	Kiyombe, Gatunda, Rukomo, Mukama, Mimuli, Katabagemu	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	233	82.7	45,022	901
NyPs02	Kiyombe Extension	Spring	Nyagatare, Rwempasha, Rwimiyaga, Karangazi, Katabagemu	New construction of dist. pipe, dist. tank, tap stands	Gravity	None	None	None	50	352	150.9	68,015	1,360
NyPs03	Tovu	Spring	Kiyombe, Karama, Tabagwe	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	149	85.0	28,791	576
NyPs04	Rubanda	Spring	Karama	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	20	11.0	3,864	77
NyPs05	Rwabigeyo A	Spring	Karangazi,	New construction of dist. pipe, dist. tank, tap stands	Gravity	None	None	None	100	55	27.5	10,627	213
NyPs06	Rwobe-Gashure	Spring	Katabegemu	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	96	45.8	18,550	371
NyPs07	Kagitumba River	River	Matimba	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	66	22.8	12,753	255
NyPs08	Muvumba River	River	Musheri	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	95	37.1	18,356	367
NyPs09	Ngoma	River	Secteurs other than Katabagemu, Musheri, Matimba	New construction of transmission pipe, dist. facilities	Gravity	None	Treatment Plant	40.0	200 × 2	None	None	52,364	1,047

Handpump Scheme							
Master Plan Code	Source Type	Served Secteur	Works	No. of Handpumps to Replace		Design Service Population (pers)	Design Supply Rate (m^3/day)
NyHp01	Groundwater	Karangazi	Borehole cleaning, pumping test, new handpump installation	2		543	11
NyHp02	Groundwater	Matimba		2		543	11
NyHp03	Groundwater	Musheri		5		1,357	27
NyHp04	Groundwater	Rwempasha		3		814	16
NyHp05	Groundwater	Rwimiyaga		13		3,527	71
NyHp06	Groundwater	Tabagwe		1		271	5

Table 2-8 (2) Facilities to be Constructed for Each Target District

Gatisbo District **Total Population: 451,079 persons (2020) Design Service Population: 260,014 pers. (2020) Design Supply Rate: 5,201 m^3/day**

Piped Scheme — Total 260,014 — Total 5,201

Master Plan Code	Source Name	Source Type	Served Secteurs	Works	Scheme Type	Receiving Tank (m^3)	Transmission Facility	Transmission Main (km)	Distribution Tank (m^3)	Public Tap Stands	Distribution Pipeline (km)	Design Service Population (pers)	Design Supply Rate (m^3/day)
GaPs01	Nyabukobero	Spring	Remera	New construction of pump house, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	None	50 × 1	32	27.9	7,668	153
GaPs01A*	Kibira-Mpaza	Spring	Muhura, Gasange	New construction of pump house, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	None	50 × 8	114	55.2	27,319	547
GaPs02	Gashure, Kaniya, Rwobe 1, 2	Spring	Nyagihanga, Gatsibo	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	90	36.0	21,568	431
GaPs03	Rwabigeyo 1	Spring	Gatsibo	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	40	20.4	9,586	192
GaPs04	Gahama, Kaniya, Nyakagera (NKG)	Spring	Kageyo, Gitoki, Kabarore, Rwimbogo	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	81	99.3	19,411	388
GaPs05	Nyakagezi	Spring	Kageyo	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	62	29.3	14,858	297
GaPs06	Akabuye	Spring	Kizuguro	New construction of pump house, trans. pipe, dist. pipe, tap stands	Gravity	None	Pump House	3.0	None	31	18.3	7,429	149
GaPs07	Cyahafi-Bugarola	Spring	Muhura, Remera, Kizuguro, Rugarama	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	259	131.7	62,066	1,241
GaPs08	Byimana	Spring	Murambi	Pump/generator replacement, new construction of dist. pipe, tap stands	Pumped	None	Pump+ generator × 2	None	None	43	12.9	10,304	206
GaPs09	Gahama-Ngarama Karama (Bugombe)	Spring	Nyagihanga, Ngarama, (Ny: Katabagemu)	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	80	43.1	19,171	384
GaPs10	Mutaraza	River	Nyagihanga, Ngarama, Gatsibo, Kabarore, Gitoki, Rwimbogo	New construction of transmission pipe, dist. facilities	Pumped	100	Pump House Treatment Plant	51.0	100 × 6 200	246	85.3	58,951	1,179

Handpump Scheme

Master Plan Code	Source Type	Served Secteur	Works	No. of Handpumps to Replace	Design Service Population (pers)	Design Supply Rate (m^3/day)
GaHp01	Groundwater	Kabarore	Borehole cleaning, pumping test, new handpump installation	1	337	7
GaHp02	Groundwater	Rwimbogo		4	1,346	27

*At the stage of formulation of the master plan, water supply was planned for the 3 secteurs of Remera, Muhura and Gasange. However, during the survey for priority projects, since a separate water source specific for Remera was confirmed, a scheme specific for Remera was given the code GaPs01 and the scheme to supply water to the other 2 secteurs was given GaPs01A.

Table 2-8 (3) Facilities to be Constructed for Each Target District

Kayonza District **Total Population: 333,344 persons (2020) Design Service Population: 227,467 pers. (2020) Design Supply Rate: 4,549 m^3/day**

Piped Scheme

Master Plan Code	Source Name	Source Type	Served Secteurs	Works	Scheme Type	Receiving Tank (m^3)	Transmission Facility	Transmission Main (km)	Distribution Tank (m^3)	Public Tap Stands	Distribution Pipeline (km)	Total 227,467 Design Service Population (pers)	Total 4,549 Design Supply Rate (m^3/day)
KaPs01	Nyabombe	Spring	Gahini, Mwiri	Pump/generator replacement, new construction of dist. pipe, tap stands	Pumped	None	Pump+ generator	None	None	87	47.0	20,910	418
KaPs02	Kanyetonga 1	Spring	Kabare	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	6	3.4	1,442	29
KaPs03	Kiburara	Ground water	Kabare, Rwinkwavu	New construction of pump house, trans. pipe, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	2.0	50	57	30.1	13,699	274
KaPs04	(New source)	Spring	Kabare	Water source develop., new construction of pump house, trans. pipe, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	3.0	50	40	19.0	9,614	192
KaPs05	(New source)	Spring	Kabare	Water source develop., new construction of pump house, dist. pipe, tap stands	Gravity	None	None	None	None	17	10.1	4,086	82
KaPs06	(New source)	Spring	Kabare	Water source develop., new construction of pump house, trans. pipe, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	2.0	50	16	9.3	3,845	77
KaPs07	Mubugazire	Spring	Kabarondo	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	69	25.2	16,584	332
KaPs08	Kazabazana	Ground water	Mukarange	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	98	40.4	23,554	471
KaPs09	Gicaca	Spring	Murama	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	55	18.9	13,219	264
KaPs10	Kabonobono	Spring	Murama	New construction of pump house, trans. pipe, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	2.0	50	28	26.4	6,730	134
KaPs11	Cyatokwe	Spring	Rukara, Murundi	New construction of pump house, dist. pipe, tap stands	Pumped	100	Pump House	None	None	119	43.7	28,601	572
KaPs12	(New source)	Spring	Murundi	Water source develop., new construction of pump house, trans. pipe, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	2.4	50	2	1.1	481	10
KaPs13	(New source)	Spring	Murundi	Water source develop., new construction of pump house, trans. pipe, dist. tank, dist. pipe, tap stands	Pumped	None	Pump House	1.6	50	70	35.0	16,824	336
KaPs14	Rwazana 1,2	Spring	Mwiri, Gahini, Rwinkwavu	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	83	31.9	19,948	399
KaPs15	Gatare Karongi	Spring	Nyamirama, Mukarange	Pump replacement, new construction of dist. pipe, tap stands	Pumped	None	Pump × 2	None	None	122	62.6	29,322	586
KaPs16	(New source)	Spring	Ruramira	Water source develop., new construction of dist. pipe, tap stands	Gravity	None	None	None	None	69	42.7	16,584	332

Handpump Scheme

Master Plan Code	Source Type	Served Secteur	Works	No. of Handpumps to Replace	Design Service Population (pers)	Design Supply Rate (m^3/day)
KaHp01	Groundwater	Gahini	Borehole cleaning, pumping test, new handpump installation	1	337	7
KaHp02	Groundwater	Murundi		4	1,350	27
KaHp03	Groundwater	Mwiri		1	337	7

Table 2-8 (4) Facilities to be Constructed for Each Target District

Rwamagana District **Total Population: 329,537 persons (2020) Design Service Population: 175,277 pers. (2020) Design Supply Rate: 3,506 m^3/day**

Piped Scheme												Total 175,277	Total 3,506
Master Plan Code	Source Name	Source Type	Served Secteurs	Works	Scheme Type	Receiving Tank (m^3)	Transmission Facility	Transmission Main (km)	Distribution Tank (m^3)	Public Tap Stands	Distribution Pipeline (km)	Design Service Population (pers)	Design Supply Rate (m^3/day)
RwPs01	(New source)	Spring	Gahengeri	Water source develop., new construction of trans. pipe, dist. facilities	Pumped	50	Pump House	2.0	100	161	59.3	38,870	777
RwPs02	Muhazi	Lake	Gishari, Kigabiro, Muhazi, Munyiginya	New construction of dist. pipe, tap stand	Pumped	None	None	None	None	155	49.5	37,422	749
RwPs03	Byimana, Mugatare	Spring	Mwulire, Rubona, Munyiginya	Pump replacement, new construction of dist. pipe, tap stands	Pumped Gravity	None	Pump Replace	None	None	330	124.5	79,671	1,594
RwPs04	Kagarama	Spring	Musha	New construction of trans. pipe, dist. facilities	Pumped	200	Pump House	2.0	200	80	41.0	19,314	386

Table 2-8 (5) Facilities to be Constructed for Each Target District

Ngoma District **Total Population: 357,239 persons (2020) Design Service Population: 153,545 pers. (2020) Design Supply Rate: 3,071 m^3/day**

Piped Scheme												Total 153,545	Total 3,071
Master Plan Code	Source Name	Source Type	Served Secteurs	Works	Scheme Type	Receiving Tank (m^3)	Transmission Facility	Transmission Main (km)	Distribution Tank (m^3)	Public Tap Stands	Distribution Pipeline (km)	Design Service Population (pers)	Design Supply Rate (m^3/day)
NgPs01	Gaseta	Spring	Gashanda	New construction of receiv. tank, dist. pipe, tap stands	Pumped	100	None	None	100	30	35.5	7,231	145
NgPs02	Nyamuhinali	Spring	Kazo	New construction of receiv. tank, pump house, dist. pipe, tap stands	Pumped	100	Pump House	None	None	23	24.9	5,544	111
NgPs03	Nyakagezi 1, 2	Spring	Kazo	New construction of dist. pipe, tap stand	Gravity	None	None	None	None	12	10.6	2,893	58
NgPs04	Rwamugende 1,2	Spring	Kazo	New construction of dist. pipe, tap stand	Pumped	None	None	None	None	12	10.6	2,893	58
NgPs05	Gaseta, Rwahita	Spring	Jarama, Rukumberi, Sake	New construction of dist. pipe, tap stand	Pumped	None	None	None	None	144	69.7	34,710	694
NgPs06	Rwarutene	Spring	Karembo, Mugesera, Zaza	New construction of dist. pipe, tap stand	Pumped	None	None	None	None	90	68.0	21,694	434
NgPs07	Rwasaburo	Spring	Kibungo, Remera, Rurenge	New construction of dist. pipe, tap stand	Pumped	None	None	None	None	77	36.1	18,560	371
NgPs08	Nyamuganda	Spring	Kibungo, Murama, Mutenderi	New construction of dist. pipe, tap stand	Pumped	None	None	None	None	69	51.7	16,632	333
NgPs09	Shyagashya	Spring	Mutenderi	New construction of receiv. tank, trans. pipe, dist. tank, dist. pipe, tap stands	Pumped	100	None	1.4	50	9	7.2	2,169	43
NgPs10	Kagoma	Spring	Mutenderi, Kazo	New construction of dist. pipe, tap stand	Gravity	None	None	None	None	13	11.9	3,134	63
NgPs11	Gasovo	Spring	Rukira, Murama, (Ki: Mushikiri)	New construction of dist. pipe, tap stand	Gravity	None	None	None	None	45	46.9	10,847	217
NgPs12	Nyakayanja 1,2	Spring	Rukira	New construction of dist. pipe, tap stand	Gravity	None	None	None	None	8	9.4	1,928	38
NgPs13	Nyagashanga	Spring	Rukira	New construction of pump house, dist. pipe, tap stands	Gravity+ Pumped	None	Pump House	2.0	100 200	18	23.4	4,339	87
NgPs14	Gitobe	Spring	Rurenge	New construction of receiv. tank, pump house, dist. pipe, tap stands	Pumped	200	Pump House	1.6	100	11	8.9	2,651	53
NgPs15	Rwamuhire	Spring	Rurenge	New construction of receiv. tank, pump house, dist. pipe, tap stands	Pumped	200	Pump House	1.7	100	40	35.0	9,642	193
NgPs16	(New source)	Spring	Zaza	Water source develop., new construction of dist. pipe, tap stands	Gravity	None	None	None	None	36	11.6	8,678	173

Table 2-8 (6) Facilities to be Constructed for Each Target District

Kirehe District **Total Population: 359,260 persons (2020) Design Service Population: 290,414 pers. (2020) Design Supply Rate: 5,808 m^3/day**

Piped Scheme												Total 290,414	Total 5,808
Master Plan Code	Source Name	Source Type	Served Secteurs	Works	Scheme Type	Receiving Tank (m^3)	Transmission Facility	Transmission Main (km)	Distribution Tank (m^3)	Public Tap Stands	Distribution Pipeline (km)	Design Service Population (pers)	Design Supply Rate (m^3/day)
KiPs01	Gashongora	Spring	Gahara	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	136	51.8	32,669	653
KiPs02	Gahezi (Gatore 1)	Spring	Kirehe, Gatore	Pump/gene replace, new construction of dist. pipe, tap stands	Pumped	None	Pump+gene	None	None	77	32.6	18,496	370
KiPs03	Gahezi (Gatore 2)	Spring	Gatore	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	35	21.0	8,407	168
KiPs04	—	Spring	Gatore	Water source develop., pump/gene replace, new construction of dist. pipe, tap stands	Pumped	None	Pump+gene	None	None	26	15.8	6,245	125
KiPs05	Gashanga II, Rwamukobe	Spring	Kigarama	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	51	47.3	12,251	245
KiPs06	Gashanga I	Spring	Kigarama	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	21	17.3	5,044	101
KiPs07	Nyakagera	Spring	Kigarama	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	18	14.4	4,324	86
KiPs08	Nyagashankara	Spring	Kigarama, Musaza	Pump/gene replace, new construction of dist. pipe, tap stands	Pumped	None	Pump+gene	None	None	58	34.2	13,932	279
KiPs09	Muguruka	Spring	Kigina, Kirehe	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	61	28.5	14,653	293
KiPs10	Kabugwe, Gasebura	Spring	Kigina	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	22	11.1	5,285	106
KiPs11	Ruhama, Mayizi	Spring	Kigina, Nyamugali, Mahama	New construction of dist. pipe, tap stands	Pumped	None	None	None	None	157	85.1	37,713	754
KiPs12	Rwakiniga	Spring	Kigina	New construction of receiv. tank, pump house, dist. pipe, tap stands	Pumped	100	Pump House	2.4	100	60	31.0	14,413	288
KiPs13	Mayizi	Spring	Mahama	New construction of dist. pipe, dist. tank, tap stands	Gravity	None	None	None	200	63	52.9	15,133	303
KiPs14	Keretavu	Spring	Mpanga	New construction of pump house, trans. pipe, dist. pipe, dist. tank, tap stands	Gravity Pumped	None	Pump House	2.2	50 100	48	20.4	11,530	231
KiPs15	Gakirarugo	Spring	Mpanga	New construction of pump house, trans. pipe, dist. pipe, dist. tank, tap stands	Gravity Pumped	None	Pump House	2.0	50 100	48	19.2	11,530	231
KiPs16	Nyagahanga	Spring	Mpanga	New construction of receiv. tank, trans. pipe, dist. pipe, dist. tank, tap stands	Gravity	50	None	1.6	100	26	13.0	6,245	125
KiPs17	Cyizanya	Spring	Musaza	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	40	25.0	9,608	192
KiPs18	Gasovo	Spring	Mushikiri	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	66	25.3	15,854	317
KiPs19	(New source)	Spring	Mushikiri	Water source develop., new construction of receiv. tank, pump house, dist. pipe, tap stands	Pumped	50	Pump House	1.8	100	50	24.8	12,011	240
KiPs20	Nyakijima	Spring	Nasho	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	8	6.6	1,922	38
KiPs21	Kireranyana 1, 2	Spring	Nasho	New construction of dist. pipe, tap stands	Gravity	None	None	None	None	33	10.7	7,927	159
KiPs22	Nkakwa	Spring	Nasho	New construction of dist. pipe, dist. tank, tap stands	Gravity	None	None	None	50	45	22.5	10,809	216
KiPs23	(New source)	Spring	Nyarubuye	Water source develop., new construction of receiv. tank, pump house, dist. pipe, tap stands	Pumped	50	Pump House	2.4	100	19	14.9	4,564	91
KiPs24	(New source)	Spring	Nyarubuye	Water source develop., new construction of receiv. tank, pump house, dist. pipe, tap stands	Pumped	50	Pump House	1.6	100	14	11.2	3,363	67
KiPs25	Kamusare	Spring	Nyarubuye	Pump/gene replace, new construction of dist. pipe, tap stands	Pumped	None	Pump+gene	None	None	27	15.5	6,486	130

Table 2-8 (7) Facilities to be Constructed for Each Target District

Bugesera District **Total Population: 378,985 persons (2020) Design Service Population: 173,175 pers. (2020) Design Supply Rate: 3,464 m^3/day**

Piped Scheme												Total 173,175	Total 3,464
Master Plan Code	Source Name	Source Type	Served Secteurs	Works	Scheme Type	Receiving Tank (m^3)	Transmission Facility	Transmission Main (km)	Distribution Tank (m^3)	Public Tap Stands	Distribution Pipeline (km)	Design Service Population (pers)	Design Supply Rate (m^3/day)
BuPs01	Lake Cyohoha South	Lake	All Secteurs	New construction of transmission pipe, distribution facilities	Pumped	None	Treatment Plant	66.7	300 × 3	718	215.4	173,175	3,464

2.5 Priority Ranking

Next, priority rankings were made for each previously explained water supply scheme construction plan.

Based on information from inquiries to districts and secteurs as well as field surveys by the study team, a point system was adopted on parameters listed in Table 2-9. First, points were added at secteur level as base points. Then, points for water schemes were added to the base points. Schemes having higher points are given priority for construction.

Table 2-9 Parameters for Priority Ranking

Level	Ranking Parameter
Secteur	1. Water supply accessibility rate (coverage rate) 2. Ranking of residents' development needs for drinking water 3. Order given by district for secteur development priority in drinking water 4. Progress rate of imidugudu resettlement
Water Scheme	1. Level of necessity for water resources development 2. Level of willingness to participate in operation and maintenance by community representatives 3. Status of other water supply projects planned or implemented in surrounding areas

For applying points, raw data were basically used not to make any relative evaluations. The objective of the point system is not to give superiority of projects, but to apply points to avoid arbitrary selection.

For schemes expanding over a number of secteurs, weighted averages using population ratios of the covered secteurs were taken as the base points to be added to the scheme points.

The point system for the above selection conditions is explained below.

Secteur Level

1. Water supply accessibility rate: The percentage figure for non-accessibility rate to water for a secteur divided by 10 is the point given to that secteur.
2. Ranking of residents' development needs for drinking water: Within the development needs (such as hospital, electricity, roads, agriculture or school) of secteur residents, according to the ranking given for water supply, if it is ranked first, then 10 points is given, second rank is 9 points, and points are reduced as the rank goes down.
3. Order given by district for secteur development priority in drinking water: Inquiry surveys were made at each district on which secteur in the district is given priority for water supply development. The numbers of secteurs in the districts differ, such that 4 districts have 14 secteurs, 2 districts have 12 secteurs and 1 district has 15 secteurs. Consequently, based on districts possessing the most number of secteurs, which is 14, 10 points is given to the secteur requiring the highest development, and points are reduced by 1 as the rank falls one step until the 14^{th} ranked secteur which receives -3 points. Then, to maintain consistency with all districts, points from 10 to -3 were distributed evenly for districts possessing 15 and 12 secteurs, and decimal points were rounded off to the nearest whole number.

4. Progress rate of imidugudu resettlement: The percentage figure of resettlement progress due to imidugudu policy divided by 10.

Water Supply Scheme Level

1. Level of necessity for water resources development: The degree of necessity for water source development of the target scheme was given points as shown below.

Level of water resources development necessity	Point
1. A sufficient amount of water source is assured and new water source is not required	10
2. A water source is available but needs rehabilitation	8
3. A new water source needs to be developed (flow rate is stable)	6
4. A new water source needs to be developed (flow rate is unstable)	2
5. Securing a water source in the service secteur is difficult	0

2. Level of willingness to participate in operation and maintenance by community representatives: Upon determination of the level of willingness to enthusiastically participate in water services by community representatives during the field surveys, points were given as follows.

Level of willingness to participate in operation and maintenance	Point
1. Strong willingness to participate	10
2. Some willingness to participate	5
3. No willingness to participate	0

3. Status of other water supply projects planned or implemented in surrounding areas: In the surrounding area of the planned water scheme, depending on whether other projects for construction or rehabilitation of water supply schemes through donor assistance or government budget are planned or implemented, points were distributed as follows.

Status of other plans	Point
1. Full-scale new construction or rehabilitation works is on-going*	-10
2. A plan for full-scale new construction or rehabilitation works is recognized	-8
3. Partial construction or rehabilitation works is on-going	-6
4. A plan for partial construction or rehabilitation works is recognized	-3
5. No plans for rehabilitation or implementation	0

*Since completion is uncertain, sites under construction are not excluded.

Using the above criteria, the results of applying points to all water schemes are shown in Supporting Report. The top 10 schemes were selected as the priority projects. The following conditions need to be considered.

- The top 10 priority projects are targeted for 2015 and the expansion plan required to cover the population growth from 2015 to 2020 is proposed in Supporting Report.
- Sites targeted for Phase 2 of the Japanese grant aid project which is now under implementation were deleted from the priority ranking procedure.
- Since handpump schemes with one or two handpumps are too small to be handled as single projects, those were combined with piped schemes in the same or nearby secteur, while schemes with 3 or more handpumps are treated as independent projects.

- As a result of the above conditions and deletion of the Japanese grant aid sites, the 93 water schemes become 77 projects plus the priority project expansion plan.

2.6 Schedule for Construction Plan

Early implementation of priority projects is desired, but unless the other projects are implemented in succession without delay, 100% water supply coverage in Eastern Province will be difficult to be achieved by 2020. In order to achieve this goal, implementation of the priority projects must be started from 2011 and thereafter, about 10 projects must be implemented continuously every year. Continuous implementation of projects for 10 years is essential to complete all projects by 2020.

Consequently, the following measures are needed to be carried out.

(1) Identification of Necessary Self-Effort Responsibilities

Self-effort responsibilities required by the Rwandan side when donor support is received, such as preparation of access roads to project sites and internal transportation of imported materials and equipment, need to be sufficiently understood and a system for handling these matters must be organized.

(2) Improvement of Organizational System

Presently in Rwanda, the National Policy and Strategy for Water Supply and Sanitation Services is enacted and a water agency is being prepared. Also, administrational reform and organizational restructuring of the water and sanitation sector are being promoted. Project supervision capacity essential for continuous implementation of the master plan requires staff capacity strengthening following this organizational and institutional improvement. Also, for successful implementation of this master plan, active participation and self-efforts by the Rwandan side, especially by Eastern Province and project target districts, are required.

(3) District Organizational Strengthening

When projects are implemented continuously, facilities construction and study for the next term need to be implemented simultaneously. In this predicament, even if donor assistance can be received, with the present supervision organization of the Rwandan side, absolute number of human resources is in shortage to create possibilities for being unable to coordinate and supervise the projects in a satisfactory manner. Therefore, water supply technicians need to be trained (in a manner such as (3) below) and they must be allocated in each district.

(4) Training Method of Water Supply Technicians

A method to train the above water supply technicians is to let water supply technician candidates participate as counterparts from districts during implementation of the priority projects where they can receive technology transfer.

(5) Request to Multiple Donors

Requesting assistance to a single donor will apply a heavy burden on the donor and reliability will be hampered. Therefore, requesting to multiple donors is necessary. By widely sharing this master plan, early coordination is desired.

(6) Self-Implementation of Small Scale Projects

Since costs of handpump schemes and other small scale projects are relatively lower, these are recommended to be implemented through governmental funds or NGO support.

As an example, since the projects of less than 50 million Frw and those of less than 100 million Frw as listed below are considered to be possible for self-implementation by the Rwandan side, implementation of these projects according to annual budgeting plans is recommended.

Project Cost	Master Plan Code	District
Less than 50 million Frw	KaPs02	Kayonza
	KaPs12	Kayonza
	KiPs20	Kirehe
	All handpump schemes in each district*	
Less than 100 million Frw	NyPs04	Nyagatare
	KaPs05	Kayonza
	KaPs09	Kayonza
	NGPs03	Ngoma
	NGPs04	Ngoma
	NGPs09	Ngoma
	NGPs10	Ngoma
	NGPs12	Ngoma
	NGPs16	Ngoma
	KiPs07	Kayonza
	KiPs10	Kayonza
	KiPs21	Kayonza

* Since the handpump scheme included in the priority project has high priority for early implementation and early budgeting for self-implementation may not be possible, donor support is recommended.

The proposed implementation plan is shown in the table below (Table 2-10) and also in Table 2-11. In Table 2-11, cost estimates for each project are listed in the right-hand column and evolutional changes in water coverage rates are shown in the bottom line.

Table 2-10 Master Plan Implementation Table (Proposal)

Implementation Year	Projects	Cost Estimate (billion Frw)	Eastern Province Water Coverage Rate (%)
2011 to 2012	Priority 10 Projects	3.20	64
2012 to 2013	13 Projects	2.24	67
2013 to 2014	11 Projects	1.95	73
2014 to 2015	11 Projects	2.04	80
2015 to 2016	15 Projects	2.27	84
2016 to 2017	7 Projects	1.72	88
2017 to 2019	7 Projects	3.07	89
2018 to 2020	3 Projects	4.87	100
After 2015	Priority Project Expansion Plan	0.06	
	Total	21.42	

N.B.: Phase 2 Japanese grant aid projects are not included in the above implementation plan.

