2-2 Basic Design of the Requested Japanese Assistance

2-2-1 Design Policy

2-2-1-1 Basic Policy

The followings are the basic policies on the Project under the Grant Aid scheme for achieving the overall goal which is "To increase irrigated paddy land in the Project area", and Project purpose which is "To distribute stable irrigation water to Maliana I area".

Basic policy-1: The rehabilitation plan is to be designed based mainly on the restoration of the existing facilities.

Basic policy-2: According to "Policies for WUA and O/M of Irrigation Facilities (draft)" prepared by MAFF, the purpose of establishing WUA is urged towards the irrigation projects with the rehabilitation of irrigation facilities, and subsequent plan of complete turn over to WUAs in the 11th year after their establishment. Since MAFF is striving to pursue this principle and intends to establish a WUA in the Maliana I through the implementation of the Project, the facilities are designed so that the burden of WUA on O/M can be reduced.

Basic policy-3: The raised portion by 0.7 m in Indonesian time, of the fixed weir constructed in 1972 under Portuguese regime, was washed out during a flood in 1992. Due to this damage, sufficient discharge has not been taken from the source of Bulobo River. The washed out portion, therefore, will be rehabilitated in the Project.

Basic policy-4: By the rehabilitation of the washed out portion mentioned above, it is expected that sufficient discharge from intake facilities can cover wider the irrigable area so that distribution system in such main and secondary canals can be designed to secure stable water distribution to the extended command area and to meet the cropping schedule planned by WUA.

2-2-1-2 Natural Conditions

The following will be adopted as the design criteria on natural conditions.

Policy-1: As to flood and droughty discharge conditions of Bulobo River, the results of analysis in the F/S report by the WB will be adopted as the criteria for the design in terms of data on rainfall quantity and River flow as the basis of determining scale of designed facilities, because they are in conformity with the result of interview survey towards beneficiary people.

Policy-2: The dimensions of the facilities are designed to have relevant function / structure so that the WUA can operate and manage in an economically feasible way, and inflow of harmful sediments contained in River flow into the main canal can be minimized.

Policy-3: Since rainfall is concentrated in rainy season, the working schedule is planned taking rainfall patterns of both rainy season (November to April) and dry season (May to October) into consideration.

2-2-1-3 Socio-economic Conditions

The following will be adopted as the policy on socio-economic conditions.

Policy-1: Because the existing irrigation canals are also used for domestic purpose such as washing clothes and bathing other than irrigation, due consideration will be made in formulating canal rehabilitation plan and construction schedule,

Policy-2: Since the Project area has been cultivated very close to both sides of existing irrigation facilities in the Project area, it will be designed to minimize area of land acquisition accompanying compensation for crops.

Policy-3: Assuming the existence of illiterate gate operators and group leaders, as many explanatory pictures as possible will be used in various instruction manuals, and simple ways of O/M will be pursued.

Policy-4: Employment opportunities are very much limited for younger generations resulting in the increase of unemployment in urban areas on one hand, almost all technical skilled labor has been supplied by Filipinos, Chinese and Indonesians, on the other. Further, local population is strongly conscious of their territorial defense and they have been accustomed to procure laborers from communities located around the construction sites in a rotational employment system. These situations will fully be regarded in the employment of labor force in the Project.

2-2-1-4 Farming and Irrigation Conditions

The following will be adopted as the criteria for conditions of farming and irrigation plan.

Policy-1: Since Maliana I area has a better condition of marketing and the beneficiaries in the area have intention of expanding the irrigated cropping area, the Project contributes to the overall goals of the Project, i.e." To increase irrigated paddy land in the Project area ".

Policy-2: Cropping pattern is proposed in a manner to reduce the peak water requirement by staggered puddling period within the Project area, thereby matching the period with February, the period of the maximum flow occurring in Bulobo River.

Policy-3: Cropping pattern is also proposed to efficiently intake the 5-year reliable low-flows, considering current cropping patterns, monthly flow of Bulobo River and pattern of effective rainfall.

Policy-4: Design criteria for irrigation plan is determined justifying the relevance of the cropping patterns as the above proposed and water requirement already proposed in the F/S report by the WB, also considering available intake discharge in the water source (Bulobo River) and effective rainfall.

The followings explain the reasons why the above policy are adopted:

(1) State of sale and marketing of rice (Policy-1)

According to the results of the Baseline survey shown in Table 2-4 on the status of marketing paddy, self consumption rate of paddy is around 60% and the rest 40% is sold outside of the Project area. The farmers carry their paddy to Maliana town market and some are purchased by Agriculture Service Center (ASC) in Bobonaro

district (7%).

Table 2-4 Marketing volume of paddy in Maliana I
(Total of effective reply from 34 farm households)

Form of consumption / sale	Total quantity of 34 farm households	Percentage
1.Self-consumption	52,710 kg	60%
2.Quantity sold		
1) Quantity delivered to Maliana market	28,650 kg	33%
2) Quantity sold to ASC	6,450 kg	7%
3) Quantity sold to middlemen	250 kg	-
Sub-total of sale	35,350 kg	40%
Grand Total	88,060 kg	100%

Source: Baseline survey

In addition, the beneficiary in Maliana I has a better condition of marketing with cheaper production cost, in promoting irrigated rice production within the area in future due to the fact that 1) middlemen visit Maliana town market from outside of the district, for example, other sub-districts of Bobonaro district, capital Dili, Erumera district (in western region) and further from Baucau district (in eastern region), and also 2) cheaper inputs such as seed paddy and fertilizers are directly imported from Indonesia (West Timor).

During the field survey of B/D on March 17 2005, a workshop was held to conduct an interview survey (in which 137 farmers have given valid response) where a question was asked to the beneficiaries on the expansion of cropping area in dry season in a way "If irrigation facilities in Maliana I is rehabilitated and sufficient water can be conveyed during dry season, how many hectares do you intend to cultivate in your field?" The result is shown in Table 2-5.

Table 2-5 Will of farmers' cultivation after rehabilitation

	less than 1 ha	**more than 1 ha**	no comment	Total
Actual cropping last year	62%	**26%**	12%	100%
Willing cropping after rehabilitation	39%	**54%**	7%	100%

Result was about two(2) times, 54% of beneficiaries intend to cultivate more than 1 ha with sufficient irrigation during dry season after rehabilitation, in comparison with current state only 26% at present. Although the respondents did not specify crop species, the figure proves that "they will cultivate more only if sufficient water is available in dry season, hence irrigated area will be expanded."

(2) Planned cropping pattern (Policy-2 and Policy-3)

The cropping pattern is proposed in Basic Design (BD) considering the expansion of irrigated area in which irrigated paddy cropping area can be maximized through differentiated puddling practice within the total target area of 1,050 ha in a staggered puddling period allocated to upstream (shared at 30%), mid-stream (shared at 30%), and downstream (shared at 40%). Also, this cropping pattern is adjusted in compliance with the maximum discharge of Bulobo River taking place in February, resulting in the cropping pattern shown in Figure 2-3.

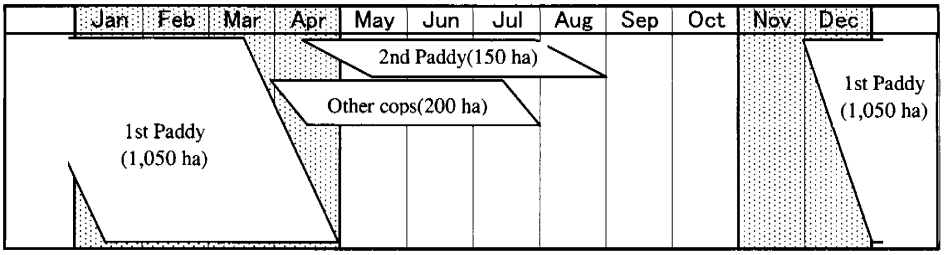


Figure 2-3 Planned cropping pattern proposed by the BD

As a result of estimating water supply for the above proposed cropping pattern, the water requirement of each crop is given in Table 2-6 (as to the detailed calculation, refer to "Appendix 5-7 Estimation of water requirement"). In this estimation, the total of planned maximum water supply is equivalent to 5-year reliable low-flows of Bulobo River.

Table 2-6 Designed intake discharge in 3-year and 5-year reliable low-flows of Bulobo River

	Rainy season, water requirement at critical period (early February) paddy area : 1,050ha upland area : 0ha	Dry season, water requirement at critical period (early July) paddy area : 150ha upland area : 200ha
1) Water requirement of paddy	1.35 m^3/sec	0.33 m^3/sec
2) Water requirement of upland	—	0.11m^3/sec
3) Water for domestic supply	0.015 m^3/sec	0.015 m^3/sec
Maximum Designed Intake Total	**1.37 m^3/sec**	**0.46 m^3/sec**
(Reference) Low flow in Bulobo River (3-year reliability)	1.67 m^3/sec	0.49 m^3/sec
Low flow in Bulobo River (5-year reliability)	1.37 m^3/sec	0.46 m^3/sec

(3) Design dimensions of irrigation planning (Policy-4)

In the F/S report by WB, design water requirements is calculated on the basis of FAO Irrigation and Drainage Paper "Crop Water Requirements". Here, the study team verifies the validity of WB F/S report based on FAO technical papers and adopted each parameter of irrigation calculation in the light of a result of field survey as shown in Table 2-7.

Table 2-7 Design criteria for calculation of water requirement

Item of parameter	F/S report by World Bank	Present view	Adopted value by study
①Crop coefficient (kc)	1) Paddy (HYV) : 1.05, 1.10, 0.95 2) Upland crop : 0.4, 0.54, 0.96, 0.98, 0.82, 0.35	Same as left	Same as left
②Crop evapotranspiration (ET_0)	Monthly value obtained by the pan evaporation method	Same as left	Same as left
③Percolation rate (paddy)	2.5mm	Up and midstream: 3.0mm Downstream: 5.0mm	Same as left
④Crop water requirement (paddy): ④=①+②+③	Maximum : 6.4mm	Maximum: 7.5 mm	Same as left
⑤Water requirement for puddling (Ponding depth : 50mm included)	1) Puddling period : 1 month 2) Water requirement (paddy in rainy season : 300mm, paddy in dry season : 250mm)	Same as left : calculation method is reviewed	Same as left
⑥Water requirement after mid drainage (paddy)	50mm/15 day after planting	Same as left : calculation method is reviewed	Same as left
⑦Effective rainfall (1953 ~for 74 year)	1 in 5 years (80 % of average rainfall above 80%)	Same as left	Same as left
⑧Irrigation efficiency: Ep = Ef×Ec	58% (There is not any distinction between the paddy and upland crops)	1) Paddy: 41.6% 2)Upland:36.4%	1)Paddy: 54.4% 2)Upland:47.6%
a) Application efficiency: Ea	Not mentioned	1) Paddy: 80% 2) Upland: 70%	1) Paddy: 80% 2) Upland: 70%
b) Canal efficiency: Eb	Not mentioned	80%	80%
c) Farm efficiency: (B.P. of tertiary canal) Ef = Ea×Eb	80% (There is not any distinction between the paddy and upland crops)	1) Paddy: 64% 2)Upland: 56%	1) Paddy: 64% 2) Upland: 56%
d) Conveyance efficiency (after improved) : Ec	72.5%	65%	85%

① Crop coefficient (kc)

The crop coefficient (kc) is used in calculation of daily water consumption for crops. It should be decided according to the growth stages of each crop and the WB F/S report has adopted those in Table 2-8.

