area affected by the delay of the Canal construction is 4,900 ha in net. These irrigation areas are considered to be the Second Phase Project Area.

The following alternative studies for the irrigation of these areas have been made:

Alternative I : Partial Construction of Siret-Baragan Canal to meet the water requirement of these second stage irrigation areas.

Alternative II : Irrigate the area under SRP-IX by SRP-V system through connected distribution canals of CD-7 and CD-11 by siphon crossing the Putna River.

Alternative I needs construction of temporary canal with length 24 km and flow capacity 3.7 m^3/s. The minimum water depth of the canal shall be of 50% of original design (about 3 m) for the pump operation. On the other hand, Alternative II needs construction of Putna River crossing structure with flow capacity approx. 2.5 m^3/s and 6 connecting canals or pipe lines with SPPs. The water head between the end of the CD.7 and the CD11 is 7.8m. Both alternatives is not economical. Therefore, the irrigation of these areas (Phase II) shall be omitted until the completion of the Siret-Baragan Canal.

(8) Automatic Irrigation Control Method

Considering the manual operation after the hydrants and practices in the Milcov System which locates near the Project Area, the automatic irrigation control system shall be limited within SPPs and SRPs in the Project. Therefore, the communication equipment among the pumping stations only is included in the Project.

4.4.2 Drainage Plan

(1) General

Drainage in the Project Area consists of the following 2 categories;

1) Drainage of the runoff coming from hillside areas which are located outside of the Project Area; and
2) Drainage of internal runoff within the Project Area.

The drainage within the first category is dealt in the Soil Conservation Plan and the other is described below in this sub-chapter.

(2) Degree of Flood Protection

As same as the irrigation planning, the degree of the drainage is set as a flood probability at 1/5 year (20%). Normally 5% probability (1/20) flood is adopted in Romania, but it is not rational in the light of the probability for the irrigation being 1/5 year, 80% of drought. Then the design discharges for planning the internal drainage are set at 60.5 mm and 88.0 mm for 24 hours and 72 hours duration, respectively.

(3) Unit Run-off in the Project Area

The unit runoff in the agricultural land is estimated at 4.20 lit/s/ha on condition that 24 hour rainfall in the drainage area is drained within 24 hours and that runoff ratio in the drainage area is 0.60.

(4) Drainage System

Basically, drains are planned at the lowest part of each irrigation block, and they sometimes function as a drainage along the distribution canals and discharge to the tributaries. The plan of the drains is shown in **Fig 4.4.3**.

4.5 SOIL CONSERVATION PLAN

4.5.1 General

The soil conservation plan in the Study Area has been prepared mainly focusing the soil erosion in due consideration of environmental preservation of the Project. Where soil erosion occurs within the arable land, losses of top-soil and soil fertility result in reduction of the agricultural productivity. According to the MAF Report "Instructions for Studies and Necessary Calculations for Soil Erosion Control, 1973", the agricultural yield in Dobrogea decreased averagely by 15% on moderately eroded soils and by 50% on strongly eroded soils. Once a soil in arable land is severely eroded and gullies begin to form, its restoration is generally very expensive. Therefore, the first priority should be given to the prevention of further erosion. The main objectives of the soil conservation plan are summarized below:

- Stabilization of Agricultural Productivity;
- Prevention of Destruction of Arable Land and Farm Roads;
- Sustaining of Functions of Irrigation Facilities; and
- Strengthening of Maintenance of Soil Conservation Works.

4.5.2 Selection of Soil Conservation Project Area (SCPA)

Taking into consideration the "basic concepts in Project formulation" and financial allocation for the required works, the following five areas have been selected as SCPA in the Project for further analysis on soil conservation. Location of these areas are listed below and shown in **Fig 4.5.1**. Soil conservation for the remaining areas in the Study Area is also very important for the rural developments. However more detailed survey and budget are required for its implementation. It should be considered as future projects to be executed with other financial sources.

Sub-SCPA	Coverage (ha)
Odobesti	1,554
Tifesti	472
Panciu	2,278
Movilita	2,477
Paunesti	2,815
Total	9,586

4.5.3 Countermeasures

Generally, the situation in irrigated area becomes worse, if rainfall occurs immediately after an irrigation application. The soil is then already full of water and its ability to absorb rain water is less than normal. Consequently, water ponds where the surface topography is level, but moves rapidly across sloping sites, causing erosion of the soil surface. Uncontrolled concentrated runoff within irrigated area can also induce gully formation and sedimentation, causing damages in the downstream area as well as reduction of soil fertility due to the outflow of top-soil. The basic countermeasures against water erosion are summarized as follows:

- To promote percolation of rainfall into sub-soil in order to minimize surface runoff;
- To take measures to minimize the velocity of the surface runoff;
- To drain out the concentrated water safely through drainage facilities;
- To make the barren period of fields as short as possible; and
- To modify soil structure to improve durability (single grained-aggregated structure).

To protect the irrigated area and facilities, the following countermeasures are planned:

(1) Soil Conservation Farming

As soil conservation farming, contouring and contour-strip-cropping are effective to promote infiltration of rain water, to retain capacity of soil moisture and to minimize the velocity of surface runoff. These soil conservation farming should be encouraged more in and around

SCPA. Actual soil loss in SCPA has been estimated by the USLE method. The annual soil loss is about 19,600 ton (15,100 m^3). If contouring is introduced into the SCPA, the above annual soil loss decreases to 9,800 ton (7,500 m^3).

(2) Level Terrace

Generally, a level terrace is constructed with non-channel grade. The channel and ridge top are built level so that runoff is stored along terrace. The ends of the terrace usually are closed. Therefore, the soil absorbs the water and serves as the terrace outlet. Due to the following reasons, level terrace is proposed to introduce in SCPA.

- Terracing is one of the best practices for soil conservation on sloped land;
- It is effective to promote infiltration of rain water, to retain capacity of rain water and to minimize the velocity of surface runoff;
- It is adaptable to arable land due to the capability of farming even on the terraced land;
- It is effective against the siltation in the distribution canal; and
- It is effective for the reduction of discharge through the drainage canal in the field.

Level terrace has been studied in the following two alternative areas (**Fig 4.5.1**). In the case of Alternative-A, level terrace is introduced to all the arable land in SCPA and the annual soil loss in SCPA will be decreased to 2,900 ton (2,200 m^3) from 19,600 ton (without soil conservation). In the case of Alternative-B, level terrace is introduced to the arable land which is classified as moderately eroded area (1,839 ha) and soil conservation farming (contouring, contour-strip-cropping) is introduced to the remaining area of the arable land in SCPA.

Sub-SCPA	Alternative-A (ha)	Alternative-B (ha)
Odobesti	777	0
Tifesti	462	0
Panciu	2,233	129
Movilita	2,431	703
Paunesti	2,758	1,007
Total	8,661	1,839

(3) Grassed Waterway

The grassed waterway is one of the basic soil conservation practices commonly used by the farmers. When rainfall exceeds the rate or volume at which the soil can take in and store moisture, surplus water passes over the land in the form of runoff. Since the success of any soil conservation plan depends on the removal of this surplus water without undue erosion, the area necessary for waterway should be dedicated to this purpose and consideration of the

production of crops should be secondary. This practice is applicable only for those areas where rainfall or irrigation provides the moisture needed to grow and sustain a good grass cover. The grassed waterway in the Project is planned for the following purposes:

- As outlets for diversions and terraces;
- To dispose of water collected by road ditches or catch drain; and
- To rehabilite natural drains carrying concentrations of runoff.

Grassed waterway has been planned at the following natural waterways. Location of the grassed waterways are shown in **Fig 4.5.1**.

Sub-SCPA	Name of waterway	Total length (km)
Panciu	PAN-GW1	5.50
	PAN-GW2	5.50
Movilita	MOV-GW1	7.00
	MOV-GW2	6.50
	MOV-GW3	4.00
Paunesti	PAU-GW1	2.50
	PAU-GW2	2.00
Total		33.00

(4) Boundary Drainage Canal (BDC)

To prevent the occurrence of soil erosion in the irrigated area, the countermeasures at the upstream side should be emphasized. The Distribution Canals (CD) and its maintenance roads are planned along the boundary of the upstream side of the Project Area. BDC has been planned at the upstream side of these maintenance roads. In the case of Odobesti and Panciu areas, existing drainage canals are planned to be used as BDC. Location of BDC is shown in **Fig 4.5.1**. Canal name, drainage canal and length of BDC are as follows:

Sub-SCPA	Canal Name	River to be drained	Length (km)
Tifesti	TIF-BD1	Susita	3.50
Movilita	MOV-BD1	Zabraut	3.30
	MOV-BD2	Carecna	3.50
Paunesti	PAU-BD1	V.Voului	2.85
	PAU-BD2	V.Voului	3.20
Total			16.35

(5) Gully and Ravine Control Works

1) Sabo Dam

There are several gullies and ravines in the Project Area. Distribution Canals (CD) cross these gullies and ravines. Siphons are planned at these points. To protect these siphons and to control the growth of gully, the following Sabo dams are planned at the downstream section of the siphons and other protective points.

(Unit: nos.)

Sub-SCPA	Type A (h=6.0m)	Type B (h=4.0m)	Total
Movilita	0	1	1
Paunesti	2	3	5
Total	2	4	6

2) Soimului Canal

The 10-year flood discharge at the base point (catchment area = 3,420 ha) of the Soimului canal in Odobesti SCPA is estimated at 48.3 m3/s. The flow capacity of the Soimului canal after dredging is estimated at 22.5 m^3/s. Therefore, 25.8 m^3/s of surplus water will overflow at the base point. To dissolve the uneasiness of flooding, rehabilitation works are required at the Soimului canal (L=8.0 km) in Odobesti SCPA. Main works are dredging the siltation and lining. Location of the Soimului canal are shown in **Fig 4.5.1**.