Table 2-11 Master Plan Implementation Schedule (Proposal)

Master Plan Code	Rank	Months	2010 1	6	12	2011 1	6	12	2012 1	6	12	2013 1	6	12	2014 1	6	12	2015 1	6	12	2016 1	6	12	2017 1	6	12	2018 1	6	12	2019 1	6	12	2020 1	6	12	Cost Estimate (mil Frw)	Project Cost (bil Frw)
KiPs19	1	5.9																																		303	
KiPs12	2	7.4																																		404	
KaPs08	3	9.0																																		132	
GaHp02	4	2.7																																		27	
KiPs13	5	11.8																																		400	
GaPs01	6	14.0																																		589	
NyPs06	7	3.9																																		168	
GaPs05	8	2.5																																		276	
NgPs13	8	11.8																																		383	
NgPs01	10	7.9																																		515	3.20
KiPs04	11	3.5																																		132	
RwPs04	12	9.6																																		298	
KaPs03	13	7.1																																		211	
KaPs07	14	5.6																																		131	
NgPs11	15	10.4																																		298	
NgPs12	15	2.1																																		61	
KiPs17	15	5.6																																		163	
NgPs09	18	4.0																																		80	
KiPs02	19	7.2																																		216	
GaPs02	20	8.0																																		191	
KiPs23	21	4.0																																		139	
KiPs24	21	4.0																																		113	
KiPs25	21	3.4																																		130	
KaPs10	24	6.0																																		205	2.24
KaPs15	25	13.9																																		396	
RwPs01	26	13.6																																		351	
NyHp04	27	2.0																																		5	
GaPs09(+GaHp01)	28	9.6																																		251	
KaPs14(+KaHp03)	29	7.1																																		168	
NyPs05(+NyHp01)	30	6.1																																		167	
NyPs08(+NyHp02)	30	8.2																																		198	
NyHp03	30	3.3																																		9	
KiPs14	33	5.0																																		143	
KiPs15	33	4.7																																		135	1.95
KiPs16	33	4.0																																		111	
NgPs05	36	15.5																																		391	
KaPs02	37	0.8																																		21	
KaPs05	37	2.2																																		61	
KaPs06	37	2.5																																		108	
NgPs08	40	11.5																																		314	
NyPs02	41	25.4																																		696	
KaPs12	42	2.0																																		47	
KaPs13	42	8.1																																		231	
KaHp02	42	2.7																																		7	
NgPs16	45	2.6																																		57	2.04
KaPs16	46	9.5																																		284	
NyPs01	47	12.4																																		342	
KiPs20	48	1.5																																		43	
KiPs21	48	2.4																																		53	
KiPs22	48	5.0																																		158	
NyPs07	51	5.1																																		115	
KiPs05	52	10.5																																		298	
KiPs06	52	3.8																																		109	
KiPs07	52	3.2																																		91	
KiPs08	52	7.6																																		239	
GaPs04	56	24.7																																		642	
NgPs02	57	5.5																																		193	
NgPs03	57	2.4																																		82	
NgPs04	57	2.4																																		68	
NgPs14	60	4.0																																		113	
NgPs15	60	8.2																																		279	
RwPs02	62	11.0																																		240	
NyPs04	63	2.4																																		79	2.27
KaPs11	63	9.7																																		240	
NyHp05	65	8.7																																		22	
KaPs04	66	4.9																																		149	
GaPs06	67	4.7																																		148	1.72
GaPs01A	68	5.1																																		289	
GaPs07	69	29.3																																		772	
NyPs03(+NyHp06)	70	8.9																																		495	
NyPs09	71	12.2																																		946	
KaPs01(+KaHp01)	72	10.4																																		311	
GaPs03	73	2.1																																		116	
GaPs08	74	2.9																																		136	3.07
GaPs10	75	30.2																																		1,649	
RwPs03	76	27.7																																		666	
BuPs01	77	62.7																																		2,551	4.87
Priority Project Extension	-																																			62	0.06
Total		586.6																																			21.42
Coverage Rate (%)			52			59			61			64			67			73			80			84			88			89			93			100		

2.7 Master Plan Facilities Design

2.7.1 Design Criteria for Water Supply Facilities in Rwanda

The final report of "Etude de développement des infrastructures d'alimentation en eau potable et d'assainissement en milieu rural (Study on Development of Rural Water Supply and Sanitation Facilities)" was prepared by PNEAR in April 2008 to promote standardization of water and sanitation facilities. The report shows detailed design criteria for main facilities of piped water schemes (refer to Table 2-12). Conditions for facilities design to be adopted for this study will be, in principle, based on Rwandan facilities standards. For facilities which standards are not listed in the report, design conditions of technical specifications written in tender documents for water supply scheme construction works implemented by PNEAR in the past were used in priority. Also, the facilities specifications used locally which were identified through the survey on existing facilities in the target area are reflected in the design. Especially, specifications which are not common in Rwanda and using special materials and equipment difficult to procure locally will be avoided to be all-purpose as a master plan and designs will consider easy operation and maintenance as well as facilities expansions.

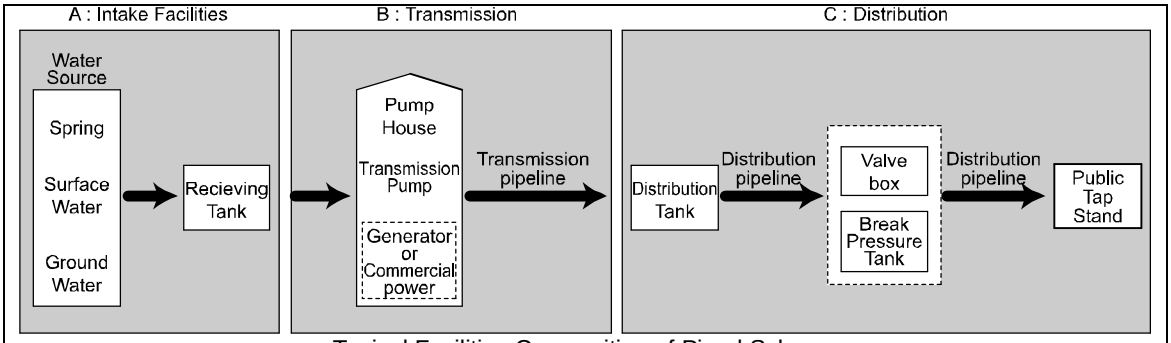
Furthermore, in the above mentioned PNEAR report, work quantities are calculated from standard drawings for each facility to determine unit facilities costs. Cost estimations for this study will be based on these unit facilities costs of Rwanda, but as a result of comparison with present unit costs of main materials confirmed during this study, materials showing conspicuous price changes were revised as necessary. Details of facilities unit costs and cost estimations of works are explained in Chapter 4.

Table 2-12 PNEAR Design Criteria

Water Supply Facility	Specification	Calculation of Work Quantity	Cost Estimate of Facilities Unit Cost	Standard Drawing
Spring Intake Facility	Extensive intake type Centralized intake type	Not available Not available	Not available Not available	Available Available
Receiving, Transmission, Distribution Tanks	Rock-piled, ground tanks	Available (5~100m3)	Available (5~100m3)	Available (25m3)
Break Pressure Tank	Rock-piled	Available	Available	Available
Rainwater Tank	Rock-piled, ground tank	Available (common with distribution tank)	Available (common with distribution tank)	Available (10m3)
Valve Box	For branching (small) For branching (medium) For branching (large)	Available Available Available	Available Available Available	Available Available Available
Public Tap Stand	2-Tap Type 6-Tap Type	Available Available	Available Available	Available Available

2.7.2 Composition of Water Supply Schemes

The number of water supply schemes planned for the master plan in this study is 93 schemes including handpump schemes (level 1) and piped schemes (level 2), but after compilation of conditions explained above, the final number is 77 schemes plus the priority project expansion plan. To effectively design facilities for each scheme, for piped schemes, designing followed the previously explained Rwandan standard composition of water supply schemes. As reference, structure photographs of similar facilities are shown in Figure 2-3. Specifications, components and installation criteria for each facility are explained in Section 2.7.3.



Typical Facilities Composition of Piped Scheme

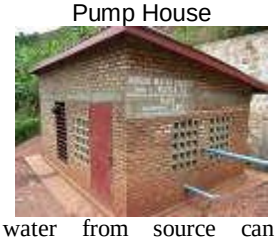
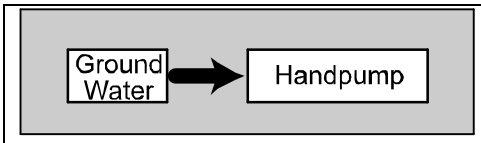
Spring Intake Facility  Intake pipes are inserted into the ground to collect spring water into receiving tank.	Surface Water (River) Intake Facility  If surface water is used as source, treatment plant is needed.	Intake Tank  If source water can be transmitted by gravity to distribution tank, then receiving tank is unnecessary.
Pump House  If water from source can be transmitted to distribution tank by gravity, then pump house is unnecessary.	Transmission Pump  Pump specifications are determined according to head loss between receiving tank and distribution tank.	Generator  If commercial power is used, generator is not installed.
Distribution Tank  Water from distribution tank to public tap stands is supplied by gravity.	Break Pressure Tank  This is installed if static pressure of distribution pipe is greater than the pipe pressure limit.	Public Tap Stand  For the master plan, tap stands will be standardized as 2-tap type.

Figure 2-3 Water Supply Scheme Components (Piped Scheme)

For handpump schemes, considerations were made on both new construction and rehabilitation works. Most of the existing handpumps in the target area were constructed in the 2000's. In consideration of new construction, upon assumption from past drilling records (Japanese grant aid project and PDRCIU projects), drilling success rates for new boreholes are low (50% to 70%). On the other hand, experiences in borehole rehabilitation works (handpump replacement) in Eastern Province are very few which are mostly those executed by the Japanese grant aid projects (as determined from Japanese grant aid and PDRCIU projects). Many handpump facilities which can be used after rehabilitation are abandoned when the handpump breaks down. For effective and continuous use of precious boreholes, handpumps broken after long usage will be replaced and aprons and other facilities will be rehabilitated as needed. Upon proper operation and maintenance, existing borehole facilities can be used until the target year. Therefore, in this master plan, broken existing boreholes will be rehabilitated as much as possible.

Various types of handpumps were confirmed in the target area. However, handpumps planned for the master plan will be "Afridev handpumps" due to the following reasons. (Refer to Figure 2-4)

- Many of this type pumps are functioning in the target area including those of the Japanese grant aid project and procurement of spare parts for these pumps in Kigali will not incur any problems.
- Since this is a VLOM type handpump, village level operation and maintenance is possible, consumables are not expensive and the pump is durable.
- Villagers are familiar with its handling and handpump technicians for repairs are gaining experience.



For the master plan, new groundwater development is not planned. Using existing boreholes as water sources, only replacement of handpumps will be made.

Kayonza District

Ngoma District

Existing Handpumps in Target Area (Afridev Type)

Figure 2-4 Handpump Scheme

2.7.3 Specifications of Water Supply Facilities

For water schemes of the master plan, design parameters are highly diverse, such as, topography geology and soil conditions of water sources and planned construction locations; facilities scale; and for facilities requiring rehabilitation, deterioration conditions and required extensions and expansions. Therefore, at the implementation stage, designing by reflecting on detailed surveys for each of these conditions is necessary. However, in this master plan, due to the necessity for early application of results, specifications of facilities were standardized as follows.

(1) Intake Facilities

1) Spring

Upon digging a spring 1.7m depth and 1m width, slotted PVC pipes are laid in the ground for intake. Architectural cut rocks are piled on the downstream side as a wall to stop water. The intake pipes are covered with water penetrable material (crushed gravel), then covered with sand and clay, and then backfilled with soil. The length of the intake pipe needs to be calculated from the design supply rate and unit flow rate of the spring which should be measured precisely during the implementation stage. However, for standardization in the master plan, 100m will be used[4].

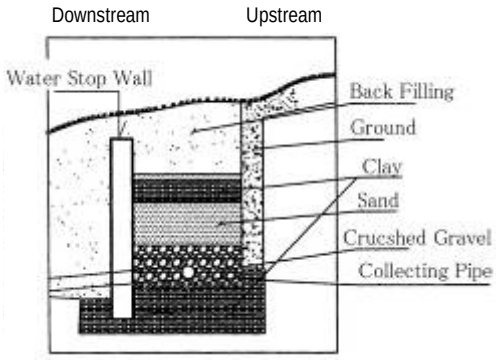


Figure 2-5 Example of Spring Intake Facility Cross Section

2) Surface Water (River, Lake)

Intake facilities using rivers as water sources are planned for Nyagatare and Gatsibo Districts. Following the structure and scale of existing facilities, these are composed of water preventive wall of piled rocks, collection channel of reinforced concrete and PVC transmission line (φ90mm). For Bugesera District, using lake water as the intake, the plan is to construct additional facilities similar to the existing one.

3) Groundwater (Handpump Facility)

Replacement of existing handpumps which are broken is planned for Nyagatare, Gatsibo and Kayonza Districts. Using the existing boreholes as water sources, new handpumps (Afridev type with riser pipes and cylinder rods) will be installed after development and pumping test of the boreholes.

4) Receiving Tank

If the water source is located lower than the distribution tank, receiving tanks (or intake tanks) will be constructed for pumping up to the distribution tank. The tank will be constructed of piled rock structure, the most commonly used type in Rwanda which is also adopted in the PNEAR facilities standards. The shape is cylindrical, the filled water depth is 2m and overflow is 50cm, with the diameter depending on the tank volume. The floor, ceiling and pillars are of reinforced concrete (RC). Galvanized steel pipe (GSP) will be used for supply/drainage (ϕ 80mm) and overflow (50mm). Valve boxes will be of piled rock structure with steel covers. Capacities of receiving tanks will depend on the scale of the scheme (amount of transmission flow rate), but will be selected from 3 types of $50m^3$, $100m^3$ and $200m^3$.

[4] For the collection pipe, since the pipe used in the Japanese grant aid project is less than 100m (for example, the intake pipe of MKM in Rwamagana district is about 90m), and this length can assure sufficient intake flow rate, the length of 100m was adopted.

(2) Transmission Facilities

1) Pump House

The pump house to install the transmission pump and generator will be of brick structure in accordance with PNEAR facilities standards. If commercial power can be used, then the generator (and fuel tank) will not be installed and so the pump house size can be reduced, but in the master plan, installation of diesel generator is presumed (standardize to one type of pump house only) since electrification is not yet planned according to Supporting Report.

2) Transmission Pump and Generator

For transmission pump, a vertical multi-stage pump which is easy for maintenance and confirmed to be available in Kigali is chosen. The pump manufacturers confirmed to be procurable at the dealer in Kigali are mainly Grundfos and KSB products. Since commercial power cannot be used for the pumps, installation of generators is planned.

3) Transmission Pipeline

For normal piped schemes, PVC90mm（PN16）will be used. For large scale, long distance transmission mains (bulk line systems) planned for Nyagatare, Gatsibo and Bugesera Districts, the pipes will be ductile pipes of DIP300mm which can be procured in Rwanda and have been used before. Steel pipes (GI) can also be used, but are not locally available and are rarely used.

(3) Distribution Facilities

1) Distribution Tank

The structure is the same as the receiving tank. Generally, distribution tank capacities are determined by using 8 to 12 hours' amount of the design daily average supply rate. However, for preliminary cost estimates of this study, detailed capacities for each scheme will not be set, but tanks will be selected from standard 3 types of $50m^3$, $100m^3$ and $200m^3$ according to design populations. However, for the long distance transmission system planned for Bugesera District, tanks to be constructed at the terminal points will be of $300m^3$ capacities.

2) Break Pressure Tank

Since the topography of Rwanda reveals steep slopes, the static pressure within distribution pipelines is high in many cases. In this case, break pressure tanks are needed to prevent

leakages due to damages in distribution pipes and taps. For the master plan, break pressure tanks of 0.7 m^3 capacity will be installed at locations along distribution pipelines where water pressure heads are predicted to be higher than 70m (static water pressure of 7.0kgf/cm^2) as determined from topographical maps of the supply area. The break pressure tank will be of piled rock structure with floors and covering of RC.

3) Distribution Pipeline

Since distribution pipelines will be laid under ground, PVC (PN10) is selected. Similar to the distribution tank, pipes will be standardized as main pipes being ϕ 110mm and branch lines of 50mm. At the time of actual construction, road crossings and bends (elbows) will need appurtenant facilities such as concrete reinforcement, but these are not considered in the master plan.

4) Valve Box (Gate Valve, Air-Release Valve, Drainage Valve)

In principle, at branches of new pipelines and replaced pipelines, branching valve boxes will be installed. Since detailed topographic surveying along the planned pipeline route was not conducted, locations of air valves and drainage valves cannot be specified. Therefore, for the master plan, installation of one each of an air valve and drainage valve for schemes of over 1km distribution pipe laying is planned and included in the cost estimates. Following the PNEAR facilities standards, valve boxes will have piled rock walls with RC floors and ceiling, and steel hatches.

5) Public Tap Stand

In the detailed design, the number of taps for public tap stands can be determined from housing distribution of target residents, but for the master plan, all tap stands will be of 2-tap type. Concerning the structure of public tap stands, various designs are adopted around the country (refer to Figure 2-6). For the master plan, following PNEAR facilities standards, the body and appurtenant valve box will be of concrete block structure and will consist of taps, gate valves, meters, floor and soakaway[5]. The number of taps for each scheme will be calculated from the 2020 design supply population, but since a clear standard for the supply population for each tap is not available in Rwanda, the design criteria of the latest Japanese grant aid project of 120 persons per tap[6] will be used.

[5] Since wastewater from public tap stands is the low quantity of water spilled during fetching, a drainage pit is believed to be over specified. If a drainage pit is installed, many cases were confirmed where the drainage pipe become clogged with sand and debris to flood the tap stand foundation which is not a favorable situation. Therefore, using a soakaway to diffuse the wastewater on the ground was determined to be a better solution.

[6] Criterion of 120 persons per tap is mentioned in the agreed report for the Japanese grant aid project "Basic Design Report for Rural Water Supply Project in Rwanda", 2006. Also, since distribution and density of houses within

1-Tap Type (Southern Province)

1-Tap Type (Western Province)

1-Tap Type House Connection (Northern Province)

2-Tap Type (Eastern Province)

4-Tap Type (Eastern Province)

Kiosk Type (Southern Province)

Figure 2-6 Examples of Tap Stands in Rwanda

2.7.4 Layout Drawings of Design Water Supply Schemes

The design water supply facilities layout drawings for each district are shown in Drawings.

the villages are not uniform, the situation needs to be confirmed during the implementation stage and the number of taps for each tap stand must be decided for each cluster where tap stands are planned to be installed.

CHAPTER 3 PRIORITY PROJECTS

3.1 Selection Results

Through the procedure explained in Chapter 2, the projects listed below are the top 10 ranked schemes and were selected as the priority projects.[1] Code numbers from PP01 to PP10 were assigned to the priority projects as shown below. Also, water supply coverage rates for each priority project for the target year 2015 are shown below. If the priority projects are not implemented, then the water supply coverage rates of the target secteurs are as shown in the column "Without Project" and if the projects are implemented, then the coverage rates are those in column "With Project" to contribute to attain 100% coverage by 2020.

Table 3-1 Coverage Rates of Priority Projects for Target Year 2015

Priority Project Code No.	District	Service Secteur	Secteur Pop. (pers)		Secteur Coverage Rate (%)		
			2008	2015	Present (2008)	2015	
						Without Project*1	With Project*2
PP01	Kirehe	Mushikiri	22,436	26,271	5	4	48
PP02	Kirehe	Kigina	21,285	24,923	15	13	63
PP03	Kayonza	Mukarange	23,790	27,857	20	17	73
PP04	Gatsibo	Rwimbogo	27,689	32,422	28	24	28
PP05	Kirehe	Mahama	18,322	21,454	17	15	100
PP06	Gatsibo	Remera	22,803	26,701	36	31	57
PP07	Nyagatare	Katabagemu	30,195	35,356	45	38	93
PP08	Gatsibo	Kageyo	18,625	21,809	53	45	60
PP09	Ngoma	Rukira	20,817	24,375	73	62	92
PP10	Ngoma	Gashanda	12,963	15,179	73	62	100
		Total	218,925	256,347			

*1 Coverage rate of design population for 2015 with the present water supply rate
*2 Coverage rate of the secteur after this priority project is implemented
N.B.: In case of population increase while maintaining the present water supply situation (new water supply project is not implemented), the water supply coverage rate of Eastern Province for 2015 is 46%, and the water coverage rate for 2015 when only the priority projects are implemented becomes 51%.

Water sources and scheme types of priority projects are shown in Table 3-2. Water sources to be used are springs and groundwater, while scheme types are pumped type piped schemes, gravity type piped schemes and handpump schemes.

[1] Within the water schemes selected as priority projects, those in Rwamanaga and Bugesera districts are not included due to their priority being lower than the other districts. However, since necessary schemes for the 2 districts are included in the master plan, if the master plan is implemented as planned, then all areas of the Eastern Province will receive water by 2020

Table 3-2 Water Sources and Scheme Types of Priority Projects

Priority Project Code	Served Secteur	Water Source Name	Source Type	Scheme Type
PP01	Mushikiri	Cyantabara	Spring	Pumped
PP02	Kigina	Rwakiniga	Spring	Pumped
PP03	Mukarange	Kazabazana	Groundwater	Pumped
PP04	Rwimbogo	Kwa Gatiroko, Rwiminazi, Ngarambe, Kabeza I	Groundwater	Handpump
PP05	Mahama	Mayizi	Spring	Gravity
PP06	Remera	Nyabukobero	Spring	Pumped
PP07	Katabagemu	Rwobe- Gashure	Spring	Gravity
PP08	Kageyo	Nyakagezi	Spring	Gravity
PP09	Rukira	Nyagashanga	Spring	Gravity+ Pumped
PP10	Gashanda	Gasetsa	Spring	Pumped

The target year for the priority projects is 2015, but the target year for the master plan is 2020 and population is expected to grow during these 5 years. Therefore, in order to achieve 100% water supply coverage by 2020, expansion works such as pipe extensions and valve installations for tap stand increase are needed for the priority projects. For explanation of the proposed expansion plan, refer to Supporting Report.

3.2 Preliminary Design of Water Supply Facilities

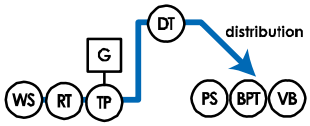
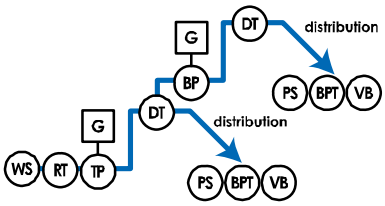
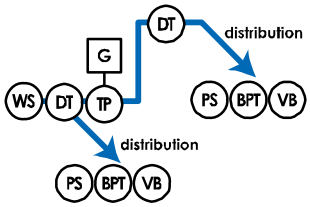
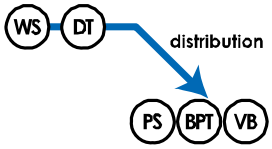
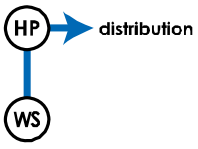
3.2.1 Composition of Water Supply Scheme

The composition of water supply facilities is basically the same as those shown in Figure 2-3 (Section 2.23 of Chapter 2). For schemes PP03 Mukarange and PP07 Katabagemu, only extension of distribution pipelines from the existing facilities and installation of additional public tap stands are planned.

3.2.2 Types of Water Supply Facilities

For piped schemes in Rwanda, depending on the location of the water source and topographical characteristics of the water service area, the transmission method will be either gravity or motorized (pumped), or a combination of both as explained in the previous chapter. Even for the same scale schemes, since machinery such as motorized pumps and generators are generally expensive, the construction costs will have big differences depending on the transmission method. Also, due to costs for fuel and maintenance of equipment, operation and maintenance costs will be greatly influenced. The 9 piped schemes of the priority projects can be categorized as shown in Table 3-3.

Table 3-3 Scheme Type Category of Priority Projects

Design Scheme Type	Relative Cost	Priority Project	District
 Motorized Pump	Construction cost: Moderate Operation cost: Moderate Maintenance cost: Moderate	PP01 Mushikiri PP02 Kigina PP10 Gashanda	Kirehe Kirehe Ngoma
 Combined Pumped and Gravity (with booster pump)	Construction cost: High Operation cost: High Maintenance cost: High	PP06 Remera	Gatsibo
 Combined Pumped and Gravity (without booster pump)	Construction cost: Moderate Operation cost: Moderate Maintenance cost: Moderate	PP09 Rukira	Ngoma
 Gravity	Construction cost: Low Operation cost: Low (no fuel costs) Maintenance cost: Low[2]	PP05 Mahama PP08 Kageyo	Kirehe Gatsibo
Pipeline Extension Only	–	PP03 Mukarange PP07 Katabagemu	Kayonza Nyagatare
 Handpump	Operation and Maintenance cost: Low[3]	PP04 Rwimbogo	Gatsibo

WS: Water source, RT: Receiving tank, TP: Transmission pump, BP: Booster pump, G: Generator, PS: Public tap stand, BPT: Break pressure tank, VB: Valve box (gate valve, branch valve, air-release valve, washout valve), HP: Handpump

[2] Since fuel costs are not needed for operation of this type of scheme, residents often refuse to pay water fees. Therefore, obtaining understanding by resident on the necessity of operation and maintenance costs is important.

[3] For handpumps, water fee collection on a volumetric rate basis is generally difficult. Although many existing facilities in Rwanda are set on a flat rate basis, due to reasons such as nonexistence of users' ledger, proper fee collection cannot be made. Therefore, since operation and maintenance costs cannot be assured, many cases of broken handpumps being left alone are found.

3.2.3 Specifications of Water Supply Facilities

At the stage of facilities designing for the master plan, Rwandan design standards were basically adopted. However, for preliminary designing of priority projects, some specifications of facilities were reviewed in consideration of implementation through the Japanese grant aid. Design standards and changes in facilities specifications are shown below.

Table 3-4 Changes in Facilities Design Standards

Facility	Type	Rwandan Standard	Japanese Standard
Intake	Spring Intake	○	
	Receiving Tank	(Rock pile structure)	○ (RC* structure)
Transmission	Pump House	(Burnt brick structure)	○ (RC structure)
	Pump and Generator	○	
	Transmission Pipeline	○	
Distribution	Distribution Tank	(Rock pile structure)	○ (RC structure)
	Break Pressure Tank	○	
	Distribution Pipeline	○	
	Valve Box	○	
	Public Tap Stand	○	

N.B.: *RC[4]=reinforced concrete

(1) Intake Facilities

1) Spring Intake Facility

Specifications are the same as those of the master plan.

2) Groundwater Intake Facility (Handpump Scheme)

At Rwimbogo Secteur in Gatsibo District, replacement of 4 broken handpumps (Afridev type including riser pipes and cylinders) is planned. Development of existing boreholes (borehole cleaning by airlifting) and rehabilitation of appurtenant facilities (concrete foundation and drainage pit) are included.

3) Receiving Tank

The commonly constructed type in Rwanda and adopted in the facilities standards of PNEAR is the rock piled structured tank, but due to disadvantages in assurance of water tightness and since structural calculations for this tank are very difficult, this type was not adopted in the Japanese grant aid project, and tanks of RC were constructed. Also for the preliminary design, these reasons were adopted[5].

[4] In Rwanda, rock pile structure is widely adopted, but from the view of assurance of water tightness and since structural calculations are difficult, the previous Japanese grant aid project also adopted RC structure.

[5] PNEAR also considers tank construction of RC, but the cost is estimated to be 150 to 200% more than the rock pile type.

(2) Transmission Facilities

1) Pump House

For pumped schemes, pump houses to install transmission pumps and generators will be constructed. In consideration of durability of the pump house, instead of burnt brick structure of PNEAR standard, the house structure will be of rigid-frame structure with RC pillars and beams, and the walls will be of concrete blocks. This house will be constructed in the same premise as the above mentioned receiving tank, and both the pump house and receiving tank will be fenced.

2) Transmission Pump and Generator

Pump specifications are determined from the design flow rates and total head losses which are calculated from altitudes of the planned sites for receiving tanks and distribution tanks as well as pipe length/diameter. However, since topographic surveying of the target area was not conducted in this study, altitudes were obtained from existing geographical maps and GPS altimeter measurements. Pump specifications of this preliminary design will be used as reference for calculating project costs explained later.

Transmission pumps will be horizontal multi-stage pumps and 2 pumps (1 for standby) will be installed in the pump house. At the time of the study, since commercial power was not available for all of the schemes and electrification is not planned, generators will be installed in all pump houses to provide power. The generator capacities were determined from pump specifications. Procurement of both pumps and generators from Europe is possible through the dealer in Kigali.

3) Transmission Pipeline

Since in general, transmission pipelines will be laid under ground, GI(80mm) will be used for pumped schemes and PVC(90mm) for gravity schemes. Static water pressures must be confirmed from pipe diameters calculated from accurate altitudes through topographical surveying results at the implementation stage. Also, to avoid water hammering effects, air chambers will be installed along transmission pipelines.

(3) Distribution Facilities

1) Distribution Tank

The structure will follow the receiving tank structure. Capacities of distribution tanks were determined from 8 hours amount of design supply rate and in consideration of operation and maintenance efficiency, 200m^3 was selected as the maximum capacity (calculated as the maximum required capacity). At the side of the tank, a valve box to house gate valves (for transmission mains and distribution pipelines) and flow meters, and a valve box for washout valve will be constructed. A chlorination facility (using powder chlorine) will be installed on top of the distribution tank (on the first distribution tank for schemes with multiple distribution tanks).

2) Break Pressure Tank

Similar to the master plan facilities design, at points along distribution pipelines where the static water pressure head are assumed to be over 7.0 kgf/cm^2, break pressure tanks will be installed. However, for PP02 Kigina, PP06 Remera and PP10 Gashanda, at points where the pipeline route must be laid along valleys, if residual water head cannot be assured at the pipeline terminal by installing a break pressure tank, then a break pressure tank will not be installed and this will be countered by using high-pressure resistant PVC(PN16). Also for this measure, pipeline calculations based on topographical surveying at the implementation stage is needed. The structure of the break pressure tank will be concrete block walls, RC for the floor and roof, and installed with float valve, steel cover and drainage pipe.