Table 2-8 Crop coefficient (kc) used in the WB F/S report

Growing stage	Growth in the Initial stage		Development stage		Mid-season stage		Late-season stage	
Paddy (HYV) : 3.5 months	1.05	1.05	1.10	1.10	0.95	0.95	0.0	—
Upland crops (maize, beans, vegetables) : 4 months	0.40	0.54	0.96	0.96	0.98	0.82	0.35	0.0

Because the crop coefficients of paddy in the WB F/S report are accorded with FAO technical paper, this value is adopted in the Project, as a result of the confirmation by the study team. Despite the fact that upland crops show different values by crop species, water requirement of paddy accounts for the most part of overall water requirement. Taking these into consideration and for convenience of calculation, the values of WB F/S report are adopted for the estimation of crop coefficient.

② Crop evapotranspiration rate (ETcrop)

The evapotranspiration rate is influenced by temperature, humidity, solar radiation, direction of wind etc. of this project area. The following values were adopted for estimation of the rate, measured with Pan's evaporation method mentioned in the WB F/S report.

Table 2-9 Monthly evapotranspiration rate (ET_0) in Maliana I area

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Evapotranspiration (ET_0, mm)	1.4	1.2	1.3	1.8	2.2	2.9	4.1	4.2	3.9	3.7	2.4	1.5

In this context, the daily crop evapotranspiration rate (ETcrop) is calculated by following formula.

$ETcrop = kc \times ET_0$

where, ETcrop : Daily crop evapotranspiration (mm)

kc : Crop coefficient

ET_0 : Daily evapotranspiration (mm)

③ Percolation rate (Paddy)

The percolation rate is calculated by soil type. Percolation rate in Maliana I area is reported as 2～3 mm/day in WB F/S report. Also, daily percolation rate observed in this field survey by the study team is shown in Table 2-10. The maximum daily percolation rate is 2.29 mm, indicating that the adopted value of the WB is basically correct.

Table 2-10 Observation of percolation rate

Date	Upstream of Ritabau canal (0.2 km downstream from diversion point) (mm)		Midstream of Ritabau canal (1.0 km downstream from diversion point) (mm)		Midstream of Ramaskora canal (1.5 km downstream from diversion point) (mm)	
	Percolation rate	Water requirement per day	Percolation rate	Water requirement per day	Percolation rate	Water requirement per day
18 March	0.76	0.76	–	–	–	–
19 March	–	–	1.94	2.31	–	–
20 March	1.39	2.55	2.24	3.25	0.45	0.46
21 March	1.73	2.44	–	–	–	-
22 March	1.33	1.85	2.29	2.99	–	–
23 March	–	–	–	–	1.17	1.33
24 March	–	–	–	–	–	–
Maximum	1.73	2.55	2.29	2.99	0.45	0.46

Note: (－) indicates that unobserved or unreliable data.

Therefore, 3.0mm/day is adopted as the percolation rate. On the other hand, 5.0 mm/day is anticipated in the

terminal reach of Maliana I area by the reasons, i) observation data is not obtained in this study, ii) this area is not irrigated in dry season and plow sole is not well developed.

④ Daily water requirement (Paddy)

The daily water requirement is shown with the sum of above-mentioned crop evapotranspiration and percolation rate. It is derived from the following formula.

Water requirement per day (mm/day) = Crop evapotranspiration rate (ETcrop) + Percolation rate

From the observation of the percolation rate in this B/D field study and the result of the calculation of crop evapotranspiration, maximum daily water requirement shall be calculated at 7.5 mm (as of beginning of July) and 7.5 mm is adopted.

⑤ Water requirement for puddling

According to WB F/S report, water requirement for puddling is estimated (i) beginning of rainy season crops, 300 mm/day and (ii) beginning of dry season crops, 250 mm/day. Because the paddy field is puddled right after harvest of rainy season crop, water requirement for puddling of dry season crop is considered less than rainy season crops.

(a) Calculation method in World Bank's F/S report

1) Rainy season crops : 300 mm／30 days＝10.0 mm/day
2) Dry season crops : 250 mm／30 days= 8.3 mm/day

(b) Calculation method in BD period in this project

In the case of puddling certain block of paddy field, the total block is not simultaneously but differentially puddled in order to reduce peak water requirement. Given that paddy is transplanted one day after the puddling and all the blocks have been puddled within N days, net mean water requirement for puddling in N days is estimated as follows.

$$Sn = [D+d \times (N-1)]／N$$

where, Sn : Net average water requirement for puddling (mm/day)
D : Water requirement for puddling
(rainy season crops = 300 mm, dry season crops = 250 mm)
d : Daily water requirement (calculated by 7.5mm, the maximum value)
N : Number of puddling day (30 days)

1) Rainy season crops (max) : Sn = [300+7.5 x (30－1)]／30 = 17.3 mm/day
2) Dry season crops (max) : Sn = [250+7.5 x (30－1)]／30 = 15.6 mm/day

⑥ Water requirement after mid-drainage

(a) Calculation method in WB F/S

50 mm／15days＝3.3 mm

(b) Calculation method in this B/D study

Similar to the calculation for puddling, the net average water layer replacement is calculated as the following.

$$Wn = [W+d \times (N-1)] / N$$

where, Wn : Net average water requirement of after mid-drainage (mm/day)
W : Water requirement of after mid-drainage (50 mm)
d : Daily water requirement (calculated maximum value is 7.5 mm)
N : Number of mid-drainage days (15 days)

$$Wn = [50+7.5 \times (15-1)] / 15 = 10.3 \text{ mm/day}$$

⑦ Irrigation efficiency

According to FAO technical paper, irrigation efficiency is considered classifying the efficiency into 3 grades of Ea, Eb and Ec. And comparison of the applied value in WB F/S report and adopted value in this BD are shown in Table 2-11.

Table 2-11 Comparison of irrigation efficiency

Efficiency	Explanation in FAO technical paper	Viewpoint in BD study	Applied value in WB F/S	Adopted value in BD (paddy)
1) Application efficiency (Ea)	Proportion of irrigation water available to crops directly and inflow at field block intake	Loss in farm land with canal ditch	－	0.80
2) Branch canal efficiency (Eb)	Proportion of inflow at field block intake and inflow at field block district intake	Canal and conveyance loss including after tertiary canals	－	0.80
3) Conveyance efficiency (Ec)	Proportion of inflow at field block district intake and inflow from water source intake	Conveyance loss of main canal and secondary canal	0.725	0.85
4) Farm efficiency (Ef)	①Application efficiency (Ea)×② Branch canal efficiency (Eb)	Loss in farm land and after tertiary canals	0.80	0.64
5) Irrigation efficiency (Ep)	③Conveyance efficiency (Ec)×④ Farm efficiency (Ef) i. e. Ep=Ea×Eb×Ec	Overall irrigation efficiency	**0.58**	**0.544**

(4) Verified result of proposed cropping pattern and irrigation plan

View result of irrigation calculation is summarized as Table 2-12 in (i) existing cropping pattern, (ii) proposed cropping pattern in WB F/S report and (iii) proposed cropping pattern in the BD study (detail refer to attached data-1, irrigation calculation).

Table 2-12 Cropping pattern and maximum intake discharge

	①Existing cropping pattern	②Proposed cropping pattern by WB F/S report			③Proposed cropping pattern in the BD study
Target area	1,050 ha	900 ha	900 ha	900 ha	1,050 ha
Rainy season (1st)	1)Paddy: 600 ha 2)Upland: 250 ha	1)Paddy: 750 ha 2)Upland: —	1)Paddy: 600 ha 2)Upland: —	1)Paddy: 500 ha 2)Upland: —	1)Paddy: 1,050 ha 2)Upland: —
Dry season (2nd)	1)Paddy: 100 ha 2)Upland: 100 ha	1)Paddy: 480 ha 2)Upland: 150 ha	1)Paddy: 480 ha 2)Upland: —	1)Paddy: 400 ha 2)Upland: —	1)Paddy: 150 ha 2)Upland: 200 ha
Dry season (3rd)	—	Upland : 210 ha	Upland : 180 ha	Upland : 150 ha	—
Total paddy area	700 ha	1,230 ha	1,080 ha	900 ha	1,200 ha
Paddy cropping intensity	67%	137%	120%	100%	114%
Maximum intake volume	1.33 m^3/sec *1)	1.07 m^3/sec	0.97 m^3/sec	0.80 m^3/sec	1.37 m^3/sec
Target reliable year	Corresponding to 3-year reliable low-flows	2-year reliable low-flows	3-year reliable low-flows	5-year reliable low-flows	5-year reliable low-flows

*1): Actual intake water is estimated less than 1.0 m^3/sec.

2-2-1-5 Rehabilitation of Intake Facilities

2-2-1-5-1 Method of Rehabilitating Fixed Weir

Table 2-13 indicates the present situation of the fixed weir and policy of rehabilitation.

Table 2-13 Present conditions of existing fixed weir and policy of rehabilitation

Works	Rehabilitation Policy	Present Situation
1. Existing fixed weir body (constructed in 1972 Portuguese period)	**Policy-1:** Eroded part of the fixed weir should be filled with high-strength concrete, and the surface should be protected.	• Eroding is observed at the downstream end of fixed weir. But it maintains the required strength (The compressive strength is 32.4 N/mm^2, which is 1.5 times stronger than that of normal concrete, 21.0 N/mm^2.) • The surface is not damaged, and minor abrasions are observed.
2. Raising existing fixed weir (raised in 1986 Indonesia period)	**Policy-2:** Raising the weir with high-strength concrete after removing existing raised part, considering required intake discharge and headwater level.	• About 10m width of central part of raising concrete was washed out during a flood. • The strength of existing raising concrete is weak (The compressive strength is 18.5 N/mm^2, which is 0.8 times for that of normal concrete, 21.0 N/mm^2) • The adhesiveness with the body of existing fixed weir is poor.
3. Downstream apron (constructed is assumed in 1972	**Policy-3:** Constructing down stream apron with requiring length of down stream apron and creep length, for preventing piping and eroding at riverbed.	• Debris of washed out apron is observed at 30m - 50m downstream from existing weir. • At the present, eroded part with 3 m depth and 15m long at downstream, which works as "water cushion".
4. Downstream riverbed protection	**Policy-4:** Similarly, constructing riverbed protection for preventing bed erosion by the waterfall over flowing downstream apron.	• Not constructed: Risk of scouring at the downstream riverbed by drop flown over the fixed weir

In this regard, the details of the above tabulated Policy-1 and Policy-2 are mentioned below;

(1) Selection of surface protection works (Policy-1)

As the surface protection works for the fixed weir, relevance of different works, in terms of abrasion-resistant, shock-resistant, workability and cost-effectiveness, are compared as indicated in Table 2-14. As a result of comparison, "high strength concrete method" is adopted as a method of concrete work [aiming at higher strength of concrete provided with higher rate of cement content (enriched proportion) than normal concrete to reinforce the structure by coating the deteriorated concrete structures]. As to "steel plate method" proposed in the F/S study by the WB, it requires anchor fixation and accompanying measurement to cope with thermal stress, entailing in higher cost.