(6) Maintenance of Soil Conservation Works

The maintenance work of the soil conservation works consists of the following items:

- Administrative affair;
- Enlightening education and training for the soil conservation to farmers and associations;
- Round patrol for soil conservation area;
- Planning and designing of maintenance works; and
- Rehabilitation of the soil conservation facilities.

Responsibilities for maintaining the soil conservation works shall be born basically by beneficiaries (state farms, associations and individual farmers) in the Project Area. Since the farmers in SCPA are not familiar with the soil conservation farming as well as the management of the large-scale irrigation scheme, a certain period for training the farmers in maintenance of the facilities and soil conservation farming will be required. For the smooth and successful initiation of the soil conservation project, the stepwise strengthening program for the

maintenance of soil conservation facilities and introduction of soil conservation farming is proposed. The basic concepts of the proposed strengthening program is summarized below:

Step-1:

- At the initial stage of 5 years after the completion of the Project implementation, the Government through RAIF shall directly manage the maintenance work. The farmers and associations provide their labour force to the maintenance work, as required.
- RAIF shall train the individual farmers in the management of soil conservation farming and the maintenance of soil conservation facilities.
- The required expenses for execution of the maintenance work shall be born by the Government.

Step-2:

- All the maintenance work shall be handed over to the water users' association.
- O/M Office of the Project shall assist the water users' association in maintenance work.
- The expenses required for the maintenance work except for the Government's assistance components shall be born by the water users' association.

4.5.4 Selection of Soil Conservation Plan

Based on the above study, the following two alternative soil conservation plans have been formulated. From the viewpoint of soil conservation, the grade of Alternative-A is higher than that of Alternative-B. The salient features of the plans are shown below:

(1) Alternative-A (Level terrace is introduced to all the arable land in SCPA)

Sub-SCPA	Level Terrace (ha)	Grassed Waterway (km)	BDC (km)	Sabo Dam (nos.)	RCW (km)
Odobesti	777	0.00	0.00	0	SC: 8.0
Tifesti	462	0.00	3.50	0	
Panciu	2,233	11.00	0.00	0	
Movilita	2,431	17.50	6.80	1	
Paunesti	2,758	4.50	6.05	5	
Total	8,661	33.00	16.35	6	8.0

Note: BDC : Boundary Drainage Canal
RCW: Ravine Control Works
SC : Soimului Canal (rehabilitation)

(2) Alternative-B (Level terrace is introduced to the moderately eroded area of the arable land in SCPA)

Sub-SCPA	Level Terrace (ha)	SCF	Grassed Waterway (km)	BDC (km)	Sabo Dam (nos.)	RCW (km)
Odobesti	0	777	0.00	0.00	0	SC: 8.0
Tifesti	0	462	0.00	3.50	0	
Panciu	129	2,104	11.00	0.00	0	
Movilita	703	1,728	17.50	6.80	1	
Paunesti	1,007	1,751	4.50	6.05	5	
Total	1,839	6,822	33.00	16.35	6	8.0

Note: SCF : Introduction of Soil Conservation Farming (Contour-strip-cropping)
BDC: Boundary Drainage Canal
RCW: Ravine Control Works
SC : Soimului Canal (rehabilitation)

Alternative-B has been selected as the proposed definitive plan for the soil conservation in consideration of the following matters:

- About 16.3 x 10^9 Lei (US$ 932,000) of construction cost can be reduced;
- The farmers in the Project Area still have not accustomed themselves to the level terrace on gentle slope land (less than 3 %). Phased introduction of soil conservation works is desirable; and
- Although there exist a fear about siltation of CD in the case of Alternative-B, other countermeasures (soil conservation farming, grassed waterway and drainage canal along CD) are effective to minimize the siltation in CD.

4.6 RURAL INFRASTRUCTURE DEVELOPMENT PLAN

4.6.1 Road Network

(1) General

Roads in the Project Area consist of national highway, district road, village road and farm road. They are mostly in poor condition except for the national highways and a part of district roads. Therefore, the improvement of them is essential for the construction works and also for the transportation of agricultural products and their marketing.

(2) Road Network Improvement

In the Project, the improvement of district roads and village roads in the Project Area are planned. The new construction of operation and maintenance (O/M) roads is also proposed. The existing national roads (No.2 and 2D) and District roads (Dj 205F and Dj 205A) are considered to be maintained or up-graded by the Ministry of Transportation and Communication or the Road Authority of Vrancea District. Therefore, the improvement of these roads are excluded from the Project. The improvement of 12 existing roads and new construction of 17 O/M roads mainly along the distribution canals are planned in the Project as follows (**Fig 4.6.1**);

- 4 lateral and 8 second roads to be widened and asphalt-paved; and
- 17 O/M roads to be gravel-surfaced.

4.6.2 Other Rural Infrastructures

(1) Domestic Water Supply

The existing domestic water supply facilities for the villages concerning the Project face the difficulties in their operation and maintenance. The urgent countermeasures to improve the existing conditions are eagerly requested. However, the improvement of these existing domestic water supply systems is not included in the Project. It shall be solved by the individual towns/villages with the assistance of the Romanian Government.

(2) Agricultural Marketing and Agro-industry Facilities

It is essential to install the collecting points and storage houses for vegetable or other agricultural products in order to reach the final target of the Project. As described in sub-chapter 4.3.6, under the new economic system, they will be installed by the private commercial company or associations under their best efforts in the financial and management conditions.

4.7 INFRASTRUCTURE FACILITIES PLANNED

4.7.1 Summary

The main infrastructure facilities planned in the Project are summarized below:

Item	Description	Unit	Quantity
1 Irrigation Works			
1.1 Distribution Pump Station	4 are almost completed	unit	10
1.2 Booster Pump Station	8 are almost completed	unit	49
1.3 Distribution Canal	11 lines, concrete lined	km	76.4
1.4 Distribution Pipe	ave. 17.7 m/ha	km	418.6
2 Drainage Works			
2.1 Drainage Canal	69 lines, earth canal	km	136.0
3 Soil Conservation Works			
3.1 Level Terrace		ha	1,839
3.2 Grassed Waterway	7 lines	km	33.0
3.3 Boundary Drainage Canal	5 lines	km	16.4
3.4 Sabo Dam		set	6
4 Road Improvement Works			
4.1 Artery Road	asphalt paved	km	31.3
4.2 Secondary Road	gravel paved, ave.B=5.5 m	km	53.8
4.3 O/M Road	gravel paved	km	97.1

4.7.2 Irrigation Facilities

(1) Calimanesti Dam and Siret-Baragan Canal

The Calimanesti Dam and the Siret-Baragan Canal, which intakes water from the Calimanesti Dam, are the main water sources of the Project. The Calimanesti Dam has been almost completed by the state owned Romanian Electricity Supply Company (RENEL), former Ministry of Energy. The construction of Siret-Baragan Canal was started under the Ministry of Water, Forest and Environmental Protection (MoE) and is still under way. In the Project, these facilities are considered as the given conditions in the water resources planning and any commitments will not be made.

(2) Distribution Pump Stations (SRP)

Distribution pumps are planned to be operated for 24 hours a day throughout the irrigation period, April to September. As stated in sub-Chapter 4.2 of this Chapter, the following ten (10) distribution pump stations are planned. The installation of 4 stations among them, i.e. SRP-I, IV, V and VII has been almost completed as of 1994.

No.	Pump Station	Benefit Area (ha)	Design Discharge (m3/s)	Total Head (m)
1	SRP-I	2,758	1.763	44.0
2	SRP-IA	1,294	0.827	7.5
3	SRP-II	743	0.475	45.0
4	SRP-III	1,188	0.759	54.0
5	SRP-IV	2,431	1.554	41.0
6	SRP-V	15,374	9.258	41.0
7	SRP-VI	883	0.564	36.0
8	SRP-VII	6,773	3.761	25.0
9	SRP-VIII	1,797	1.002	18.0
10	SRP-IX	1,996	1.088	31.0

1) Method of Water-taking

The water resources and methods of water-taking for respective distribution pump stations are as follows:

Name of Pump Station	Water Resources	Method of Water-taking
SRP-IA	Calimanesti Dam	Minus-back type
SRP-V and -IX	Main Canal	Plus-back type with Siphon
SRP-I and -VII	Distribution Canal	Minus-back type (Vertical-type Pump)
SRP-II, III, IV, VI and VIII	Distribution Canal	Plus-back type (Horizontal-type Pump)

2) Number and Size of Pumps

The combined installation of pumps of different sizes is planned for respective stations in consideration of economical operation of pumps or minimizing the operation cost of pumps in coping with the seasonal big change of water requirements in the field. The proposed number and size of pumps for respective pump stations are finalized as shown in **Table 4.7.1** in due consideration of minimization of probable troubles in pump operation in addition to the above factors. However, the pump facilities in SRP-I, -IV, -V and -VII which have already been installed are to be used without modifying or changing any part of the facilities in consideration of the capacities of the existing pumps and design requirements for them.

3) Type of Pump

Judging from the required pump head and discharge, horizontal-axial single-stage volute type mixed flow pump (BRATES), horizontal-axial single-stage volute type centrifugal flow pump (NDS, RDN, NC and LOTRU) and vertical-axial multi-stage mixed flow pump (MV and MA) are adaptable. Due to cheaper price and easier operation & maintenance because of simpler structure of the horizontal-axial type pumps compared with the vertical-axial type ones, the horizontal-axial type pumps are adopted in the Project (**Table 4.7.1**). However, the vertical-axial mixed flow pumps are adopted for SRP-I and -VII, because the pump facilities of these stations have already been installed at the site.

4) Operation Control and Protection of Pumps

The control of water discharge is to be made by increasing or decreasing number of pumps to be operated with the seasonal fluctuation of irrigation water requirement. The operation of pump is to be made locally by manual control at each station; 24-hour continuous operation and 3-sifts a day is planned. The counter facilities against the unexpected decrease of water level at the suction side or increase at the pressure tank are planned to install.