3) Distribution Pipeline

Same as the master plan, distribution pipes will basically be PVC pipes (PN10). However, as explained before, PVC(PN16) will be used in some schemes. The pipe mains of new construction schemes will be 90mm. Since the pipe mains of PP03 Mukarange and PP07 Katabagemu which are planned for pipeline extension only are of 63mm, the extension pipes will also be of the same diameter. At the implementation stage, upon surveying the pipeline route, exact height differences and pipeline lengths can be calculated, and after locations of public tap stands are decided, adjustments in pipe diameters are necessary to ensure correct flow velocities. Furthermore, although ancillary facilities such as concrete protection at street crossings and bends (elbows) are needed, locations and numbers will be determined after the pipeline route is decided at the stage of detailed design.

4) Valve Box (Gate Valve, Branch Valve, Air-Release Valve, Washout Valve)

A valve box with gate valve for operation and maintenance will be installed every 500m along newly installed pipeline routes. Also, branching valve boxes are installed at points of branching along pipe mains. Moreover, air-release valves are installed at high points and washout valves at low points along pipelines. Structure of valve boxes will be concrete block walls, RC floor and roof with steel cover, drainage pipe and soakaway. Exposed pipes inside the valve box will be galvanized steel pipes (GI).

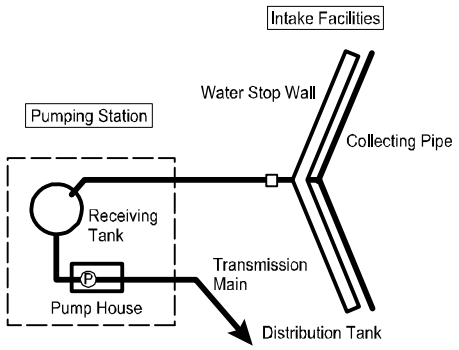
5) Public Tap Stand

As explained previously, one tap will cover 120 persons and the necessary number of taps was calculated for each scheme from the design water supply population for 2015. The necessary numbers of public tap stands were calculated by assuming 4 tap type stands. For this study, only calculation of the number of public tap stands is made, and the actual locations of tap stands will be decided based on residential distribution survey at the implementation stage. The structure of tap stands is the same specifications as the master plan facilities design.

3.2.4 Summary of Water Supply Facilities Plan

PP01 Mushikiri	Kirehe District	Mushikiri Secteur (S02º09'00, 3" E30º40'28.0")

The newly planned water source is located along the valley developed from the northeastern to southwestern direction in the northern part of Rugarama Cell in Mushikiri Secteur. This area is surrounded by hard sandstone and quartzite directly outcropped along ridges of altitude of 1,850 to 1,900m. From there, groundwater flowing along the border of talus sediments and basement rock developed in the direction of the valley is collected by culvert pipes.



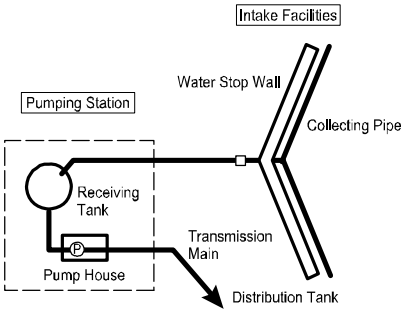
Intake Point

A: Intake	Spring Intake*	Receiving Tank			
	1	50m3			
B: Transmission	Pump House	Transmission Pump		Generator	Trans. Pipe (GI)
	1	600L/min-150m-30.0kW		125kVA	1,057 m
C: Distribution	Distribution Tank	Chlorinator	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)
	100m3	1	3	25	9,610 m
	Gate Valve	Air Valve	Washout Valve		
	17	1	1		

*Intake includes water preventive wall and water collection pipe.

PP02 Kigina	Kirehe District	Kigina Secteur (S02º14'19.8", E30º41'10.2")

The newly planned water source is located in the valley floor developed from the southeastern to northwestern direction along the border of Rugarama and Ruhanga Cells in Kigina Secteur. The area is surrounded by 1,600m high ridges of phyllite as basement rock. Water will be taken from the underflow in the river sediments in the valley using culvert pipes.



Intake Point

A: Intake	Spring Intake*	Receiving Tank			
	1	100m3			
B: Transmission	Pump House	Transmission Pump		Generator	Trans. Pipe (GI)
	1	500L/min-190m-30.0kW		125kVA	2,456 m
C: Distribution	Distribution Tank	Chlorinator	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)
	100m3	1	3	26	14,640 m
	Gate Valve	Branch Valve	Air Valve	Washout Valve	
	24	5	3	3	

*Intake includes water preventive wall and water collection pipe.

PP03 Mukarange	Kayonza District	Mukarange Secteur

Pipeline extensions from the existing water supply scheme are planned. The existing water sources are 2 boreholes drilled in the valley along the border of Kayonza and Rugendabari Cells in Mukarange Secteur. These boreholes were drilled in 1999 and 2007 and their pumping rates are each 2.2 l/sec with both of 55m drilling depths and well diameters of 100mm and 150mm.

Borehole (right end) constructed by Japanese grant aid project (2007) and transmission pipes

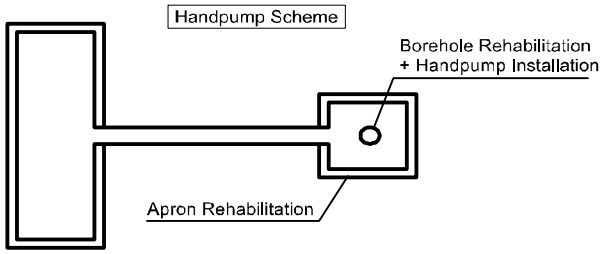
Borehole drilled in 1999 (under rehabilitation by PNEAR)

C: Distribution	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)	Gate Valve	Branch Valve
	1	43	10,593 m	18	6
	Air Valve	Washout Valve			
	2	2			

PP04 Rwimbogo	Gatsibo District	Rwimbogo Secteur

This is a handpump scheme consisting of 4 facilities to be rehabilitated. All are Afridev type handpumps which were constructed in 2001 through the PDRCIU project and one to two years have passed since they were broken. The boreholes are probably using groundwater existing in weathered layers thinly distributed in valleys of granitic rocks. Since borehole drilling information is not available, details of the borehole structure is unknown, but the drilling depth of 40 to 50m with diameter of 100mm can be assumed from geological conditions of surrounding areas and minimum well diameter possible for installing Afridev pumps. Most of the facilities are designed so that spilled water can be used for livestock watering. Presently, target residents are using functioning handpumps located farther away, but if repaired, they wish to use handpumps located nearer to them. Determining from water supply conditions before the handpumps broke down, reuse is possible with only replacement of existing boreholes and drilling new boreholes is not necessary.

1. KABEZA 1 Source
2. RWIMINAZI Source
3. GATIROKO Source
4. NYAMATETE Source

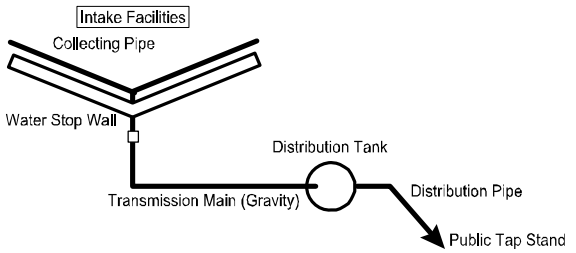


Target Facility (RWIMINAZI)

Handpump scheme	Borehole rehabilitation + Handpump installation + Rehabilitation of appurtenant facilities
	Target 4 facilities

PP05 Mahama	Kirehe District	Mahama Secteur (S02º15'48.4", E30º44'47.2")

The newly planned water source is located in the talus sediments of the downstream of the Mayizi water source group in the northeastern part of Gatarama Cell in Kigina Secteur. The Mayizi water source group consists of groundwater flowing within talus sediments distributed over hard sandstone in valleys expanding from the north-northeastern to south-southwestern direction and supplies water to 3 surrounding secteurs. The new water source for Mahama will be taken from the groundwater flowing in different talus sediments developed in the southern fault of the Mayizi water source group and will be transmitted by gravity to Mahama Secteur.



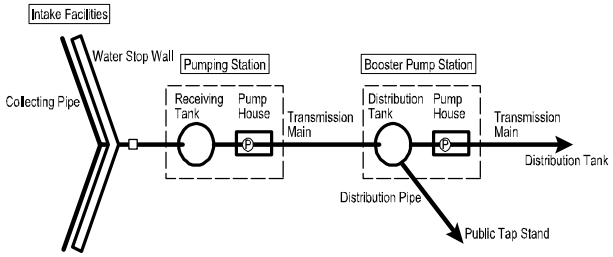
Intake Point

A: Intake	Spring Intake*				
	1				
B: Transmission	Trans. Pipe (GI)				
	6,650 m				
C: Distribution	Distribution Tank	Chlorinator	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)
	100m3	1	1	39	19,911 m
	Gate Valve	Branch Valve	Air Valve	Washout Valve	
	32	9	6	6	

*Intake includes water preventive wall and water collection pipe.

PP06 Remera	Gatsibo District	Remera Secteur (S01º41'30.5", E30º17'29.1")

The existing intake is located at the junction between Kambukimandwa gorge and Nyarutojo Biyanga small ravine in Nyagisozi Cell on the Kageyo side of the border between Remera and Kageyo Secteurs. The mountain ranges of these gorges are covered with talus sediments and the valley floor is filled with alluvial sediments. Culvert pipes (80mm) are laid along the border of talus sediments and alluvial sediments. This existing scheme was constructed in 1989 through the support of an Italian NGO (MLFM), but since deterioration of the system including distribution facilities is becoming conspicuous, new construction of the entire scheme is needed.



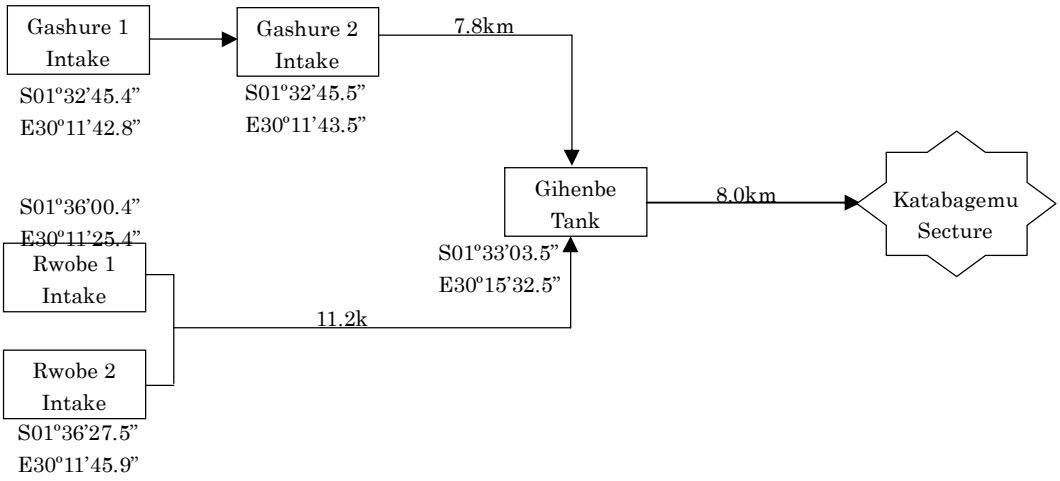
Existing Intake Facility

A: Intake	Spring Intake*	Receiving Tank			
	1	100m3			
B: Transmission	Pump House	Transmission Pump		Booster Pump	
	2	267L/min-300m-37.0kW		600L/min-80m-18.5kW	
	Generator	Generator	Trans. Pipe(GI)		
	125kVA	80kVA	1,894 m		
C: Distribution	Distribution Tank	Chlorinator	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)
	50m3, 100m3	1	13	32	21,185 m
	Gate Valve	Branch Valve	Air Valve	Washout Valve	
	37	15	3	3	

*Intake includes water preventive wall and water collection pipe.

PP07 Katabagemu	Nyagatare District	Katabagemu Secteur

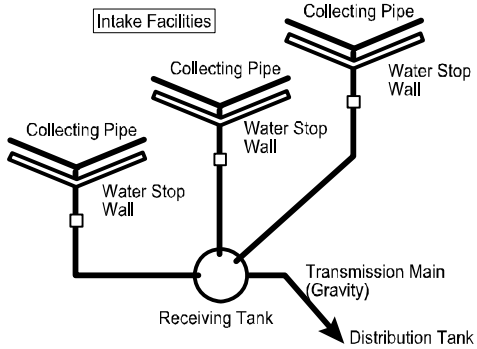
Pipeline extensions from the existing scheme are planned. The existing water sources are 2 water source groups of Rwobe and Gashure in Nyagihanga Secteur of Gatsibo District. Water for both Rwobe and Gashure water source areas are taken from 1,700 to 1,800m points on mountainous areas formed by alternating layers of sandstone and schist with 2,000m altitudes ranging along the border of the Eastern Province and Northern Province. Since the surface soil is not very thick, groundwater collected from cracks in rocks is believed to be used as the sources. Water is transmitted by gravity to Gihenbe booster tank (in Ngarama Secteur) through transmission mains of 11.2km and 7.8km (pipe diameters of 50 to 75mm). Then, the water is transmitted 8.0km to the target supply area. This scheme constructed in 2008 can be called a mini-bulk line system.



C: Distribution	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)	Gate Valve	Branch Valve
	5	43	17,550 m	32	9

PP08 Kageyo	Gatsibo District	Kageyo Secteur

The 2 existing water sources are located midway along the northeastern slope in the western part of Kintu Cell in Kageyo Secteur, which are Nyakagezi 1 (S01°40'04.3", E30°14'39.6") and Nyakagezi 2 (S01°40'04.2", E30°14'37.5"). This slope consists of a large marsh and a small marsh, and both the existing 2 sources are being taken from the small marsh. Water from the large marsh is not taken and so a new culvert pipe will be installed into this area to collect water from a total of 3 springs. The existing 2 intakes will be reconstructed.



Intake Point

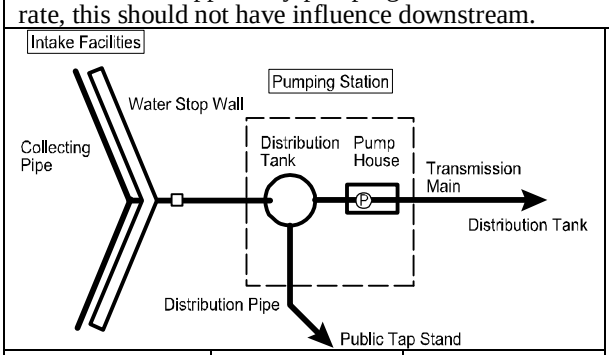
A: Intake	Spring Intake*	Receiving Tank
	3	100m3
B: Transmission	Trans. Pipe (GI)	
	510 m	

C: Distribution	Distribution Tank	Chlorinator	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)
	100m3	1	3	28	10,767 m
	Gate Valve	Branch Valve			
	18	5			

*Intake includes water preventive wall and water collection pipe.

PP09 Rukira	Ngoma District	Rukira Secteur (S02º07'47.5", E30º37'28.4")

The newly planned water source is located upstream of Gisuma gorge which flows from the northeastern to southwestern direction at the northern part of Kibatsi Cell in Rukira Secteur. This is surrounded by hills of hard sandstone, valley slopes are covered with talus sediments and the valley floor is distributed with 5 to 10m thick alluvial sediments. Flowing water can always be observed and at downstream, most of it is used in the paddy fields for agricultural purposes. However, the only source usable for domestic purposes which is the underflow in the upstream will be collected through culvert pipes and transmitted by gravity to the lower water service areas while for service areas located in middle and higher parts, water will be supplied by pumping. Since the intake rate is equivalent to about 1.5% of the river flow rate, this should not have influence downstream.



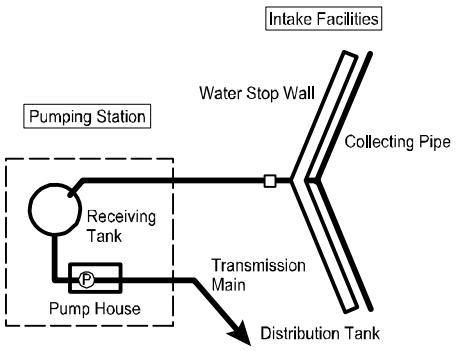
Intake Point

A: Intake	Spring Intake*				
	1				
B: Transmission	Pump House	Transmission Pump		Generator	Trans. Pipe (GI)
	1	500L/min-190m-30.0kW		125kVA	832 m
C: Distribution	Distribution Tank	Chlorinator	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)
	100m3,200m3	1	3	21	17,014 m
	Gate Valve	Branch Valve	Air Valve	Washout Valve	
	32	4	1	1	

*Intake includes water preventive wall and water collection pipe.

PP10 Gashanda	Ngoma District	Gashanda Secteur (S02º10'46.5", E30º26'28.6")

The newly planned water source is located near the border between Gashanda and Karembo Secteurs along the Budihidihi valley developed from the southeastern to northwestern direction in Cyerwa Cell within Gashanda Secteur. In this area, sandstone layers covered with talus sediments are distributed and alluvial sediments fill the valley. Groundwater flowing along the border between talus sediments and basement rocks will be collected by culvert pipes.



Intake Point

A: Intake	Spring Intake*	Receiving Tank			
	1	100m3			
B: Transmission	Pump House	Transmission Pump		Generator	Trans. Pipe (GI)
	1	500L/min-230m-37.0kW		125kVA	2,659 m
C: Distribution	Distribution Tank	Chlorinator	Break Pres. Tank	Public Stand	Dist. Pipe (PVC)
	100m3	1	12	32	22,830 m
	Gate Valve	Branch Valve	Air Valve	Washout Valve	
	39	11	4	4	

*Intake includes water preventive wall and water collection pipe.

3.2.5 Water Supply Facilities Layout Drawings

Concept drawings for the 10 priority projects are shown in Drawings.

3.2.6 Considerations on Construction Works of Priority Projects

Construction and rehabilitation works for the priority projects need to be implemented upon consideration of construction conditions in Rwanda and Eastern Province.

(1) Influence of Rainy Season on Works

In Eastern Province, the national roads connecting the districts are paved, but when moving away from these main roads into the villages, most of the roads are unpaved and passage to villages during the rainy season is difficult. Therefore, if works are to be conducted during the rainy season, sufficient surplus periods for transporting materials and equipment and considerations for storage of materials and equipment as well as protection of facilities under construction are needed.

(2) Work in Parallel

In Rwanda, delays in construction works often occur. To maintain the time schedule, working in parallel with a number of work teams becomes essential and considerations are needed on procurement conditions, work schedule and possibilities for quality control of materials and equipment.

(3) Procurement of Materials and Equipment

Since most materials and equipment will be imported from third countries, transportation and customs procedures will require abnormally long time periods and difficult handling conditions. Therefore, time and handling requirements using information of local conditions and situation of other projects need to be sufficiently considered.

Also, for assured sustainability after construction, use of materials and equipment procurable mainly in the local market is essential. Although many of them are available in Kigali through dealers and shops, only simple items are available locally in district centers. Considering quality control and stable supply, procurement following the table below is recommended.

Table 3-5 Procurement Sources for Materials and Equipment

Materials and Equipment	Local	Third Country
Cement	○	
Sand, gravel, aggregate, etc.	○	
Paint	○	
Pipes	○	○
Iron bars	○	
Pumps, generators	○	○
General valves	○	○
Special valves		○
Construction machinery		○

(4) Site Accessibility

Since accessibility especially to water sources is difficult in many sites, mobilizing construction machinery is expected to be difficult. Therefore, the work plan should consider using local workers to transport materials and equipment by hand at the sites and selecting construction machinery appropriate for the sites.

(5) Selection of Workers

Finding local workers to conduct high level tasks such as supervision or management is difficult in Rwanda. However, laborers to carry out unskilled work are locally available, but sufficient supervision of the work is required.

Also, in past projects, the Rwandan side has requested hiring local workers as much as possible. When village residents who are not technicians are to be used, considerations are needed to use local workers for manual labor which do not require machinery, such as on-site transportation and pipeline trenching. .

Local contractors for construction works are available mostly in Kigali, but based on implementation information of other projects, their capacity is limited, and problems in quality control and safety management need to be considered. Also, local contractors prefer to work in Kigali and tend to avoid work in rural areas since they are based mostly in Kigali, work is more is available in Kigali and there are possibilities for getting multiple works. Therefore, if subcontractors are to be used, sufficient supervision is essential. However, for borehole drilling and development works, the only borehole drilling company in Rwanda conducts proper work with sufficient capacity, supervision and management as confirmed from achievements in other projects.

CHAPTER 4 COST ESTIMATES

4.1 Cost Estimates of Master Plan

4.1.1 Unit Costs of Facilities Construction

In the PNEAR report on facilities standards, unit costs for main construction works of water supply schemes are shown. Cost estimates of the master plan will be based on these unit costs. For pipe materials and handpumps, materials costs collected in this study were used. Facilities construction costs were estimated from these unit costs and these were reviewed through comparison with costs of water supply facilities construction works[1] implemented in Eastern Province in 2008. Then, the unit facilities construction costs adopted for the master plan are shown in Table 4-1. Refer to Supporting Report for breakdown of unit facilities construction costs.

For surface water (rivers and lakes) intake facilities and large scale transmission under ground laying works using ductile pipes which are not included as PNEAR facilities standards, preliminary designs were made with reference to existing similar facilities in Gatsibo and Bugesera districts. Based on these costs, construction cost estimates were made.

Table 4-1 Construction Unit Costs

No.	Facility	Unit	Unit Construction Cost (Frw)	No.	Facility	Unit	Unit Construction Cost (Frw)
1	Spring Intake Facility	Set	13,451,000	11	Valve Box A	ea	375,000
2	Surface Water Intake Facility	Set	14,059,000	12	Valve Box B	ea	416,000
3	Treatment Plant	Set	55,000,000	13	Valve Box C	ea	561,000
4	Storage Tank 5m^3	ea	1,382,000	14	Public Tap Stand	ea	563,000
5	Storage Tank 50m^3	ea	4,302,000	15	Transmission Pipe DIP300	m	20,000
6	Storage Tank 100m^3	ea	9,245,000	16	Transmission Pipe PVC90(PN16)	m	6,100
7	Storage Tank 200m^3	ea	18,428,000	17	Distribution Pipe PVC110(PN10)	m	5,900
8	Storage Tank 300m^3	ea	23,880,000	18	Distribution Pipe PVC50(PN10)	m	2,800
9	Pump House	ea	6,372,000	19	Handpump Installation	ea	1,730,000
10	Break Pressure Tank	ea	687,000				

4.1.2 Cost Estimates by Districts

From the above unit construction costs and quantities of facilities for each planned scheme, cost

[1] Construction de l'adduction d'eau par pompage de Kirehe dans le district de Kirehe (2008)

estimates[2] by districts were calculated (Tables 4-2 to 4-8).

Table 4-2 Cost Estimate: Nyagatare District

Scheme Code	Project Cost [1000Frw]	Scheme Code	Project Cost [1000Frw]
Piped Scheme			
NyPs01	341,906	NyPs06	255,445
NyPs02	695,820	NyPs07	114,880
NyPs03	492,947	NyPs08	194,582
NyPs04	78,904	NyPs09	945,915
NyPs05	163,892	-	-
Handpump Scheme			
NyHp01	3,459	NyHp04	5,189
NyHp02	3,459	NyHp05	22,488
NyHp03	8,649	NyHp06	1,729
Nyagatare District Total [1000Frw]		3,329,264	

Table 4-3 Cost Estimate: Gatsibo District

Scheme Code	Project Cost [1000Frw]	Scheme Code	Project Cost [1000Frw]
Piped Scheme			
GaPs01	134,531	GaPs06	148,307
GaPs01A	321,226	GaPs07	772,147
GaPs02	191,077	GaPs08	136,329
GaPs03	116,412	GaPs09	249,674
GaPs04	641,785	GaPs10	1,648,698
GaPs05	162,710	-	-
Handpump Scheme			
GaHp01	1,729	GaHp02	6,919
Gatsibo District Total [1000Frw]		4,531,544	

Table 4-4 Cost Estimate: Kayonza District

Scheme Code	Project Cost [1000Frw]	Scheme Code	Project Cost [1000Frw]
Piped Scheme			
KaPs01	309,480	KaPs09	94,932
KaPs02	20,665	KaPs10	204,583
KaPs03	210,896	KaPs11	239,731
KaPs04	149,249	KaPs12	46,698
KaPs05	61,307	KaPs13	231,069
KaPs06	107,673	KaPs14	166,706
KaPs07	130,501	KaPs15	395,896
KaPs08	217,163	KaPs16	283,964
Handpump Scheme			
KaHp01	1,729	KaHp03	1,729
KaHp02	6,919	-	-
Kayonza District Total [1000Frw]		2,880,891	

[2] The project costs listed here are the costs required for local construction works including local indirect costs, but in case of implementation by Japan grant aid, these are equivalent to the direct construction costs.

Table 4-5 Cost Estimate: Rwamagana District

Scheme Code	Project Cost [1000Frw]	Scheme Code	Project Cost [1000Frw]
Piped Scheme			
RwPs01	351,128	RwPs03	665,831
RwPs02	239,747	RwPs04	297,989
Rwamagana District Total [1000Frw]		1,554,695	

Table 4-6 Cost Estimate: Ngoma District

Scheme Code	Project Cost [1000Frw]	Scheme Code	Project Cost [1000Frw]
Piped Scheme			
NgPs01	254,483	NgPs09	80,139
NgPs02	193,491	NgPs10	77,520
NgPs03	81,543	NgPs11	297,676
NgPs04	67,717	NgPs12	61,043
NgPs05	390,901	NgPs13	210,489
NgPs06	421,936	NgPs14	112,953
NgPs07	205,310	NgPs15	278,565
NgPs08	313,663	NgPs16	57,235
Ngoma District Total [1000Frw]		3,104,666	

Table 4-7 Cost Estimate: Kirehe District

Scheme Code	Project Cost [1000Frw]	Scheme Code	Project Cost [1000Frw]
Piped Scheme			
KiPs01	270,789	KiPs14	143,435
KiPs02	216,349	KiPs15	134,984
KiPs03	124,199	KiPs16	110,740
KiPs04	132,385	KiPs17	162,977
KiPs05	298,495	KiPs18	134,566
KiPs06	109,006	KiPs19	184,444
KiPs07	91,060	KiPs20	42,536
KiPs08	238,625	KiPs21	53,026
KiPs09	161,418	KiPs22	157,958
KiPs10	65,934	KiPs23	139,137
KiPs11	490,302	KiPs24	113,071
KiPs12	228,885	KiPs25	129,585
KiPs13	346,623	-	-
Kirehe District Total [1000Frw]		4,280,532	

Table 4-8 Cost Estimate: Bugesera District

Scheme Code	Project Cost [1000Frw]	Scheme Code	Project Cost [1000Frw]
Piped Scheme			
BuPs01	2,550,997	-	-
Bugesera District Total [1000Frw]		2,550,997	

4.2 Cost Estimates of Priority Projects

4.2.1 Cost Survey of Materials and Equipment

In addition to the unit costs for materials such as pipe materials and handpumps collected to make cost estimates for the master plan, a local cost survey was conducted on specifications of pumps and generators determined for preliminary designing of the priority projects. The list of companies surveyed for main materials and equipment (all in Kigali city) are shown in Table 4-9. Almost all materials and equipment necessary for water supply facilities construction are imported. Construction materials produced and procurable in Rwanda are sand, gravel and concrete blocks.

During the almost half year study period, the rise in prices of materials and fuel was confirmed. Therefore, if this project is to be implemented after one to two years, unit costs are predicted to rise even further (an annual rise of less than 10%).