Comparatively, an effect of surface protection as experienced in the initial fixed weir concrete in Maliana I can be expected in "high strength concrete method", and this method does not require any particular technique, meaning cheaper cost. (reference: Table 2-14 Comparison of surface protection works)

(2) Height of raising (Policy-2)

The top elevation of the upper crest of the fixed weir is calculated in the following, at EL. 254.40m, thus raising 0.70m will be required as mentioned in the request report from MAFF Timor-Leste.

The top elevation at upper crest of the fixed weir = water level required in the main canal + head loss at sediment basin + head loss at intake work + freeboard

= WL. 253.95m + 0.13m + 0.22m + 0.10m

= EL. 254.40m

Table 2-14 Comparisons of surface protection works

Item/Works	Masonry method	Steel plate method	Elastic plate method	Vacuum concrete method	High strength concrete method
Outline	Cut stone, wedge stone and quarry stone are used as usual. It is constructed filling to substrate concrete.	Steel plate is fixed to bottom concrete by anchor and weld. The steel plate can be removed by thermal stress. It can be waved by the impact of pebble and boulder and abraded partially.	The polyurethane elastic plate is fixed substrate concrete by anchor and weld. Anchor is used to joint with concrete. If anchor was spoiled, protection material can be lost.	It reinforces the strength of concrete with vacuum process that is to reduce the moisture of the concrete after concrete cast in immediately. Usually, the strength and abrasion proof will be increased 20 to 30%.	High strength concrete is low W/C ratio concrete. It needs more cement. It will be more effective to use smaller aggregate.
Abrasion-resistant	If high quality pieces of stone are used and filling to substrate concrete is enough, it shows high abrasion proof. ◎	It shows high abrasion proof with proper fixation of the anchor and measurement to thermal stress. ◎	It shows high abrasion proof with the proper fixation of the anchor. ◎	It has very high strength and good abrasion proof. ○	It has enough strength than ordinal concrete (Fc = 21N/mm^2) comparatively. Abrasion proof is high. ◎
Shock-resistant	If high quality pieces of stone are used and filling to substrate concrete is enough, it shows high impact proof ◎	It shows high impact proof with proper fixation of the anchor and measurement to thermal stress. ◎	It shows high impact proof with the proper fixation of the anchor. ◎	The impact proof of this method is same as non-treat concrete, thus impact proof is poor. △	It has enough strength than ordinal concrete (Fc = 21N/mm^2) comparatively. Impact proof is high. ○
Workability	It is difficult to get skilled labor. Processing of stone is unworkable. △	It is needed to weld the anchor fixation. Workability is not high. △	The anchor is filled in elastic plate in factory, it is not needed to weld at construction site. Therefore workability is high. ◎	To handle not harden concrete, it is needed proper preparation and skill of technicians. Workability is low. △	It can be cracked caused by rich mixed concrete. It needs to treat well after cast in concrete. ◎
Cost-effectiveness	Bit expensive ○	Expensive △	Very expensive △	Cheap ◎	Cheap ◎
Sample	None in recent.	・Minowa head work ・Hanishina head work ・Nisiiwasaki head work ・Kawai-Hanishina head work	・Shin-kinomata head work ・Inuyama head work (Partially Improved)	None in recent	・Kansagawa head work ・Kaisei head work ・Iwasaki head work ・Asuwagawa head work ・Yokoe head work ・Ishibe headwork
General Evaluation	It is expected effective as surface protection. But, skilled labor and good quality stone is difficult to prepare. And recent experience is less. ○	It is needed anchor fixation and measurement to thermal stress. The cost is expensive. ○	The cost is very high. △	The cost is low, but the effectiveness of surface protection is not expected. And it is required special skill for construction. △	Special skill is not required. The cost is also cheap. It is expected to effect as surface protection. ◎

2-2-1-5-2 Countermeasures for Sedimentation

In the light of what is indicated in the Basic policy-1 for implementing the project under the Grant Aid scheme, regarding "the specification and the scale of the facilities that WUA can operate and maintain at economically reasonable basis", the principles to cope with sedimentation is established as follows:

Policy-1: to stabilize gut (line of River-flow inside the stream) of Bulobo River and install a scouring sluice gate in order to secure sufficient water intake.

Policy-2: to reinforce the body of scouring sluice preparing against the collision of boulder flowing down during floods.

Policy-3: to install an intake gate to control inflow of harmful sediment into the main canal at the minimum level, at the same time, the existing sediment settling basin is rehabilitated where the scouring gate is renovated.

Policy-4: to completely renovate the dilapidated canal intake the operation of which is currently difficult.

The following explains the reasons why the above policies are adopted;

(1) Necessity of maintaining gut (line of River-flow inside the stream) and selection of scouring sluice type (Policy-1)

① Necessity of maintaining gut

Currently irrigation water is taken in from Bulobo River by training gut towards the intake weir through a masonry guide wall diagonally traversing the streambed. However, due to water leakage from (dry masonry) guide wall and insufficient cross-sectional area of flow caused by sedimentation inside the present gut, quantity of intake is limited to the extent of only 50 to 70% of total River flow whenever the flow is depleted under the current state of gut. Also, if the guide wall (by dry masonry) is partially demolished by flood and the present gut lane is consequently buried with sediment, the intake will not well function to lead River flow into the canal. This is the reason why a scouring sluice that prevents inflow of sediment has to be installed keep stable intake of irrigation water from the streams like Bulobo River.

② Prevention of sedimentation at intake weir

Flood flow of Bulobo River contains large quantities of harmful silts (above 0.3 mm in diameter), the concentration of which is estimated to reach 0.04% in rainy season and 0.01% in dry season. It follows that irrigation water taken in also contains much silts, and assuming that the designed quantity is taken into canal, quantities of intruded silts taken into the canal is estimated at 2,700m^3 in rainy season, +210m^3 in dry season, totaling at about = 2,910m^3 (refer to the reference 5-8 on "Examination of sediment control works").

Intrusion of sediment silts cannot be prevented at the existing water intake without scouring sluice gate, so a large quantity of silts is flowing into canal along with the intake of irrigation water. Currently, demolished part of dry masonry guide wall and dredging of gut play complementary role of scouring sluice, thus intruding silts at intake may more or less be reduced, but still fairly large sedimentation is estimated at 80% in rainy season (around 1,520m^3) and at 60% (about 80m^3) in dry season, amounting to an annual total of 1,600m^3 (refer to Appendix 5-8 "Examination of

sediment control works").

The weir with a scouring sluice can reduce intrusion of silts by the proper operation of sluice. Thus, sediment intrusion into the intake is estimated at 20% in rainy season (around 540 m^3) and at 7% (about 15 m^3) amounting an annual total of about 555 m^3.

③ Selection of the type of scouring sluice

As shown in Table 2-9 "Comparison of several types of surface protection works" was made among 1) to construct a fixed weir without scouring sluice, 2) to construct fixed weir with a scouring sluice of the gate-type and 3) to construct fixed weir with stop logs scouring sluice, and after comprehensively evaluating these, fixed weir with a scouring sluice of the gate was adopted regarding the following reasons.

(2) Reinforcement work of scouring sluice gate (Policy-2)

Bulobo River is a torrential stream with the horizontal gradient averaged at 1/50 where the flow velocity during flooding reaches about 5.0m/sec. The topography of the bank at the upstream of the weir is subject to scour / collapse where boulders with a diameter of 2.0m or so are scattered over the riverbed.

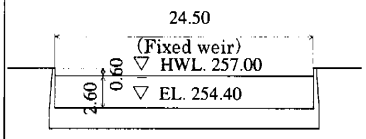
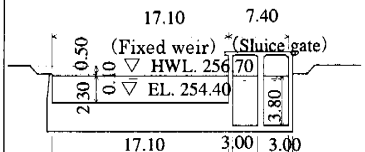
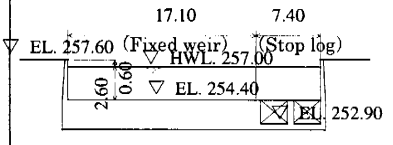
In case of constructing a gate of scouring sluice in such a torrential stream, the gate should be fully open during flooding. If the gate happens to be miss-operated to completely be closed during flooding, flowing boulders may hit the gate giving damages of deform on the gate (skin plate, main beam, roller and its axis) and guide frame. The reinforcement works shall therefore be reinforced preparing against the risk of damages by flowing boulders in the following conditions.

(3) Prevention of harmful sediment inflow into the main canal (Policy-3)

To avoid sedimentation inside the canal, it is necessary to remove silts with its diameter over 0.5mm intruded from the intake by at sediment settling basin. The existing weir without scouring sluice allows large amount of harmful silts to sediment in the sediment settling basin, estimated at around 1,330m^3 in rainy season + in dry season (around 540m^3) and at about 70m^3 = amounting an annual total of approximately 1,400m^3. According to this sedimentation, the frequency of required scouring will be estimated at about 24 times (5 days per scouring) in rainy season + about 2 times (60 days per scouring) in dry season = totaled at about 26 times / year.

Since the weir equipped with a scouring sluice can scour harmful silts, accumulated sediment in the sediment settling basin will be reduced at around 270m^3 per annum consisting of 270m^3 in rainy season + about 0m^3 in dry season. Hence, the frequency of required scouring will be estimated at about 5 times in rainy season (24 days cycle / time) + 0 time in dry season = totaled at around 5 times / year (refer to the information on "study on scouring sluice").