5) Ancillary Facilities

A flow meters is to be installed at the outlet of each pump station; an electromagnetic-type flow meter and ultrasonic-type one are selected for pump of 400 mm diameter or less and 500 mm or more, respectively, due to the economy of them. Furthermore, a vacuum pump is to be installed in the case of minus-back type horizontal-axial pump and siphon type horizontal-axial pump.

The manual operation type screen and stop log for maintenance are planned for respective pump stations except for the ones which take water directly from the Main Canal. A drainage pump is planned for plus-back type horizontal-axial pump and vertical-axial pump. The overhead crane is planned for all pump stations.

6) Motor

A 3-phase electric asynchlonous motor is adopted. The receiving service electric pressure is 20 kV. The specified voltages of the motor are 400 V in the case of low voltage (the motor output is less than 315 kW) and 6,000 V in the case of high voltage (more than 315 kW), respectively.

7) Pump House

The pump house of reinforced concrete is planned to protect the pump's mechanical and electrical equipment in consideration of the following (**Fig 4.7.1**):

- to secure easier maintenance of the pump facilities during winter season;
- to protect the mechanical and electrical equipment from severe weather;
- to decrease maintenance cost such as painting of mechanical equipment;
- to make sure the insulation among electric cables; etc.

(3) Distribution Pipeline

Water lifted by the distribution pumps is conveyed to the distribution canals through the distribution pipelines. Distribution pipelines are considered as a part of pump station facilities, whose lifting heights are determined in consideration of friction losses of distribution pipes. Most of the existing design of distribution pipes are applied in the Project. Distribution pipes crossing the tributaries are carefully designed in due consideration of degradation of drainage canals. The concrete ground sills are provided within 20 m downstream of the structure, and also the revetments on the bank slopes are provided where necessary. Distribution pipes are of steel pipe or prestressed concrete pipe and the earth cover over the pipe is more than 90 cm in view of the protection of pipes from frost heaving. In the case of SRP-III and -VII, each pump of which covers two different areas, the distribution of water is made by single line of pipe up to the edge of the areas and water is diverted to respective areas there due to the economy of the pipeline facilities. The control of water volume at diversion point is made by butterfly valve. Furthermore, the water pressure regulation tank is planned to protect the facilities from their damage by probable water hammer except for SRP-VII and IX.

(4) Distribution Canals

There are 11 lines of distribution canals with the total length about 76 km in the Project (**Table 4.7.2**). They are located at 3 stages depending on the pump lifting capacity and irrigation field alignment. They run along the contour line with gentle gradient between 1/5,000 and 1/10,000 with open canal and most of the flow section are arranged under the excavated section. Twenty one (21) control gates, 13 discharge gates, 14 road crossing structures and 15 river/drain crossing structures are required.

1) Flow Capacity and Cross Section

The cross section of distribution canal is determined by the required flow capacity and storage capacity to cope with the pump operation time lags between SRP and SPPs. In order to obtain the easy construction and maintenance of the canal, its bottom widths are set at 1.0, 1.5 and 2.0 m with side slope 1 to 1.5. Standard section of the distribution canal is shown in **Fig 4.7.2**. The canal lining shall be cast-in-situ concrete with slide forms, because the presently used precast concrete slab lining causes poor joint works between the slabs and increase the seepage losses through the joints.

2) Water Level Regulating Structures

To maintain the water level in the upstream and downstream canals for the safety drive of pumps of SRPs and SPPs which suck water from the distribution canals. In Romania, automatic regulating gates are widely used in the irrigation canal, at which the gate with counter weight is mechanically operated with the balance of the upstream and downstream water levels set. Totally 21 water level regulating structures and 13 sets of side gates are planned at the end of distribution canal , which are usually connected to the spillway for discharging excess water and evacuate the water in the canal during the inspection and maintenance of canals.

3) Road/River Crossing Structures

Totally 43 road crossing structures and 15 river/drain crossing structures are required. Basically road crossing structures are the precast reinforced concrete culvert covered with the concrete for reinforcing the concrete culvert depending on the earth coverage over the culvert and traffic loads. Considering most of the rivers or drains in the Project Area being shallow, the siphon type river/drain crossing structures is adopted in the Project. Design conditions of river/drain crossing structures are shown in **Table 4.7.3**.

(5) Booster Pump Stations (SPP)

Booster pumps are planned to be operated for 20 hours a day throughout the irrigation period, April to September. Totally 49 booster pump stations are planned, 13 stations (SPP-6, 7, 9A, 10, 11, 14-2, 14-3, 15A, 17A, 19, 22, 25 and 28) out of which have been almost completed as of 1994.

1) Method of Water-taking

The water resources and the methods of water-taking for respective booster pump stations are summarized below:

Name of Pump Station	Water Resources	Method of Water-taking
SPP-10, 11, 20, 20A, 21, 26, 27 and 28A	Calimanesti Dam and Main Canal	Plus-back type with Siphon
SPP-6, 7, 14-2, 14-3, 15A, 17A, 19, 22, 25 and 28	Distribution Canals	Minus-back type (completed vertical-axial pump)
31 SPPs other than the above	Distribution Canals	Plus-back type

2) Number and Size of Pumps

The combined installation of pumps of different sizes is planned for respective stations in consideration of economical operation of pumps or minimizing the operation cost of pumps in coping with the seasonal change of water requirements in the field. The proposed number and

size of pumps for respective pump stations are finalized in due consideration of minimization of probable troubles in pump operation in addition to the above factors. Furthermore, the design unit discharge of irrigation facilities is set based on the water requirement of maize. Therefore, the adjustment of irrigation water amount to the fields of different crops shall be made by adjusting the operation time of sprinkling.

3) Type of Pump

Judging from the required pump head and discharge, horizontal-axial single-stage volute type centrifugal flow pump (RDN, NC and LOTRU) and vertical-axial multi-stage mixed flow pump (MV and MA) are adaptable. Due to the same reasons as for SRP, the horizontal-axial type pumps are adopted in the Project. However, for the pumps which have already been installed at the site, the following arrangements are planned:

SPP with Vertical-axial Pumps

- Increase of pump unit for SPP-6, 7, 14-2, 14-3, 15A, 17A, 19, 22, 25 and 28
- Transfer of 4 pump units of MA 200x2 at SPP-7, 14-2 and 14-3 to other projects

SPP with Horizontal-axial Pumps

- Transfer of 3 pump units of RDN 200-150-220 and 3 units of AN 200-150-315 at SPP-9A to other projects
- Transfer of 5 pump units of RDN 200-150-235 at SPP-11 to SPP-9A by adding one more same unit
- Construction of new station at SPP-11 by demolishing the existing one

4) Operation Control and Protection of Pumps

The control of water discharge which is changed due to the seasonal change of cropping areas is to be made by increasing or decreasing number of pumps to be operated. The operation of pump is to be made locally by manual control at each station, 20-hour operation and 3-sifts a day is planned. The counter facilities against the unexpected decrease of water level at the suction side or increase at the pressure tank are planned to install.

5) Ancillary Facilities

An electromagnetic-type flow meter is to be installed at the outlet of each pump station in consideration of the size of pumps being 400 mm diameter or less. A vacuum pump is to be installed in the case of siphon type horizontal-axial pump. The manual operation type screen and stop log for maintenance are planned for respective pump stations except for the ones which take water directly from the Calimanesti Dam or Main Canal. A drainage pump is

planned for boosting-type horizontal-axial pump and vertical-axial pump. The overhead crane is planned for all pump stations.

6) Motor

A 3-phase electric asynchronous motor is adopted. The receiving service electric pressure is 20 kV. The specified voltage of the motor is 400 V in low voltage for all SPPs.

7) Pump House

The pump house of reinforced concrete is planned to protect the pump's mechanical and electrical equipment with the same reasons as for SRP (**Fig 4.7.3**).

(6) Distribution Pipes(CPs), Sub-distribution Pipes(Antenna) and Hydrants

The pressed water is delivered to the field through distribution pipes, sub-distribution pipes and hydrants installed on the sub-distribution pipes. They are installed based on the filed geometrical condition and in consideration of land ownership of the field. The alignment of sub-distribution pipes is designed considering the sprinkler facilities not crossing the farm roads as much as possible.

1) Water Conveyance Method

Irrigation water is to be conveyed directly to CPs and Antenna through the pressure water tank to be provided at the outlet of each pump station in consideration of the following:

- The field is generally flat and practically no place is available for constructing a distribution reservoir;
- Easy control of water pressure at the nozzle of sprinkler;
- Adjustability to the small discharge;
- Easy control of design pressure of pipeline; and
- Prevension of water hammer.

Steel pipe is used around the pump unit. Prestressed concrete pipe, asbestos cement pipe or PVC pipe is used for CPs and Antenna depending on the site conditions. The minimum earth cover over the pipes is 90 cm due to protection of pipe from its frost heaving.

2) Hydrants

Hydrants are the point of the lateral pipe connecting with sub-distribution pipes. The hydrant is installed in the sub-distribution pipe at the interval of 72 m, considering sprinklers to be

installed. In Romania, all the lateral pipes are of 100 mm diameter, therefore, the hydrants are of the same standard at 100 mm diameter with maximum pressure of 10 kgf/cm^2.

(7) Field Irrigation Equipment

1) Sprinklers

Based on the following design criteria, type of sprinkler is determined of diameter 7 mm with sprinkling pressure 3.5 kgf/cm^2:

a. Design net water requirement : 1,460 m^3/month/ha or 4.71 mm/day
b. Irrigation interval : 12 days with sprinkling time of 10 hours
c. Size of one sprinkler unit 24 m x 18 m
d. Standard length of Antenna : 400 m

In this case, the irrigation water intensity is 7.1 mm/hr, which is within the allowable intensity for the soil type. The irrigation interval is estimated at 9.4 hr, which is less than the assumed sprinkling time of 10 hr.