Table 4-9 Companies Surveyed for Cost Estimate of Materials and Equipment

No.	Company Name	Materials and Equipment	Contact
1	Davis & Shirtliff	Transmission pumps, handpumps, flow meters	0783231045
2	SONATUBE	Pipes (PVC), valves, flow meters	0252585607, 0788299477
2	Comptoir Produits	Generators	0252503438
3	AZ Impex	Generators	0252576594, 0252577624
4	Quincaillerie MUHIRWA	Pipes（GI）	-
5	SOFAL	Pipes（GI）	-
6	MUDENGE Construction	Unit labor costs	Information from Implementation Review Study
7	Foraky	Borehole development	02551575, 0788580507

4.2.2 Unit Costs of Facilities Construction

Since accurate construction quantities for each facility cannot be determined at the level of preliminary designing conducted in this study, construction costs cannot be calculated through compiling materials costs and labor costs. Therefore, in this cost estimate, local civil engineers were used to collect unit construction costs of main facilities, and the numbers of facilities of schemes were multiplied to these costs to estimate project costs. For transmission pumps and large equipment such as generators, installation costs were added to prices obtained from the local cost survey mentioned in the previous section to calculate the project costs. Also, review of estimated costs were made through comparison with project costs of construction works actually being implemented in Eastern Province to determine the unit

facilities costs to be used for this study as shown in Table 4-10. For the master plan of all of Eastern Province, facilities design was carried out principally using local standards specifications, but for the priority projects, specifications were modified upon assuming implementation through Japanese grant aid project. Therefore, even for similar schemes in the master plan, the costs for the priority projects differ. Changes in specifications are as shown in Table 3-2 such as the Rwandan standard for structure of tanks is rock pile, but the Japanese standard is RC. Construction unit costs for the master plan are shown in Table 4-1 and those for the priority projects are shown in Table 4-10. However, at the stage of estimating costs of priority projects, quotations on local construction costs including facilities without specification changes were newly requested and detailed examinations were made on results of survey on materials unit costs. Moreover, since unit cost estimates of facilities construction are lump sum costs including materials and labor, costs are not broken down into materials costs and labor costs.

Table 4-10 Unit Costs of Design Facilities Construction

No.	Facility	Specifications	Unit	Unit Construction Cost (Frw)
1	Spring Intake	RC+block stacking, PVC collecting pipe	unit	17,238,000
2	Storage Tank 50m3	RC structure, GI pipe, float valve	unit	12,028,000
3	Storage Tank 100m3	RC structure, GI pipe	unit	19,325,000
4	Storage Tank 200m3	RC structure, GI pipe	unit	32,755,000
5	Chlorinator	Block pile, dosing pump, chlorinating tank	unit	3,611,000
6	Pump House	RC+block stacking, GI pipe	unit	11,982,000
7	Break Pressure Tank	RC structure, GI pipe, float valve	unit	927,000
8	Valve Box for Gate Valve	RC+block stacking, GI pipe	unit	620,000
9	Valve Box for Air Valve	RC+block stacking, GI pipe	unit	462,000
10	Valve Box for Washout Valve	RC+block stacking, GI pipe	unit	736,000
11	Public Tap Stand (4 Taps)	RC+block stacking, GI pipe	unit	1,635,000
12	Pipe Works GI80		m	24,000
13	Pipe Works PVC90 (PN16)		m	11,000
14	Pipe Works PVC90 (PN10)		m	7,000
15	Pipe Works PVC63 (PN10)		m	3,000
16	Handpump Installation	Afridev pump set, borehole development, RC slab rehabilitation	set	6,035,000

4.2.3 Cost Estimates of Priority Projects

Cost estimates were made from unit construction costs shown in the previous section and quantities of facilities of each planned scheme (refer to Table 4-11). For each of intake facility, transmission facility, distribution facility and handpump facility, the ratios of costs against the total project cost are shown in Table 4-12.

Table 4-11 Cost Estimates of Priority Projects

Unit: 1,000Frw

Scheme	Intake Facility		Transmission Facility				Distribution Facility								Handpump Facility			Mobil. Demo	Project Cost
Code No. Secteur	Spring Intake	Receiving Tank	Pump House	Trans Pump	Generator	Pipe [m]	Dist. Tank	Chlori-nator	Break Tank	Tap Stand	Valve Box Gate	Valve Box Air	Valve Box Washout	Pipe [m]	Bore. Devel.	Hand pump	Slab Rehab.		
PP01 Mushikiri	1	1	1	2	1	1057	1	1	3	25	17	1	1	9610				27,571	303,285
	17238	12028	11982	38253	25245	25368	19325	3611	2781	40875	10540	462	736	67270					
PP02 Kigina	1	1	1	2	1	2456	1	1	3	26	29	3	3	14640				36,709	403,796
	17238	19325	11982	38253	25245	58944	19325	3611	2781	42510	17980	1386	2208	106300					
PP03 Mukarange									1	43	24	2	2	10593				12,029	132,316
									927	70305	14880	924	1472	31779					
PP04 Rwimbogo															4	4	4	2,414	26,554
															12994	6995	4151		
PP05 Mahama	1					6650	1	1	1	39	41	6	6	19911				36,343	399,774
	17238					73150	32755	3611	927	63765	25420	2772	4416	139377					
PP06 Remera	1	1	2	4	2	1894	1	1	8	32	53	1	1	21185				53,581	589,387
	17238	19325	23964	87024	43890	45456	12028	3611	7416	52320	32860	462	736	170151					
PP07 Katabagemu									5	43	41			17550				15,301	168,311
									4635	70305	25420			52650					
PP08 Kageyo	3	1				510		1	3	28	23			10767				25,121	276,326
	51714	19325				5610		3611	2781	45780	14260			75369					
PP09 Rukira	1		1	2	1	832	1	1	3	21	36	1	1	17014				34,811	382,919
	17238		11982	38253	25245	19968	19325	3611	2781	34335	22320	462	736	119098					
PP10 Gashanda	1	1	1	2	1	2659	1	1	12	32	50	4	4	22830				46,802	514,820
	17238	19325	11982	35750	25245	63816	19325	3611	11124	52320	31000	1848	2944	172490					
Total for 10 Priority Project Schemes																			3,197,488

※For each scheme, upper figure is number of facilities and lower figure is construction cost

※Mobilization/demobilization is considered as 10% of construction cost for each scheme

※If JICA regulation exchange rate for October 2009 (1Frw=¥0.16) is applied, the total direct construction cost is about ¥511,598,000.

Table 4-12 Facilities Cost Ratios

Unit: 1,000Frw

Intake Facility	Transmission Facility	Distribution Facility	Handpump Facility	Mobilization/ Demobilization	Total
244,470	746,606	1,891,591	24,000	290,681	3,197,488
7.6%	23.3%	59.2%	0.8%	9.1%	100.0%

4.2.4 Other Considerations Related to Project Costs

(1) Project Cost for Implementation by Japanese Grant Aid

Since the prices shown in the previous section are costs estimated from locally obtained unit facilities construction costs, if construction is to be implemented by Japanese contractors through Japanese grant aid, these are equivalent to direct construction costs. In this case, other costs such as indirect costs (mobilization/demobilization, management costs and transportation costs) and consulting fees (detailed design fees, supervision fees and software component costs) need to be added to form the project cost.

As a reference, based on cost ratios from the Rural Water Supply Project, Phase 2 (Implementation Review Study) 2009, being implemented in Eastern Province, the project cost calculated from the cost estimates is shown below.

Table 4-13 Project Cost of Priority Projects

Unit:1000Frw

Item	As Direct Construction Cost	Indirect Cost	Consulting Fees	Project Cost
Ratio to Direct Construction Cost	—	38%	14%	152%
Priority Projects	3,197,488	1,215,045	447,648	4,860,181

(2) Access Roads

For schemes planned with construction of spring intake facilities, construction of access roads for construction vehicles passage and materials transportation is needed. The construction costs shown in section 4.2.2 do not include costs for construction of access roads. Construction of access roads was the responsibility of the Rwandan side for the Japanese grant aid project implemented in 2007, but delays in budget allocation and construction procedures resulted in not being able to construct access roads within the scheduled time to influence the total construction schedule. When the present plan is implemented, inclusion of access roads construction in the project construction works is highly recommended to ensure a proper construction schedule.

CHAPTER 5 OPERATION AND MAINTENANCE PLAN

5.1 Present State and Problems of Operation and Maintenance in Target Area

5.1.1 State of Management and Operation and Maintenance

Six types of management organizations for water supply schemes, including management by RWASCO in urban areas, are found in the Eastern Province as shown below.

Table 5-1 Summary of Rural Water Supply Scheme Management in Eastern Province

Management Type	District	Summary of Situation
Water Users' Associations	Ngoma	Seven WUAs are conducting operation and maintenance activities for 7water supply schemes and changeover to management by private operators is under consideration.
	Kirehe	Previously, a district WUA managed all the water supply facilities in the district. However, decentralization of the WUA was decided in March 2008 and operation and maintenance activities are now conducted by 9 secteur level WUAs.
Private Operators	Kayonza	Privatization started from November 2007 through a tendering process and now 4 private operators are managing water supply schemes with supervision by a district water board. (Until May 2009, 5 private operators were managing water schemes, but thereafter, after one of them abandoned its work, RWASCO is supplying water.)
	Gatsibo	Five private operators are now managing water schemes. Privatization started from December 2007 by a tender process similar to that of Kayonza District and a district water board was established, but the board was dismissed in March 2009 and now the District is directly supervising the private operators.
Water Users' Associations (WUAs)/ Private Operators	Rwamagana	Four private operators and two WUAs are conducting operation and maintenance activities for one each of 6 water supply schemes. Privatization started from 2007 to 2008 for some water schemes, but a district water board is not yet established. Some WUAs still exist; and therefore the district is planning to privatize them after financial and economical evaluations.
Private Operators /Local Government (*Secteur*)	Nyagatare	Previously in western and central areas, several WUAs existed in units of former communes, but they were dissolved by the former ELECTROGAZ in 2007. Now some water supply schemes are managed by secteurs themselves. One private operator is conducting operation and maintenance of a scheme in the southern part.
Central Government (MININFRA)	Bugesera	One large water supply system supplies water to almost all parts of the district. The operation and maintenance system is now managed under MININFRA.
RWASCO	Nyagatare	Water is supplied through public taps and house connections in Nyagatare secteur.
	Kayonza	Water is supplied to Kabarondo secteur.
	Rwamagana	Water is supplied to Munyiginya, Gishari and Muhazi secteurs as well as a part of Kigabiro secteur.
	Ngoma	Water is supplied to Remera secteur as well as a part of Kibungo secteur.

As explained above, water supply schemes in the target area are being managed by various types of systems according to the situation of water supply and background of each area.

5.1.2 Management by Water Users' Associations

The Water Users' Association (WUA) is an organizational structure established in 1987 when ownership of existing water supply schemes was entrusted to the commune (former district) by a Rwandan governmental ordinance[1]. Thereafter, due to administrative organizational reform in January 2006, WUAs were separated from the administrative organization to become community-based self-supporting organizations[2]. This type of organization forms the basic structure for operation and maintenance of water supply schemes presently in Eastern Province.

(1) Organizational Structure

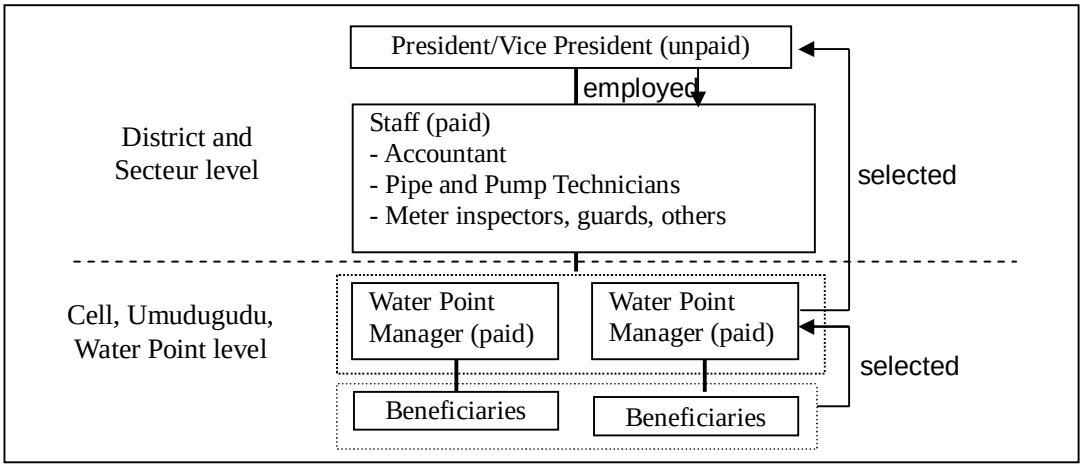


Figure 5-1 Organizational Chart of Water Users' Association

The lowest level of WUAs is a group which consists of local beneficiaries and water point managers with secteur or district upper level organization depending on the scale of the scheme. The upper body collects water fees from the lower group and dispatches technicians.

Collected water fees are transferred to the upper level WUA by the accountant or water meter reader, and the upper WUA manages their expenses, such as operation, material for maintenance, salaries of staffs and miscellaneous expenses. WUAs which carry deficits cannot pay salaries and operational costs for diesel fuel or electric power. In this case, examples of the administration allotting subsidies are reported.

The President and Vice President are selected from beneficiaries and approved by the secteur or district administration. WUAs are still existing and working in Rwamagana, Ngoma and Kirehe Districts.

[1] The World bank WSP : Mission to analyze the document, the delegated management of rural water supply systems, Final report – Tome 1 (June 2009)

[2] JICA : Basic Design Report on Rural Water Supply Project in Rwanda, June 2006

(2) Characteristics

Communication and coordination between beneficiaries and local administration are easier. Since many presidents of WUAs were chosen from Executive Secretaries of Cells, they can make considerations on water fee setting/payment and the poor/vulnerable, and they are aware of community problems such as vandalism of facilities. Therefore, they are in a good position to easily coordinate and solve these problems through discussions between the cell and secteur. For consideration on the vulnerable, water fees for areas designated by the secteur (such as returnee settlement areas) are set at a lower rate than others.

(3) Issues

Generally, capacity for management and operation and maintenance by WUAs is poor. Since the president of WUA receives no salary, he has only a few obligations and responsibilities. Therefore, the management of a WUA greatly depends on the capacity of the president for proper decision-making, high activeness and strong responsibility. Also, if the president is the Cell Executive Secretary, since he is very busy with his responsibilities, he would have difficulties in carrying out his role as WUA president.

Financially, most WUAs have some kind of debts which consist of unpaid electricity bills (to RECO) and unpaid staff salaries. One of the reasons for these debts is the lack of financial management by the accountants of WUAs since the accountants are selected from residents who have no basic knowledge or skills. Furthermore, since the president has no obligation to take responsibilities for debts, the matter becomes worse. To solve this problem, Kirehe District decided to obligate WUAs to submit financial reports every month to confirm their financial status.

Technicians of WUAs have skills only for repairing pipelines and taps, repairing leakages and making house connections and other small works, but cannot repair control panels, pumps and generators. Therefore, for major repairs, specialized technicians are sometimes called from Kigali (this is also the case for private operators). Furthermore, for handpump schemes, technicians who can repair handpumps are rare.

The above situation will create a negative synergistic effect, such that if a problem in the water supply scheme occurs, the WUA has no budget to buy materials and cannot pay salaries to technicians. Therefore, water supply facilities become neglected to deteriorate and create problems in management. This will have effect on the profit of the WUA to further degenerate the system and create a vicious spiral.

Moreover, since most WUAs do not have sufficient materials and equipment such as spare parts, tools and motorcycles, this is another reason for causing difficulties in operation and maintenance.

5.1.3 Management by Private Operators

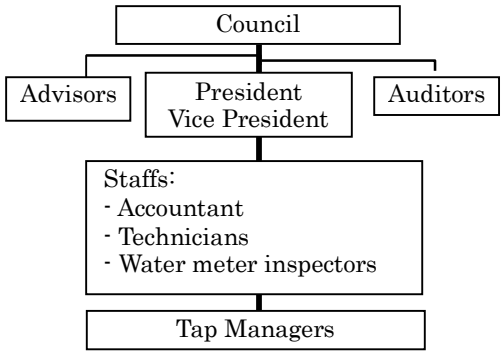
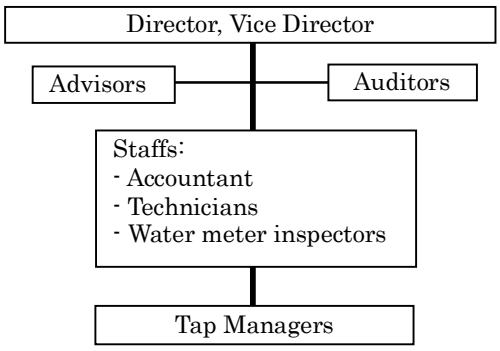
Private operators manage water schemes through a contract with the district. Four private operators in Kayonza District, 5 in Gatsibo District, 4 in Rwamagana District and one in Nyagatare District for a total of 14 service providers are now managing water schemes.

(1) Organizational Structure

The Public-Private Partnership (PPP) program of the water supply sector was started by the Water and Sanitation Program (WFP) of World Bank in 2004 in order to clarify the responsibilities which could not be made with WUAs and ensure a consistent technical standard. The present aim is 50% privatization of water supply schemes by 2012. The process involves selection of local private operators through tendering.

Private operators are classified as cooperatively invested "Cooperatives" or individually invested "Enterprises". The characteristics of these are as follows. When districts require contracting with private operators, both types can tender.

Table 5-2 Organization and Management Characteristics of Private Operators

	Cooperative	Enterprise
Structure		
Remarks	The Council formed by members is the highest decision-making group which decides on the selection of the president and employment of the staff. A staff has the right to become a member when he/she pays a share which varies between 10,000Frw and 200,000Frw.	The director has the right to make decisions and staffs are employed by the director. Some Enterprises have also employed advisors and auditors for confirmation and auditing of their work..

(2) Characteristics

The most prominent characteristic of private operators is that they are able make prompt decisions and use of their budget.

In a cooperative, the president and vice president are selected from members of the council and the council gives them the delegation for management. Auditors and advisors are also

selected from the members of council to audit the management periodically. When the management is not well, it is reported by the auditors in council meetings, and the president may be recalled and a new president will be decided by the council. The council meeting is held three to four times per year, and the status of management is reported by advisors and/or auditors. If a profit on annual balance is made, the members can receive up to 5% dividends or if they are in debt, additional investment is demanded. Since most of the employed pipe technicians are those from the former WUAs, they do not have specialized skills capable of repairing pumps and generators.

For an enterprise, all information about operation and maintenance of water supply is brought to the director so that he/she can make quick decisions when a problem occurs. Advisers and auditors to check their work are chosen by the director.

(3) Issues

WSP and MININFRA held a workshop for analyzing the water supply management by private operators in July 2009. Results of monitoring the use of private operators revealed the following.

1) Private operators can pay running costs and management fees, but cannot save up for facilities replacements and expansions.
2) Private operators have tendency to increase private house connections, but they do not construct additional public tap stands.

The results of field surveys by the study team confirmed that, in Kayonza and Gatsibo Districts, beneficiary communities do not understand the management methods of private operators, as follows:

- Since private operators are contracted to the district, although the district needs to be involved with secteurs and cells of their service area, routine communication channels do not exist.
- For handpump schemes, since local beneficiary residents cannot agree with the tariff of 300Frw per month per household, fees cannot be collected. A cause for this is that some beneficiary residents think that the amount paid to the private operator is being used to repair other water supply schemes and is not contributing to operation and maintenance of the handpumps they are using.

In consideration of this situation, residents need sensitization, but both the district and the private operators are saying that this must be an obligation of the other party. This is explained in 5.1.8.

5.1.4 Management by Local Government (Secteur)

(1) Organizational Structure

In Nyagatare District, a gravity water supply scheme using water source from mountains in the western part was constructed in the 1980's. Through a 40km transmission main, water is

sent to the eastern part and along the way, branch lines are supplying water to those areas in the central part. The scheme was being operated by WUAs, but since fees were collected by a flat rate system, residents were not aware of the amount they used and water distribution was not well managed. Therefore, water supply to Nyagatare town in the central part of Nyagatare Secteur which is located at the pipeline terminal was in an unstable condition. To secure enough water for this system and give priority to Nyagatare town, in 2008, former ELECTROGAZ stopped WUA management and dissolved them in areas between the plant and distribution area and is now directly managing the main pipeline.

Karama Secteur, one of these dismissed areas, possesses a gravity scheme and from the beginning of 2009, the administration decided to operate and maintain branch schemes directly by themselves. The secteur is employing 4 technicians to operate and maintain water treatment facilities and pipelines. Also, managers are assigned for each public tap stand and they prepare a list of users. They manage the list and collect water fees based on the list. Ten percent (10%) of collected water fees become their salaries. The managers bring the collected fees to the accountant of the secteur, and upon confirmation of the executive secretary of the secteur, the accountant deposits these fees into the bank account to be used for purchasing spare parts.

(2) Characteristics

Since the secteur is the water service provider, communications and coordination between the administration and beneficiaries can be made easily. When problems such as suspension of water or payment arrears occur, the executive secretaries of the secteur and cells can solve them promptly.

(3) Issues

The facilities are so old that many leakages are detected. Since the area is remote, procurement of spare parts for repairs require a long time. The technicians are ex-technicians of WUAs so that their skills are not high similar to that of private operators and WUAs explained above.

5.1.5 Management by Central Government (MININFRA)

(1) Organizational Structure

In Bugesera District, the water supply system constructed by KfW in 1998 and extended by EU in 2007 covers all secteurs in the district. The water source of the system is Lake Cyohoha Sud located along the border with Burundi, and the water treatment plant, transmission and distribution pipelines are managed directly by MININFRA.

Operation of the treatment plant, laboratory and maintenance of pipelines are handled by 39 staffs. Staffs are employed by MININFRA on an annual basis and all staffs are paid. Public tap stand managers are contracted with MININFRA.

(2) Characteristics

The operator makes monthly reports to MININFRA which show the amounts of water supplied, incomes, rates of unaccounted-for water and detailed breakdowns of expenditure. Therefore, the status of the water supply scheme can be easily confirmed from the report. Vehicles and spare parts are sufficiently stocked. Also, since highly skilled technicians are selected by MININFRA, they have sufficient management and technical skills. The organization seems to be similar to that of an Enterprise described above.

(3) Issues

The presently collected water fee was not calculated from costs necessary for operation and maintenance of the water scheme, but is set at low suppressed rate of 620Frw/m^3 (15Frw/jc) through the request of Bugesera District. However, if the water fee is calculated in terms of the total cost needed for operation, the tariff should be 1,075Frw/m^3 (25Frw/jc) and the difference is being borne by MININFRA. This fee setting for a pumped scheme is a special case where 30Frw/jc is set by WUAs of Rwamagana and Kirehe Districts. Since this fee is approved by the districts, for Bugesera District, the cost can be raised to 25 to 30Frw/jc on a self-supporting basis, but understanding by the district, secteurs and residents is essential.

Since the water fee needs to be raised by MININFRA, the management system should be changed to that of a private operator or RWASCO.

5.1.6 Management by RWASCO

(1) Organizational Structure

The former ELECTROGAZ, established in 1976, is a Rwandan corporation to supply water and electrical power mainly to urban areas. Branch offices in Eastern Province are located in the 3 cities of Rwamagana, Kibungo and Nyagatare. As explained in 1.3.4, ELECTROGAZ was separated in to RWASCO and RECO, and presently water supply is handled by RWASCO.

A branch office has 2 sections, one for water supply and another for power supply, with about 20 staffs. Three to four water supply technicians are employed on a monthly basis and they usually work for operation and maintenance of pipelines such as repairing leakages, and connecting and disconnecting house connections.

(2) Characteristics

Staffs have sufficient managerial and technical skills, and RWASCO also possesses vehicles, motorcycles and other means of transportation as well as spare parts and equipment to respond to urgencies. Since capacities of technicians are high, they can repair pumps and generators. Materials for repairs are purchased and stocked in Kigali headquarters, and are sent to branch offices whenever necessary.

(3) Issues

In order to insure water sources to supply urban areas, RWASCO has occupied water sources originally managed by WUAs or private operators to cause decrease in water supply to original service areas.

5.1.7 Evaluation of Present Situation on Operation and Maintenance Organization of Water Service Providers

Evaluations related to operation and maintenance for each management type are summarized below.

Table 5-3 Present State and Evaluation of Type-Wise Management

Type of Water Service Provider	Operation and Maintenance Level	Management and Financial Level	Organizational and Institutional Level	Level of Consideration for Vulnerable and Poor[3]
WUAs and Local Government (Secteurs)	Can handle at least distribution pipe repairs	Income raising and expense management are not carried out, resulting in debts and non-payments	Although bylaws are established, responsibilities of staffs are vague	Considerations are made for the vulnerable and poor
Private Operators	Can handle at least distribution pipe repairs	Although financial reports are made, financial status is only enough for operational funding	Clarified in bylaws	Areas of vulnerable and poor are recognized, but arrangements cannot reach them
Central Government and RWASCO	Specialized technicians are permanently employed to promptly cope with emergencies and complicated disasters	Statement of accounts is reported and balance management is properly carried out	Clearly stated in laws and bylaws	Tariff is uniformly 10Frw/jc even for areas of vulnerable and poor

As evaluation of management by WUAs, other than consideration to the vulnerable and poor, evaluation is the same or lower than other water service providers. Especially since the financial situation which is important for management is degenerating and responsibilities are vague, problems such as operational discontinuation of water schemes and water fee runaway are occurring. In order to improve this situation, the World Bank WSP started private management of water schemes from 2004, and effects can be observed in Western and Southern Provinces. Also, in Eastern Province, privatization of water schemes started in 2005 and as explained previously, improvement of weak points are being proven. However, while continuing the present trial and error conditions, the problems explained in 5.1.8 must be solved and private management should be promoted.

5.1.8 Problems in Contracting with Private Operators

(1) Contractual Problems

The tender documents for private operators include tender conditions, form of contract and list of water supply schemes to be contracted. When tender proposals are submitted, assumption is made that the tenderers agree to tender conditions and contents of the contract. However, some private operators seem to have difficulties in managing water supply schemes because they offered tender proposals without fully understanding the conditions. Detailed problems of the contract are as follows:

[3] Local administration is supplying water free of charge to the vulnerable and poor. Private operators are making considerations to an extent which does not hinder their management, but this is not sufficient. RWASCO tariff is uniformly 10Frw/jc and this is not an amount which the vulnerable and poor can pay.

1) Restrictions in Income

The following water fees, which are the same for both Kayonza and Gatsibo Districts, are clearly described in the contract.

Table 5-4 Contract Water Tariff of Kayonza and Gatsibo Districts

Type of Water Supply Scheme		Unit	Fee (Frw)
Pumped Type Piped Scheme	Public Tap Stand	Jerrican (jc)	**20**
	Private House Connection	m^3	**900**
Gravity Type Piped Scheme	Public Tap Stand	jc	**10**
	Private House Connection	m^3	**450**
Handpump and Protected Spring		household/month	**300**

If water fees are unified, income becomes low for high operation and maintenance cost schemes which are originally difficult to manage, and without profit, the service provider goes into the red. As a consequence, to establish water tariffs, a) amount of affordability to pay (ATP) in the service area, b) amount of willingness to pay (WTP) in the service area, c) minimum amount necessary for operation and maintenance, and d) availability of subsidies need to be considered and then water tariffs should be calculated for each scheme. (Refer to Supporting Report)

On the other hand, since handpumps are difficult to collect water fees by a volumetric method (per jerrican or per m^3), collection of fees needs to be by a flat rate method (per household per month or year). In this case, careful consideration is necessary to sensitize residents to create willingness to pay and setting a fee which is affordable to pay.

2) Contract Period

Period of the contract is 2 years in both Gatsibo District and Kayonza District, and upon reviewing the performance of the operators at the time of contract completion, the district decides whether to terminate or continue the contract. Under this condition, private operators cannot invest in improvement of water supply system by their profit due to the short period of contract. Furthermore, since extension of the contract is decided only by the district after 2 years, the private operators are passive in investing on improvement of the water supply schemes because they are not assured of getting returns of this investment in the future.

3) Unclear Responsibilities and Obligations

The following 2 obligations are presently not clearly described in the contract.

3-1) Demarcation of Responsibilities in Management of Water Schemes

The district is the owner of the water supply schemes and the private operators have the right to operate and manage them. However, when repairs are needed, the responsibility for handling this situation is not clearly mentioned in the contract.

For Kayonza District, demarcation of costs for management and repairs is not written in the contract. For Gatsibo District, since the contract mentions that "When the cost of repair exceeds 40,000Frw, cost sharing should be discussed with the district", the private operators are discussing with the district on such repairs, but the costs have never been allocated. In actuality, private operators are carrying out the repairs, but since the repair cost is high and difficult to bear, the operators may need to suspend the water supply which can create difficulties in accounting to cause discontinuation of management, and then the operators can go bankrupt.