Table 2-15 Comparison of weir type

Items	1)Fixed weir without scouring sluice	2)Gate type scouring sluice	3)Stop log type scouring sluice
Schematic	 Front view	 Front view	 Front view
Intake of irrigation water	・Maintenance of water gut is needed. ・Intake is estimated 70% of stream flow because maintenance of river gut and guide banks is inadequate. ・Irrigation area : (Paddy rice, 5-year recurrence interval) Rainy season 750ha + Dry season 100ha = 850ha/year	・All stream flow is taken because the gut is stable and enough intake depth is kept. ・Irrigation area : (Paddy rice, 5-year recurrence interval) Rainy season 1,050ha + Dry season 150ha = 1,200ha/year	・Maintenance of water gut is needed. ・Intake capacity is estimated 85% of stream flow because dredging of gut is not enough. ・Irrigation area : (Paddy rice, 5-year recurrence interval) Rainy season 900ha + Dry season 130ha = 1,030ha/year
Design flood	・Design flood stage : HWL257.00m ・HWL is 0.20m higher than the top elevation of existing upstream revetment, so that 0.8m wet masonry protection wall is needed. ・Length of riverbed protection is 12m shorter than these of other plans	・Design flood stage : HWL256.70m ・HWL is 0.10m lower than the top elevation of existing upstream revetment, but 0.5m dry masonry wall is needed. ・Length of riverbed protection is 12m larger than these of fixed weir.	・Design flood stage : HWL257.00m ・HWL is 0.20m higher than the top elevation of existing upstream revetment, so that 0.8m wet masonry protection wall is needed. ・Length of riverbed protection is 12m larger than these of fixed weir.
Sediment inflow	Huge amount 1,610m^3/yaer	Little amount 555m^3/yaer	Huge amount 1,700m^3/yaer
Facilities size (Only comparing work type)	・Rising of fixed weir : 24.5m ・Downstream apron : 24.5m ・Downstream riverbed protection : 370m2 ・Rising of wet masonry protection wall : 105m	・Canal of sluice gate : 28.5m ・Piers of sluice gate : 3 set ・Scouring sluice gate : 2 set ・Rising of Fixed weir : 17.1m ・Downstream apron : 17.1m ・Downstream riverbed protection : 590m2 ・Dry masonry embankment : 105m	・Canal of sluice gate : 28.5m ・Stop log : 2 set ・Rising of fixed weir : 17.1m ・Downstream apron : 17.1m ・Downstream riverbed protection : 590m2 ・Rising of wet masonry protection wall : 105m
Safety	・The gate or the stop log is not set up in the river, and because it is concrete and stone construction, the safety of facilities is high.	・Reinforcing work of skin plate, main beam, roller, and roller axis is needed against boulders at a flood ・Gate full opening operation is necessary at a flood.	・Reinforcing work of stop log is needed against boulders at a flood.
Workability	・The construction of the fixed weir is easy because there is no sluice gate which has complex structure.	・Because the gate has tall gate piers, the construction of this type weir is difficult.	・Not having tall gate pier, the construction of this type weir is easy.
Yearly operation and maintenance (Only comparing work type)	・Dredging of gut : 3 times ・Embankment of guide bank : 3 times ・Sand removal of intake sand sediment basin : 26 times ・Sand removal of canal sand sediment basin : 1 time	・Operation of gate : Full year ・Dredging of gut : null ・Embankment of guide bank : null ・Sand removal of intake sand sediment basin : 5 times ・Sand removal of canal sand sediment basin : 2 times	・Operation of stop log : Full year ・Dredging of gut : 3 times ・Embankment of guide bank : null ・Sand removal of intake sand sediment basin : 27 times ・Sand removal of canal sand sediment basin : 1 time
Economical Efficiency (Only comparing work type) million yen)	Weir repair work cost ・Fixed weir repair work : 52.3 ・Scouring sluice construction : 0.0 ・Rising of protection wall : 2.9 **Weir repair work cost 55.2** (1.00) O&M cost (Full year) ・Operation of intake gate : 0.64 ・Maintenance of gut and guide bank : 1.58 ・Sand removal of both sand sediment basin : 0.33 ・Repair of facilities : 1.00 **Sum of O&M cost 3.55** (1.45) **Construction cost + O&M cost : 197.2** (1.08)	Weir repair work cost ・Fixed weir repair work : 32.5 ・Scouring sluice construction : 51.0 ・Rising of protection wall : 0.8 **Weir repair work cost 84.3** (1.53) O&M cost (Full year) ・Operation of intake gate : 0.77 ・Maintenance of gut and guide bank : 0.00 ・Sand removal of both sand sediment basin : 0.07 ・Repair of facilities : 1.61 **Sum of O&M cost 2.45** (1.00) **Construction cost + O&M cost : 182.3** (1.00)	Weir repair work cost ・Fixed weir repair work : 33.2 ・Scouring sluice construction : 33.6 ・Rising of protection wall : 2.9 **Weir repair work cost 69.7** (1.26) O&M cost (Full year) ・Operation of intake gate : 0.77 ・Maintenance of gut and guide bank : 1.08 ・Sand removal of both sand sediment basin : 0.35 ・Repair of facilities : 1.61 **Sum of O&M cost 3.81** (1.56) **Construction cost + O&M cost 222.1** (1.22)
Evaluation	○	◎	△

(4) Necessity of constructing the intake gate (Policy-3)

The intake gate will newly be constructed by the following reasons.

① The flood control

Since water depth during floods at the intake is estimated at 3.1m, a permanently open intake without gate just like the existing one has a risk of damage caused by inflow of flooded water in sediment settling basin ad main canal. It is therefore necessary to control the flood at the intake.

② Prevention of sediment inflow by floods

In the case of the existing intake weir where no intake gate is installed but the intake is always open, there is a risk of inflow of enormous silt accompanied with inflow of flooded water. It is therefore needed to control the intrusion of sediments at the intake. This is the reason why the "steel made slide gate (4-side back sealing)" will be designed for the head-works.

(5) Necessity of construction of the sediment settling basin of headworks (Policy-3)

① The size of existing sediment settling basin (13m long ×12m wide×0.9m deep ×1 set) is as follows.

(a) The depth of sediment settling basin

The effective water depth of the existing sediment-settling basin is 0.5m, in which the flow velocity is measured at about 0.3m/sec. This basin is deep enough to set sediment because the marginal flow velocity to allow to precipitate the target silt with particle size ranges 0.5 to 40mm (around 0.4 m/sec). Nevertheless, the existing basin allows to sediment only 0.2m as mean depth, and the capacity of accommodating sediment is limited to only $35m^3$. Naturally, high frequency of scouring follows to evacuate the sediment. To solve this, the mean depth will be designed at 0.4m equivalent to the volume of sedimentation at about $55m^3$, so that the frequency of scouring can be reduced. To achieve this capacity, the elevation of the bottom of the basin will be designed at around 0.3m lower than the bottom of the existing basin.

(b) The width and the number of sets of the sediment settling basin

Because the existing sediment-settling basin has the width of 12.0m with the flow velocity of 0.2m/sec, the designed width of the basin can be narrowed down to 6m. On the other hand, the sidewall at the left of existing sediment settling basin has been widely cracked and the cracks should be repaired. It will be designed to construct a new sidewall at 4.0m forward of the existing left sidewall in order to make the width of the basin at 8m after repairing. Normally, 2 sets of the sediment settling basin are constructed so that intake is made possible even during scouring. However, only one sediment settling basin will be designed similar to the existing one by the following reasons.

1) The gap of water level between the upper- and lower-stream at this intake weir is so wide, 5.4m, that scouring of the sediment settling basin is mainly made by flushing off and complementarily by manual labor. Only one set of basin exists in which it takes about 0.5 day for each scouring. Single set of basin will therefore do well for scouring from labor and time points of view.

2) Suppose scouring is tried by subdividing the sediment settling basin into more than two sets. In this case, because intake is too little, attractive force for flushing out is also weak, resulting in longer time to scour in the sediment settling basin.

3) As to frequency of scouring, about 5 times of scouring will be needed during rainy season (24 days / 1 scouring) Normally, water loss during the management of irrigation facility is equivalent to about 5% of discharge and it will be increased in rainy season only by 2%. It follows that even if the sediment settling basin is divided into 2 sets, the merit of division hardly leads to the efficient use of irrigation water

4) If the sediment settling basin is designed as more than two sets, two-story structure would be unavoidable from the sectional configuration to accommodate both intake gate and scouring, thus it becomes too difficult to design layout of canal intake gate and scouring gate.

(c) The length of the sediment settling basin

Because the required length of the sediment settling basin to precipitate the target silt diameter 0.5～40mm is estimated at about 9 m, present length of the basin, 13m is enough to meet the requirement.

② The structure of existing sediment settling basin

(a) Main body of sediment settling basin

The structure of existing sediment settling basin consists of wet masonry provided with required strength. The left-side retaining wall has however heavily been cracked by earth pressure from behind. It is therefore designed that the right-side wall is utilized as it is but the left-side wall will newly be constructed in front of the existing retaining wall. Also, as regards the bottom plate to be lowered, the existing one will be removed and newly installed.

(b) The scouring sluice facility of sediment settling basin

The existing scouring gate has been spoilt due to incomplete maintenance through corrosion of gate body and mechanical damage of hoisting roller. Therefore, existing wet masonry of scouring facility will be removed and newly replaced with reinforced concrete structure.

(6) Rehabilitation of canal intake (Policy-4)

Though the strength of concrete at the existing canal intake is sufficient, but it will be wholly rehabilitated by the following reasons;

1) The corrosion is identified at gate body and other parts of the existing intake gate of main canal. In addition, the gate operation is too difficult to adequately operate it.

2) The size of the existing gate is measured at 1.0m in width × 1.0m in height of the gate, whilst the flow velocity through the gate is too fast, 2.3m/sec, that flowing from sediment settling basin into the main canal cannot be smoothly kept. So, the newly constructed gate is designed at 1.80m in width × 1.0m in height for controlling the velocity at about 1.4m/sec.

3) The rehabilitated intake gate of the canal is designed with steel-made slide gate with manual operation to make accurate water management easier.

2-2-1-5-3 Maintaining River Channel Upstream of Weir

(1) Rehabilitating the existing protection wall

The principles shown in Table 2-16 will be applied to rehabilitate the existing protection wall for proper maintenance of River channel upstream of the intake weir.

Table 2-16 Present situation and policy of rehabilitation on river protection retaining wall

Method	Policy of rehabilitation	Present situation
1. General	**Policy-1:** At he rising portion that hasn't enough strength, joint mortar exposing wet masonry will be removed, then that part shall be refilled with new mortar	The strength of the rising mortar (9.8 to 12.6 N/ mm^2) is not enough, equivalent to only half of strength of the normal retaining wall concrete, 18N/mm^2. Lower part has enough required strength (18.7 to 23.7 N/ mm^2).
2. The foundation of River protection retaining wall at upstream of the weir	**Policy-2:** Preventing from scour, crossing tyoe concrete block will be constructed along right side bank foundations as foot protection.	There is considerable scouring by flood debris flow.
3. The River protection retaining wall right bank at upstream of weir	**Policy-3:** Existing wet masonry structure upstream side of the existing crack will be removed and rehabilitated.	It was tilted a bit to River channel and large crack is observed.
4. The River protection retaining wall right bank at downstream of weir	**Policy-4:** It will be repaired with wet masonry.	The dimension of scour is 5m in width × 3.5m in height × 1.5m in length by the dropping water from existing fixed weir.

(2) Raising elevation of the protection wall

The flood level of raised flow when design flood discharge of 310 m^3/sec (100-year reliable flood-flows) occurs is calculated at HWL 256.70 m. As the top of elevation of the existing retaining wall: EL. 256.80m is higher by 0.10m than design flood level of raised flow: HWL. 256.70m, raised portion of River protection retaining wall is not subject to scouring by floods. It is therefore constructed as shown in Figure 2-4 with embankment by earth filling surface cover is needed to avoid scouring by rain at the surface of embankment. Though turf is in general employed for the surface protection, but in this case dry masonry will be adopted because no rain is expected for six months of dry season.

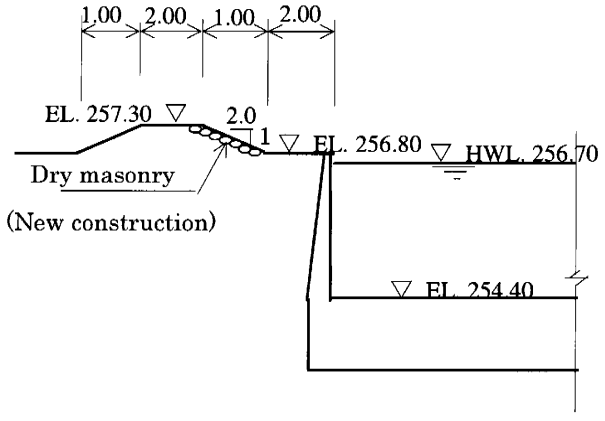


Figure 2-4 Cross section of river protection retaining wall and embankment

2-2-1-6 Length of Rehabilitating Canal and Lining Method

Policy-1: The existing lined canals are rehabilitated with wet masonry mortar method depending on their degree of dilapidation.