2) Lateral Pipes

Lateral pipes distribute pressed water from hydrant to sprinklers. Normally aluminum made pipes with 6 m long and 10 mm diameter is used as a lateral pipes considering the manual installation and shifting. They are connected by handle and sprinklers are installed on the pipe. The minimum pressure at 3.5 kgf/cm^2 shall be kept in the lateral pipes.

4.7.3 Drainage Facilities

Totally 69 drains with 136 km long drainage canal are provided (**Table 4.7.4**). They are discharged to the natural rivers. The field drains are constructed as an earth canal which collects the excess water from field directly and convey to the major drain.

Based on the unit drainage discharge, the drainage canal capacities are determined. They are aligned along the distribution canals, lower-side boundary of each irrigation block. Therefore, their slopes are gentle at 1/1,500 to 1/ 2,000. Each drainage canal has shorter distance less than 6.2 km. The cross section of the drainage canal is set at the canal bottom of 0.5 and 1.0 m widths with side slope 1 to 1.5 covered with grass. The canal height is changeable from 0.5 to 2.0 m. Standard cross section of the drainage canal is shown in **Fig 4.7.4**.

4.7.4 Soil Conservation Facilities

(1) Level Terrace

Level terrace has been planned in the moderately eroded area (1,839 ha) of the Project Area. The storage of terrace area must be equal to or more than 10-year flood runoff. Their design conditions and dimensions for 3% original ground are summarized below. Typical cross section is shown in **Fig 4.7.5**.

	Dimension
Spacing between two terraces:	120 m
Maximum depth of cut:	0.46 m
Storage capacity of terrace area:	2.94 m^3/m
Runoff volume:	2.41 m^3/m

(2) Grassed Waterway

Taking into consideration the catchment area and topographic conditions, the proposed grassed waterway consists of the following 3 canal types. Typical cross section of each canal type is shown in **Fig 4.7.6**. To prevent the longitudinal erosion, concrete cross beams are planned at interval of 300 m. Typical cross section of concrete cross beam is shown in **Fig 4.7.5**.

Canal Type	Width of Canal Bed (m)	Side Slope Gradient	Water Depth (m)	Mean Canal Slope	Flow Capacity (m^3/s)
A	2.00	1: 4	1.60	1/50	49.22
B	1.00	1: 4	1.20	1/50	20.50
C	0.50	1: 4	0.80	1/50	6.56

(3) Boundary Drainage Canal (BDC)

1) Design Discharge

Based on the Romanian design manual for soil conservation, the flood of 10-year return period is adopt as design discharge for BDC. Design discharge has been estimated with the rational formula as follows:

Sub-SCPA	Canal Name	Catchment Area (ha)	Discharge (m^3/s)
Tifesti	TIF-BD1	345	13.46
Movilita	MOV-BD1	215	8.24
	MOV-BD2	200	7.77
Paunesti	PAU-BD1	325	16.05
	PAU-BD2	265	9.79

2) Canal Type

Standard cross section of BDC is a trapezoid and concrete lining canal. Based on the drainage area, the canal type have consists of the following 8 types (**Fig 4.7.7**).

Canal Type	Width of Canal Bed (m)	Slope of Sidewall	Height of Sidewall (m)	Canal Gradient	Flow Capacity (m^3/s)	Total Length (m)
A	0.50	1: 1.0	0.50	1/200	0.96	3,000
B	1.00	1: 1.0	1.00	1/200	6.12	3,550
C	1.50	1: 1.0	1.00	1/200	7.79	3,120
D	1.70	1: 1.0	1.00	1/200	8.45	1,650
E	2.00	1: 1.0	1.00	1/200	9.40	1,000
F	2.20	1: 1.0	1.00	1/200	9.98	1,850
G	2.20	1: 1.0	1.20	1/200	13.94	500
H	2.50	1: 1.0	1.25	1/200	16.38	500

3) Related Facilities

The following related facilities have been planned in BDC.

(Unit: nos.)

Canal	Chute Works	Drop	Box Culvert
TIF-BD1	0	5	3
MOV-BD1	1	1	5
MOV-BD2	1	1	4
PAU-BD1	0	11	2
PAU-BD2	0	3	5
Total	2	21	19

(4) Gully and Ravine Control Works

1) Sabo Dam

Based on the economical and technical viewpoints, a concrete gravity dam is selected as the proposed Sabo dam. It consists of the following two types.

Dam type	Dam Height (m)	Number of Dams
A	6.0	2
B	4.0	4
Total		6

2) Soimului Canal

Based on the Romanian design manual for soil conservation, the flood of 10-year return period is adopt as design discharge for the Soimului canal. Design discharge at the base point (catchment area = 3,420 ha) has been estimated at 48.3 m^3/s with the Romanian formula due to the catchment area being ranged between 10 and 100 km^2.

The capacity of the Soimului canal after dredging is estimated at 22.5 m^3/s with the Manning's formula. In this case, 25.8 m^3/s of surplus water will overflow at the base point. Therefore, concrete lining will be required. Its capacity after lining is estimated at 52.8 m^3/s. Typical cross section of Soimului Canal after dredging and lining is shown in **Fig 4.7.8**.

4.7.5 Rural and Operation & Maintenance Roads

Totally 29 lines of road are to be improved with length of 85.1 km or newly constructed with length of 97.1 km. Their locations and stretches are shown in **Fig 4.6.1**. Summary of the rural and O/M road is shown in **Table 4.7.5**. Their standard cross sections are shown in **Fig 4.7.9**.

(1) Artery Roads

The improvement of four artery roads is planned for their widths and surface pavement with total length of 31.3 km. The standard width is considered to be of single traffic lane on both directions with asphalt pavement (Romanian standard class V road). Totally 17 canal crossing structures of reinforced concrete culvert type are required newly, and some existing bridges and culverts shall be rehabilitated.

(2) Secondary Roads

Eight secondary roads, which are mostly secondary district roads or community roads, shall be improved for their widths and surface pavements with total length of 53.8 km. Their class of the road shall be the same as the above artery road. However, the pavement shall be made with gravel. Totally 10 canal crossing structures are required.

(3) Operation & Maintenance Roads

Totally 17 lines with 97.1 km long O/M roads shall be constructed newly. They are aligned on hillside along the distribution canals which most of SRPs/SPPs are located. 8 canal crossing structures of reinforced concrete bridge or culvert type are required.

CHAPTER 5

PROJECT IMPLEMENTATION AND OPERATION & MAINTENANCE

CHAPTER 5 : PROJECT IMPLEMENTATION AND OPERATION & MAINTENANCE

5.1 PROJECT IMPLEMENTATION SYSTEM

5.1.1 Project Implementation Method

The Project Implementation Agency shall execute the detailed design of the Project facilities, preparation of tender documents, tendering and tender evaluation, selection of the contractor, signing the contract and supervision of the construction works with the assistance of the Consultant to be contracted prior to the commencement of the Project. The Consultant shall assist the Implementation Agency mainly for the technical matters involved in the duties of the Implementation Agency.

The construction works shall be performed on the contract basis by the successful contractor(s). All the construction machinery required for the construction works shall be provided by the contractor(s) itself(themselves). The materials necessary for the construction works shall be procured from domestic and/or international markets under the full responsibility of the contractor(s).

5.1.2 Project Implementation Agency

(1) General

The Implementation Agency for the Project shall be RAIF of MAF. Formerly LRD had been responsible for the execution of such construction works. It was reorganized, however, to RAIF together with its full rights and responsibilities as part of the restructuring of MAF in October 1994 (**Fig 5.1.1**). Therefore, RAIF has sufficient capability for fulfilling its responsibilities in implementing the Project without any troubles. Furthermore, RAIF shall establish the Project Office under the branch office of RAIF in Focsani in order to implement the Project successfully in consideration of the distance between the Project Area and the Headquarters of RAIF in Bucharest. The proposed Project Organization Chart is shown in **Fig 5.1.2**.

(2) Project Office

It is recommended that the present RAIF Marasesti Workshop be used as the Project Office by improving its facilities. The proposed staff members of the Project Office are proposed as shown below. This Project Office shall be used as the O/M Office of the Project after the completion of the construction works of the Project facilities.

Position	Number
Manager	1
Asst. Manager (Civil Eng. & Admi.)	2
Civil Engineer	3
Asst. Civil Engineer	3
Mechanical Engineer	2
Asst. Mechanical Engineer	3
Electrical Engineer	1
Asst. Electrical Engineer	2
Secretary	1
Administration	4
Diver	5
Others	3
Total	30

(3) Consultant

The Consultant shall provide the Implementation Agency mainly with the technical services on the contract basis. The consulting services involve the detailed design work and evaluation of tender in the Detailed Design Phase and supervision of the construction works such as their workmanship, programming and safety control in the Construction Phase. The Consultant shall be composed of highly qualified engineers and experts specialized in project planning, detailed design, construction, hydrology, geology, etc. The Consultant is also expected to undertake the technology transfer to local engineers of the Implementation Agency. Above all, seminars on the quality control of workmanship and irrigation water management will be included in the scope of the consulting services. The estimated man-months (M/M) for the above consulting services are 69 M/M and 318 M/M for foreign and local components, respectively, totaling 387 M/M as shown below :

(Unit: M/M)

Detailed Design Phase			Construction Phase			Total		
Foreign	Local	Sub-total	Foreign	Local	Sub-total	Foreign	Local	Total
27	57	84	42	261	303	69	318	387

5.2 CONSTRUCTION SCHEDULE

The implementation period of the Project construction works is set as 60 months in total consisting of 12 months for the Detailed Design Phase and 48 months for the Construction Phase. During the Detailed Design Phase, the topographic survey and geological investigation of the sites proposed for the main structures, detailed design work, preparation of tender documents, etc. are to be performed. On the other hand, during the Construction Phase, the acquisition of land for the proposed structures, tendering, the construction works of the Project

facilities, procurement of operation/maintenance (O/M) equipment, etc. are to be conducted (**Fig 5.1.3**).