3-2) Demarcation of Sensitization Activities

Residents need to be sensitized on water fee payment and use of facilities. However, the contract does not mention who should conduct the sensitization activities. Especially for gravity type piped water schemes and handpump schemes, since willingness to pay water fees by residents is low, understanding of residents on management and fee collection is essential.

The results of our field surveys revealed that, in Gatsibo and Kayonza Districts, the staffs of private operators are conducting sensitization activities in addition to their allotted responsibilities. Actual activities are uncertain, but the director with other staffs of an enterprise in Gatsibo District has contacted umudugudu leaders to carry out sensitization activities together with public tap stand managers.

(2) Policy for Smooth Management by Private Operators

At the above 2 districts, a "Water Fund" as a bank account and a "District Water Board" to manage the account were established.

1) Water Fund

The district collects scheme use fees (15% of income) in accordance with contracts and manages them as a Water Fund to be used for large-scale and high level repairs of facilities they own. The water fund is supervised by the water board described below.

2) District Water Board

Members of the district water board mainly consist of the vice mayors in charge of economic affairs and social affairs, staff in charge of infrastructure, staff in charge of health, representative of beneficiaries and representative of the private sector. The board has the right to manage and use the water fund.

However, the water board in Gatsibo District was dissolved in 2009. The reasons for the dissolving are a lack of right for decision making, misunderstanding on the purpose of the board by members, and non-sharing on the objective of the water board. Presently, the water fund is managed directly by the infrastructure staff of Gatsibo District.

In Kayonza District, the first board meeting was held in February 2009, but thereafter, activities stopped. However, due to support from the Japanese technical cooperation project, the second meeting was held in September 2009 where water service providers reported their problems and the district responded on its concept for solving them. The technical cooperation project is conducting activities aiming to establish a reporting/communication system between the district and water service providers from a viewpoint of organization of operation and maintenance.

5.2 Consideration on Operation and Maintenance Cost

5.2.1 Composition of Operation and Maintenance Cost of Water Service Providers

Compositions of the operation and maintenance cost for each type of water service provider existing in Eastern Province are explained below.

(1) Management Costs

For WUAs, salaries are paid to the accountant, secretary, sanitation facilitator, pipe technicians, pump managers and guards, and the monthly amount is between 10,000 and 60,000Frw. For private operators, salaries are paid also to the president and vice-president, but the amount is within the same range as above. At the tap stands, 10 to 40% of water sales become the salaries of tap stand managers.

(2) Operation Costs

For pumped water schemes, to operate the pumps, power costs or fuel costs to run generators are added on as operation costs. In the case of generators, fuel costs as well as fuel transportation costs are generated. Operating pumps with generators needs about 40-70% of the scheme management cost. If commercial power is extended, the operation cost will be about 1/4 to 1/5 cheaper than fuel costs, which is about 20 to 40% of the management cost.

(3) Repair Costs

Most of the repair costs are costs for materials such as pumps, pipes, valves and taps. For old schemes and large scale schemes, along with operation costs, repair costs are the main expenses. At Gatsibo District, in line with privatization, costs to install meters for gravity schemes are being borne by private operators, but this can be considered as repair costs.

(4) Other Expenses

Other expenses include communication fees, motorcycle rental fees, fuel costs and office rental costs, but these are about 10% to 25% of the management cost.

5.2.2 Water Tariff Setting and Issues in Eastern Province

Water tariff settings in Eastern Province are deeply related to the type of water supply scheme. Tariffs for pumped schemes are set with volumetric (metered) rates and gravity and handpump schemes which are not installed with meters are flat rates. Also, for volumetric rates, the unit fee is per jerrican for public tap stands and units of m^3 for house connections. At public tap stands, tap stand managers are invoiced in m^3 the same as house connections and the difference between the sales amount per jerrican and the invoiced amount in m^3 becomes the salary. Therefore, the water fees at public tap stands are comparatively higher than fees for house connections[4].

Setting of unit water tariff is different between water service providers. Water tariff of RWASCO is decided by governmental regulation. Water tariff of private operators is decided by the district at the time of tendering. Water tariff of WUAs is set by the administration (district or secteur) of the service area, but since many are in deficit, cases are found where the administration permits an increase in tariff.

Water tariffs set by existing water service providers in Eastern Province are shown below.

Table 5-5 Water Tariff System of Existing Water Service Providers

Water Fee at Public Tap Stand	Water Service Provider		Scheme Type
5 Frw/jc	Rukira WUA (Ngoma District)		Gravity
10 Frw/jc	RWASCO		Pumped+Gravity
	COOGIEP (Rwamagana Disrict, contracted with RWASCO)		Pumped
	Kayonza District gravity schemes*		Gravity
	Gatsibo Districts gravity schemes*		Gravity
15 Frw/jc	AEP Bugesera (Bugesera District)		Pumped
20 Frw/ jc	Kayonza District pumped schemes*		Pumped
	Gatsibo District pumped schemes*		Pumped
	Karembo WUA (Ngoma District)		Pumped
25 Frw/ jc	Zaza WUA (Ngoma District)		Pumped
30 Frw/ jc	MKM WUA (Rwamagana District)		Pumped
	Kirehe-Kigina WUA (Kirehe District)		Pumped
40 Frw/jc	DERCO (Kayonza District)		Pumped
	Gatore 2 WUA (Kirehe District)		Pumped
Flat Rate (per year /household)	1,000Frw	Karama Secteur (Nyagatare District)	Gravity
	2,000Frw	Murama WUA (Ngoma District)	Handpump
		Kigarama WUA (Kirehe District)	Gravity
	3,600Frw	Kayonza District handpumps*	Handpump
		Gatsibo District handpumps*	Handpump

*Although these are uniform tariffs set after privatization, in actuality, due to problems in existing water schemes and insufficient sensitization activities, many schemes are facing financial difficulties.
Source: Partially revised from Accounting Manual of technical cooperation project

[4] The World bank WSP : Tariff Recommendation for the Rural Water Sector in Rwanda – Final Report (August 2009)

(1) Water Fee Collection and Payment Method

Although water fee collection and payment methods differ between scheme types and depend on availability of flow meters, the following methods were confirmed.

1) Billing and collection by meter reader (such as COOCIEP of Rwamagna District and Voma Meza of Kayonza District)

The meter reader checks the water flow meter, makes invoices to users (house connection users) and collects the fees. The 2 methods of collection are directly paying to the meter reader and the other is to transfer the amount into the designated bank account. The meter reader is either a staff of the water service provider or employed by the service provider. In the latter case, the salary of the meter reader is determined from the amount collected to act as incentive. Also, examples were confirmed where some meter readers were making simple repairs of pipelines.

2) Billing by technician and collection by accountant (such as CODEANGA of Gatsibo District and former MKM WUA of Rwamagana District)

When the pipe technician makes inspection patrol, he reads the meters and makes invoices. Then, later the accountant collects the fees from users. In this case, the pipe technician carries the billing book and after reading the meter, the original bill is given to the user and a copy is submitted to the accountant.

3) Billing and collection by accountant who is also meter reader (such as MKM WUA of Rwamagana District)

The above method 1) is carried out by the accountant. Usually, since there is only one accountant regardless of the scheme size, this is effective for small schemes with few users.

4) Billing and collection by tap stand manager or handpump manager (such as Murama handpump scheme WUA of Ngoma District and handpump scheme WUA of Nyagatare District)

For gravity schemes and handpump schemes where meters are not installed, the facility manager goes around to homes of users to collect fees. The collected fees are handed to the accountant and a salary in accordance with the collected amount is paid to the manager. For fee collection, sometimes cooperation from secteurs and cells is requested.

The survey confirmed that water service providers are making good use of the limited number of staff and equipment (such as motorbikes) to reduce expenses. Information on fee billing and collection methods is not shared with districts and other service providers. Comparisons and sharing of fee collection methods are needed to consider improvements.

(2) Issues on Operation and Maintenance Fee

Since water supply is a service having high public interests, the administration must be involved in determining the fee. On the other hand, the water fee needs to be set at a minimum for continuous operation of water supply facilities.

As shown in Table 5-5, the water fee system of water users' associations can be revised upon appealing to the district according to the cost necessary for operation and maintenance as well as financial situation of the association. On the other hand, in Kayonza and Gatsibo Districts where management is privatized, as a condition for tendering, the water fee set by the district must be complied with. In this case, rise in water fee due to changes in conditions of the water supply facilities are not considered giving cause for debts and non-payments.

(3) Issues for Water Fee Collection and Payment

In the case of installing meters in a gravity scheme to change over to a volumetric billing system, social problems are found where residents are refusing to pay fees caused by the lack of willingness for operation and maintenance.

At some public tapstands, incidents of running away with collected money or using up the money were observed. For tap stand managers to receive a stable amount of income and prevent embezzlement, proper operation and maintenance as well as a stable supply of water are important factors. Also, the weaknesses of social penalty for non-payment and facilities damage and their control are big issues and so support from the district, secteurs and cells is needed.

5.3 Operation and Maintenance Plan for Master Plan

5.3.1 Organizational System for Operation and Maintenance

Planning on operation and maintenance for the master plan is related to the national policy and strategy for water supply and sanitation services, and requires consideration of decentralization and PPP promotion.

However, not making a clear regulation in the national policy on the function of residents is an issue[5]. Continuous participation of community organizations in water supply provision such as users pay principle, activities for conservation of water supply facilities and water sources and improvement of sanitation environment is important for the success of rural water supply services. Therefore in this chapter, transition to using private operators and management focusing on community organizations from the construction stage of new schemes are to be planned. Also, issues clarified in 5.1 and 5.2 need to be considered.

[5] In "National Policy and Strategy for Water Supply and Sanitation Services, February 2010", Section 4.2.2 mentions that "User associations/ committees shall be involved in the oversight and shall have the role to represent consumer interests and user rights; their rights and obligations will be firmly established in the contractual and regulatory arrangements".

5.3.2 Main Stakeholders of Management (Organization and Structure)

Stakeholders for management of water supply schemes are as follows.

Table 5-6 Stakeholders for Water Supply Scheme Management

Level	Stakeholder	Function
Central	MININFRA	Overall project supervision and support
	MINISANTE	Support to districts which conduct sanitation improvement activities supervision
Target Area	Eastern Province	Overall supervision in province and coordination between districts
	District	Owner of water supply schemes and supervisor of water service provision
	Secteur	Coordination between water service providers, community organizations and users
	Cell	Coordination between water service providers, community organizations and users (sanitation promotion)
	Water Board	Supervision of the water fund.
	Water Service Provider	Operation of water supply schemes, water supply service provision and scheme management
	Community Organization	Mobilization support from the users' side and participatory promotion of water supply services
	User	Participation in water supply services based on users pay principle

5.3.3 Management Type and Allocation of Staff for Priority Project Sites

(1) Management Type

As a result of survey on the present state of management at the 10 priority project sites, either a water service provider exists, or a provider is planned to be established, and these service providers are expected to manage the schemes after construction. These are summarized below.

Table 5-7 Water Service Providers for Target Sites

Site	Scheme Type	New/Rehab/Ext	Expected Water Service Provider
PP01 Mushikiri	Pumped	New	Mushikiri WUA (Tentative)
PP02 Kigina	Pumped	New	Kigina/Kirehe WUA
PP03 Mukarange	Pumped	New Extension	Voma Meza Kayonza[6] (Private)
PP04 Rwimbogo	Handpump	Rehabilitation	EGT (Private)
PP05 Mahama	Gravity	Rehabilitation	Mahama WUA
PP06 Remera	Pumped	Rehab+New Ext	Enterprise Girmurava (Private)
PP07 Katabagemu	Gravity	New Extension	Umutara Construction Enterprise (Private)
PP08 Kageyo	Gravity	Rehabilitation	EGT (Private)
PP09 Rukira	Pumped	New	Rukira WUA
PP10 Gashanda	Pumped	Rehabilitation	Gashanda WUA

[6] Due to financial problems, the contract between this cooperative and the district was dissolved and a different cooperative COGEPRENA is managing the scheme since July 2010, but information is not yet available.

(2) Staff Allocation

Allocation of staffs is planned as follows.

1) For schemes planned for extension or rehabilitation of existing facilities, management will be conducted by existing water service providers. In this case, only staff required for management of the rehabilitation and extension portion is allocated.
2) Staffs proposed in this section are based on organizational structure after privatization. Therefore, even for schemes presently managed by WUAs, staff arrangement after privatization is assumed.
3) Tap stand managers (and handpump managers) are not included in the above staff structure.

Upon compiling the above conditions, allocations are as follows.

Table 5-8 Additional Staffs of Water Service Provider Required for Management of Target Sites

Expected Water Service Provider	Additional Recruit Staff						
	President	Vice President	Accountant/ Meter Reader	Sanitation Facilitator	Pump Technician	Plumber	Total
Mushikiri WUA (Tentative Name) 1)	1	1	1	1	1	1	6
Kigina/Kirehe WUA 2)	1	1	Exist	1	1	1	5
Voma Meza Kayonza (Private) 3)	Exist	Exist	Exist	1	1	1	3
EGT (Private) 4)	Exist	Exist	Exist	Exist	1	1	2
Mahama WUA	1	1	1	1	N/A	1	5
Enterprise Girmurava (private)	Exist	Exist	Exist	1	2	1	4
Umutara Construction Enterprise (Private)	Exist	Exist	Exist	1	N/A	1	2
Rukira WUA	1	1	1	1	1	1	6
Gashanda WUA	1	1	1	1	1	2	7

1) Does not include technicians for operation and maintenance of Japanese grant aid project
2) Presently, the 2 secteurs are managed jointly, but in the future, after separate management, existing members can be utilized.
3) Since information of new cooperative is not available, information of cooperative at time of survey is used.
4) Total for additionally recruited staffs of 2 schemes of Rwimbogo and Kageyo

5.3.4 Costs for Management, Operation and Maintenance

(1) Calculation Parameters and Conditions

The following parameters and conditions were applied for calculation of management, operation and maintenance costs. .

Table 5-9 Parameters and Conditions for Management Costs

Parameter	Unit	Unit Cost (Frw)	Conditions for Calculation (Actual Cost)	Annual Cost
1) Staff salaries/ personnel expenses	person/mon	40,000	31,363Frw (CODEANGA, average, includes temporary staffs), 37,333Frw (E.Girmurava, average, includes temporary staffs), 50,000Frw (MKM WUA)	480,000
2) Management expenses (transport fees, remunerations, communication fees, etc.)	person/mon	10,000	Calculated as 25% of 1) above, based on E.Girmurava and checked with the other 2 providers. CSR[7] not included	120,000
3) Generator fuel costs	(refer to Table 4-10)		Fuel cost 870Frw/lit (cost at end Sep. 2009, performance at 75% load)	
4) Fuel transport costs	200 lit/trip	30,000	Actual cost for MKM. Annual cost calculated from 3)	
5) Generator spare, oil exchange	1 time/gen/4mon	350,000	Since calculation of actual cost cannot be made, used cost of Basic Design Study 2004	1,050,000
6) Pump operation costs	Frw/kW/yr	10,000	Since no actual cost, used cost of Basic Design Study, 2004	300,000
7) Chlorination chemical	barrel	250,000	From 2005 cost (45kg Ca-HCl65%: 1mg/lit, as amount for 3 months)	1,000,000
8) Transmission pipe repair cost	m/yr	533	GSP D80, 80,000Frw(6m) All replacement after 25 years (half of Japan)	533
9) Distribution pipe repair cost	m/yr	175	2004 BD, uPVC/D90, 26,212Frw(6m) All replacement after 25 years (half of Japan)	175
10) Cleaning of receiving and distribution tanks	2times/tank/yr	9,600	CODEANGA, actual cost as average	9,600
11) Tap replacement (Talbot)	1 time/tap/3yr	23,114	Replacement once/3years, assumed from other existing schemes	23,114
12) Meter replacement	1time/meter./3yr	15,997	After 1 year, about 1/3 broken or damaged (MKM)	15,997
13) Float valve replacement	1time/valve/2yr	132,954	D100, replacement of packing in half of float valves in half year (MKM)	132,954
14) Valve replacement	1time/valve/5yr	18,191	No damage at MKM	18,191
15) Handpump rehabilitation	handpump	1,748,750	Assuming annual parts replacement, partial replacement after 5 years, complete replacement after 15 years	274,547

(2) Management Cost of Target Sites

Based on the above parameters and conditions, management costs in consideration of scheme type, scale, and staff number of each site are as follows.

[7] CSR=Caisse Sociale du Rwanda (Rwanda Social Insurance)

Table 5-10 Operation Cost of Generator

Site Name	Code No.	Supply Pop.(2015)	Water Demand per Day (m3)	Produced Water per Day (m3)	Capacity of Pump (m3/hr)	Operation Hours	Fuel Consp. Rate	Fuel amount consumed	Fuel Price (Sep 2009)	Fuel Fee			Fuel Transportation Fee	
						hr/day	lit/hr	lit/day	Frw/L	Frw/day	Frw/Month	Frw/Yr	Frw/Month	Frw/Yr
Mushikiri	PP01	11,559	231	254	36	7.1	19.3	136.3	870	118,612	3,607,792	43,293,505	613,512	7,464,397
Kigina	PP02	12,462	249	274	30	9.1	19.3	176.4	870	153,446	4,667,328	56,007,933	793,688	9,656,540
Remera1	PP06	15,220	304	335	16	20.9	19.3	403.4	870	350,945	10,674,566	128,094,792	1,815,231	22,085,309
Remera2	PP06	5,000	100	110	36	3.1	15.4	47.1	870	40,938	1,245,208	14,942,492	211,750	2,576,292
Rukira	PP09	9,750	195	215	30	7.2	19.3	138.0	870	120,056	3,651,693	43,820,312	620,978	7,555,226
Gashanda	PP10	15,179	304	334	30	11.1	19.3	214.8	870	186,905	5,685,030	68,220,361	966,751	11,762,131

Table 5-11 Estimated Operation and Maintenance Cost of Target Sites

Items	1-1) Salary for President, V.p. and Accountant	1-2) Salary for Technicians and H/S staff	2)Manage-ment expenses	3)Generator fuel costs	4)Fuel operation costs	5)Generator spare, oil exchange	6)Pump operation costs	7) Chlorination chemical	8)Transmission pipe repair cost	9)Distribution pipe repair cost	10) Cleaning of receiving and distribution tanks	11)Tap replacement (Talbot)	12)Meter replacement	13)Float valve replacement	14)Valve replacement	15)Handpump rehabilitation	Annual O/M Total Cost	Monthly O/M Total Cost	Daily O/M Total Cost
Unit Price per Year (1000Frw)	480	480	120	(Refer to Table 4-10)		1,050	300	1,000	1	0	10	23	16	133	18	275	1,000Frw	1,000Frw	Frw
PP01	3	3	6	LS	LS	1	2	1	1,057	9,610	2	100	25	3	19				
Mushikiri	1,440	1,440	720	43,294	7,464	1,050	600	1,000	564	1,679	19	2,311	400	399	346	0	62,726	5,227	171,852
PP02	2	3	5	LS	LS	1	2	1	2,456	14,640	2	104	26	3	35				
Kigina	960	1,440	600	56,008	9,657	1,050	600	1,000	1,310	2,558	19	2,404	416	399	637	0	79,057	6,588	216,595
PP03	0	3	3	LS	N/A	1	1	1	3,385	10,593	0	172	43	1	28				
Mukarange	0	1,440	360	17,903	0	1,050	300	1,000	1,805	1,851	0	3,976	688	133	509	0	31,016	2,585	84,974
PP04	0	1	1	N/A	N/A	0	0	0	0	0	0	0	0	0	0	4			
Rwimbogo	0	480	120			0	0	0	0	0	0	0	0	0	0	1,098	1,698	142	4,653
PP05	3	2	5	N/A	N/A	0	0	1	6,650	19,911	1	156	39	1	53				
Mahama	1,440	960	600			0	0	1,000	3,547	3,479	10	3,606	624	133	964	0	16,362	1,364	44,829
PP06	0	4	4	LS	LS	2	4	1	1,894	21,185	2	128	32	8	55				
Remera	0	1,920	480	143,037	24,662	2,100	910	1,000	1,010	3,702	19	2,959	512	1,064	1,001	0	184,375	15,365	505,137
PP07	0	2	2	N/A	N/A	0	0	1	20,000	17,550	0	172	43	5	41				
Katabagemu	0	960	240			0	0	1,000	10,667	3,067	0	3,976	688	665	746	0	22,008	1,834	60,295
PP08	0	1	1	N/A	N/A	0	0	1	510	10,767	1	112	28	3	23				
Kageyo	0	480	120			0	0	1,000	272	1,881	10	2,589	448	399	418	0	7,617	635	20,869
PP09	3	3	6	LS	LS	1	2	1	832	17,014	1	84	21	3	38				
Rukira	1,440	1,440	720	43,820	7,555	1,050	600	1,000	444	2,973	10	1,942	336	399	691	0	64,420	5,368	176,492
PP10	3	4	7	LS	LS	1	2	1	2,659	22,830	2	128	32	12	58				
Gashanda	1,440	1,920	840	68,220	11,762	1,050	740	1,000	1,418	3,989	19	2,959	512	1,595	1,055	0	98,520	8,210	269,919

N.B.: Shaded boxes are non-applicable items

5.4 Setting Water Tariff

5.4.1 Consideration on Facilities Use Fee

Presently, in areas where districts are carrying out management through private operators, districts are collecting 15% as facilities use fee from water service providers. However, for pumped schemes requiring fuel costs and electricity bills, the 15% fee is a large burden and is a cause for degenerating the balance. Therefore, to consider this problem, the priority projects are used as examples. Assuming 25 years amortization of construction investment costs deducting the facilities repair costs included in the operation and maintenance costs calculated in Table 5-11, the daily amortization costs (see Table 5-12) as being equivalent to facilities use fees (since in actuality, the facilities use fee placed in the water fund is different) are calculated as shown in Table 5-13. The ratios of facilities use fees within the total operation and maintenance costs is between 5.4% and 34.6%, but those for gravity schemes are over 10%, showing higher ratios. This is due to the non-necessity of including fuel costs into water tariffs and since water tariffs become lower, ratios of facilities use fees become conversely higher.

Table 5-12 Amortization Costs of Water Schemes

Scheme	Project Cost (1000Frw)	To be Deducted (1000Frw)				Deducted Total (Frw)	Daily Amortization (Frw)
		Preparatory Works	Distribution Pipes	Public Tap Stand	Transmission Pipes		
PP01 Mushikiri	303,285	27,571	67,270	40,875	25,368	142,201,000	15,583.7
PP02 Kigina	403,796	36,709	106,300	42,510	58,944	159,333,000	17,461.2
PP03 Mukarange	132,316	–	–	–	–	–	–
PP04 Rwimbogo	26,554	–	–	–	–	–	–
PP05 Mahama	399,774	36,343	139,377	63,765	73,150	87,139,000	9,549.5
PP06 Remera	589,387	53,581	170,151	52,320	45,456	267,879,000	29,356.6
PP07 Katabagemu	168,311	–	–	–	–	–	–
PP08 Kageyo	276,326	25,121	75,369	45,780	5,610	124,446,000	13,637.9
PP09 Rukira	382,919	34,811	119,098	34,335	19,968	174,707,000	19,146.0
PP10 Gashanda	514,820	46,802	172,490	52,320	63,816	179,392,000	19,659.4

Table 5-13 Ratio of Facilities Use Fee of Priority Projects

Scheme	Scheme Type	Pop.	Supply Rate (l/d)	Daily O&M Cost (Frw)	Daily Facilities Amortization Cost (Frw)	Total Cost	Water Tariff		Facilities Use Fee Ratio
		A	B=Ax①x (1-(②+③))	C (Tab.5-11)	D (Tab. 5-12)	E=C＋D	Frw/lit F=E/B	Frw/jc G=Fx20	F=D/E
PP01 Mushikiri	Pumped (Diesel)	11,559	184,944	171,852	15,583.7	187,435.7	1.0	20	8.3%
PP02 Kigina	Pumped (Diesel)	12,462	199,392	216,595	17,461.2	234,056.2	1.2	24	7.5%
PP03 Mukarange	Pumped (Elect.)	20,335	325,360	91,550	－	－	－	－	－
PP04 Rwimbogo	Handpump	1,348	21,568	7,940	－	－	－	－	－
PP05 Mahama	Gravity	18,450	295,200	44,829	9,549.5	54,378.5	0.2	4	17.6%
PP06 Remera	Pumped (Diesel)	15,220	243,520	510,068	29,356.6	539,424.6	2.2	44	5.4%
PP07 Katabagemu	Gravity	20,507	328,112	65,226	－	－	－	－	－
PP08 Kageyo	Gravity	13,085	209,360	25,800	13,637.9	39,437.9	0.2	4	34.6%
PP09 Rukira	Grav+P(Diesel)	9,750	156,000	176,492	19,146.0	195,638.0	1.3	26	9.8%
PP10 Gashanda	Pumped (Diesel)	15,179	242,864	269,919	19,659.4	289,578.4	1.2	24	6.8%

① Unit supply rate: 20 lcd, ② Public tap manager allowance: 10%, ③ Unaccounted-for water rate: 10%
PP03 Mukarange and PP07 Katabagemu are pipeline extensions only.
Since PP04 Rwimbogo is a handpump scheme and applies a flat rate, water fees are collected monthly per household.

Since gravity schemes and pumped schemes are combined in the private operator tender lots, ratios of facilities use fees need to be uniform for all schemes, rather than setting them for each scheme type. For example, if the water fee is assumed to be 10Frw/jc for gravity schemes and 30Frw/jc for pumped schemes, then the facilities use fee necessary for renewal of all master plan schemes to be saved in the water fund becomes less than 10%.

5.4.2 Calculation of Water Tariffs

Establishment methods for water tariffs are based on the following preconditions.

1) Cost to cover the management costs (operation and maintenance costs and amortization costs) calculated in 5.3.4 will be set
2) Facilities use fee to the district is set as 10% of water fee income
3) Allowance to public tap stand managers is 10% of water fee income (present salary system of privatized schemes)
4) Unaccounted-for water rate is 10% (present situation of existing schemes)

Water tariffs per jerrican were calculated in Table 5-13, but when payment is actually made, since the minimum coin unit in circulation in rural areas is 5Frw, water tariffs were set as shown in the table below and the facilities use fee ratios for these tariffs are also shown in the table. If diesel generators are used for pumped schemes, the tariff can be between 20 and 30 Frw for most of the sites, but only for PP06 Remera, it is 45 Frw. However, if commercial power is used for PP06 Remera, the water tariff can be set as 20 Frw, and therefore, changing over to commercial power is recommended. However, during the transitional period, calculate the operation and maintenance cost for the scheme and reflect it into the water fee, and receive understanding by the residents through sanitation promotion activities.

Table 5-14 Set Water Tariff

Scheme	Scheme Type	Water Tariff (Frw/jc)		Facilities Use Fee Ratio
		Calculated	Set	
PP01 Mushikiri	Pumped (diesel)	20	20	8.4%
PP02 Kigina	Pumped (diesel)	23	25	7.0%
PP05 Mahama	Gravity	4	10	6.5%
PP06 Remera	Pumped (diesel)	44	45	5.4%
PP08 Kageyo	Gravity	4	15	8.7%
PP09 Rukira	Gravity+Pumped (die)	26	30	8.2%
PP10 Gashanda	Pumped (diesel)	24	25	6.5%

5.5 Consideration on Management System using Private Operators

(1) Transition of Management from Water Users Associations to Private Operators

After successive completion of water scheme constructions following the master plan implementation schedule (Table 2-12) and following the procedure of Table 5-15, districts must evaluate the performance of water users' associations to transfer over to management by private operators. However, for newly constructed schemes, first, community organizations need to be formed and during the establishment of the organizations, consideration is necessary to create willingness to participate in water services to aim for formation of a smooth management system. For areas with existing water schemes, strengthening of the existing organizations is required.

Table 5-15 System Establishment by Districts for Management by Private Operators

Existing Water Scheme (Management by WUA)	New Construction Scheduled
1. Strengthen management capacity of WUA 2. Evaluate management capacity (about 1 year after completion) Good management⇒Transform into cooperative 【Direct contracting】 Poor management⇒Dissolve WUA*[1] (Remain as community representative organization) ⇒ 【Prepare tendering for management contracting】	1. Form community organization 2. Establish WUA 3. Strengthen WUA 4. Evaluate management capacity (about 1 year after establishment) Good management⇒Transform into cooperative 【Direct contracting】 Poor management⇒Dissolve WUA*[1] (Remain as community representative organization) ⇒ 【Prepare tendering for management contracting】
5. Carry out tendering and contract with private operator to start management of water service provision	

*[1] Minus assets (unpaid salaries and unpaid fuel bills) are left as debts to be paid by water fund after contracting with private operator.