Policy-2: The length of lining canals will be determined by verifying the pertinence of what have been requested. As to means of construction, wet masonry mortar will be adopted.

The following is the background of the above policies of rehabilitation.

(1) Requested length of canal rehabilitation and extension

The length of canal lining and corresponding command areas among each block section of command in the request of application for the rehabilitation of the main canal and secondary ones of Ramaskora and Ritabau is compiled in Table 2-17. Of these tabulated sections, 3) and 4) of Ramaskora secondary canal and 2) of Ritabau secondary canal are those additionally requested sections of canals. The existing masonry lined canals are rehabilitated with wet masonry mortar work depending on their degree of dilapidation.

Table 2-17 Length and command area of each canal

The requested canal section for rehabilitation	Present status	Length	Irrigated command area	Ratio	Remarks
1. Main canal	Lined with masonry works	**1,530m**	1,051ha	100%	To be Rehabilitated
2.Ramaskora secondary canal					
1) Sta. 0+000 to 1+570	Existing masonry lined canal	1,570m	744ha	71%	To be Rehabilitated
2) Sta. 1+570 to 3+020	Earth lining	1,450m	425ha	40%	To be examined
3) Sta. 3+020 to 3+945 (additional request -1)	Earth lining	925m	175ha	16%	To be examined
4) Sta. 3+945 to 4+650 (additional request -2)	Earth lining	705m	120ha	11%	To be examined
Sub-total		**4,650m**			
3.Ritabau secondary canal					
1) Sta. 0 to 2+980	Existing masonry lined canal	2,890m	304ha	29%	To be Rehabilitated
2) Sta. 2+980 to 5+250 (additional request)	Earth lining	2,360m	161ha	15%	To be examined
Sub-total		**5,250m**			
Total		**11,430m**			

As regards the sections of earth canal and additionally requested sections, they need further elaboration.

(2) Comparison of flow capacity by different lining methods

The results of comparing discharge ability among the works including 1) wet masonry mortar lining, 2) clay masonry lining and 3) earth canal are given in Table 2-18.

Table 2-18 Comparison of flow capacity of each lining work

Items	1) Wet masonry mortar lining	Evaluation	2) Masonry clay lining	Evaluation	3) Earth canal	Evaluation
1.Roughness coefficient	0.025	1.0	0.030	0.83	0.035	0.71
2.Effectiveness of conveyance	0.85	1.0	0.70	0.82	0.65	0.76
General evaluation		**1.0**		**0.68**		**0.54**

Remark) Each evaluation is based on 1.0 as wet masonry mortar lining in flow capacity

As evident from the above table, provided that discharge ability of the canal lined with wet masonry mortar is 100%, those of clay masonry lining and earth canal is lower, at 68% and 54%, respectively. These values are converted into unit water requirements at critical spell (falling on early February) as shown in the Table 2-19.

Table 2-19 Comparison of unit water requirement of each lining work

Wet masonry mortar lining	Clay masonry lining	Earth canal
1.29 liter/s/ha	1.90 liter/s/ha	2.39 liter/s/ha

Then, these are converted into irrigable areas by applying terminal water requirement, as shown in Table 2-20.

Table 2-20 Decrease of irrigation area by adopting other lining in replacing of wet masonry

Canal	Block	Length	Maximum irrigation area	Reduced area by different work	
				Clay	Earth canal
1.Ramaskora secondary	1) No lining after earth lining	1,450 m	425 ha	136 ha	195 ha
	2) No lining after additional request-1 (earth lining)	925 m	175 ha	56 ha	81 ha
	3) No lining after additional request-2 (earth lining)	705 m	120 ha	38 ha	55 ha
2.Ritabau secondary	No lining after additional request (earth lining)	2,360 m	161 ha	52 ha	74 ha

Based on the results of comparison by various lining methods as shown in Table 2-21, it was found that the wet masonry lining work showed the best result. Therefore, wet masonry mortar is employed for the design of the whole sections including rehabilitation and extension.

Table 2-21 Comparisons of canal lining works

Items	Mortar wet masonry		Clay wet masonry		Earth canal	
Work	To form cross section by filling the aperture of pebble with mortar	-	To form cross section by filling the aperture of pebble with clay	-	To form cross section by cutting and filling present ground	-
Coefficient of roughness	0.025 (Rough wet masonry)	◎	0.030 (Clayey loam): Canal width is 10 % wider than mortar wet masonry.	○	0.035 (Whole grass): canal width is 20% wider than mortar wet masonry.	△
Effectiveness of convey	0.85	◎	0.70	○	0.65	△
Allowable flow velocity	2.5 m/s (Block wet masonry)	◎	0.9m/s (Clay loam)	○	0.6 m/s (Sandy loam)	△
Workability	Same method of existing canal. It is possible to hire skilled labors.	○	Availability of clayey soil is not confirmed.	○	Fundamentally, same work with the tertiary canal, farmers can construct.	◎
Cost	Little bit expensive.	○	Cheap	◎	Cheap	◎
Maintenance	No needs of maintenance unless broken, but cement is expensive.	○	Easy, if clayey soil is available.	○	The slope may slide, until grass is grown. And it needs frequent weeding.	△
General evaluation	It is easy to maintain and able to be repaired by farmers, because it is the same work as the existing canal.	◎	It is easy to maintain. In case of large fluctuation of the water level, it will be cracked at surface. Check before starting irrigation is needed	○	It needs more requirement water because cross section is wider, irrigation area is narrower and convey loss is increased.	△

From the above results, extension of lining and block is designed as in Table 2-22.

Table 2-22 Methods and length of lining

Canal	Block/ Condition	Mortar wet masonry	Earth canal	Remarks
1.Main canal	All block is lining	**1,530m**		
2.Ramaskora Secondary canal	1) Lining canal	1,570m		
	2) Earth canal	1,450m		
	3) Additional request-1 (earth canal)	925m		
	4) Additional request-2 (earth canal)		705m	To be considered as a tertiary canal
	Sub total	**3,945m**	**705m**	
2.Ritabau Secondary canal	1) Lining canal	2,890m		
	2) Additional request (earth canal)	2,360m		
	Sub total	**5,250m**		
Grand total		**10,725m**	**705m**	**(Total area in application: (11,430m)**

2-2-1-7 Appurtenant Facilities of Irrigation Canals

(1) Diversion facilities

Policy-1: Because the water source is limited to that of Bulobo River, manually operated steel slide gates are installed for the existing turn outs by which efficient and proper water management is feasible.

Policy-2: Partly because deterioration at the portion of mortar develops to the extent that strength of wet masonry structure of the existing turn outs gives about 0.6 times as strong as the ordinary strength of wet masonry, partly because of the necessity of installing slide gates in the existing structure, turn outs will be wholly rehabilitated.

Policy-3: Since present conventional turnouts are just constructed by opening holes of ϕ 100 to 300mm at the masonry sidewall of canals, they have caused heavy leakage, thus making proper water management difficult. Therefore, structure of turn out is designed to trench a guide furrow frame at a side of diversion chamber in which stop logs groove with wooden stop logs can be fitted.

(2) Scouring sluice facility

Policy-1: In order to prevent inflow of harmful sediment (the grain diameter of which is larger than 0.3 mm) into terminal of the irrigated command, it is eliminated with a sluice facility installed in the main canal.

Policy-2: The longitudinal gradient of the main canal at upstream of the scouring sluice gate is so flat, measured at 1/3,500, that scouring of silt accumulated in the main canal is impossible even if the gate were fully opened. Therefore, the longitudinal slope of canal bottom will be adjusted at 1/100 at a section of 70m upstream.

Policy-3: The existing scouring sluice facility has been dilapidated to the extent that its strength is about 0.8 times as strong as that of reinforced concrete, and corrosion is observed over the scouring gate body. It has been difficult to smoothly operate and therefore proper scouring operation is impossible. Judging from such conditions, the scouring gate is wholly rehabilitated.

(3) Drop structure

Policy-1: The existing drops worked with wet masonry the strength of which has been deteriorated have to be rehabilitated, but others with enough strength are used as they are.

Poicy-2: The drops without any existing water cushion floor are wholly rehabilitated.

Policy-3: Because a fatal accident of a child took place at a drop (Ritabau secondary canal, at STA.1+025) installed amidst a residential area, an anti-accident fence will be installed enclosing this drop.

(4) Other appurtenant facilities

Policy-1: The existing concrete bridges are partially repaired since no exfoliated portion is observed over the major body thereof.

Policy-2: A wooden pedestrian bridge (Ritabau secondary canal, at STA.0+580) is wholly be renewed with reinforced concrete accompanying with rehabilitation works on canal since it has been in a dangerous state owing to

dilapidation.

Policy-3 : As to the existing drainage crossing works, inlet parts and crossing works (corrugated pipe ϕ=1,000mm) are continuously used as they are, though the outlet parts have to be reinforced with lining by wet masonry works because they are already scoured.

Policy-4: The existing washing basin is continuously used as it is but only the joint mortar of wet masonry and the surface mortar finish are repaired.

2-2-1-8 Wet Masonry Retaining Wall at Aqueduct

(1) The wet masonry retaining wall works of right bank

Policy-1: The upstream section that has been cracked, about 8 km long at right bank, is wholly rehabilitated by the removal of existing wet masonry.

Policy-2: The midstream section that has not been subject to any damage is continuously used as it is.

Policy-3: The downstream section around 7 km long where the wet masonry retaining wall work has been collapsed is wholly rehabilitated by the removal of existing wet masonry.

Policy-4: Foot protection block is newly installed in front of wet masonry retaining wall against scour and subsidence of riverbed.

Policy-5: Back-soil filled at the crest of the retaining wall is covered with wet masonry against scour by overflow at floods.

(2) Wet masonry retaining wall works of left bank

Policy-1: Retaining wall works at left bank is newly constructed with wet masonry for preventing slide on the slope.

Policy-2: Foot protection works (by crossing type concrete block) are newly constructed at left bank to prevent riverbed scour in front of the wet masonry retaining wall.

(3) Aqueduct

Policy-1: Water leaking from the joint at left bank is sealed with elastic sealing work.

Policy-2: The partly broken wooden deck will be restored with new material.

2-2-1-9 Building Facilities

Policy: Out of the building facilities to construct requested from Timor-Leste, the storage depot to accommodate equipment and gate keeper's hut are included in Grant Aid element, while storage house and dry flour are excluded there from.

(1) Storage for O/M equipment: (the requested Japanese assistance)

① Purpose of using storage for O/M equipment

Main purposes of utilizing storage for O/M equipment are shown in Table 2-23.

Table 2-23 Utilization purpose of Storage for O/M equipment

Purpose of Utilization	Detail of Utilization
1) A storage for O/M equipment	This depot serves as a storehouse for intake gate-body/key, handles of turnouts, grease, recoating paint for gate body and conventional off-takes etc., and is also used as space to accommodate various manuals, safe to keep collected water fee etc.
2) As space to hold meetings	The building is used as space to hold meetings including the following: ① Holding workshops for deploying planned soft-component, ② Registration works of water fee collection ③ Agreement on the date of beginning irrigation, consultations on water rotation and solution of disputes on water distribution, ④ Consultations / discussions on schedules, methods and burden-sharing of regular drainage works for canals, managerial and maintenance works including weeding ⑤ Consultations / discussions on repairing works of canals/drains, burden-sharing and means of collecting water fee, etc.