5.2.1 Detailed Design Phase

During the Detailed Design Phase, the detailed design of the required Project facilities is to be completed. The review of the design only is required for some of the Project facilities the design of which has already been finished by MAF. However, some modifications or changes are proposed for some of the Project facilities/structures. For such facilities/structures, redesigning of them based on the results of the detailed topo-survey of the respective sites and/or geological investigation at the sites to be conducted newly is definitely necessary. After the detailed design of the Project facilities is completed, the following documents necessary for the Tendering of the Project construction works are to be prepared. The period required for the Detailed Design is set as 12 months.

- Prequalification Documents
- General Specifications
- Special Specifications
- Technical Specifications
- Tender Drawings
- Bill of Quantities
- Cost Estimation
- Construction Schedule
- Others

5.2.2 Construction Phase

(1) Land Acquisition

Prior to the commencement of the construction works of the Project, the lands required for the Project facilities such as pump stations (SRPs and SPPs), distribution canals (CDs), siphons, farm roads and soil conservation facilities shall be acquired by RAIF, MAF.

(2) Tendering and Contract

After the completion of the tender documents, the prequalification and short listing of the interested contractors are to be conducted. Tendering shall be conducted on the basis of the International Competitive Bidding (ICB) and contract procedures for the above prequalified contractors and the contractor(s) to perform the construction works shall be selected among them. The tender evaluation and contract signing follow the above tendering. The period required for the Construction Phase is set as 36 months.

(3) Implementation of Construction Works

In order to realize the expected objectives of the Project as soon as possible, the construction works shall be shortened as much as possible by overlapping the respective works in due

consideration of the anticipated inconvenience by the overlapping of the construction works. In preparing the proposed construction schedule, the phasing of the construction works by focusing the completed section of the Main Canal and almost completed main distribution pump station SRP-V is also considered in order to facilitate the production of crops under irrigation. The proposed general construction schedule is as shown on **Fig 5.1.3**.

5.3 PROJECT COST

The Project cost consists of the construction cost, land acquisition cost, O/M equipment procurement cost, administration cost, consulting services cost, and physical and economic contingencies.

5.3.1 Condition of Cost Estimate

The Project cost is estimated on the following conditions:

a. The basic costs such as labor cost, material cost and equipment cost are based on the unit costs adopted by RAIF;
b. The requirements per unit work are based on the standard adopted by RAIF;
c. The prices of domestic materials are based on those including transportation of them to the construction sites. On the other hand, the prices of the imported materials are based on the material CIF Constanta price plus domestic transportation cost and import tax;
d. The construction cost are estimated with foreign and local components. However, US$ is used for both components. The unit costs for respective work items consist of direct cost and indirect cost, and the indirect cost is set as 35% of the direct cost in accordance with the regulation of RAIF;
e. The exchange rate used is US$ 1.00 = Lei 1,753 as of October 1994; and
f. The physical contingency is set as 10% of the construction cost and other costs. The economic contingency is set as 3% per annum.

5.3.2 Project Cost

(1) Construction Cost

The construction cost is estimated with the foreign and local portions at the proposed tendering lots basis as shown in **Fig 5.3.1**. The foreign portion covers a part of steel works including pumps, construction equipment, electrical equipment, fuel for construction equipment, etc. The annual disbursement of the construction cost is determined based on the proposed schedule of the construction works.

The construction cost consists of the following construction items:

- Preparatory works for the construction;
- Irrigation works including mechanical works such as pumps and gates;
- Drainage works;
- Soil conservation works;
- Road improvement works; and
- Construction of Project Office .

The total construction cost is estimated to be $72x10^6$ US$ which includes the foreign portion of $11x10^6$ US$ (15%) as shown below (**Table 5.3.1**):

(Unit : 10^3 US$)

Description	L/C	F/C	Total
1. Preparatory Works	2,920	515	3,435
2. Irrigation Works	52,037	9,183	61,220
3. Drainage Works	987	174	1,161
4. Soil Conservation Works	1,654	292	1,946
5. Road Improvement Works	3,369	595	3,964
6. Project Office	339	60	399
Total	61,306	10,819	72,125

(2) Land Acquisition Cost

The acquisition cost of lands necessary for the construction of the Project facilities such as the pump stations (SPPs and SRPs), distribution canals (CDs) including maintenance roads and drainage canals, farm roads and soil conservation facilities including Sabo dams and flood control canals is estimated to be $6,171x10^3$ US$ in total and allotted for the local portion.

(3) O/M Equipment Procurement Cost

The following O/M equipment for the operation and minor repair works is to be procured by the Project Implementation Agency at the 2nd year of the construction period and it shall be renewed at times when its useful life is expired. The procurement cost of the O/M equipment is estimated to be $494x10^3$ US$ and allotted for the foreign portion and, and $25x10^3$ US$ of handling charge and other expenses in Romania for the local portion.

Name	Requirement	No.	Name	Requirement	No.
Bulldozer	11 ton	1	Pick-up Truck	2 ton	5
Back Hoe	0.6 m^3	1	Motorcycle	125 cc	10
Dump Truck	6 ton	1	Concrete Mixer	350 lit	1
Motor Grader	3.1 m	1	Communication Equip.		5

(4) Administration Cost

The administration cost necessary for the operation of the Project Office includes procurement of office supplies, payment to the office staff, general expenses, etc. The annual administration cost is estimated to be $430x10^3$ US$ and allotted local portion.

(5) Consulting Services Cost

The cost for the provision of the consulting services is estimated to be $4,115x10^3$ US$ consisting of $1,456x10^3$ US$ for the Detailed Design Phase and $2,659x10^3$ US$ for the Construction Phase. The proportion of the foreign component is 56.6% and that of the local one is 43.4%.

(Unit: 10^3 US$)

Detailed Design Phase			Construction Phase			Total		
Foreign	Local	Sub-total	Foreign	Local	Sub-total	Foreign	Local	Total
950	506	1,456	1,378	1,281	2,659	2,328	1,787	4,115

(6) Project Cost

As a result of the above, the Project Cost is estimated to be $93x10^6$ US$, the foreign component of which represents $15x10^6$ US$ (16.2%) and the local component $78x10^6$ US$ (83.8%) (**Table 5.3.2**)

(Unit : 10^3 US$)

Description	L/C	F/C	Total
1. Construction Works	61,307	10,818	72,125
2. Land Acquisition	6,171	0	6,171
3. Procurement of O/M Equipment	25	494	519
4. Administration	1,507	0	1,507
5. Consulting Services	1,787	2,328	4,115
Sub-total (1-5)	70,797	13,640	84,437
6. Physical contingency (10%)	7,080	1,364	8,444
Sub-total (1-6)	77,877	15,004	92,881
7. Economic Contingency	11,637	2,248	13,885
Total (1-7)	89,515	17,254	106,769

The disbursement of the Project Cost is to be made in 5 years. The proportions of the disbursement for each year are 0.1% for the first year, 3.5% for the second, 36.6% for the third, 43.7% for the forth and 16.1% for the fifth (**Table 5.3.3**).

5.4 OPERATION AND MAINTENANCE

5.4.1 Operation and Maintenance Method

The operation and maintenance (O/M) of the irrigation facilities from the main and re-pumping pump stations (SRPs) to the booster pump stations (SPPs) and also the maintenance of the soil conservation facilities shall be made by RAIF. The control system of the above pumps shall be the same as the one having been adopted by the former SCELIF for the time being. The improvement of the control system shall be considered step by step with the improvement of the farming technology and the financial level-up of the farmers involved in the Project. On the other hand, the O/M of the lateral lines (As) including the control of valves at hydrants are to be made by the water users' associations which shall be organized newly by the beneficiaries within the respective irrigation blocks. The proposed O/M organization is shown in **Fig 5.4.1**.

Furthermore, it is recommended that the duties and responsibilities of RAIF for the O/M of the Project facilities shall be transferred item by item and step by step to the water users' associations with the aggressive improvement of the organization of the water users' associations through confirming the improvement of capability of the associations for dealing with the objective items.

5.4.2 Operation and Maintenance Office

RAIF shall have the overall responsibility for the O/M of the main Project facilities. The O/M Office shall be reorganized from the above-mentioned Project Office. The main duties of the O/M Office are as follows:

- Operation and maintenance of the main Project facilities such as SRPs and SPPs;
- Maintenance of the CDs including the O/M roads along CDs and other farm roads;
- Maintenance of the soil conservation facilities;
- Instruction to the water users' associations on O/M of valves at hydrants, etc.; and
- Collection of water charge from the users.

The required staff members of the O/M Office are proposed as follows:

Management Section		Pump Operation Section		Irrigation Facility Maintenance Section		Soil Conservation Facility Maintenance Section	
Position	No.	Position	No.	Position	No.	Position	No.
Manager	1	Chief	1	Chief/Mech. Eng.	1	Chief/Civil Eng.	1
Asst. Manager	1	Asst. Chi.	2	Asst. Mech. Eng.	2	Asst. Civil Eng.	3
Accountant	1	Operator	156	Electric Engineer	2	Driver	1
Driver	2	Monitor	10	Equip. Operator	4	Others	2
Others	2	Others	2	Asst. Equip. Oper.	4		
				Welder	1		
				Driver	5		
				Others	2		
Sub-total	7	Sub-total	171	Sub-total	21	Sub-total	7
						Total	206

5.4.3 Operation and Maintenance Cost

The annual operation and maintenance cost is 2,472,900 US$ as shown below:

Item	Amount (US$)
1. Salary	309,400
2. Repayment of O/M Equipment	51,900
3. Cost of Spare Parts	18,400
4. Other Office Running Cost	547,600
5. Electricity for Pumps Operation	1,545,600
Total	2,472,900

Furthermore, some of the mechanical items and heavy equipment shall be renewed due to their shorter durability than the Project life. Sixty percent (60%) of the initial cost of pump equipment, pipes and gates or $1,500 \times 10^3$ US$ as the partial replacement in 15 years after new installation and the total replacement at $2,500 \times 10^3$ US$ in 25 years after new installation is estimated and used for the evaluation of the Project.