Furthermore, along with the above procedure, districts need to form water funds to supervise and support private water service provision, and collect facilities use fees from private operators to be used for facilities rehabilitation. As the organization to manage and supervise the water fund, a water board composed of staffs from districts and secteurs, representatives from private operators and other stakeholders must be established.

When entrusting management to private operators, contracts which include the following must be concluded between the district and private operators.

1) Water tariff agreed by both parties
2) Facilities use fee agreed by both parties
3) Demarcation of costs for large-scale repairs between district and private operator

Moreover, since the present contract term is short, private operators are reluctant to invest in the water supply schemes. Therefore, the first contract period can be set for 1 to 2 years, but at the time of contract renewal, if the district determines that the private operator is conducting proper management, then the period of the second term should be extended to a longer term in consideration of investment possibilities.

Demarcation of responsibilities between the district and water service providers is as follows.

Table 5-16 Allocation of Responsibilities between Water Service Provider and District (Water Fund)

Responsibilities of Water Service Provider	Responsibilities of District (Water Fund)
Personnel expenses Management costs Generator fuel costs and operation costs Repairs costs for motorized pumps and generators Repair costs for taps, valves and flow meters (materials included) Leakage repair costs for transmission and distribution pipelines Handpump repair and replacement costs	Replacement costs for motorized pumps and generators Distribution pipeline extension costs Rehabilitation and reconstruction costs of structures (such as pump houses and tanks) Tap stand extension costs Repayment of WUA debts

(2) Management using Private Operators as Main Service Providers

After contracting with private operators, they are able to handle management by themselves and the organization is expected to be basically more strengthened than WUAs. However, responsibilities for explanation to beneficiaries and transparency are not assured, and considerations for the local vulnerable as well as communication with administration are not carried out.

Therefore, trainings on the following activities are required for private operators.

1) Reporting on Annual Activities Plan, Budget, Mid-Term Account Balance, Year-End Account Balance of Water Service Providers and Explanation to Users

Presently, this information is provided only to the representatives and staffs or members of the private service providers, and is not obligated to districts and secteurs. Since water supply is a highly public service, the service provision activities need to be widely reported to not only the administration, but to the general users as well. In the presently on-going technical cooperation project, establishment of a system for reporting and communication is being supported through the use of report formats and proposal on its dissemination.

2) Preparation of Annual Operation and Maintenance Plan and Activities Plan

Since the present private operators are not preparing annual plans for operation and maintenance, they handle repairs spontaneously. Also, some schemes are discontinued due to poor operation and maintenance. Furthermore, for many piped schemes, daily operational records of pumps are not taken. Therefore, records, especially operational records and leakage records as well as repair records need to be prepared and monthly reports on operation and maintenance activities are needed. Through determination on the conditions of facilities based on these reports, annual plans must be prepared. The annual operation and maintenance plans prepared by each private operator should be discussed with the water board.

3) Establishment of Collaboration System with Water Supply Zone Administration

In order to conduct sanitation promotion activities and discuss measures for vandalism with residents, a communication system between the private operators and secteurs/cells/local police needs to be established. As a concrete example, private operators should participate in local meetings held at the secteurs.

4) Acquisition of Legal Status as Private Water Service Provider

Presently, most of the private operators are acknowledged as water service providers by the responsible district, but are not registered as cooperatives or enterprises. Therefore, these service providers need to be legally registered as final objective for organizational strengthening.

The above activities should be realized by the water board supported by donors and NGOs, through the water fund or district budget, by preparing and executing a plan for training of private operators. For these trainings, manuals and guidelines prepared by the Japanese grant aid projects and technical cooperation project should be utilized. The province and central government should support the districts and establish an information sharing system. Also, coordination with RWASCO for allocation of service provision is needed.

CHAPTER 6 PROJECT EVALUATION

6.1 Financial and Economic Evaluations of Master Plan

6.1.1 Issues Related to Water Supply Service

Water supply service in rural areas, the object of this development study, has two different characteristics: one is a human development aspect of supplying safe water to all people and the other is a business aspect of water service management through water tariff collection. The human development side especially needs to be deeply considered to understand the results of analyses based on monetary value.

GoR sets the goal in VISION 2020 based on MDGs of supplying safe water for all in 2020, which has the above two characteristics. On the other hand, the National Policy and Strategy for Water Supply and Sanitation Services, enacted in March 2010, prescribes cost bearing by water users at local level and promotion of PPP (public private partnership) of water facilities management.

In Rwanda, water is regarded as a business commodity targeted to the BOP[1]. Therefore, private operators entrusted with management of water supply schemes in the PPP framework need to run their business at least always in the black. Although profits must exceed costs, in the low income countries such as Rwanda[2], affordability to pay (ATP) of residents often exceeds costs, but the results of the social-economic survey indicate that households which can purchase 20 liters/capita/day (lcd) of water are few.

To relive this predicament, efforts are needed by both water service providers and administration to fix water tariff at an amount that poor people can afford to buy. Based on this discussion, this section starts with the examination of water tariff that poor inhabitants can afford to pay and then explain the financial and economic evaluations if private operators manage water supply services.

6.1.2 Preconditions for Financial and Economic Analyses

Financial and economic analyses are evaluation methods of development projects by comparing cost and benefit and appraising them from a monetary point of view. In this study, financial evaluation is analyzed using market price and indicates whether the concerned project is desirable especially for the project owner. Also, economic evaluation is analyzed, using the economic cost, by how much the concerned project can generate beneficial effects at national or local levels.

The Master Plan was evaluated under the following preconditions.

① Target projects of the evaluation composes of 77 schemes (including 6 handpump sites

[1] Base of pyramid: the people whose daily income is below 2 US Dollars who have not been considered as the target of business.
[2] Classification by The World Bank, 2009

attached to piped schemes) described in Table 2-11 "Master Plan Implementation Plan" in Chapter 2. Expansion plan for priority projects is also included in the master plan, but this will be handled as a part of the priority projects.

② Costs are calculated applying the market price as of September 2009 in Rwandan Franc (Frw).

③ Operation and maintenance (O&M) costs are average values based on O&M costs of priority projects listed in Table 5-11 (Chapter 5) for each scheme type of pumped, gravity and handpump. For each type, calculations were made from O&M costs and average design water supply rates of each water scheme. As for handpump schemes, average O&M cost for one handpump of the priority project is used.

④ Benefits are estimated by using 2020 design populations for each scheme described in Table 2-8, and adding cash income of each district to cost of self-sustenance products of 350 Frw/pers/day (source: Implementation Review Study Report on the Project for Rural Water Supply in the Republic of Rwanda, JICA, March 2010). For handpump schemes, average population size per handpump in the priority project is applied to the service population. For piped schemes, the service population of the handpump scheme is subtracted from the entire district service population; then, the result is divided proportionally according to the design water supply rate of each scheme.

⑤ As project component, the project active lifespan is set at 25 years in consideration of the actual service life of main materials (transmission pipes: steel pipes) in projects implemented in African countries. However, it is set at 15 years for handpump schemes due to the service life of handpumps. Also, benefit and operation and maintenance cost are expected to generate from the next year after completion of construction.

⑥ Costs are converted into economic project costs to be used for economic analysis by applying the standard conversion factor of 0.70, which was calculated by the market price and border price of important materials to be used for the project[3].

⑦ A rate of 5% of facilities renewal cost is applied as physical contingency, which is the reserve for increase in project cost preparing for changes in design or specifications during the project period. Also, for price contingency, which is the reserve for change in project cost due to consumer price change during the project period, the rate of 1.3% is applied. This rate is calculated by "average consumer price fluctuation rate – average foreign currency exchange fluctuation rate" based on both the average consumer price increase rate in recent three years in Rwanda as 9.2% per year[4], and the exchange fluctuation rate between Japanese Yen and Rwandan Franc of 7.9%[5]. The discount rate of 12% is used for Net Present Value (NPV) analysis which is the rate that the "Transport Sector Development Project" of the World Bank (2007) used.

⑧ With regards to the "without project case" for the economic analysis, such situation is assumed when inhabitants living in project sites continue to use the presently used water sources.

Costs and benefits of each Master Plan scheme are summarized in Table 6-1.

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[3] In a strict sense, standard conversion factor (SCF) is calculated from the total price of principal import goods, principal export goods, weighted average of import/export tariff rates and weighted average of export subsidies. However, it is generally difficult to acquire these statistical data. The Asian Development Bank adopts a calculation method using total of export/import goods prices and tariff rates. In Rwanda, however, it is also difficult to acquire these data; therefore, 30% of the import tax rate is adopted as a more convenient calculation method and the SCF is set at 70% of the market price as the border price.

[4] Source: Monthly consumer price fluctuation rate from January 2006 to August 2009, NISR

[5] Source: JICA foreign currency exchange table.

Table 6- 1 Costs and Benefits of Master Plan Schemes

No.	District	Master Plan code	Project cost 1000Frw	O&M cost estimate 1000Frw/year	Benefit estimate 1000Frw/year	Remark
1	Nyagatare	NyPs01	341,906	42,624	31,218	
2		NyPs02	695,820	64,410	47,173	
3		NyPs03	492,947	27,280	19,979	
4		NyPs04	78,904	3,647	2,671	
5		NyPs05	163,892	10,088	7,388	
6		NyPs06	255,445	17,571	12,869	PP07
7		NyPs07	114,880	68,684	8,845	
8		NyPs08	194,582	98,851	12,730	
9		NyPs09	945,915	49,586	36,316	
10		NyHp01	3,459	692	382	HP*
11		NyHp02	3,459	692	382	HP*
12		NyHp03	8,649	1,698	937	HP
13		NyHp04	5,189	1,006	555	HP
14		NyHp05	22,488	4,465	2,463	HP
15		NyHp06	1,729	314	173	HP*
16	Gatsibo	GaPs01	134,531	147,345	24,616	PP06
17		GaPs01 A	321,226	7,260	6,885	
18		GaPs02	191,077	20,412	19,396	
19		GaPs03	116,412	9,093	8,640	
20		GaPs04	641,785	18,376	17,461	
21		GaPs05	162,710	14,066	13,366	PP08
22		GaPs06	148,307	7,057	6,705	
23		GaPs07	772,147	58,774	55,848	
24		GaPs08	136,329	55,486	9,270	
25		GaPs09	249,674	18,139	17,236	
26		GaPs10	1,648,698	317,563	53,058	
27		GaHp01	1,729	440	315	HP*
28		GaHp02	6,919	1,698	1,215	HP, PP04
29	Kayonza	KaPs01	309,480	112,588	55,728	
30		KaPs02	20,665	1,373	3,866	
31		KaPs03	210,896	73,802	36,530	
32		KaPs04	149,249	51,715	25,597	
33		KaPs05	61,307	3,884	10,932	
34		KaPs06	107,673	20,740	10,266	
35		KaPs07	130,501	89,424	44,262	
36		KaPs08	217,163	126,864	62,794	PP03
37		KaPs10	204,583	36,093	17,865	
38		KaPs11	239,731	154,068	76,259	
39		KaPs12	46,698	2,693	1,333	
40		KaPs13	231,069	90,501	44,796	
41		KaPs14	166,706	18,897	53,195	
42		KaPs15	395,896	157,839	78,126	
43		KaPs16	283,964	15,724	44,262	
44		KaHp01	1,729	440	933	HP*
45		KaHp02	6,919	1,698	3,600	HP
46		KaHp03	1,729	440	933	HP*

47	Rwamagana	RwPs01	351,128	209,285	139,841	
48		RwPs02	239,747	201,743	134,802	
49		RwPs03	665,831	310,946	286,881	
50		RwPs04	297,989	103,969	69,470	
51	Ngoma	NgPs01	254,483	39,056	17,400	PP10
52		NgPs02	193,491	29,898	13,320	
53		NgPs03	81,543	2,747	6,960	
54		NgPs04	67,717	15,622	6,960	
55		NgPs05	390,901	186,929	83,280	
56		NgPs08	313,663	89,693	39,960	
57		NgPs09	80,139	11,582	5,160	
58		NgPs11	297,676	10,277	26,040	
59		NgPs12	61,043	1,800	4,560	
60		NgPs13	210,489	16,971	10,440	PP09
61		NgPs14	112,953	14,276	6,360	
62		NgPs15	278,565	51,984	23,160	
63		NgPs16	57,235	8,193	20,760	
64	Kirehe	KiPs02	216,349	99,659	44,400	
65		KiPs04	132,385	33,669	15,000	
66		KiPs05	298,495	11,603	29,400	
67		KiPs06	109,006	4,783	12,120	
68		KiPs07	91,060	4,073	10,320	
69		KiPs08	238,625	75,149	33,480	
70		KiPs12	228,885	77,573	34,560	PP02
71		KiPs13	346,623	14,350	36,360	PP05
72		KiPs14	143,435	45,062	27,720	
73		KiPs15	134,984	45,062	27,720	
74		KiPs16	110,740	5,920	15,000	
75		KiPs17	162,977	9,093	23,040	
76		KiPs19	184,444	64,644	28,800	PP01
77		KiPs20	42,536	1,800	4,560	
78		KiPs21	53,026	7,530	19,080	
79		KiPs22	157,958	10,230	25,920	
80		KiPs23	139,137	24,511	10,920	
81		KiPs24	113,071	18,046	8,040	
82		KiPs25	129,585	35,015	15,600	
83	Bugesera	BuPs01	2,550,997	932,758	593,710	
計			20,185,677	4,851,602	2,900,471	

Note: PP01 – PP10 refer to priority project sites, HP = handpump sites, HP* = handpump sites attached to piped schemes. The number of schemes for master plan implementation is 77 because there are 6 schemes of handpump- piped scheme combined projects.

6.1.3 Financial Evaluation

Due to different project life spans, the 83 master plan schemes (72 piped schemes + 11 handpump schemes) are divided into piped scheme (25 years life span including construction completion year) and handpump schemes (15 years life span including construction completion year) for evaluation. After calculation of the cash flow of each scheme by financial cost, Financial Internal Rate of Return (FIRR) and Net Present Value (NPV) were calculated based on the cash flow. The results are shown in Table 6-2. Then, in addition to the basic case, sensitivity analyses[6] were made according to several conditions.

Table 6- 2 (1) FIRR and NPV（Piped Schemes）

	Basic case	Sensitivity analysis	
		O&M cost -50%	Project cost -20%, O&M cost -60%
Benefit/Cost ratio	0.478	0.834	1.042
FIRR	minus	minus	Minimum value
NPV per capita (1000Frw)	-14.71	-7.12	-3.97

Table 6- 2 (2) FIRR and NPV（Handpump Schemes）

	Basic case-	Sensitivity analysis	
		O&M cost -50%	Project cost -10%, O&M cost -50%
Benefit/Cost ratio	0.616	0.983	1.025
FIRR	minus	-0.6%	0.9%
NPV per capita (1000Frw)	-3.91	-1.51	-1.17

As these tables show, cost exceeds benefit and FIRR and NPV are negative in both piped schemes and handpump schemes for the basic case. Cost and benefit are approximately the same amount for piped schemes when project cost is reduced by 20% and O&M cost is reduced by 60%. For handpump schemes, cost and benefit is almost the same amount when project cost is reduced by 10% and O&M cost is reduced by 50%. The results indicate that project implementation needs to consider and employ means of reduction in cost, especially O&M cost, in order for the master plan project to be realized[7].

[6] Sensitivity analysis is an examination method to determine the degree of effect produced by changes in project preconditions on the project profitability. Certain fluctuations above and below the expected value (basic conditions applied at the project planning stage), meaning optimistic case and pessimistic case, are applied on important factors which influence project costs and benefits, in order to measure their effects on the indices of financial and economic evaluation. (Source: JICA "Study on Economic Evaluation Method for Development Study, General Aspect"

[7] With regard to cost reduction, refer to "6.2.4 Summary of financial and economic evaluations and recommendations"

6.1.4 Economic Evaluation

Cash flows of master plan schemes were made from economic costs and then economic internal rate of return (EIRR) and NPV were calculated using the cash flow data. In addition to the basic case, sensitivity analyses were conducted for some cases through increase and decrease of important factors. The results are shown in Table 6-3.

Table 6-3 (1) EIRR and NPV（Piped Schemes）

	Basic case	Sensitivity analysis	
		Project cost -10%, O&M cost -10%	O&M cost -50%
Benefit/Cost ratio	0.931	1.035	1.554
EIRR	minus	Minimum value	9.8%
NPV per capita (1000Frw)	-4.23	-2.97	-0.66

Table 6-3 (2) EIRR and NPV（Handpump Schemes）

	Basic case	Sensitivity analysis	
		O&M cost +10%	O&M cost -10%
Benefit/Cost ratio	1.150	1.077	1.233
EIRR	5.4%	3.1%	7.6%
NPV per capita (1000Frw)	-0.39	-0.62	-0.16

Economic benefit is lower than cost and both EIRR and NPV are negative for piped schemes. However, by reducing project cost and O&M cost at the same time, benefit/cost ratio is improved and cost and benefit are almost the same amount if both project cost and O&M cost are reduced by 10%. Also, under this condition, EIRR is also positive even though it is the minimum value. If O&M cost is reduced by 50%, EIRR goes up to 9.8%, which means the project has effect on local economy. For handpump schemes, benefit exceeds cost and EIRR shows a positive number even in the basic case, which means the project again, has effect on local economy. However, NPV is negative in all cases for piped schemes and handpump schemes, which means that consumer price increase denies economic effect.

Consequently, piped schemes have economic effect by reducing cost, especially O&M cost on the local economy, while handpump schemes have economic effect even in the basic case.

6.2 Financial and Economic Evaluation of Priority Projects

6.2.1 Preconditions for Evaluation

In addition to preconditions used for evaluation of the master plan, the following preconditions are used for the 10 priority projects.

⑨ Priority project water demand for 2015 is predicted by applying population growth as explained in Section 2.3.1 of Chapter2. Thus, the 2015 predicted design population is applied as the beneficiary population.
⑩ The design O&M cost is analyzed based on the scheme management cost (Table 5-11) required when all inhabitants buy the design water supply rate (20 liters per capita per day).
⑪ On the assumption that the project will be implemented by the Japanese grant aid scheme or assistance of other donors, recovery of initial investments is not considered.
⑫ As reserve for future facilities renewal[8], "the amount of money for facilities repairs included in the O&M cost is subtracted from the depreciation cost when the scheme project cost is depreciated in 25 years", described as the basis for facilities renewal in Chapter 5, is used. Facilities renewal cost is assumed to be needed after 10 years, 15 years and 20 years from completion of the construction works. However, since PP03 Mukarange and PP07 Katabagemu are extension of existing facilities only, renewal cost is set at zero.
⑬ As reserve for unaccounted-for water cost, the rate for unaccounted-for water is set at 5% for the first 10 years and 10% for the next 15 years, and 5% and 10% of fuel costs (including costs for fuel transport, generator spare parts and oil exchange) are applied.
⑭ As for physical contingency, by limiting to large scale repairs and rehabilitation works, 5% of facilities renewal cost is used.

Table 6-4 shows the basic information used for analysis. As for results of the social survey used for the analysis, refer to Annex-4.

Table 6-4 Basic Information of Priority Projects

Site	Scheme Type	Service population 2015 prediction	Unit income (Frw/cap/day)	ATP (Frwlcd)	Required amount (Frw/lcd	Set water tariff (lcd)
PP01 Mushikiri	Pumped scheme	11,559	397	20	19	20
PP02 Kigina	Pumped scheme	12,462	439	22	22	20
PP03 Mukarange	Extension of pumped scheme	20,335	448	22	5	10
PP04 Rwimbogo	Handpump scheme	1,348	419	21	7	10
PP05 Mahama	Gravity scheme	18,450	435	22	3	5
PP06 Remera	Pumped scheme	15,220	383	19	40	15
PP07 Katabagemu	Extension of gravity scheme	20,507	478	24	4	5
PP08 Kageyo	Gravity scheme	13,085	520	26	3	5
PP09 Rukira	Pumped scheme	9,750	410	21	23	20
PP10 Gashanda	Pumped scheme	15,179	436	22	22	20

N.B.: Unit incomes were calculated by adding 350 Frw/pers/day (cost of self-sustenance products) to cash incomes from results of the socio-economic survey

[8] Though facilities renewal cost is fixed at 10% of water sales in Chapter 5, in reality it varies between schemes and sometimes much different from the amount equivalent to 10% of sales. Thus, the direct estimate amount is used for the evaluation in this chapter.

6.2.2 Economic Analysis

(1) Economic Cost of Priority Projects

Projects for rural water supply, the target of this study, do not generally aim at monetary profit but at human development by supplying a stable amount of safe water. Therefore, investment does not expect an effect in numerical value at national economy level in water supply projects in poor areas, even though the effect on increase of human development standard of Rwanda is expected. O&M cost of each priority project was converted to economic cost by applying the standard conversion factor of 0.70 to domestic prices (Rwandan market prices). Price contingency, taxes and public charges, and other market expenses are excluded from the economic cost.

Table 6-5 summarizes the economic costs of priority projects in the case that all O&M costs are covered by the water tariff.

Table 6-5 Economic Costs of Priority Projects

Unit: 1000 Frw

Site	1. Project cost[9]	2. O&M cost	3. Physical contingency	Total
PP01 Mushikiri	0	956,632	3,724	960,357
PP02 Kigina	0	1,204,651	4,055	1,208,706
PP03 Mukarange	0	479,586	0	479,586
PP04 Rwimbogo	0	25,330	137	25,467
PP05 Mahama	0	247,949	1,827	249,777
PP06 Remera	0	2,699,499	7,947	2,707,446
PP07 Katabagemu	0	360,770	0	360,770
PP08 Kageyo	0	126,178	3,532	129,710
PP09 Rukira	0	984,752	5,221	989,973
PP10 Gashanda	0	1,500,693	4,729	1,505,422

(2) Economic Benefit

Economic benefit is set at the incremental amount of payment for 'with project case' in comparison with the amount for 'without project case.' Because all inhabitants living in the priority project sites except a few households use water of rivers, marshlands or natural springs, all of which are free of charge, incremental benefits when the service population purchase 20 lcd are calculated by multiplying water value by the standard conversion factor.

Cost benefit analysis is conducted adopting this economic cost and benefit, and NPV is calculated. Table 6-6 shows the NPV of each site.

[9] As Japanese grant aid project or assistance of other donor agencies is expected for implementation of priority projects, project costs are set at zero. However, since the Rwandan side will also share several activities during the implementation stage as shown in Chapter 8, costs will be generated.

Table 6-6 NPV from Economic Cost

Site	Cost A	Benefit B	Net Benefit B-A	NPV	Per capita NPV
PP01 Mushikiri	960,357	1,413,717	453,360	145,773	12.6
PP02 Kigina	1,208,706	1,524,081	315,375	109,897	8.8
PP03 Mukarange	479,586	1,243,517	763,930	227,749	11.2
PP04 Rwimbogo	25,467	47,988	22,522	11,407	8.5
PP05 Mahama	249,777	564,125	314,349	94,539	5.1
PP06 Remera	2,707,446	1,396,023	-1,311,424	-335,515	-22.0
PP07 Katabagemu	360,770	627,005	266,235	82,413	4.0
PP08 Kageyo	129,710	400,078	270,368	79,976	6.1
PP09 Rukira	989,973	1,192,436	202,463	73,914	7.6
PP10 Gashanda	1,695,186	1,856,403	161,216	73,098	4.8

As a result of the above, for sites other than PP06 Remera, NPVs from financial cost are positive. Due to topographical conditions (severe height differences) of PP06 Remerea, a booster station is needed which increases the burden on fuel costs and raises the operation and maintenance cost. However, since economic benefits can be obtained for the other 9 sites, implementation of the priority projects can contribute to rural economy.

6.2.3 Financial Analysis

Financial incomes and expenditures used for the evaluation are shown in Table 6-7. NPVs were calculated if all O&M costs are covered by water tariffs. As water tariff to determine benefits, NPVs were calculated for cases when operation and maintenance costs can be covered by the water tariff.[10]

Table 6-7 Financial Expenditures of Priority Projects

Unit: 1000 Frw

Site	1. Project cost	2. O&M cost	3. Tax & public charges	4. Physical contingency	5. Price contingency	Total
PP01 Mushikiri	0	1,366,618	506,682	5,321	93,931	1,972,551
PP02 Kigina	0	1,720,930	512,686	5,793	111,970	2,351,379
PP03 Mukarange	0	723,381	195,750	0	45,957	965,087
PP04 Rwimbogo	0	36,185	8,223	196	2,230	46,834
PP05 Mahama	0	354,214	79,930	2,610	21,838	458,591
PP06 Remera	0	3,856,427	1,178,612	11,353	252,320	5,298,712
PP07 Katabagemu	0	515,386	113,134	0	31,426	659,946
PP08 Kageyo	0	173,169	42,218	5,046	11,022	231,454
PP09 Rukira	0	1,406,788	377,933	7,458	89,609	1,881,789
PP10 Gashanda	0	2,143,847	573,469	6,756	136,204	2,860,276

Cost benefit analysis was carried out using the above project costs, O&M costs and benefits, and NPV was calculated as Table 6-8 shows. This shows that, if all costs for operation, salary of tap manger, reserve for renewal and reserve for unaccounted-for water (only for pumped schemes) are covered by the water tariff, then ATP is equivalent to the maximum sales amount

[10] However, at the stage of implementation, since residents will buy water at the ATP of their household economy regardless of the water tariff setting, considerations are needed when formulated the plan.

and sales is in the black for gravity schemes, handpump schemes and Mushikir pumped scheme as well as extension scheme of Mukarange. At these sites, even if management relies on income only from water tariff, the situation is expected to be financially sound.

Table 6-8 NPV from Financial Cost

Discount rate 12%, unit: 1000 Frw

Site	Expenditure	Income	Income - Expenditure	NPV	NPV income/expenditure ratio	Per capita NPV
PP01 Mushikiri	1,972,551	2,019,808	47,257	35,948	106%	3.1
PP02 Kigina	2,351,379	2,177,258	-174,120	-50,534	93%	-4.1
PP03 Mukarange[11]	965,087	1,776,453	811,366	262,918	185%	12.9
PP04 Rwimbogo	46,834	68,554	21,720	10,201	146%	7.6
PP05 Mahama	458,591	805,894	347,302	111,782	175%	6.1
PP06 Remera	5,298,712	1,994,318	-3,304,394	-1,051,827	38%	-69.1
PP07 Katabagemu	659,946	895,721	235,776	75,140	135%	3.7
PP08 Kageyo	231,454	571,539	340,085	110,102	248%	8.4
PP09 Rukira	1,881,789	1,703,480	-178,309	-59,411	90%	-6.1
PP10 Gashanda	2,860,276	2,652,004	-208,272	-70,633	92%	-4.7

<Sensitivity analysis>

The above analysis results are calculated on conditions for plan basis (all target population consume the design unit rate of 20 lcd). On the other hand, due to conditions of the poor in the target area, restricting consumption to reduce expenditures and nonuse of facilities can be expected. Therefore, financial indicators for decrease in rate of facilities use were calculated. Facilities use rates were set at 85% and 75%. This means that all target population reduces their consumption rate from 17 lcd (use rate of 85%) to 15 lcd (use rate of 75%), or the population not using the facilities decrease from 15% to 25%, or a combination of both. Also, due to lowering of the use rate, operation and maintenance costs such as for fuel will decrease.

Table 6- 9 NPV from Financial Cost for 85% Use Rate

Discount Rate 12%, Unit: 1000 Frw

Site	Expenditure	Income	Income - Expenditure	NPV	NPV income/expenditure ratio
PP01 Mushikiri	1,727,787	1,716,837	-10,950	11,052	102%
PP02 Kigina	2,030,271	1,850,670	-179,602	-60,264	91%
PP03 Mukarange	871,155	1,509,985	638,829	204,956	173%
PP04 Rwimbogo	46,540	58,271	11,731	5,446	125%
PP05 Mahama	454,811	685,009	230,198	73,979	150%
PP06 Remera	4,496,198	1,695,170	-2,801,028	-909,571	38%
PP07 Katabagemu	656,166	761,363	105,197	32,987	115%
PP08 Kageyo	227,674	485,808	258,135	83,649	214%
PP09 Rukira	1,669,932	1,447,958	-221,974	-73,194	86%
PP10 Gashanda	2,534,878	2,254,203	-280,675	-93,525	89%

[11] Mukarange uses commercial power of RECO (former ELECTROGAZ).