② Significance of establishing storage depot for keeping equipment and its multi purpose use

1) The storage for O/M equipment shall function storage space for parts of intake and offtake facilities including intake gate body and key, handles of turnouts, wooden stop log sets of conventional turnouts, grease for O/M, recoating paint for gate body and operation manuals. It shall be built for a facility of accommodating equipment fixtures procured by the Project.
2) MAFF is to establish WUA in response to improvement of Maliana I irrigation facilities complying with t policy for WUA and O/M of Irrigation Facilities (draft)". In addition, IWMD staffs shall have discussion with beneficiaries in collaboration with Governor of Bobonaro district, village chiefs of Maliana I areas for WUA establishment. Board members of WUA will also be elected whenever the agreement is reached with beneficiaries. In other words, in Maliana I Irrigation facilities, water fee will later be collected so that they can be maintained and managed by WUA. This is why the necessity as mentioned in Table 2-23 arises and by this reason it is planned to secure enough scale and structure to provide the space for holding meetings of WUA in addition to the function of accommodating equipment and parts /fixtures.

(2) Gate keeper's hut: (the requested Japanese assistance)

The gate keeper's hut is essential for operation and maintenance for newly installed scouring sluice gate, intake gate, scouring gate of sediment settling basin and canal intake gate. Especially, it is necessary during flooding in rainy season to occasionally open and close them depending on stream flow. Gate keeper's hut shall be established aside diversion weir because the scouring sluice gate is installed in the river channel and it requires stationed operation by gatekeepers to cope with sudden floods during rainy season. Hence, the hut shall be covered under the Grant Aid scheme.

(3) Storage shed: (Out of the requested Japanese assistance)

There are 4 paddy-storing facilities on the scale of 1,500 ton around Mariana I area. While two of them have regularly been used by ASC, another one has been used only during the harvest period in rainy season, the rest of them has been owned by MAFF, but has not been utilized since 2002. Whereas WUA of Marco irrigation scheme in Bobonaro district, payment of water fee in paddy has not been practiced and it doesn't have storage shed either. Accordingly, it is appropriate to exclude establishment of storage shed from target component of Grant Aid scheme by the reasons of uncertain utilization of requested storage shed at the present moment, including possibility of diverted use of existing storage facilities, the fact that WUA is not yet established as of now, pending state as to collection method of water fee.

(4) Drying floor: (Out of the requested Japanese assistance)

It is desirable to establish the drying yard nearest to storage shed because drying yard is to be used to dry paddy before storing it in storage shed. So far as the validity of establishing storage shed is not recognized, drying yard shall also be excluded from Grant Aid scheme.

2-2-1-10 Construction and Equipment Procurement

Policy-1: In collecting aggregates and stone materials, operation and procurement plans are formulated in a way that regulations and traditional habits are observed.

Policy-2: Method of construction is elaborated so as to minimize compensation on crops and land occupation, as well period of breaking irrigation water.

Policy-3: As to the procurement of equipment / material and construction machinery, suppliers / place of procurement are decided in due consideration on the situation prevailing in Timor-Leste with very short period elapsed after independence, the scale, content, kind, quantity, deadline and economy of the works.

Policy-4: Workers to be employed in construction works are planned to combine technically skilled laborers from the third countries with local ordinary workers.

Policy-5: A policy will be followed in procuring / manufacturing steel gates to ask a southeast asian producer firm to import produced parts of Japanese specification standard from Japan and to assemble them at the site, considering that WUA will maintain and manage them in future.

The following is the background of the above policies of rehabilitation.

(1) Various environmental factors affecting the construction works (Policy-1 and Policy-2)

① Collection of stone materials and production of aggregates for works

Concerning the collection of river aggregate and stone materials, an Environmental Guideline (draft) has been reviewed for its enforcement in Timor-Leste. Out of which, the part related to this Project is in "Guideline No.2: Mechanical extraction of sand and gravel from riverbeds and quarries". This guideline stipulates prohibition of installing a stock yard within the river basin, that of change of watercourse causing a probable bank erosion, boundary identification and notice of area for extraction, restriction in extracting fluvial gravels, etc. Also, prior to sand and gravel extraction, it is required to explain the extraction plan to the personnel of local authorities and communities and to consider the employment of local population for the extraction works of materials.

② Compensation to be occurred by the works

(a) Compensation for agricultural crops and land

It is designed under the policy to minimize the acquisition and occupation of the agricultural land but maximize those of non-cultivated land and/or moorland, however, it is required to make due compensation on the standing agricultural crops in the case that the Project utilizes land under cropping. Also, though it is not necessary to acquire the large-scale land nor to deforest, some agricultural land acquisition and resulted compensation will be inevitable when the access roads are to be constructed for the transportation of equipment and materials for the rehabilitation works, for it was found that the agricultural land has been extended to very edge of the existing irrigation facilities. To minimize the adverse impact on compensation, it is also planned to minimize felling of existing stands and crops as well to employ the manpower in place of mechanical means for the works as far as possible.

At present, in Timor-Leste, laws concerning the land ownership, legal procedure for land acquisition, expropriation and compensation for public works are not well established legally. Moreover, basic data for the legal land ownership, tenancy or usufruct, easement right along with cadastral maps, land registration book and etc. have been lost. Thus, legal rights in terms of land ownership, usufruct / tenant are not legally secured, but land usage and occupation are customarily accepted through agricultural activities. It is understood that the land acquisition and expropriation is needed to proceed case by case, asking Maliana sub-district office or Bobonaro district office of MAFF for necessary mediation whenever necessity thereof arises.

(b) Restricted water supply of agriculture activities and livelihood

The water supplied through existing irrigation canals is used for not only for agriculture purpose but also for livelihood such as washing clothes, bathing, etc. As the length of irrigation canal to be rehabilitated would be so long as around 10km, temporary arrangement of drainage facilities instead would not be realistic. Thus, the implementation of rehabilitation works is planned to carry out in as much short period as possible with the minimum break of water supply. In the central part of Maliana town, the pipeline for public water supply has been installed underground along the canals to be rehabilitated for the Project. In the implementation plan, proper method shall be considered so as not

to cause any damage to those pipeline facilities.

(2) Procurement of material/equipment and labor force for the construction (Policy-3 and Policy-4)

① Transportation routes for the mobilization of materials and equipment

There is a route for the transportation of materials and equipment for the Project from Dili Port to Maliana town, that is the National Road running along the coastal area westward from Dili up to Batugade town located just confronting the boarder of West Timor in Indonesia, then turn southward towards inland over the 500m height highland and then reached to Maliana town. Total distance covers 143 km and it takes for 3.5 to 4 hours by 4WD vehicle. The route has curves with large radius and with less unevenness of surface where 20t-trailer is able to pass through. Hence, no problem is judged to happen as far as transportation from Dili to the construction site is concerned.

② Procurement of materials/equipment

In Timor-Leste, any manufactured products have not domestically been produced but imported and there are small stocks of common construction materials in the market. Those items are imported from Indonesia, Australia and Singapore for the sale in the market. In case large quantity is required, it will be economical to import them directly from abroad. However, this project may require procurement in small quantity or on the spot, and then it would be inevitable to procure materials from local market stock in Timor-Leste. The specific materials and equipment (such as large size section steel materials, steel gates, construction plant, testing instruments etc), which are not usually handled by local suppliers, are planned to import directly from Indonesia or from Japan. Procurement sources shall be determined taking account of the quantity, delivery time and costs based on the market survey.

③ Construction equipment and plant

In the past, as a large number of construction equipment and plants had been imported for the emergency rehabilitation projects, those common civil construction equipment and plants are usually available for rent in the market of Timor-Leste. After the stabilization of chaos on independence, civil construction activities were sharply increased for the implementation of emergency rehabilitation projects and the construction equipment and plants were imported to meet the demand of increased works. At that time due to the lack of rental market, it caused high rental market and high level of rental cost has been maintained up to now.

Taking account of the nature of works and the size (less quantity and short construction period) of the Project, it is appropriate that the common civil construction equipment and plants are planned to procure in local market. As specific equipment and testing instruments will be imported from Indonesia, Australia or Japan, the procurement source will be determined based on the comparison with delivery time, transportation methods (charter ship or regular liner ship) and transportation cost in each source.

For the specific equipment to be used for only 2-3 months, total equipment cost including overseas transportation cost would come to expensive. Therefore, it is more economical that such equipment, with even a high rental fee, should be procured in local market or from nearby country such as Indonesia.

④ Labor force for construction

As the employment opportunity for young generation of 20-years old and younger who cover 50% of population are quite limited especially in Dili and other cities as well, the job less are increasing. On the other hand, according to the experiences encountered by the contractors who are now implementing or have implemented the project in the past, almost all of experienced engineers and technicians having high technical knowledge or techniques are dominated by Filipino, Chinese and Indonesian and there are quite less experienced local engineers or technicians.

In the local region, there exist strong customary practices in the communities that construction manpower is to be employed from the communities in and around the project area in the manner of rotation. Therefore, the experienced manpower could not be kept employed continuously and the efficiency of work or productivity used to be low. However, this manner can give the job opportunities to the communities in and around the site. Thus, in the plan of the Project, it is proposed to hire experienced foreign technicians in combination with local laborers.

(3) Manufacture and procurement of steel gates

The existing steel gates have been operated for approximately 15 years but at present are not operable because of dilapidation by rusting on gate leaves, guide frames and spindle bars and as well as rusting and damages on gear portions in the hoisting device. Taking account that WUA is responsible for the future O/M of the facilities as a principle of this Project, the proposed gates to be procured should stably be functional, operational and durable as well as economical for O/M. It is decided to plan the gates, which comply with the specification applied in Japan for this project, after comparing the gates that are popular in Japan with those available in Southeast Asia having similar function to the existing gates in the intake facilities of Maliana I Weir. The results of comparison are shown as below Table 2-24. From the aspect of costs, the steel gate makers operating in Southeast Asia could supply the cheaper gates by procuring and assembling body and parts imported from Japan.

Table 2-24 Comparison of function of gates (Japanese specification and South-east Asia specification)

Items	Japanese Specification	Southeast Asia Specification
Hoisting Device	1)Type : manual with rack type 2)Protection : cast iron enclosed structure 3)Drive method : manual 4)Material : cast iron Rustproof, durable, long-operable, less power for turning, only periodic lubrication for O&M	1)Type : manual with spindle type 2)Protection : open structure 3)Drive method : manual 4)Material : steel Operation becomes worse year by year, 10-15 years duration, frequent lubrication required
Lifting Bar	1)Type : rack bar type 2)Materials : stainless steel Rustproof, durable, long-operable, More than 30 years duration, non-lubrication	1)Type : spindle 2)Materials : mild steel Operation becomes worse year by year, 10-15years duration, frequent lubrication required
Gate Leaf	1)Materials : mild steel 2)Seal holder : stainless steel 3)Water tight seal method : rubber seal Better-paint quality, rustproof, durable, better-water tight sealing, more than 30 years duration	1)Materials : mild steel 2)Seal holder : mild steel 3)Water tight seal method : rubber seal Easily rust, 10-15 years duration, frequent painting required.
Guide Frame	1)Materials : mild steel/stainless steel 2)Rail : stainless steel 3)Water tight seal method : rubber seal Rustproof, durable, better-sealing, more than 30 years duration	1)Materials : mild steel 2)Rail : mild steel 3)Water tights Seal method : rubber seal Easily rust, 10-15 years duration, frequent painting required.