CHAPTER 6

PROJECT EVALUATION

CHAPTER 6 : PROJECT EVALUATION

6.1 BASIS OF EVALUATION

6.1.1 Approach

The project evaluation method to assess the Project for validity of its implementation includes economic evaluation, financial evaluation, socio-economic evaluation (effect) and environmental analysis. Emphasis is placed on the economic evaluation since the main objective of the Project is agricultural development, and public profitability is also emphasized. The financial evaluation is oriented to the investment and disbursement plan and farm households economic analysis. The basic approach of the project evaluation conforms to the methodology and criteria adopted by the international organizations and the adopted parameters are related to MAF.

6.1.2 Conditions of Evaluation

The evaluation criteria used in the economic and financial evaluations are as follows:

a. The project life is set as 50 years from the commencement of the Project including detailed design period and construction works period, considering the vital life periods of the Calimanesti Dam and the Siret-Baragan Canal.
b. The currency used for the estimation is US$.
c. The exchange rate used is US$ 1.00 = Lei 1,753 as the official exchange rate of the National Bank of Romania as of October 1994.
d. The prices of agricultural products are farm-gate prices and the prices of agricultural production materials and construction materials are prices on delivery at the production and construction sites.

Problems involved in determining prices in Romania in this moment are rapid inflation and Romanian currency depreciation. It is evident that all the costs and benefits based on Romanian internal price in this period must be treated carefully. As a result of the considerable difficulties associated with internal economic instability of Romania, all the prices for the project evaluation are calculated in US$ with reference to actual market price in October 1994, and Lei values have been converted to US$ at the rate appropriate to the time when lei value was observed.

6.2 BENEFIT OF THE PROJECT

6.2.1 Estimation of Benefit

The benefit of the Project refers to a difference of net profit expected between with Project and without Project conditions under irrigation and soil conservation developments through the whole project life. The project benefit consists of quantifiable benefit; i.e. an increase in agricultural production and unquantifiable benefit such as stabilized food supply, creation of employment opportunities and improvement of living standard of rural people. Quantifiable benefit is directly subjected to economic and financial evaluations, while unquantifiable benefit is integratedly analyzed for socio-economic effects.

The benefit from the construction of operation and maintenance roads along the canals and the improvement of existing roads is considerable as a saving of transportation time and cost, decrease of damage on transportation goods etc. and they can be tangible at some part. Therefore, improvement of transport facilities will be uncertain and the benefit is judged extremely small as compared with the main one, and is not taken into account. Furthermore, the agricultural production benefit is considered only for the primary production and the benefit from the value-added secondary production such as wine and livestock productions is not considered.

6.2.2 Agricultural Production Benefit

(1) Generation of Benefit

The agricultural production benefit including wine and livestock productions is derived from an increase in cropping rate, a change of cropping pattern and an increase in unit yield which is resulted from introduction of the irrigation system and effective production practices. The proposed agricultural development plan is prepared on condition that most of the individual small-scale farmers in the Project Area organize some associations, which meets the policy of the Government of Romania, even though some of them still continue their farming individually.

(2) Annual Variation of Benefit Accrual

On the with-Project condition, the gestation period before maturing of production depends on two constituents as follows:

a. Secular change in irrigation area which occurs in the process of construction works and in accordance with the maturity of irrigation control system.
b. Secular change in yield in the course to the maturity of production practice.

The estimated progress of the construction works by year order is as shown below:

Year order	Area (ha)	Portion (%)	Accumulation (%)
1	0	0	0
2	0	0	0
3	0	0	0
4	7,132	31.9	31.9
5	10,881	48.7	80.6
6	4,347	19.4	100.0
Total	22,360	100.0	100.0

The benefit is generated from the next year of the completion of construction works the farm land of which can be irrigated and the targeted benefit can be attained on the third year after completion of construction. Annual variation of the total irrigation area including Phase I (17,409 ha) and Phase II (4,951 ha) is as follows: 5th year of the Project is 7,132 ha (32%), 6th year is 18,013 ha (81%) and 7th year is 22,360 ha (100%). While the proportion of the reduced benefits until the third year is 40% on the first year and 20% on the second year.

On the other hand, on the without-Project condition, some increase in agricultural production is considerable by effects except for the implementation of the Project, but at the same time, some decrease of production is prospected on account of the reducing trend on national level and long term, the trend of drought, etc. Accordingly, the production on the without-Project condition is not changed and remains constant as same as the present condition.

The agricultural production benefit in financial price is summarized below:

(Unit: 10^3 US$)

Item	With Project	Without Project	Increased Value
Gross Production Value	64,071	11,763	52,308
Production Cost	17,767	4,056	13,710
Net Production Value	46,305	7,707	38,598

Annual net production value on the with-Project condition is about 46×10^6 US$, about 6.0 times that of the without-Project condition, and the annual agricultural production benefit is about US$ 39×10^6 US$.

6.2.3 Soil Conservation Benefit

(1) Generation of Benefit

The soil conservation countermeasures are closely related to the agricultural production concerning stability and recovery of the productivity of soils. In this sense, the project benefit from the soil conservation plan is considered as an avoided damage of agricultural production to be caused by soil erosion in the arable land, including a concept of soil productivity, damage of irrigation facilities, efficiency of production works and transportation, etc. It means that the benefit is a deference of decreased net production values between without-Project and with-Project conditions. The benefit is generated only from a part of the arable land.

(2) Annual Variation of Benefit Accrual

According to the existing ISPIF's soil conservation projects, the countermeasure works against the soil erosion resulted in some higher crop yields, obtaining as an average increment of 15-20% or 20-25% against the yields obtained before countermeasure. Furthermore, according to the report "Instructions for Studies and Necessary Calculations for Soil Erosion Control Design, MAF", the yield decreases averagely by 15% on moderately eroded soils and 50% on strongly eroded soils. The decreasing rates of agricultural productivity used in the estimation as compared with normal yields are as follows:

a. Without Project on the moderately eroded area (1,839 ha): from 15% of the present condition to 50% for the strongly eroded area and on the slightly eroded area (6,822 ha) from 0% of the present condition to 15% for the moderately eroded area in 10 years.
b. With project on both areas: the productivity recovers to the same rates as those of the present condition in 2 years after the completion of countermeasure works.

The soil conservation project area is the same as the irrigation development area, and the benefit is generated only from the Phase 1 area. The annual net production value in financial price on the with-Project condition is $7,707 \times 10^3$ US$, 1.12 times that of the without-Project condition, and the annual increase of soil conservation benefit is 835×10^3 US$ as shown below:

(Unit: 10^3 US$)

Item	With Project	Without Project	Increased Value
Gross Soil Conservation Value	11,763	10,928	835
Soil Conservation Cost	4,056	4,056	0
Net Soil Conservation Value	7,707	6,872	835

6.3 ECONOMIC EVALUATION

6.3.1 Evaluation Criteria

The economic evaluation is to analyze economic effect of the Project on the basis of economic benefit and economic cost as computed at economic prices in the light of national economy. Based on the incremental benefit and the Project cost (initial investment cost or capital cost), operation and maintenance cost and replacement cost of the Project, all the prices are converted into economic prices.

The evaluation uses three interrelated indexes: economic net present value (ENPV), economic benefit-cost ratio (E.B/C) and economic internal rate of return (EIRR). The benefit and cost of the Project which are estimated based on implementation schedule of the Project are discounted by the opportunity cost of capital through the project life. The term ENPV is a difference between accumulated benefit and accumulated cost, and E.B/C is the ratio of the former to the latter. The term EIRR means a discount rate by which accumulated benefit is equalized to accumulated cost.

The criteria to economically validate the implementation of the Project are that ENPV is positive, B/C is more than 1 and EIRR exceeds the opportunity cost of capital. The opportunity cost of capital (discount rate) is social marginal productivity of capital input in the Project, and the discount rate in agricultural sector is considered to be 12%. This figure has also been used in all cash flow analyses of " the Study of Irrigation and Drainage in Romania, 1994 " financed by the World Bank. Therefore, it is selected as a reasonable guide to the level of returns that are considered acceptable worldwidely in agricultural development projects.

6.3.2 Price Conversion

The evaluation in economic prices corrects financial prices (market prices) to reflect distortions in foreign exchange rate, the impacts of taxes, subsidies and rents, and possibly to reflect shadow (economic) wage rates. The adjusted set of prices is used in the evaluation of the costs and benefits of the Project, reflecting their true resource values and thus determining the true economic returns from the Project to Romania.

The economic prices used in the economic estimation correspond to shadow prices. To obtain shadow prices, market prices are subtracted by transfer items other than real resources used for the Project, and the differences obtained are multiplied by the conversion factors to correct distortions of the market prices. However, these conversion factors are not established by the Romanian Government

The prices of import goods such as construction materials are economically estimated using the shadow foreign exchange rate. The inter-bank foreign exchange rate (parallel rate) or the foreign exchange rate of the private money changer (open market) is substantially higher than the official exchange rate. Originally, the parallel rate is not equal to the shadow exchange rate, but has influence on formation of trade commodity prices as taxes and subsidies. Therefore, this evaluation applies the mean inter-bank exchange rate as of October 1994, US$ 1.00 = Lei 1,875 as the shadow exchange rate converted international prices (border parity prices) into prices calculated in the official exchange rate (US$ 1.00 = Lei 1,753). The conversion factor is 1.07.