Table 6-10 NPV from Financial Cost for 75% Use Rate

Discount Rate 12%, Unit: 1000 Frw

Site	Expenditure	Income	Income - Expenditure	NPV	NPV income/expenditure ratio
PP01 Mushikiri	1,588,183	1,514,856	-73,327	-8,894	98%
PP02 Kigina	1,851,225	1,632,944	-218,281	-72,486	88%
PP03 Mukarange	818,485	1,332,339	513,855	164,685	162%
PP04 Rwimbogo	46,540	51,416	4,876	2,213	110%
PP05 Mahama	452,291	604,420	152,129	48,778	133%
PP06 Remera	4,044,390	1,495,739	-2,548,652	-827,417	37%
PP07 Katabagemu	653,646	671,791	18,145	4,886	102%
PP08 Kageyo	225,154	428,654	203,501	66,014	191%
PP09 Rukira	1,528,694	1,277,610	-251,084	-82,382	83%
PP10 Gashanda	2,317,946	1,989,003	-328,943	-108,786	86%

As a result of the sensitivity analysis, for 85% use rate, 4 sites same as the 100% use rate are in the red, and for 75% use rate, PP01 Mushikiri is added to the 4. Therefore, if managed only by water tariff, the water tariff set within the ATP can presents financial problems in management. On the other hand, for the other sites, management can be financial sound even if use rate decreases. To achieve stable water supply services, government support to cover the red is required.

6.2.4 Summary of Financial and Economic Evaluation and Recommendations

<Summary of Evaluation>

1. Results of the socio-economic survey indicate that 10 Frw/jc is the unit water price on median that inhabitants living in the priority project area can afford. Significantly, about 70% of inhabitants replied that they would purchase water at prices higher than the expected tariff if they can procure safe water at near places. However, as their cash income is limited, the water volume that they can purchase naturally decreases according to the increase in unit price[12]. This goes against the achievement of WHO standard of "20 liters per capita per day" and reduces income of private operators in charge of operation and maintenance which leads to the instability of water supply provision by contracted private operators. This will also contradict progress of human development.
2. From the economic evaluation, sites other than Remera, which has a high height difference, gave good results for favorable effects on rural economy due to implementation of this project.
3. From the financial evaluation, in the case where the water tariff is to cover all operation and maintenance costs including net O&M costs, tap manager salaries and renewal costs, Remera site as well as 3 other pumped schemes will be in the red. In order to maintain a good economic value, some kind of financial subsidy is needed.
4. If diesel generator, the most serious factor for high O&M cost of pumped schemes, is replaced by commercial power, great reductions in O&M costs can be expected.

[12] Results of socio-economic survey reveals that the volume of water a household can afford is determined by the functions such as water unit price and household cash income.

<Recommendations from Results of Financial and Economic Evaluation>

1. If water supply provision is regarded as an aggregate of safe water supply to poor people as a human right and a BOP business for water supply service, then available service (water supply within the affordable tariff range) and sustainable business (stable water supply service) must be in complementary relation. In order to establish water supply business and make service sustainable, each stakeholder, administration organs (competent authorities), private sector (contractors for management of water supply business) and consumers must fulfill their roles and prepare desirable conditions. To achieve MDGs, the administration is obliged to give support. Also, private operators are required to provide effective water supply services through economic management.
2. In order for water supply provision business to become a usable service, (i) fixing water tariff affordable even for poor people, (ii) giving support to the poorest people who have no cash income, and (iii) lifting the people's low standard of living are indispensable.
3. In order to establish water supply provision as a stable business, (iv) strengthening the awareness of administration on their role in water supply provision (as owner), (v) strengthening of management capacities of private operators in charge of water service provision, and (vi) assurance of fund raising opportunities for business are thought to be indispensable.
4. The biggest obstacle for financially sound water supply service is fuel and fuel transport costs of pumped schemes. From the viewpoint of MDG achievement, government subsidies are recommended to improve financial conditions for a stable management. Use of commercial power is the most promising measure, though not the absolute one, to reduce the water tariff. At the time of evaluation of the priority projects, electrification of pumped schemes (Mushikiri, Kigina, Remera, Gashanda, Rukira) is not planned. Therefore, GoR (MININFRA in charge) is required to put electrification plans into immediate action to promote electrification especially in hilly areas.
5. As for the reserve for renewal, this is not a big burden on the users of gravity schemes. However, the district as scheme owner needs to be responsible for it in consideration of the actual situation which includes pumped schemes. It is recommended that financial analysis be conducted again in the future to reconsider the consumers' share in water supply service provision when the economic power of Rwanda rises and people can easily afford the water cost.
6. Taxes are not included in the project costs and O&M costs used for this evaluation. However, in order to set water tariffs at the level affordable by the poor, O&M costs are recommended to be tax-free as public service.
7. From a viewpoint of social welfare, administration should support vulnerable people like widows, handicapped and orphans who have little means of production, for example, exemption of water tariff.
8. Improvement of inhabitant's affordability also needs to be considered. Especially in Mushikiri and Mahama, even if the water tariff does not cover reserve for renewal as well as fuel and fuel transportation costs, the private operators may be in the red. It is necessary for these schemes to immediately carry out promotion to the inhabitants on safe water use and raise overall economic standards to ensure implementation effects of the priority projects and to establish their sustainability.

   Income generation activities in rural areas do not necessarily propel the rise in affordability,

but they can support improvements in living standards on a long term basis, and therefore, planning and implementation of these activities are required. For example, "The study on sustainable rural and agricultural development in Bugesera District", a JICA development study, introduced several income generation activities as pilot project and found that some crops like plantain banana and pineapple were effective. Governments at each level (central, province and district) need to positively disseminate these activities to the districts.

9. From the viewpoint of service delivery to consumers, management capacities of entrusted private operators determine their success. They require technical skills in operation and maintenance, and also, they need to possess minimum assets for initial investment and running costs, estimate investment efficiency, and understand the break-even point. Therefore, the government must promote participation of operators having high management capabilities for water supply provision when water scheme management is entrusted to private operators. However, since the number of capable operators is limited in Rwanda, support in capacity building is required from outside (state, donors).
10. Though private operators in charge of water supply provision are not aiming for large profit, they will have difficulties to run their services only through low water tariffs. Administration needs to create an opportunity for financing with zero or low interest so that private operators can raise money for initial investment and facilities maintenance[13].
11. Inhabitants are both beneficiaries of MDG achievements and consumers of water. To secure a sustainable water supply, they are obliged to pay the water tariff (within affordable range). Also, local communities are considered to have duties to protect facilities from vandalism.

Raising the water supply rate is one of the government goals and task of administration. In view of the remarkable achievements in economic development of Rwanda, the JICA study team expects that Rwanda as a nation can push the progress of "business for human rights". However at the time of this study, government institutions are not satisfactorily fulfilling this task, such as the lack in number of staffs in charge of water supply.

The water supply service that this master plan proposes will be successful when each government institution becomes aware of their duties and clearly understand their roles. That is, the central government (MININFRA) must control overall water supply service, the province is the water supply provision supervisor, and the district is the scheme owner and responsible for service delivery, and laws and systems need to be prepared to realize these tasks if found to be necessary.

From now, as many water supply schemes are constructed according to the master plan, one private operator will manage several schemes. Though it is out of scope of this section as 'project evaluation', it will be rational to combine management of high profit schemes (gravity schemes) with low profit schemes (pumped schemes). Also, an operator managing water supply provision in the urban area should manage schemes in rural areas to appropriate profits generated from urban water supply to rural areas. In this case, it is possible to regard the water supply in poor areas as social business without aiming for profitability and to set water tariff according to ATP of consumers.

[13] As water supply service has characteristics of human development and human rights, rather than commercial institutions, public institutions having mission to achieve MDGs are desirable for financial procurement.

6.3 Organizational and Institutional Evaluation

With respect to organizational and institutional aspects, compliance with policies and strategies of the water supply sub-sector as well as effectiveness and sustainability of recommended operation and maintenance systems were considered as follows. Refer to Chapter 5 for evaluation on operation and maintenance basis.

(1) Compliance with Policies/ Strategies of Water Supply Sub-Sector

In the National Policy and Strategy for Water Supply and Sanitation Services, the use of private operators for management of water supply schemes is proposed. The proposal for entrusting management of water schemes to private operators of this study can be evaluated to comply with the present strategy of Rwanda.

(2) Effectiveness of Proposed Operation and Maintenance System

Evaluation on effectiveness of the proposed operation and maintenance system is as follows.

1) The present water users' association has the main objective of water supply to the residents. Therefore, attention was not given to effectiveness of the operation and maintenance system. Since the operation and maintenance system proposed in this study is contracting to private operators for effective management which can be linked to profitability, this is feasible from the viewpoint of effectiveness.
2) On the other hand, when one private operator manages multiple schemes, to pursue effectiveness, schemes having low profits might be abandoned to possibly create a system where water supply to certain residents is ignored. To avoid such situation, a system where the district or other local administration periodically checks the management situation of water service providers is necessary. In this system, through reporting and feedback between the water service providers and the district, the district must improve the condition by understanding the situation of low profit schemes, formulating rehabilitation plans and executing the plans.
3) To assure this effectiveness, increase of staffs in charge of water supply in the districts and other local administrations and strengthening of their capacities are needed. Also, technical and social supports to private operators are indispensable.

(3) Sustainability of Proposed Operation and Maintenance System

Evaluation on sustainability of the proposed operation and maintenance system is as follows.

1) For the past water users' associations, examples where the rights for income and expenditure were with the district and profits were transferred as revenue of the district were found to create a poorly sustainable situation. The system of entrusting management to private operators proposed in this study can be evaluated where sustainability is assured since shares can be allotted to investors in accordance with the profit of the service provider.

2) Also for private operators, due to increase in internal reserves from sound management, effectiveness in management from scheme rehabilitations, increase in income from expansions and income stability from increase in house connections can create motivation to promote sustainability.
3) However, private operators whose profits are low or cannot be made will be eliminated in the tendering process or be notified of their cancellation. In this case, since operation and maintenance skills of private operators might not be transferred, sustainability may not be assured. Therefore, fostering of ownership of water schemes and accumulation/sharing of knowledge on operation and maintenance to staffs in charge of water supply in local administration through trainings and OJTs are required. Also, contracts between districts and water service providers need to be improved, and water service providers need some kind of incentive to invest in management and expansions.

6.4 Technical Evaluation

With respect to technical level of proposed water supply plans and water supply facilities plan, feasibilities were considered in view of adopted standards, local conditions and capacity of local administration. As shown below, according to evaluation of water sources, spring sources were evaluated to be feasible for this study due to their sustainability.

(1) Spring

A spring is groundwater naturally flowing out from mountain sides or in valleys. In Eastern Province, springs are abundant and if properly protected, good quality can be assured. However, since spring flow rates may have seasonal fluctuations, use of perennial springs is most feasible.

(2) Groundwater through Borehole

Groundwater can be pumped up from machine-drilled boreholes through handpumps or motorized pumps. Groundwater in general has good quality, but in Eastern Province, success rates of borehole drillings are very low and availability is limited to certain areas only. Therefore, groundwater development has geographical restrictions.

(3) Surface Water (Lakes and Rivers)

Naturally formed lakes and rivers are susceptible to water contamination, but they can be easily accessed by all. Therefore, treatment is required and operation and maintenance of treatment plants requires highly technical skills.

Next, for water supply scheme types, level 2 piped schemes are most feasible in consideration of the topography and water source characteristics of this country.

(1) Level 1 Scheme

1) Handpump

Handpumps installed in boreholes are operated by human power to pump up water, but manual pumping is hard labor. Also, in most cases, residents must travel long distances with large height differences from their houses to the handpump and carrying the fetched water is also hard work. Furthermore, in Eastern Province, distribution area and potential of groundwater are hydrogeologically restricted. However, since operation and maintenance of handpumps is easy, these are appropriate in limited areas.

2) Protected Spring

Since spring water flows continuously, water can be fetched any time and operation and maintenance is very easy. Also, water quality is good if facilities are properly constructed. However, going down slopes from houses to water sources and going up slopes can be very dangerous and carrying water up to the slopes is hard work. Moreover, due to seasonally fluctuations, sustained flow cannot be assured and this uncertain sustainability in water supply makes this scheme inappropriate.

(2) Level 2 Scheme

1) Gravity Fed Piped Scheme

If intake is located higher than the supply area, then gravity supply is possible and water can be distributed through public tap stands constructed near households. Although the scheme has topographical restrictions, operation and maintenance is easy and since power is not necessary, low water tariffs can be set.

2) Pumped Type Piped Scheme using Spring or Borehole

Water from spring intake or borehole is pumped up to a distribution tank and is supplied by gravity through public tapstands constructed near households. If public tap stands are installed within the PNEAR standard of 500m, this scheme is suitable even for residents living on hilltops. However, operation and maintenance of motorized pumps needed for pumping up water requires appropriate technical skills and costs for power (diesel generator or commercial power) can be expensive.

3) Pumped Type Piped Scheme using Surface Water

Water from lakes or rivers is pumped up from the intake to a treatment plant. The treated water is pumped to a distribution tank and is supplied by gravity through public tapstands constructed near households. Similar to the pumped type piped scheme using spring or borehole mentioned above, if tapstands are located within reasonable distances, this scheme is suitable even for residents living on hilltops. However, since operation and maintenance of the treatment plant requires highly technical skills and operation and maintenance of motorized pump requires some skills as mentioned above for surface water, this is not appropriate for rural water supply, for areas without water sources nearby, long distance transmission is indispensable.

(3) Level 3 Scheme (House Connections)

The water distribution system is the same as those for Level 2, but water is supplied directly to the households. Although costs for connection to each household are required, water tariff is collected on a metered basis. However, since house connections are in private property, operation and maintenance of connected facilities must be carried out by each household.

The priority projects are evaluated on their technical aspects as follows. The results show that all project sites are considered to be feasible.

Table 6-11 Technical Evaluation of Priority Project Water Schemes

Service Level	Water Scheme		Applicable Site	Evaluation
	Water Source	Type		
Level 1	Groundwater	Handpump Scheme	PP04 Rwimbogo	Capacities of existing boreholes are sufficient, but after airlifting and conducting pumping tests, installations of new handpumps are needed.
Level 2	Spring	Gravity fed Piped Scheme	PP05 Mahama PP07 Katabagemu PP08 Kageyo	Since flow rates of existing water sources are sufficient, existing facilities are useable. Distribution pipeline extensions and new construction of public tap stands are required.
		Pumped type Piped Scheme	PP01 Mushikiri	From water source potential and topographical features, new spring developments are anticipated. Also, since existing water schemes are not available in the secteur, new construction of water schemes is needed.
			PP10 Gashanda	Flow rate of existing water source is sufficient and since existing facilities are partially useable, the scheme can be improved through distribution pipeline extension and new construction of receiving tank, distribution tanks and public tap stands.
			PP02 Kigina PP06 Remera	Flow rates of existing water sources are sufficient, but since existing facilities are deteriorated and cannot be used, new constructions of all facilities are needed.
		Gravity and Pumped type Piped Scheme	PP09 Rukira	From water source potential and topographical features, new spring development is anticipated. Since only the receiving tank of existing water scheme can be used and other facilities are deteriorated, new construction of these facilities are needed.
	Groundwater	Pumped type Piped Scheme	PP03 Mukarange	Since yield of existing water source is insufficient, connection to an additional existing borehole can assure the water source. Although existing facilities can be used, distribution pipeline extensions and new construction of public tap stands are necessary.

6.5 Environmental Evaluation

Table 6-12 is the environmental evaluation results for each priority project. Based on "the JICA Guidelines for Environmental and Social Considerations", the Initial Environmental Evaluation (IEE) was carried out[14]. Detailed evaluation results are shown in the Supporting Report.

Table 6-12 Environmental and Social Evaluation of Priority Projects

Applicable Project	Eval.	Impacts on Social Environment
All projects		- Generally, the project may have positive impacts on the area to be benefited from the Project in terms of people's health conditions and daily livelihoods. - In the design stage, it is required to identify ownerships and land uses of project sites. If land expropriation of non-public spaces is necessary, the Rwandan Government needs to prepare compensation plans including resettlement action plans in manners described in A5.1.4.
PP08 Kageyo	B	- To achieve sustainable management of the facilities to be constructed, mutual cooperation must be achieved among the existing private operator, new users and the local authorities. - Area planned for tank construction is close to rice fields and vegetation areas. Therefore, when project construction areas for the tank and pipelines are to be determined, public and private lands in the target area and surrounding areas must be clearly identified.
PP10 Gashanda		- To achieve sustainable management of the facilities to be constructed, new WUAs need to be established and a new water fee system is expected to be established for management of WUAs and facilities. Presently, since most of the residents of the target area are procuring domestic water free of charge, introduction of a new water fee system may have social and economic influences regardless of the possibility to procure water of improved quality. - Area planned for tank construction is close to rice fields and vegetation areas. Therefore, when project construction areas for the tank and pipelines are to be determined, public and private lands in the target area and surrounding areas must be clearly identified.
PP01 Mushikiri PP02 Kigina PP05 Mahama PP09 Rukira	C	- To achieve sustainable management of the facilities to be constructed, new water users' associations (WUAs) will be necessarily established. The establishment of new WUAs and their establishment of water fee systems may affect people's livelihoods on social and economic aspects. - Basically, pipelines will be laid under the ground along public roads, and tanks and pumping stations will be built in public spaces.
PP03 Mukarange		- This scheme is an extension of the existing scheme. To achieve sustainable management of extension facilities, management by the present private operator is proposed and due to expansion of management and water fee, and since social and economic influences are expected, discussions between new users, water service provider and local authorities are needed to obtain consent. - Basically, transmission pipelines are planned to be laid along public roads and tanks and pump stations are planned to be constructed on public lands.
PP04 Rwimbogo		- To achieve sustainable management of the facilities to be constructed, mutual cooperation must be achieved among the existing private operator, new users and the local authorities. Presently, since most of the residents of the target area are procuring domestic water free of charge, introduction of a new water fee system may have social and economic influences.
PP06 Remera		- To achieve sustainable management of the facilities to be constructed, mutual cooperation must be achieved with WUAs of surrounding areas. Also, discussions with new users, cooperatives and local authorities are necessary. - Basically, transmission pipelines are planned to be laid along public roads and tanks and pump stations are planned to be constructed on public lands.
PP07 Katabagemu		- This scheme is an extension of the existing scheme. To achieve sustainable management of extension facilities, management by the present private operator is proposed and due to expansion of management and water fee, and since social and economic influences are expected, discussions between new users, water service provider and local authorities are needed to obtain consent. - Presently, since most of the residents of the target area are procuring domestic water free of charge, introduction of a new water fee system may have social and economic influences. - Basically, transmission pipelines are planned to be laid along public roads and tanks and pump stations are planned to be constructed on public lands.

[14] Conceivable impacts to be caused by the implementation of the Master Plan and priority projects to be proposed will be identified and evaluated especially from the following points of view:
(1) importance of impacts, (2) the number of people / area to be affected, (3) spatial extent and duration of the impacts, (4) reversibility of the impacts and (5) possibility of secondary impacts.

Applicable Project	Eval.	Impacts on Natural Environment
PP01 Mushikiri PP02 Kigina PP03 Mukarange PP05 Mahama PP06 Remera PP07 Katabagemu PP08 Kageyo PP09 Rukira PP10 Gashanda	B	Construction works may include land preparation works especially around tanks and pumping stations. That may affect the present soil conditions and vegetation to some extent.
PP04 Rwimbogo	C	Main works consist of replacing handpumps and cleaning boreholes. Access to the project sites is easy. Therefore, few significant impacts on natural resources are expected.

Applicable Project	Eval.	Impacts related to Pollution
PP01 Mushikiri PP02 Kigina PP03 Mukarange PP05 Mahama PP06 Remera PP07 Katabagemu PP08 Kageyo PP09 Rukira PP10 Gashanda	B	Main pollutants generated from the project are small amounts of construction debris during the construction period.
PP04 Rwimbogo		Development of existing boreholes and installation works on handpumps may have impact around the project area with small quantities of dusts and drainage.

Evaluation Categories: A: Serious impact is expected
B: Some impact is expected
C: Extent of impact is unknown
D: No impact is expected. EIA is not necessary

CHAPTER 7 RECOMMENDATIONS ON SANITATION PROMOTION ACTIVITIES PLAN

In this chapter, from study results of the 7 target districts and following the rural water and sanitation program (PNEAR) being promoted by MININFRA as well as the health program focused on preventive care promoted by MINSANTE, recommendations will be made on sanitation promotion activities believed to be favorable for execution in the target area and its executing system.

7.1 National Plan and Strategy related to Sanitation Promotion

The conceptual framework for the sanitation sector given by related organizations proposes decentralization, importance of program coordination at administrative levels close to communities, and activities through community initiatives. Also, to escape from the negative cycle of poverty, "promotion of behavior change" by the residents themselves is given as an important activity.

7.1.1 Sanitation Service as Defined by MININFRA[1]

In MININFRA, sanitation involves provision of facilities and services for sanitary treatment of nightsoil and solid wastes, and treatment of rainwater and wastewater. Also, sanitation should not hinder the promotion activities for health and hygiene. In rural areas, sanitation is defined as a comprehensive service for constructing public hygiene facilities and sustaining this environment by the communities. As an issue, although water supply and sanitation are exemplified as the wheels of a vehicle, sanitation is usually treated as a supplementary component to water supply services.

7.1.2 Goals of National Plan related to Water and Sanitation Sector

In Vision 2020, in the section on community health and sanitation, the rates of accessibility to proper sanitation conditions are given as 40% in 2010 and 60% in 2020. Following the PRPS, EDPRS as a national development plan along with Vision 2020, the accessibility rate for basic sanitary services[2] will increase from 38% to 65% in the target year. Also, increasing the ratio of schools with simple toilets satisfying standards in view of health and sanitation from 10% to 80% is also given. Further, the National Policy and Strategy for Water Supply and Sanitation Services[3] enacted in March 2010 focuses on improvement of environmental sanitation service provision.

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[1] Water and Sanitation Policy Retreat; Retreat Statement, p. 1 (Working paper for MININFRA Workshop held at Gisenyi, 5th- 6th February 2009)

[2] Sanitary services defined here is not only access to toilets. As explained above, sanitation refers to provision of facilities and services related to sanitary treatment and disposal of drainage/wastewater, nightsoil and solid waste.

[3] Refer to Chapter 1 on the National Policy and Strategy for Water Supply and Sanitation Services.

7.1.3 Promotion Activities on Water and Sanitation Recommended by MININFRA

The following 2 activities are recommended by MININFRA as presently important activities to achieve the goals for the water and sanitation sector.

1) Execution of "activities for promotion of raising awareness on water and sanitation" through PHAST (Participatory Hygiene and Sanitation Transformation)
2) By using the PHAST method, execution of HAMS[4] (Hygiène et Assainissement en Milieu Scolaire) aiming at dissemination to community societies through activities of children as focal points for sanitation activities at schools

As for HAMS, a national HAMS committee is established by the ministries responsible for the water and sanitation sector, MININFRA, MINEDUC and MINISANTE as well as other related ministries. The concept of HAMS joins parents and children; children and teachers, PTA and relatives, and neighbors and other community societies become involved. This phenomenon can be imaged as when 2 stones are thrown into water, the waves expand and they overlap to create an infinite wave pattern. Therefore, under the cooperation of local administrations, using schools as information dispatch centers to create connections with community societies is the key to a successful program.

7.1.4 "National Policy on Environmental Health, April 2007" of MINISANTE

To break away from the negative cycle of falling in to a poverty condition without being able to participate in productive activities resulting from poor health due to an inferior sanitary environment and that poverty generating destruction of the sanitary environment and non-provision of sanitary services, as strategy to improve environmental sanitation at community and household levels, the "Environmental Health Policy" was proposed. The following are the 11 main policy items and residents are urged to initiate promotion of this policy. Important parameters given to promote the policy are differences in needs between children, women, men and elders; assurance of willingness through sensitization and sanitation education; promotion of decentralization; and risk analysis.

1. Environmental health education	7. Environmental pollution
2. Food and water safety	8. Port health
3. Personal and domestic hygiene	9. Disposal of the dead
4. Liquid and solid waste management	10. Proper housing and settlement
5. Occupational health and safety	11. Disaster and emergency preparedness
6. Diseases vectors and vermin control	

Source: Environmental Health Policy; MINISANTE, April 2007

The above 11 items are public health measures indispensable for people to spend healthy and peaceful lives. However, for actual realization, preparation of concrete activities, methods for formulation of plans as well as standardization of educational materials are needed. Also, assurance of human resources to execute these activities and capacity building are anticipated.

[4] For example, in the DDPs formulated by all districts of Eastern Province, the priority of public toilet installations is given not to medical facilities, but to primary and secondary schools. The name HAMS is not yet penetrated, but the trend to use schools for sanitation education and sanitation awareness raising is strongly promoted in Eastern Province.

7.1.5 "National Community Health Policy, March 2007" of MINISANTE

Provision of health services in close relation with communities and aiming to achieve goals of the health and hygiene sector in national development plans such as MDG, EDPRS and Vision 2020, and with instructions from the central government, a community health policy was enacted to fulfill better service through decentralization. Along with promotion of decentralization, foundations for medial and health (including primary health care) are planned to be decentralized from the present districts to cells as focal points for plan formulation and implementation. Taking the cell as the unit to promote the formulation and implementation of health programs, under the direction of the staff in charge of health in the cell, sensitization activities for disease prevention, increasing nutrition and infant immunization are carried out.

7.2 Issues related to Water and Sanitation in the Target Area

Issues related to water and sanitation of Eastern Province can be summarized as follows.

- High infection rate of water-borne diseases[5] and preventive diseases
- Shortage of information on hygiene and health as well as lack of means for obtaining these information at the individual level
- Shortage of information on safe sanitation facilities
- Low value placed on safe water
- Low willingness of residents to participate in water supply services
- Difficulties in identification and information management of present situation of activities promoted in areas under jurisdiction by the local administration

Almost the same issues are applicable throughout the master plan target area in Eastern Province. Also in the priority project sites, communities having special differences from other areas are not confirmed.

7.2.1 Environmental Sanitation of Target Area

(1) Environmental Sanitation Conditions of Rwanda

According to the "Assessment of the Environmental Health Situation in Rwanda[6]" held by MINISANTE in 2006, in about 85% of existing water sources, contamination from coliform bacteria above the recommended level are reported. Also, only 0.8% of residents are said to be using toilets satisfying hygienic sanitation standards and this can be assumed as one of the causes for coliform bacteria contamination of water sources.

On the other hand, as the accessibility rate of sanitary facilities in rural areas, a case shows that a figure of about 85% of households possess toilets. However as explained above, the actuality is that specifications of these toilets cannot be defined as being safe and sanitary.

[5] The recognition of a high rate of water-borne diseases is based on "Seuil d'alerte (alert threshold)" being taken periodically under MINISANTE. Since patients having values over or near the threshold are confirmed daily, inquiries to local administration staff mostly respond by saying the high rate of patients is an issue for hygiene and sanitation.

[6] Assessment of the environmental health situation in Rwanda (2006), MINISANTE

(2) Environmental Sanitation Conditions in Target Area

From inquiries to concerned governments and organizations in Eastern Province, the high rate of patients with water-borne diseases such as cholera and typhoid is recognized. Also, from results of the social survey (household survey) conducted during the first year, the most frequently infected diseases were given in order as diarrhea, bilharziasis, trachoma and dermatitis (such as scabies).

In all cases, many residents are using contaminated water from rivers and stagnant waters without proper treatment for drinking and domestic purposes. Also, since excrements and wastes are not properly treated, and sanitary practices are not rooted, infection routes are spreading.

In the target area of Eastern Province, most of the sanitation facilities (latrines and toilets) possessed by households are, in actuality, traditional simple latrines (generally, their construction is a hand-dug hole in the ground with a wood platform and simple fencing) which do not conform to the sanitation facilities criteria set in "Etude de développement des infrastructures d'alimentation en eau potable et d'assainissement en milieu rural, Rapport provisoire, July 2007, PNEAR". Therefore in contrary to the accessibility rates given in the National Policy and Strategy for Water Supply and Sanitation Services[7], the present situation falls greatly below these values. From results of inquiries and field surveys, although households possessing sanitary facilities other than toilets (such as household wastewater treatment bins and garbage disposals) are rare, in Kirehe District, dustbins are placed at a number of locations where households are clustered and these are being collected[8].

Results of the household survey conducted during the first year at the 7 target districts are as shown below. Those referred to as toilets used by respondent households do not meet the standards of EDPRS and sanitation facilities criteria, which means that survey target households are not using safe toilets satisfying facilities standards.