2-2-1-11 Employment of Local Contractors

There are around 10 contractors who possess a numbers of engineers and who are eligible for a main contractor. Among them, there are no companies with 100% of capitals owned by Timor-Leste nationals, but there are those owned by Australian, Singaporean or Indonesian nationals. In addition, as of March 2005, there are 5 Japanese contractors experienced in Timor-Leste, namely Tobishima Corporation, Dai-Nippon Construction Co., Ltd., Toa Corporation, Wakatsuki Construction Co., Ltd. and Mirai Construction Co., Ltd. They have involved in the construction works mainly such as roads, irrigation facilities, ports and schools.

Their head offices are all located in Dili City, having stock of construction equipments (general construction equipment, concrete plants, crushing plants, asphalt plants, etc.) in Dili and mobilizing their construction equipment to the sites depending on the necessity. Materials suppliers and equipment rental companies are also situated in Dili City. For the projects in local region, they set up main project office in Dili city and set up the temporary offices and temporary construction facilities on the site. Japanese construction companies used to employ some of these local contractors for the projects depending on the nature of works. Also in this Project, it is planned to actively employ the suitable local contractors depending on the kinds of works.

2-2-1-12 Ability on Operation and Maintenance of Implementing Agency

Policy: Timor-Leste suffers from shortage of human resources and insufficiency of their capacity in the ministries and other Government organizations since only a short period has elapsed after its independence. Because problems are observed in the way of instructing operation and management of irrigation facilities and water management to farmers' organizations etc. by MAFF, under such circumstances, it is planned to introduce a soft component plan as an Grant Aid scheme, so as to instruct on the managerial fortification of WUA and methods of water management through the irrigation facilities to be rehabilitated.

IWMD headquarters under MAFF has one(1) water management advisor. Also, Bobonaro agriculture office has three(3) fulltime officers for O&M of the Maliana I irrigation system, i.e. a District Agriculture Coordinator (DAC) as the head, a District Irrigation Officer (DIO), and an officer in charge of WUA strengthening. It is possible to efficiently utilize these human resources.

Nevertheless, these human resources, especially staff working in the Bobonaro agricultural office are not fully equipped with knowledge on strengthening organizations, O/M and water management, in acute need of capacity building. In this context, it will be difficult to secure enough budget to fully instruct them judging from the amount of O/M cost that MAFF will input to Maliana I irrigation system. Under such circumstances, early materialization of the envisaged effect of the rehabilitated irrigation facilities is expected through efficiently strengthening WUA to be established by means of introducing soft component plan into a financial umbrella of the Grant Aid scheme by Japan.

2-2-1-13 Determination of Grades for Facilities and Equipment

The Project aims at rehabilitating the lost, raised portion of the fixed weir of Maliana I intake facilities with a basic policy of rehabilitating the facilities in a proper scale and structure that can economically be managed and maintained by WUA to be established.

As to intake facilities, beneficiary (WUA) has been forced to regular practices including 1) reconstructing and dredging works of dry masonry guide wall, 2) manual evacuation of sediment on account of broken and dysfunctional gate of sediment settling basin and 3) dredging works of excessive sediment accumulated on canal bottom caused by insufficient sediment preventing function at headworks. Therefore, in order to alleviate such heavy labor to a maximal extent, not only a scouring sluice gate is installed but also the existing mal-functioning gates are rehabilitated. As regards manufacture and procurement of gates, appropriate method is adopted in such a way that they are enough workable and durable, saving of labor and cost of O/M can be expected and eventually their operational functions can last for more than 30 years by applying relevant maintenance and management.

As concern canal facilities, the existing lining is planned to rehabilitate with wet masonry mortar works so that WUA can maintain, manage and repair for a long period, along with lining of earth canals for the necessary length by the same method in order to provide a distribution system to efficiently irrigate up to the terminal border of the command area.

2-2-1-14 Construction / Procurement Methods and Construction Periods

Policy-1: Aggregates and stone materials are collected from three streams running near the construction sites.

Policy-2: The maximum average discharge in dry season is taken into account in determining design flood discharge for temporary works.

Policy-3: Existing public roads are utilized as the road for temporary works, keeping access to water intake facilities and irrigation canals, where widening the roads is worked whenever necessity arises.

Policy-4: In order to make the impact on land acquisition of the land along the irrigation canals minimum, the rehabilitation works are designed mainly be means of manual labor, but in the sites where automobiles are accessible, small sized dump trucks (4t class) are used.

Policy-5: To meet the necessity of completing the planned works within a short period, two(2) sections are delineated and three(3) temporary work yards are planned to establish.

Policy-6: Works with coffer dam and temporary diversion channel are employed for the temporary works of intake facilities.

Policy-7: It is planned to establish an aggregate supplying plant to prepare aggregates for concrete works because substantial quantities thereof is required for construction works.

Policy-8: The scale of consolidating infrastructure required for the management of construction works is determined considering the current status of public facilities.

Policy-9: Construction period is determined adopting a plan of efficiently concentrating the works on dry season for those of riverbed structure such as intake weir and rehabilitation of canal facilities.

(1) Procurement of stones and aggregates (Policy-1)

It is planned for the Project that necessary stones and aggregates shall be procured from the Contractors who collect them from nearby three riverbeds. Sand, gravel and stone materials suitable for the Project will be available from three rivers (namely; Bulobo, Sosso and Nunutra Rivers), consisting of kind of limestone and sandstone. Generally in Timor-Leste, the coarse aggregates suitable for the concrete are to be produced by collecting gravel and stone from neighboring rivers and the mechanical screening and crushing, and fine aggregates suitable for the concrete are available from the alluvial bed material by screening smaller size of sands. Surface concrete works with high strength concrete (35 N/mm^2) are planned to design in the revetment surface concrete for the weir body, it is judged possible to domestically manufacture it according to the survey on the performance of concrete casting. Stone materials for masonry works are planned to obtain from these three rivers, as it was found that there are enough quantities with suitable size and shape required for the Project.

(2) Design flood discharge for applying to temporary works (Policy-2)

Dry season in West region where Maliana town is located ranges for 6 months from May to October, with annual rainfall of approximately 2,000 mm. The flow discharge of Bulobo River, required for designing the implementation plan for the temporary cofferdam, temporary diversion canals and etc. are estimated by the following results of floods analysis: Design maximum discharge to be applied to the period of above mentioned works is set at 5.0 m^3/sec with approx. three(3) of safety factor versus mean flood discharge of 1.4 m^3/sec during the period of temporary works (June to October).

(3) Temporary works

① Temporary roads for the works (Policy-3 and Policy-4)

As to temporary roads, seventy percent of the total length of canals to be rehabilitated is located along the existing public roads, so access to the canals to be rehabilitated is ready for the planned works, but the width is widened as need arises. On the other hand, the rest 30% thereof are located amidst farmland and privately owned land, and necessity arises to pass through these grounds to have access to the canals to renovate. In order to minimize land expropriation and other problems, it will be planned to use as much manual works as possible. Where the construction vehicles are accessible, the small sized dump trucks (4t class) that are popular in Timor-Leste will be used. It is planned that following temporary roads for works are to be constructed considering the size of rehabilitation and repair works.

1) An access road necessary for transportation of equipment and materials to the location of intake weir facilities: It shall be ensured that the width of road shall be enough for allowing 4-ton dump trucks to pass. It is planned to reuse existing earthen roads constructed under Indonesian age with repairing and improving their damaged surface and alignment.
2) An access road for transportation of equipment and materials necessary for rehabilitation works of irrigation canals: It is planned that few access roads are to be constructed covering from the existing public road to above-cited access road to the sites of rehabilitation works. The proposed access roads shall be secured with the

enough width for manual transport of materials / equipment.

3) An access road for transportation of equipment and materials necessary for the works of riverbanks and bed protection at aqueduct bridge area: a temporary access road is planned covering the area from downstream abutment of aqueduct to the riverbed to be rehabilitated.
4) Access roads for rehabilitation works of canal around Sta. 600 to 700 in Ritabau secondary canal route: The existing village roads are to be improved and used.
5) For the access to other areas to be rehabilitated than the above, the existing public roads will be used.

② Temporary work yards /temporary buildings (Policy-5)

Proposed rehabilitation and improvement works can be divided into two(2) sections, namely 1) rehabilitation and improvement works of intake weir facilities and main canal, and 2) secondary canals rehabilitation and improvement works and construction works of building, in terms of location, size and nature of works. Likewise, in order to secure the completion of planned works within a short period, it is planned that both temporary yards and temporary facilities with similar content and scale shall be provided at three locations, and out of these three yards, two concrete manufacturing plants are established in two sites so that one of them can be substituted with the other even if any trouble happened in either side.

Temporary yards and temporary facilities are planned at the following locations;

Yard ① To be located at left bank on the upstream side of the head-works. To be used for facility ground including concrete plant, material depot and warehouse.

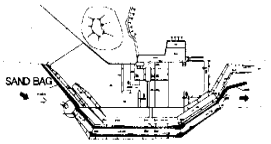
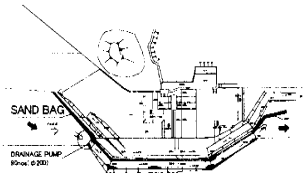
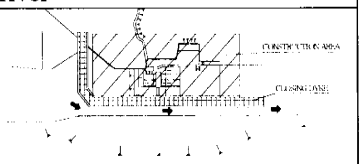
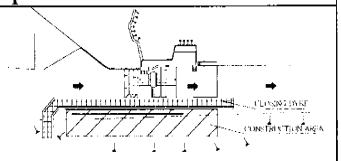
Yard ② To be located around the turnout structure between main canal and secondary canal. To be used for facility ground including concrete plant, material depot and warehouse.

Yard ③ To be located at left bank on the downstream side of the aqueduct. To be used for facility ground including material depot and warehouse.

③ Temporary works for intake facilities (Policy-6)

On the construction for the structures of intake, weir, aprons and scouring sluice gates, it is necessary to dry up riverbed of Bulobo River for securing suitable working condition for the works by providing temporary river closure and diverting river flow. After the comparison with three alternatives as shown below Table 2-25, it is concluded that temporary river closure and diversion canal will be applied because they are more economical and workable method for the implementation. As the works for weir and aprons structures and riverbed protection are expected to conduct below the water level of riverbed, it is planned to provide dewatering systems (shallow sump and dewatering pipes) at both upstream and downstream of the section for works so that water is evacuated with submersible pumps (refer to Figure 2-5).