Main crop farm-gate prices used in the economic evaluation are based on estimated Romanian border parity prices. These crops such as wheat, maize and beans offer foreign exchange benefits. They are either themselves imported or exported or they are direct inputs into livestock feed, thus supporting livestock exports, which remain one of Romanian main sources of export revenues. International trade items in production cost are based on international prices, but otherwise are based on Romanian internal prices, converted to US$, if quantity is extremely small. Standard conversion factor and shadow wage rates are not applied for this economic evaluation because of obtainable difficulty on basic and adequate economic data. Opportunity cost of land purchase and compensation are regarded as 0.0.

Salvage value or residual value is considered as a negative cost on the principal structures and equipment which have vital life period at the end of the project life. Sunk cost is taken into consideration for a part of former investments on the Calimanesti Dam and the Siret-Baragan Canal constructions and the existing irrigation system (Ruginesti-Pufesti-Panciu Project) in the Project Area.

(1) Estimation of Benefit

Transfer items to be subtracted in the estimation of the benefit of the Project are as follows:

- Agricultural tax and sales tax (30% of net production value) occupied in production cost;
- Water charge occupied in production cost;
- Subsidy occupied in seed prices (30%) of wheat and sugar beet, and chemicals (70kg/ha) for wheat production;
- Agriculture loan interest occupied in other costs (50%) of production cost;
- Value added tax (18%) imposed and occupied in production cost items; and
- Depreciation cost (80%) of marketing cost occupied in the production cost.

Shadow prices to be applied in the estimation of the benefit of the Project are as follows:

- Farm-gate price of main crops of wheat, maize and beans to be converted to the international prices; and
- Agricultural chemical price in production cost; conversion factor 1.07.

Furthermore, self-labor force of the farmer is valued as a part of production cost and depreciation cost of marketing cost is converted into a part of the initial cost (the total economic price is $11,712 \times 10^3$ US$ at the 3rd and 4th year) in economic evaluation. The annual net production value in economic price on the with-Project condition is 59.70×10^6 US$, 5.9 times that of the without-Project condition, and the increase of the annual agricultural production benefit is 49.51×10^6 US$ as follows:

(Unit: 10^3 US$)

Item	With Project	Without Project	Increased Value
Gross Production Value	67,985	15,122	52,863
Production Cost	8,285	4,932	3,353
Net Production Value	59,701	10,190	49,510

On the other hand, the annual net soil conservation value in connection with the soil conservation works in economic price on the with-Project condition is 10.19×10^6 US$, 11.3 times that of the without-Project condition, and the increase of annual soil conservation benefit is 1.14×10^6 US$ as shown below:

(Unit: 10^3 US$)

Item	With Project	Without Project	Increased Value
Gross Soil Conservation Value	15,122	13,981	1,141
Soil Conservation Cost	4,932	4,932	0
Net Soil Conservation Value	10,190	9,049	1,141

(2) Estimation of Cost

The Project cost is composed of the costs for construction works, land acquisition, equipment procurement for operation and maintenance, project administration, consultant service and physical and price contingencies. However, price contingency is excluded from the project evaluation. Transfer items to be subtracted in estimation of the cost of the Project are as follows:

- Social charge and unemployment fund of salary on labors in the project cost, operation and maintenance cost and replacement cost;
- Some fund charges in the project cost;

- Value added tax (18%) imposed in the project cost, operation and maintenance cost and replacement cost; and
- Facility depreciation cost in the operation and maintenance cost.

Shadow prices applied in estimation of the cost of the Project are as follows:

- Land acquisition and compensation cost; conversion factor 0.0; and
- Foreign exchange rate, conversion factor 1.07.

Transfer items and shadow prices of the sunk cost are also considered. The Project cost in economic price is the sum of $59,110 \times 10^3$ US$ for local currency and $13,735 \times 10^3$ US$ for foreign currency, totaling $72,844 \times 10^3$ US$ as shown in the table below. On the other hand, annual operation and maintenance cost is $5,112 \times 10^3$ US$ and the replacement cost is $2,500 \times 10^3$ US$.

(Unit: 10^3 US$)

Year order	Local Currency	Foreign Currency	Project Cost
1	0	0	0
2	98	0	98
3	812	956	1,768
4	20,825	4,260	25,085
5	27,548	6,293	33,842
6	9,826	2,225	12,052
Total	59,110	13,735	72,844

6.3.3 EIRR, ENPV and E.B/C

The period of evaluation is 50 years of the whole project life. Therefore, replacement cost is required for some machines and equipment with shorter service life at the end of economic vital life of them. These machines and equipment have small residual values at the final year of the project life. If the evaluation proves that EIRR exceeds the opportunity cost of capital in agriculture sector of 12%, ENPV is positive and B/C exceeds 1.0, it will be judged that implementation of the Project is economically validated.

Table 6.3.1 shows a flow of project cost, operation and maintenance cost and replacement cost and the all the project benefit. Where EIRR of the Project is 20.5% and at discount rate of 12%, ENPV is $137,884 \times 10^3$ US$ at price in October 1994, E.B/C is 2.19 at the same discount rate. The Project evaluation has proven that EIRR exceeds the opportunity cost of capital in agriculture sector of 12%, ENPV is positive and E.B/C exceeds 1.0. It is judged that the implementation of the Project is economically validated.

6.3.4 Sensitivity Analysis

The sensitivity analysis shows the sensibility on estimation for variation of the main assumed factors in the project evaluation, and the analysis has been made under the following conditions: 1) 10% increase of the project cost, 2) 10% decrease of the project benefit and 3) 1 year delay of the completion of the construction works.

Increase of the estimated project cost is attributable to the rise of construction material cost and wage and increase of work volume. Decrease of the project benefit is attributable to the increase of the estimated production cost, reduction in the expected yield and fall in farm-gate price of agricultural products, and delay of the completion of the construction works means the delay of occurrence of the benefit. The results of sensitivity analysis of economic evaluation is summarized below:

Item	EIRR (%)	ENPV (10^3 US$)	E.B/C
Base	20.5	137,884	2.19
Project cost increased by 10%	20.2	137,776	2.18
Project benefit decreased by 10%	19.4	113,529	1.98
Construction delayed for 1 year	18.8	113,291	2.00

Sensitivity analysis has proven that a change in the construction period has stronger influence on economy of the Project than a change in project cost and project benefit. Furthermore, the implementation of only Phase I portion, EIRR of the Project is 20.2% and at discount rate of 12%, ENPV is $105,195 \times 10^3$ US$ at the price as of October 1994, E.B/C is 2.10 at the same discount rate.

6.4 FINANCIAL EVALUATION

6.4.1 Evaluation Criteria

The financial evaluation is to evaluate soundness of financial state of the Project, which will generate the justifiable profit with the implementation of the Project, from the viewpoint of the project implementation organization and beneficiary based on financial benefit and financial cost with financial prices (market prices).

The evaluation in financial prices utilizes the actual market prices for inputs and outputs faced by the farmers to calculate their expected gross income and farm profit in order to explore the farm level economic surplus and farmers' ability to contribute to cost recovery of the Project. The financial prices are also used to analyze the cash flow and balance sheets of the whole

Project including the operation and maintenance cost and replacement cost, and to analyze the cash flow of project investment and repayment.

6.4.2 FIRR, FNPV and F.B/C

The evaluation uses three same relevant indexes as for the economic evaluation: financial net present value (FNPV), financial benefit-cost ratio (F.B/C) and financial internal rate of return (FIRR). The benefit and cost of the Project which are estimated based on the implementation schedule of the Project are discounted by the financial discount rate through the project life. The term FNPV is a difference between accumulated benefit and accumulated cost, and F.B/C is the ratio of the former to the latter. The term FIRR means a discount rate by which accumulated benefit is equalized to accumulated cost.

The criteria to financially validate the implementation of the Project are that FNPV is positive, F.B/C is more than 1.0 and FIRR exceeds the financial discount rate. As the financial discount rate in the agricultural sector, the effective rate of interest on the National Bank of Romania of 10% is used.

The governmental subsidy for the Project is considered as income of the Project. Accordingly, it is possible to evaluate the validity of the implementation of the Project based upon proportion of the governmental subsidy. However, the Project is to be implemented on condition that the subsidy of the Government of Romania covers almost all the part of the project cost, operation and maintenance cost and replacement cost except for a part of the operation and maintenance cost which is to be borne by the farmers as water charge.

Table 6.4.1 shows a flow of the project cost, operation and maintenance cost and replacement cost and all the project benefit. Where FIRR of the Project is 29.9% and at discount rate of 10%, FNPV is $150{,}851 \times 10^3$ US$ at the price as of October 1994, F.B/C is 2.46 at the same discount rate. Project evaluation has proven that FIRR exceeds the financial discount rate in agriculture sector of 10%, FNPV is positive and F.B/C exceeds 1.0. It is judged that the implementation of the Project is also financially validated.

Sensitivity analysis in the financial evaluation for three cases stated previously is also carried out under the same condition as for the economic evaluation. The results of sensitivity analysis of financial evaluation are summarized below:

Item	FIRR (%)	FNPV (10^3 US$)	F.B/C
Base	29.9	150,851	2.46
Project cost increased by 10%	27.5	144,308	2.31
Project benefit decreased by 10%	26.8	127,401	2.21
Construction delayed for 1 year	24.7	130,862	2.31

Sensitivity analysis has proven on finance of the Project that a change in the construction period has stronger influence at FIRR and a change in project benefit has stronger influence at FNPV and F.B/C than a change of other items. Furthermore, the implementation of only Phase 1 portion, FIRR of the Project is 28.3% and at discount rate of 10%, FNPV is 115,638x10^3 US$ at the price as of October 1994, F.B/C is 2.35 at the same discount rate.

6.4.3 Investment and Repayment

For the implementation of the Project, it is necessary to procure the project cost including the price contingency (price escalation) in foreign and local currencies.