Table 7-1 Toilets used in Target Area

Type Household Usage %	Subsurface Structure	Superstructure
Toilet (excreting place) 19.6%	Hand dug pit for excreting, mostly of large diameter and about 50cm depth As platform (floor), wood planks are placed over the pit or there is nothing over the pit	None
Traditional Toilet 40%	Hand dug pit for excreting usually with small diameter and 20cm to 30cm depth Since pit diameter is small, usually nothing is place across the pit	Mud wall (mud blocks) with wood strips for simple blinding
Simple Toilet 33.7%	Hand dug pit for excreting Usually the platform is a board	Wooden walls and zinc sheet roof

[7] The national household sanitation coverage rate is 45% in 2009 and the objective is to raise this to 65% by 2012 and 100% by 2020.

[8] Whether proper off-site treatment and disposal is conducted is unconfirmed.

In areas where the priority projects are located, overwhelming number of households possess what they call toilets which are simple excreting places (small hole of 20cm depth with simple superstructure). Since actual behavior of residents on use of toilets is difficult to clarify, identification of a baseline for safe access to sanitation facilities to formulate an improvement plan involves many difficulties.

Even if residents are aware that they possess toilets, since they lack "knowledge" on using proper technology, "behavior change" cannot be anticipated. Not only toilets, houses are mostly made of mud walls covered with zinc sheet roofs, and since mud walls easily become media for vectors[9] which transmit diseases, the walls need to be protected such as by coating material. Also, handwashing devises are installed outside of the toilet housing in some areas, but large area-wise differences are observed. Although in areas where water is easily available, handwashing facilities are installed even in schools, those areas where water fetching is difficult, facilities are devised through minimum information, but they are usually of unusable structure or without water and in many cases, handwashing is not carried out. Also, in the social survey of the first year, the response for handwashing after using toilets was 64% to 91% of the residents, but in many cases, the water used for handwashing has problems. For example, cases were confirmed where water used for cleaning hands after washing with soap is reused many times for other used in the family[10].

7.2.2 Issues in Target Area on Placing Value on Water and Participation in Water Service

In the target area, multiple water sources for drinking and domestic use are commonly available which can be given as a characteristic of Rwanda. In areas where water supply schemes are existing, the households do not limit water fetching to public tap stands or handpumps which can assure safe water, but many also use a number of other sources such as protected springs, unprotected springs, lake water, rainwater and river water.

(1) Lack of Value on Water due to Lack of Sanitation Awareness

As clarified through results of this study until July 2009, in the target area, construction of water supply schemes through development of safe and stable water sources which meet the demands has difficulties. However, under the present living conditions of residents, water is mistaken as an abundant resource and actually, if unsanitary factors are not considered as a problem, then procuring drinking water is not much of a problem. Placing value on safe water is difficult due to lack of awareness on sanitation.

[9] Disease transmitting insects such as flies and mosquitoes

[10] According to Baseline Survey of Project for Improvement of Water and Sanitation in Eastern Province, 2009

(2) Lack of Value on Water due to Lack of Willingness to Participate

As mentioned in Chapter 5, the difficulty in receiving residents' participation is given as one of the present problems in operation and maintenance of water schemes in the target area. In consideration of user-pays principle, decentralization and community participation which are focused in the National Policy for Water Supply and Sanitation Services of Rwanda, active participation from the 3 parties of administration, residents as users and service providers, and cooperation are indispensable through awareness that each is the owner of water and sanitation services. However, residents' present awareness especially on procuring stable and safe water is low. In addition to not properly understanding the value of safe water, the low awareness on participation as owner is contributing to not placing value on safe water. Therefore, water fee payment is hesitated and unsanitary water is continued to be used leading to low rate of water fee collection which is the biggest problem from the viewpoint of operation and maintenance.

7.2.3 Identification of Environmental Sanitation Conditions by Local Administration and Issues on Information Control

In health service provision closely related to the community which is being promoted by MINISANTE, smooth progress of decentralization is essential and strengthening the capacity of local administration to make use of the transferred rights is necessary. In the present condition, the system to identify the execution status of sanitation promotion activities to be conducted by water service providers is not organized, and actual situation and other information on sanitation promotion activities of water service providers are not transmitted to district health units and health centers[11]. In addition, due to decentralization, districts are in a transition stage where many changes in water service policies are made such as transferring of water service supervision responsibilities to secteurs (in Kirehe District) which is a role of districts. Therefore, establishment of a reporting system and organization of an information system are causing difficulties to cope with the changes. Creating an execution system rooted in the communities is one of the issues to be considered.

At the cell level having responsibilities for hygiene and sanitation activities, even at the present time, activities are being planned together with ASCs (Agents Santé Communautaire[12]) selected in each umudugudu. However, from results of inquiries, most cells are lacking a system for monitoring and feedback of the activities.

[11] Water service providers are obliged to report on the activities to the district infrastructure unit

[12] Refer to Supporting Report for details on activities and responsibilities of ASCs.

7.3 Recommendations and Basic Policy for Sanitation Promotion Activities Plan

As mentioned in 7.2 above, rural water and sanitation services presently have many problems. In order to deal with these problems and smoothly operate and maintain water schemes, organization of community residents and creation of a willingness to actively participate in water services by beneficiaries along with execution of sanitation promotion activities are needed. The construction of water supply schemes can increase benefits in water procurement for community residents and this can become an opportunity for creating awareness for improving the sanitation environment.

At sites for new construction of water supply facilities and for residents possessing existing water schemes to be rehabilitated through the master plan, along with construction works and community organization establishment, execution of sanitation promotion activities is proposed. Since big differences are not recognized in residents' living conditions, sanitation awareness and environment of target 7 districts, the proposal will be uniform for all 7 districts.

Recommendations for sanitation promotion activities related to water and sanitation and recommended activities are summarized below.

【Recommendation on Sanitation Promotion Activities 1】
Execution of sanitation promotion activities related to safe water needed to place value on safe water
【Issues to Consider】

- High infection rate of water-borne diseases and preventive diseases
- Low willingness of residents to participate in water supply services
- Shortage of information on hygiene and health as well as lack of means for obtaining these information at the individual level
- Difficulties in identification and information management of present situation of activities promoted in areas under jurisdiction by the local administration

【Recommendation on Sanitation Promotion Activities 2 】
Execution of sanitation promotion activities related to safe living environment
【Issues to Consider】

- High infection rate of water-borne diseases and preventive diseases
- Shortage of information on safe sanitation facilities
- Shortage of information on hygiene and health as well as lack of means for obtaining these information at the individual level
- Difficulties in identification and information management of present situation of activities promoted in areas under jurisdiction by the local administration

【Expected Effects】

- In order to create a healthy, peaceful and safe living environment, convey accurate information and concepts in a form appropriate for the local conditions and strengthen bonds between communities as well as promote dissemination to individuals
- By placing value on safe water, create a synergistic effect for smooth operation and maintenance of facilities (daily use and management including fee collection), and promote understanding and practice of proper sanitary habits
- Improvement of standards for community mobilization and sensitization activities techniques related to water service management by administration and private sector

【Important Considerations】

- Strengthening of relationships in communities: organization of residents and collaboration with community public facilities (schools and health centers)
- Proper selection of facilitators, support to facilitators and assurance of sustainability
- Strengthening of collaboration system between local administration, water service providers and community residents
- Formulation and realization of IEC program through selection of information transmission method suitable to local conditions
- Establishment and continuation of follow-up system

7.4 Proposal on Sanitation Promotion Activities Plan for Priority Projects

7.4.1 Stakeholders of Execution System for Sanitation Promotion Activities

The stakeholders to carry out sanitation promotion activities proposed in 7.3 are as follows.

Table 7-2 Stakeholders for Execution of Sanitation Promotion Activities related to Water and Sanitation (Proposal)

Level	Stakeholder	Function
Central	MININFRA	Overall project supervision and support
	MINISANTE	Support to districts which supervise sanitation improvement activities
Target Area	Eastern Province	Overall supervision in the province and coordination of districts
	District	Supervision of sanitation promotion activities as social health service provider and coordinator of health centers and medical facilities, and support to community-based organization formation and sanitation promotion activities execution as water service supervisor
	Water Board	Support to community-based organization formation and sanitation promotion activities for smooth water service management
	Health Center	Support to ASCs and sanitation and hygiene facilitators, management of information
	Cell	Main actor for sanitation promotion activities and information management Coordination of water service concerns, sanitation promotion concerns, community-based organization and users
	School	A base for community sanitation environment improvement activities; main facilitator for hygiene and sanitation promotion activities as well as environmental sanitation promotion activities
	Community Health Officer	Main facilitator of promotion activities on disease prevention and other hygiene and sanitation related issues to community residents based on MINISANTE guidance
	Community-based Organization	Mobilization support on user side; promotion for participation in water services; main actor of hygiene and sanitation promotion activities as well as environmental sanitation promotion activities
	User	Participation in water services based on user responsibility, and main actor of environmental sanitation improvement activities

7.4.2 Sanitation Promotion Activities (Proposal)

The following 2 activities are proposed[13].

Activity A: "Activities for raising sanitation awareness related to water and sanitation" within villages through cooperation of 3 stakeholders of local administration, water service providers and residents

Activity B: "Sanitation activities in schools" through 3 stakeholder cooperation between local administration, schools and surrounding residents

For each activity, supplemental options (activities having model cases in other areas and other countries) assumed to be possible for introduction in the target area will be explained in Supporting Report. This should be proposed at the stage of project formulation in accordance with the funding organization, project duration and project scale.

【Activity A】Activity for Sanitation Awareness Raising of Water Users in the Village

1. Stakeholders' meeting: Clarification of roles and responsibilities of stakeholders
   Stakeholders (examples): District water and sanitation related staff, Secteur/Cell staff in charge of social health, water users association staff (president, in charge of sanitation, in charge of community mobilization), umudugudu chiefs, umudugudu leaders, community representatives (women's cooperative, youth cooperative, agricultural cooperative, cattle breeding cooperative, commercial cooperative, etc.), ASCB[14]
   1) Confirmation of existing resources
      - Human resources (confirmation of capacities of existing ASB, confirmation on necessity for sanitation facilitator allocation mainly at water points, confirmation on necessity for additional resources)
   2) Confirmation of previously conducted activities on health and hygiene promotion
   3) Confirmation of execution organization in local administration

2. Identification and compilation of effectively useful existing resources ＝＞ consistency with contents of support

3. Execution of support activities: Sharing of support activities for raising sanitation awareness and sharing monitoring items
   1) Correlation between living environment improvement through water and sanitation awareness improvement and behavior change
      - Placing value on improving living environment through residents' participation
      - Handwashing custom using soap and appropriate treatment of excrements
      - Improvement of family health and living／roles of family, women and children
      - Sanitation Ladder[15]

[13] The proposed activities are being tested in the presently on-going technical cooperation project, "Project for Improvement of Water Supply and Sanitation in Eastern Province" (2007 to 2010).

[14] ASCB= Agent Santé Communautaire Binôme: a man and woman pair of health facilitators

[15] Sanitation concept promotion method generally used in PHAST/SARAR. This is a tool to support formulation of a long term plan for environmental sanitation improvement by the village itself using visual materials such as photos and charts showing specifications of a few favorable types of sanitation facilities (toilets) and sharing information such as identification of present conditions, realizable specifications and most desirable specifications.

2) Relationship between placing value on water and operation and maintenance
   - Correlation between smooth operation of facilities and sanitation awareness improvement of community residents
   - Correlation between importance of transparency assurance of water service management and improvement of residents on willingness to pay
   - Correlation between success of water service management and productivity raising in communities

3) Activities for raising awareness on water and sanitation
   - Training of facilitators for activities using PHAST/SARAR methods
   - Confirmation and preparation of educational materials necessary for above methods
   - On-the-job training of facilitators
   - Confirmation of implementation schedule

4) Establishment of activities monitoring system at priority sites
   Sharing of monitoring items, frequencies, methods and facilitators
   Proposal of monitoring items for priority sites
   - Handwashing practices using soap and appropriate treatment of excrements and wastes

   Proposal of self-monitoring method for priority sites
   - House-to-house visits by facilitators
   - Inquiries at water points

4. Execution of support activities and monitoring
   1) Training of facilitators
   2) Execution guidance

5. Measurement of effects of support activities
   1) Feedback on activities

【Activity A: Organization for Execution (Proposed Example)】

Information Managers: District, Secteur, Health Center

Activities Managers: Health Center Staff in charge of Umudugudu Health and Sanitation, Cell Social Health Staff; Umudugudu Chiefs, Umudugudu Leaders

Activity Level	Within Umudugudu	Water Service Provider	Activity
On Site (Households, Water Points)	Sanitation Facilitator	In Charge of Sanitation In Charge of Resident Mobilization	Daily sanitation improvement activities at water points Sensitization activities to served community residents
Community (Area*, Umudugudu)	ASCB	In Charge of Sanitation In Charge of Resident Mobilization	Health and hygiene guidance in communities Cooperation and collaboration (or execution) in activities to raise sanitation awareness related to water and sanitation

*: A cluster of communities needs to be selected in accordance with the scale of the water supply scheme to be constructed or rehabilitated. As examples, establishment of community health committees by village for handpump schemes or by cells and secteurs for piped schemes to supervise activities of ASCBs also needs to be considered.

【Activity B】Activity to Raise Sanitation Awareness in Schools

1. Stakeholders' meeting at school: Confirmation of willingness to accept activities

2. School condition survey: Design of ancillary sanitation facilities and selection of appropriate sanitation facilities
   Survey Items (proposal)
   - Categorization between primary schools, secondary schools and primary-secondary combined (group) schools
   - Pupils and teachers (male-female ratio), class shift number, classroom number, school staff number
   - School facilities survey = existing sanitation facilities, availability of canteen, availability of cultivating area
   - Existence of sanitation activities in school, availability of school meals and others

3. Kick-off meeting of school related stakeholders
   Stakeholders (examples): district education related staff, staffs in charge of social health in secteurs and cells, school headmaster, teachers, PTA, children/pupils, umudugudu heads, umudugudu leaders, community representatives

4. Local administration meeting (district secteurs, cells)
   Confirmation of support organization and roles for support activities of local administration

5. Stakeholders' meeting
   Stakeholders (examples): district education related staff, staffs in charge of social health in secteurs and cells, school headmaster, teachers, PTA, children/pupils, umudugudu heads, umudugudu leaders, community representatives
   1) Sharing of support activities for raising sanitation awareness in schools
   - Analyses of problems and present state (sanitation conditions, strengths/weaknesses/ opportunities/threats)
   - Demand analysis (support contents = training items and collaborative work on support activities)

   2) Roles of activities for sanitation awareness raising in schools, and defining and sharing of responsibilities

6. Training of school teachers, staffs and PTA
   Training items (proposal)
   - Basic items related to water and sanitation
   - Public health in schools and households
   - Environmental conservation in schools and communities
   - Sanitation clubs in schools and method of establishing a committee
   - Method of child fostering as the focal point

7. Confirmation of organization for self-monitoring
   - Preparation of monitoring sheets
   - Simplified KAP survey in schools to identify baseline

8. Execution of activities at schools

9. Effects measurement and follow-up of school support activities

【Activity B: Organization for Execution (Proposed Example)】

Information Managers	District, Secteur	Manage information on activities execution situation
Activities Managers	Cell Social Health Staff, Umudugudu Chief, Umudugudu Leaders, PTA Members, School Headmasters	Support, guide and advise on activities
Activities Facilitators	Teachers, Children, Students	Carry out sanitation promotion activities in schools, at households and in the community

For the above activities, use of HAMS activities educational materials developed in the on-going technical cooperation project is recommended.

7.4.3 Other Recommendations

(1) Execution of Pre-baseline Survey

Not only for the sanitation sector but other sectors as well, due to the rapid progress of decentralization, the trend is towards support using various funds from other than the central ministries. Since collaboration between projects and standardization of facilities will probably become more difficult, before implementing projects, conducting pre-baseline surveys to identify conditions of target communities and re-identify community needs is recommended.

(2) Construction of Sanitation Facilities at Water Supply Scheme Construction Sites

If conveniences of water fetching increase, in Rwanda where value on safe water is very low, sensitization activities for improvement of sanitation awareness becomes essential. However, not only software activities, but construction of safe sanitation facilities at a number of locations as pilot is needed. Through participatory activities during actual construction and use of the facilities, the number of people who can actually experience the improvements in the sanitary environment through a rise in conveniences should be increased to disseminate the effect to surrounding areas.

CHAPTER 8 PROJECT IMPLEMENTATION PLAN

8.1 Demarcation of Implementation Work

For the residents of Eastern Province, to realize 100% water supply coverage by 2020, implementation of the master plan following the proposed schedule is indispensable. Demarcation of works by stakeholders before, during and after implementation is proposed as follows.

Table 8-1 Proposed Demarcation of Works

Stakeholder		Work Allocation		
		Before Construction	During Construction	After Implementation
Rwandan Side	MININFRA	・As executing agency, contract with international consultant ・Tender for construction ・Contract with contractor	・As executing agency, supervision and coordination of project progress	・Warranty inspection ・Hand over of water schemes to district
	MINIRENA	・Confirmation on quantitatively and qualitatively proper use of water resources and consideration of environmental conservation	・Confirmation on quantitatively and qualitatively proper use of water resources and consideration of environmental conservation	
	RURA	・Confirmation on regulations related to project implementation		
	REMA	・Confirmation of environmental impact due to project implementation		
	MINISANTE		・In coordination with districts, participation in environmental sanitation improvement activities (supervision assistance)	・In coordination with districts, participation in environmental sanitation improvement activities (supervision assistance)
	Eastern Province	・Compilation of programs for district development and coordination of districts	・Compilation of programs for district development and coordination of districts	・Compilation of programs for district development and coordination of districts e
	District	・Responsible for project explanation ・Preparation of access roads ・Coordination of secteurs, cells and imudugudu	・Direct project supervision ・Coordination of secteurs, cells and imudugudu	・Project owner ・Coordination of secteurs, cells and imudugudu ・Large scale repairs
	Secteur	・Prepare residents' mobilization (social mobilization)	・Execute residents' mobilization and supervision	・Follow-up and monitoring on conditions of facilities use ・Supervision of residents' mobilization
	Cell	・Prepare residents' mobilization (including sanitation promotion and residents' promotion activities)	・Continue residents' mobilization (including sanitation promotion and residents' promotion activities)	・Sanitation promotion and sensitization activities to residents
	Water Service Provider	・If existing scheme: continue work by existing water service provider ・If new scheme: prepare community organization	・If existing scheme: continue work by existing water service provider ・If new scheme: form water service provider	・Management of scheme ・Fee collection ・Small scale repairs ・Activities to raise sanitation awareness
	Community Organization	・Prepare water users association	・Assistance to construction works (internal transport of materials and equipment, pipeline trenching, pipe material distribution along pipeline route) ・Prepare for participation in water and sanitation service activities	・Operation and maintenance of water scheme (facilities and water source conservation) ・Fee payment and follow-up ・Follow-up on small scale repair ・Assistance to sanitation awareness raising activities
	Beneficiary Residents	・Prepare for project acceptance	・Assistance to construction works ・Prepare for participation in water and sanitation service activities	・Operation and maintenance of water scheme ・Fee payment ・Follow-up on small scale repair ・Start sanitation activities (such as cleaning around facilities)

Donor Side	Contractor	・Contract with Client by contractor selected through tender	・Procurement/installation of pumping equipment ・Construction of pump house ・Construction of storage tank ・Procurement and laying of pipeline ・Installation of public tap stands and handpumps ・Construction of access road	・Respond to warranty inspection
	Local Consultant or NGO	・Prepare for support to social mobilization including sanitation promotion and sensitization activities	・Support to social mobilization including sanitation promotion and sensitization activities	
	International Consultant	・Contract with MININFRA as the client ・Assist construction tendering	・Supervision of construction	・Presence at warranty inspection

8.2 Tendering of Contractors

Under the regulations of the Rwandan side, construction and rehabilitation works of projects will be handled by contractors selected through a tendering process. An example of the procedures for tendering is described below.

- To prequalify candidate contractors, a call for intention of interest is advertised in newspapers and other public media.
- Tender documents are distributed to the prequalified contractors.
- The contractors who obtained the tender documents must submit their tender proposals at the time, date and place specified in the tender documents.
- After going through the tender procedures such as confirmation of the submitted documents, opening of proposal envelopes and evaluation of proposals, a contractor is selected as the prospective tenderer having the right to go into negotiations.
- The Rwandan executing agency who is the client of the project negotiates with the prospective tenderer.

Following the above tender procedures, the prospective tenderer proceeds through the following steps, implements the works and hands over the works to the Rwandan side.

- The contractor concludes a contract with the Rwandan executing agency
- The works commence
- At each stage of the works, various inspections are made
- Test-run of completed facilities is carried out and approval is received from the Rwandan side
- Water supply facilities are temporarily handed over to the Rwandan side
- Necessary arrangements are made during the warranty period
- Upon completion of the warranty period, final inspection of the facilities is conducted
- Upon receiving final approval from the Rwandan side, the water supply scheme is finally handed over to the Rwandan side

8.4 Supervision of Works

Construction and rehabilitation works will be carried out by the contractor. During the work period, supervision on the progress of the works is necessary by the client. The following items require supervision.

- Schedule management
- Manning management
- Quality control
- Safety management
- Attendance at various inspections
- Attendance at test-runs
- Attendance at warranty inspections

For the above supervision, the support of a qualified consultant is highly recommended.

CHAPTER 9 CONCLUSION AND RECOMMENDATIONS

9.1 Conclusion

The average rural water supply coverage rate for the country is 71% and from this study, the coverage rate for Eastern Province was identified to be far below this at 53%. Therefore, the urgent need to raise the coverage rate of Eastern Province was confirmed. On the other hand, the water and sanitation sector of Rwanda has an ambitious objective to "raise the water coverage rate to 100% by 2020". With this background, the master plan was formulated in this study. Also, from the master plan, 10 projects having high priority were selected and preliminary designing and cost estimates were made.

In 2020, the target year for the master plan, the amount of water required to supply Eastern Province is about 53,000 m^3/day[1]. On the other hand, the usable amount of water sources available in Eastern Province needed to promote the plan is estimated at about 99 million m^3 annually, or about 270,000 m^3/day[2]. As a result, the potential of water sources is sufficient to supply water to the residents of the province, but the water sources are not evenly distributed and therefore, a water supply plan for equal distribution was formulated.

Furthermore, to achieve 100% coverage by 2020, the proposed implementation plan must be followed without delay. As the first step for this realization, early implementation of the priority projects (target year 2015) is essential.

[1] Refer to Table 2-5 in Chapter 2.
[2] Refer to Supporting Report.

9.2 Recommendations

For smooth realization of this master plan, the following are recommended to the Rwandan side.

Water Resources Development

- Since water resources in Eastern Province are not distributed evenly, large volume water transportation systems from water resources rich areas to water resources poor areas through long distance transmission systems are needed to be adopted. If areas without sufficient water source presently or in the future are supplied through these transmission systems, progress of imidugudu and improvement of water supply coverage can be assured. However, these facilities require high costs for construction and also after construction, cost for operation and maintenance of water treatment becomes high. Since these costs cannot be covered by income from water fees alone, support such as subsidies from the state or district to water service providers is needed. In the future, the need for this type of large scale water supply systems will rise and involvement of the state or district will become essential.

Information Compilation

- Concerning the water supply scheme inventory presently being promoted by the Rwandan side, database required for an inventory (such as information on locations of facilities and complementary information) is not available. Information on water sources and water supply facilities prepared in this study is recommended to be used as part of the database. Also, for preparing the database, procurement of GPS equipment and training on data handling and compilation should be included in the inventory preparation project of Rwanda.

Design and Cost Estimate

- Rwanda possesses proper water supply facilities design standards, but these are not fully utilized due to insufficient capacity of staffs in charge. Since most construction and rehabilitation works on water supply facilities are being conducted without drawings, we recommend district staffs in charge to make effective use of design standards for construction and rehabilitation plans.
- Examination of water supply facilities construction/rehabilitation plans and drawings as well as supervision of construction/rehabilitation works are under the responsibility of the person in charge of infrastructures of the district. However, since this staff is always busy due to wide range of responsibilities covering many fields, a staff specialized in water supply who can focus his work on water supply only needs to be allocated.

Management and Operation/Maintenance

For smooth management as well as operation and maintenance of water supply schemes, measures to improve present conditions such as insufficient capacity of existing water users associations, deteriorated water supply schemes and insufficient management capacity need to be carried out. Also, since payment of water fees is low, residents must be sensitized and the water tariff system needs to be reviewed, then the actual water supply situation and amount of residents' affordability to pay must be discussed between the district and water service providers to reset the water tariff.

- After rehabilitation of existing water supply schemes being managed by water users associations, we recommend that districts evaluate the water users associations and consider shifting to a contracted management by private operators.
- When new water supply schemes are constructed, to ensure collaboration with residents, a community organization needs to be formed and after a few years, consideration of private management is recommended.
- We recommend that districts establish water funds to supervise and support private operators, and collect facilities use commission from private operators for scheme rehabilitations. Also, a water board should be formed as the body to manage water funds.
- When management is entrusted to private operators, understanding by beneficiaries and transparency are not ensured and also, collaboration with administration is lacking. Therefore, training of private operators on the following subjects is recommended.
  - Preparation of annual activities plan and annual operation and maintenance plan
  - Establishment of collaboration system with water supply administration
  - Acquiring legal status as water service providers and registration in social insurance

Concerning management and operation/maintenance, the Japanese technical cooperation project is supporting the improvement of the management system for water supply services and activities for strengthening the supervision and management capacities of districts are being carried out. As mentioned above, this is consistent with the policy of the technical cooperation project and is linked to the activities of the district staffs in charge of infrastructure.

Organizational and Institutional Aspects

- In order to continuously entrust management of water schemes to private operators by districts, establishment of water boards and hiring of accountants are recommended. Also, since the water fund should be used for large scale repairs, district technicians are needed. Districts need to allocate at least one person in charge of water supply before management of water schemes is completely transferred to private operators.
- Allocation of auditors by districts to audit private operators is recommended.

Sanitation Promotion Activities

- Along with construction of water supply schemes, execution of sanitation promotion activities is recommended.
- Making use of toilets which is a component of a safe living environment, promotion of hand washing practices is recommended.
- Sanitation awareness raising activities related to water and sanitation in villages through local administration, water service providers and residents are recommended.
- Sanitation education activities in schools on water use through local administration, schools and surrounding residents are recommended.

Financial and Economic Analyses

To increase the amount of water purchasing by all residents, the following are recommended.

- As a result of financial and economic evaluation of the priority projects, for the case where donors allocate the project costs, gravity scheme areas will be in the black, but in areas of pumped schemes using diesel generators, fuel costs will be high to require high water fees. However, using commercial power can clearly turn the situation into the black.
- To raise household cash income, formulation and execution of a living improvement policy in rural areas is required.
- As relief for the vulnerable who have no means of obtaining cash income, similar to the present support given for medical insurance to vulnerable households, administration needs to also give support to the water supply sector as a social welfare policy in order for vulnerable households to receive safe and stable water.

Environmental and Social Consideration

- Prior to project implementation, it may be recommended to examine the following in order to mitigate adverse impacts on the natural environment:
  - methodologies applied in land preparation works, consisting of cutting trees and excavating soil in and around project sites
  - management of waste produced during land preparation and construction works

  As for priority projects, their draft environmental management plans shown in Appendix 4 have description related to these items.
- Water supply projects have possibilities for land expropriation around the sites of the priority projects, especially for installing pipelines and constructing tanks and structures. Law relating to Expropriation in the Public Interest has to be observed for land expropriation in projects for public works. The Rwandan Government (central, provinces, districts), especially MININFRA for the case of water supply projects, is expected to encourage understanding of the Law, and clear any disturbance in the expropriation process and compensations prior to project implementation.

Master Plan Implementation Plan

To achieve the goal for 2020, successive implementation of all master plan projects is essential, but realization involves many difficulties and therefore the following points are recommended.

- For project implementation, the Rwandan side must sufficiently understand the undertakings to be borne by themselves (such as construction of access roads and inland transportation of imported materials and equipment) and organize a self-effort system.
- For proper and effective supervision of successive project implementation, further promotion of administrative reform, organizational restructuring and staff capacity strengthening in the water supply sector of Rwanda is essential.
- Self-implementation of small scale projects is highly recommended to ensure achievement of 100% coverage by 2020.