Table 2-25 Comparison of methods of river closure and river diversion

No / Method	No.1: Temporary closure and diversion canal	No.2: Temporary closure and discharge pumps	No.3: Closing of half width of river
Sectional View			
	Closing temporarily and diverting through canal	Closing temporarily and using pumps	Closing half width of river: Step-1
	Refer to section B-B as attached Figure 2-1-14.1		
	Section of Temporary diversion canal		Closing half width of river: Step-2
Outline	To construct a closure dike crossing river width at upstream of existing weir, and to divert water through the diversion canal to be constructed on the right bank of river	To construct a closure dike crossing river width at upstream of existing weir, and to discharge water using the temporary pumps to downstream of river.	To construct a temporary dike along the center of the river and to lead water to the either side in order to construct one half of weir, then to conduct it alternately.
Workability	Only require common construction equipment, special technique is not required.	Allow quicker construction. Require the dewatering system such as discharge pumps and pipes.	Weir and scouring sluice gate should be constructed at the same time. If not, works could not be finished during the dry season. Therefore, this method is not realistic.
Construction Period	Comparing with No. 2 method, it takes longer time for temporary canal construction.	Comparing with No. 1 method, the construction period would be a little shorter.	
Sureness	If a closure is properly constructed, dewatering would be able to be surely done. As enough working space could be secured, favorable progress of works would be achieved.	Enough capacity of pumps to be placed in order to have suitable performance to meet the river discharge volume. However, in case of failing in pump operation such as power failure, the system would cease operation. Therefore, it is necessary to maintain and control generators and pumps very carefully day and night.	
Cost	*Closure: embankment, sandbags. *Diversion canal: wet masonry, earthwork *Temporary roads, etc. Cost : US$ 51,000.-	*Closure: embankment, sandbags *Dewatering: Piping, pumps, generator, operation cost (period: more than 150 days) *Temporary roads, etc. Cost : US$ 958,000.-	Not acceptable.

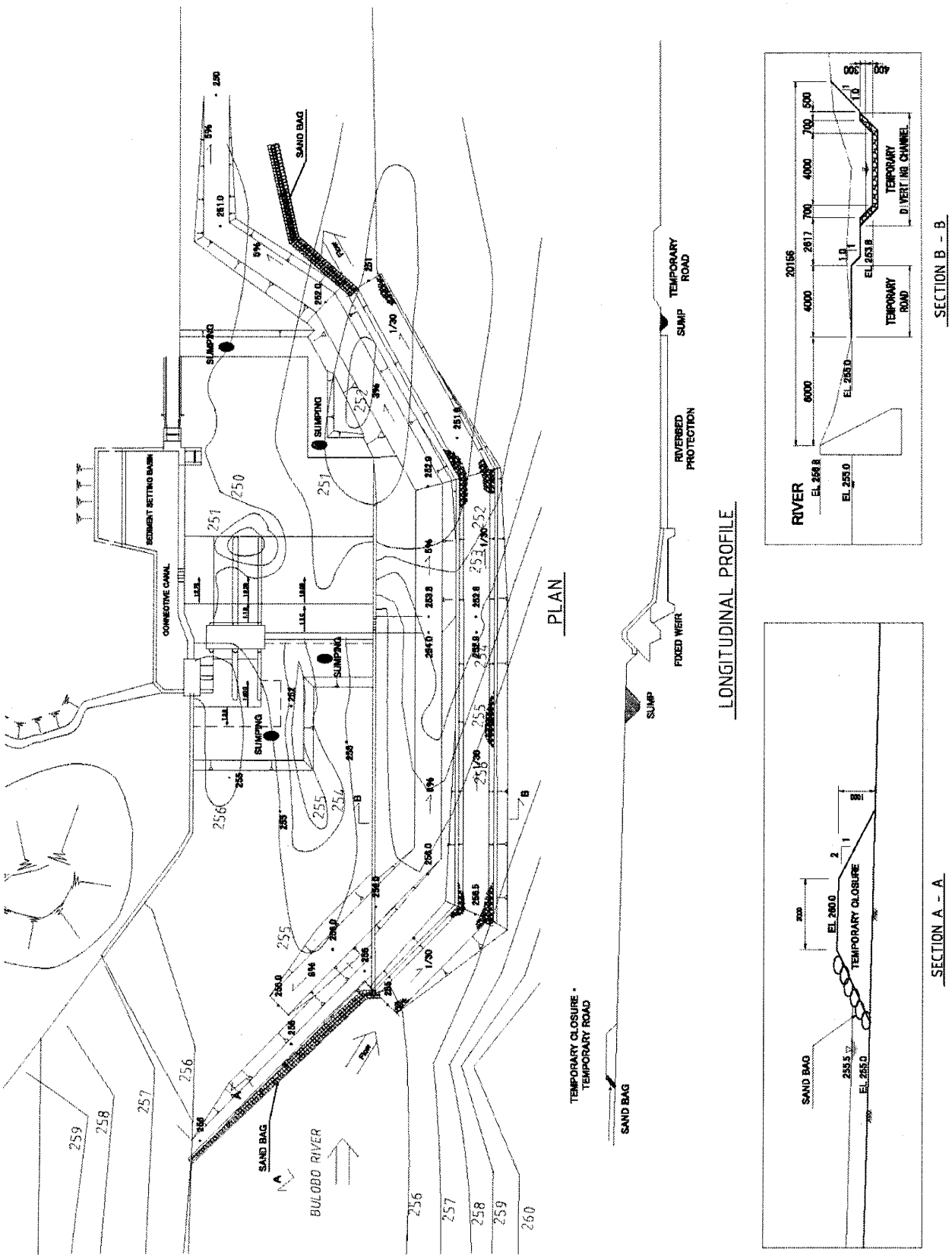


Figure 2-5 Proposed temporary river closure and diversion

④ Concrete plant and stone crushing plant (Policy-7)

As the required volume of concrete for the Project is estimated approximately 4,500 m^3, details of which is shown in Table 2-26, that is considerable amount, the concrete plants are to be set along proposed canal to be rehabilitated to provide aggregate materials. The produced materials will be transported with dump trucks from these plants to 1) the intake weir, 2) to two concrete crushing and grading plants to be installed at around the location of the diversion regulator between the main canal and the secondary ones. Produced concrete at the concrete crushing and grading plant is to be delivered to the site by concrete agitator trucks.

Table 2-26 Work plan of concrete plants

Items	Headworks, main canal, and improvement of bank protection of the aqueduct	Rehabilitation of secondary canals	Construction of building
Concrete volume (estimated)	Approx. 2,000 m^3	Approx. 2,250 m^3	Approx. 250 m^3
Plant	Concrete plant-1) : 1 set	Concrete plant-2) : 1 set	
Electric power	Generator	Generator	
Transportation	Concrete mixer truck 3 to 4.5 m^3	Concrete mixer truck 3 to 4.5 m^3	
Casting method	Truck crane equipped with a concrete bucket	Truck crane equipped with a concrete bucket	

⑤ Infrastructure services necessary for the works (Policy-8)

As for communication service, there is a fixed telephone line system and it is able to communicate from Maliana town to Capital Dili or to abroad as well though the lines are not readily available because of limited number of lines installed. Now new relay facility is under construction, however, when their services could be opened is not sure yet, nor it is expected to procure a line for the Project. On the other hand, cell phone system has become popular and very convenient. Although sending e-mails and facsimile can be managed using existing lines, it is difficult to expect an exclusive line for this purpose since all the existing lines have already been occupied. Therefore, it is planned that cell phone will be used for daily communication, but facsimile and e-mails will be sent through satellite line.

Regarding public electricity supply, township has a power plant in Maliana town with generators (260kW, 4 units), but all of these generators are out of order, so public electricity is not available at the moment. Therefore, own-generators have commonly been used in private houses. Even the generators are repaired and public electricity supply is resumed, available hours would be limited for 5 to 6 hours during the night only. So far as public electricity cannot be anticipated, it must be planned that the own-generating system shall be prepared for the Project.

As to public water supply, it is planned that the river water and public water as well could be used for the construction purpose according to test results of the water quality. Domestic water can be availed from the public water supply, but it is supplied only in the limited hours and available water quantity used to be significantly reduced during dry season, causing troubles in supply operation. Therefore, it is planned to dig own well to secure own water supply for domestic use for the Project.

Table 2-27 Conditions of infrastructure services for the work sites

	Place	Communications	Electricity	Water Supply
Dili liaison office	Inside Dili city	Cell phone, satellite phone (e-mail, fax)	Public electricity, stand-by generator	Public supply water
Site office/Laboratory	Maliana town and area nearby	Cell phone, Satellite Phone (e-mail, fax)	Public electricity, stand-by generator	Public supply water and own-well
Site accommodation	Maliana town and area nearby	Cell phone	Own generator	Public supply water and own-well
Temporary yard intake /Plants /Work sites	Maliana town and area nearby	Cell phone	Own generator	River water
Work sites along the canal	Maliana town, and area nearby	Cell phone	Own generator	Irrigation water

(4) Project implementation period (Policy-9)

Climate in Maliana district is divided into dry season between May and October and wet season between November and April. 80% of annual rainfall is concentrated in wet season, keeping rainfall continuously for 3 to 4 days for a week, falling heavily in the afternoon. As water discharge in rivers is rapidly increased, construction works in the river during rainy season is hard with higher risk. Besides, workable hours in wet season are shorter, equivalent to 30% of dry season, proving inefficient. In addition, because paddy is cultivated between December and April, it is required to avoid any interruption of water supply caused by the works of the Project during this period. On the contrary, almost no rain occurs during dry season, entailing to change streams into dried-up state. Further interruption in water supply is judged possible during the period from May to November judging from the farming performance observed in the past. Taking these and the volume of planned works into consideration, a principle is applied so that works can intensively be concentrated during dry season, including intake, weir and apron structure as well as rehabilitation and improvement works of canals, in formulating construction schedule of the Project.

② Irrigation canal

Table 2-32 Planned elements of the main and secondary canals to be rehabilitated

Name of canal	Main canal	Ramaskora secondary	Ritabau secondary
1) Scale			
Design discharge:	1.37～1.35 m^3/sec	0.96～0.16 m^3/sec	0.39～0.17 m^3/sec
Canal length:	L = 1,527m Existing canal: 1,570m Existing lined section:1,527m	L = 3,945m Existing canal: 1,570m Extension lining: 2,375m	L = 5,250m Existing canal: 2,890m Extension lining:2,360m
2) Typical cross section			
Type of canal:	Open lining canal by wet masonry lining	Open lining canal by wet masonry lining	Open lining canal by wet masonry lining
Width of canal invert: Height of side wall: Width of canal top:	1.60m～5.70m 0.90m～1.80m 1.60m～7.10m	0.40m～1.60m 0.30m～0.80m 1.00m～3.20m	0.40m～1.10m 0.40m～0.80m 0.80m～2.30m
3) Appurtenant structures	Total 25 places	Total 48 places	Total 79 places

③ Plan of bank protection retaining wall for aqueduct

Table 2-33 Design parameters of retaining protection wall of the Aqueduct to be rehabilitated

Subject	Right bank	Left bank
1) Retaining protection wall		
Structure type	Wet masonry	Wet masonry
Extension	72.5m	34.0m
Height	3.0～4.5m	4.5m
2) Block for riverbed foot protection	345m^2	252m^2

④ Building facilities

Table 2-34 Proposed building facilities

Description	Gate keeper's hut	Storage for O/M equipment
1) Location	Upstream side of the left bank of Maliana I headwork	Near Sta. 3+360, station of Ramaskora secondary canal
2) Structure type	One story house of RC beam, block wall, concrete foundation	One story house of RC beam, block wall, concrete foundation
3) Building area	4.2m × 3.5m = 14.7 m^2	10.5m × 6.5m = 68.3 m^2