The Project attempts to introduce external loan from an international financial organization to cover expenses mainly to be paid in foreign currency or a certain portion of the total project cost. Expenses to be paid in local currency are to be budgeted in the frame of the public investment account under the responsibility of the Government of Romania. An example of investment and repayment conditions of the foreign loan for the Project indicates that proportion of the foreign loan covers 75% of the total project cost with the annual interest rate of 3%, loan maturity of 30 years, grace period of 10 years and equal annual payment in principal.

In the 11th project year, the sum of equal annual reimbursement and interest becomes the maximum of 6,286x10^3 US$. In the 5th project year, the sum of the reimbursed interest of the foreign loan and investment to the Project becomes the maximum of 11,677x10^3 US$. This amount accounts for about 0.17% of the national budget in 1995 (US$ 1.0 = Lei 2,001) and about 1.61% of the budget of MAF.

6.4.4 Analysis of Farm Economy

From the results above, the economic impact to an unit farm management expected from the proposed Project is briefly recapitulated as below:

The production cost structure indicates that the major cost components will shift from machinery plus seed/manure costs to water cost for conventional crops and sales tax for

perishable cash crops. If a new rate of taxation (30-45%) is employed instead of currently employed rate of 30% of the net profit, the margin derived from vegetables will be considerably eroded from the given estimation. Introduction of vegetables in a state-sponsored project would be ideal for increasing fiscal revenue prior to promising their benefit.

On the other hand, net benefit ratios of crop production are improved by 10-20% through the Project, while those of animal husbandry decline in the case of individual management but increase in the case of associations. Those for winery/vineyard remains at the level of 33-35%. Cropwise ratios show quite mixed results. Generally those for cereals and other conventional crops show a negative gain. Meanwhile, those for vegetables result in a positive gain owing to augmented yield level and constant price levels for inputs.

So far as the net annual agricultural income per farm unit is concerned, contribution from the crop sub-sector including vegetables accounts for an overwhelmingly greater share, reaching 80-90% of the total net income at with-Project stage, or virtually the entire portion of project gain. Whereas, that from livestock sub-sector is limited, because its cost-benefit ratio is quite low as compared with that of crop and the acreage under forage crop is also limited. As regards vineyard and winery sub-sectors, the management will have to be radically rationalized in view of lower per-hectare gain, as proceeded currently in west European countries. In conclusion, the proposed Project will bring the following improvement:

Management Type	Farm Size	Farm Income (10^3 Lei)		
	(ha)	w/o Project	w/ Project	Growth Rate (%)
Individual	4	1,851	8,681	469
Association	500	452,142	707,966	157
Private Winery	500	680,183	896,883	32

6.5 SOCIO-ECONOMIC EVALUATION

As stated before, the Project brings about the following secondary or indirect intangible benefits which are important in reviewing validity of the implementation of the Project as well as the direct or tangible benefits:

(1) Contribution to the national development plan

Implementation of the Project contributes to the national development in ensuring accomplishment of many objectives of the agricultural irrigation development and soil erosion control plans, which are ones of the important political terms on the agricultural sector of the national development plan.

(2) Stable supply of food

The stable production of maize and wheat, which are basic major crops, is maintained with the introduction of irrigated farming method. Furthermore, the diversity of agricultural production occurs around the Project Area because of new crops such as vegetables being introduced in the Project, and answers to the stable supply of food to the people and contributes to the improvement of self-sufficiency rate.

(3) Increase in employment opportunity

The agricultural production requires annually about $1,200 \times 10^3$ man/day of agricultural laborers, and about 250 man/day in agricultural laborers increase annually compared with the case of without-Project. Implementation of the Project absorbs excess labor in and around the Project Area, reduces unemployed laborers and improves the living standard of employed laborers, thus contributes to the stabilization of civil living in and around the Project Area.

(4) Improvement of living standard

As evidently proven by the financial evaluation, the farmer's economic surplus is increased to a great extent with the implementation of the Project, even if a part of the operation and maintenance cost is borne to the farmers as water charge. A rapid increase in funds in farmer's economy by far exceeds cost of improving living environments.

(5) Promotion of marketing and processing of agricultural products

Increased production of agricultural products stimulates the marketing system and opens a door to the improvement of the system. In addition, processing of vegetables ensures increased values added. Stable supply of raw materials effectively utilizes the existing processing facilities that would otherwise be left in poor utilization efficiency, thereby contributing to the promotion of the agricultural product processing sector.

(6) Correction of differences among areas

Construction of the maintenance roads along the canals and improvement of agricultural roads not only serve to the operation and maintenance of canals but reduce economic differences among areas by stimulating distribution of goods among areas.

(7) Agriculture for environmental consideration

Introduction of leguminous crop and diversified farming by combining cultivation of crops and animal husbandry is judged as an environmental and sustainable agricultural system with preventing soil erosion.

(8) Economic stimulation

The implementation of the Project increases the income of local farmers and improves the living standard of them to a great extent. Improved income further increases purchase power of the local farmers and vitalizes local commercial activities. Increased purchase power and vigorous commercial activities are expected to promote local industries. In this way, the implementation of the Project will bring about significant repercussive effect to Vrancea District and finally to the economy of Romania, not limited to the Project Area.

6.6 ENVIRONMENTAL EVALUATION

6.6.1 Impact of the Project

Main impact sources can be classified according to the impact elements of the Project (Table 6.6.1). Irrigation activity in the field is expected to be the most important impact source. Construction of civil works is a limited impact source since the main works, Calimanesti Dam and Main Canal, are the elements of the initial state. Soil conservation works are not retained as a source of impact. While such works enhances environmental quality of the initial state, eventual impacts would be a consequence of retained soil conservation techniques. Therefore, the maintenance of these works/facilities is very important for the preservation of environment.

6.6.2 Impacts on Natural Environment

(1) Water Quality

The data for analyzing water quality of the Calimanesti dam which is the source of the irrigation water of the Project are not available. But according to the test result of water samples collected near the Intake at the Calimanesti dam and conducted by the Study Team, the water quality has been proved to be sufficient for irrigation. There is still possibility that the water will be polluted with the inflow of the pollutants from the industries located at the upstream section of the Siret River and also from the agricultural field in a long run.

However, an action plan for improving the environment in the upstream area of the Siret River has been taken off in order to improve the water treatment facilities of the factories and towns, and this action will be able to expect as a limiting factor against water contamination. In the case of the large-scale development of livestock farm, the installation of the treatment plant will be required in order to protect the groundwater in good quality.

(2) Soil Quality

The sprinkler irrigation may damage the surface soil, if it is done on the sloped vineyard. However, it will be possible to minimize the probable soil erosion by limiting the irrigation, performing the soil conservation works, etc. Furthermore, the soil in the Project Area may be contaminated with the industrial and agricultural pollutants to be brought from the factories and/or farming activities upstream the Project Area. It will also be expected that the contamination of soil will be minimized by the above-mentioned action for water quality improvement, limiting the use of agro-chemicals, soil conservation farming proposed in the Project, etc.

6.6.3 Impacts on Social Environment

As regards to the water resources problem, indirect effects of the Project would be water shortage or conflicts as a result of increased needs for use of domestic water and municipal or industrial water. Since groundwater represents 100% of water resources in towns (Panciu, Marasesti, Odobesti) and villages, the possible contamination of groundwater due to the implementation of the Project would threaten health of consumers. Agricultural development will result in an increasing number of point sources of pollution, involving an increased quantity of solid waste, wastewater and sludge of breeding cattle activity in the mean term. Consequences are mixed alternatives between an acceptable increased risk on health and increased costs for waste treatment.

6.6.4 Main Measures to Improve Environmental Quality

The following proposed measures deal with water quality as being the major possible impact of the Project, and with improvement of environmental quality through implementation of the Project. While the former is a preventive measure, the latter aims at carrying out environmental positive impact.

(1) Measures to Mitigate Water Quality Degradation

Since the water quality problem must be solved at its source (upstream industries), there is no measure to mitigate the impact at the Project level except for the use of agrochemical. However, an appropriate monitoring of water quality seems to be necessary, particularly during the transition period of implementation of action plans at the upstream industries.

(2) Measures to Enhance Quality of Environment

The Branch Environmental Agency of Vrancea is considering the possibility of combining irrigation with ecological rehabilitation of forest. This action would consist in establishing forested corridors in order to rebuild natural forest within the Project Area. This is still a general

concept without clear proposition, but is regarded as a complementary functional element of the irrigation scheme.

Advantages or contributions would be the following:

- Protection against north/south wind;
- Positive effects on micro-climate (maintenance of humidity of air);
- Countermeasures against drought;
- Decrease in the needs of energy, water and materials input, since irrigation water is partly compensated by natural humidity; and
- Decreased risk of groundwater contamination.

In other words, this measure would be considered as an element of environmental sustainability of the Project. Since the Agency is the authorized entity for delivering environmental approval of the operation of the Project, a proposition for afforestation will be received very favorably. This measure would be a very positive aspect of the Project from the standpoint of environment.

6.7 COMPREHENSIVE EVALUATION

The implementation of the Project allows prediction that the living standard of local people in and around the Project Area is greatly improved, which results from an increase in agricultural production, soil conservation, stable supply of food, increase in employment opportunity, expansion of income, etc. All these benefits are attained mainly by an increase in cropping rate, a change of cropping pattern, an increase in unit yield and an introduction of cash crops owing to the irrigation system. The implementation of the Project is highly evaluated to serve to stabilization of civil living and welfare in Project Area, to give an intensive impact to production activities and to contribute to the national economy.

Thus, the implementation of the Project is judged as valid with the result of economic and financial evaluations as computed from tangible benefit. In addition, socio-economic impact evaluated from intangible benefit is also judged as sufficiently expectable. Any remarkable negative impact from the implementation the Project is not confirmed on the environmental evaluation, and the Project is evaluated as a sustainable agricultural development plan considering the environmental situation. Moreover, the implementation of the Project is justified to be feasible from technical and organizational operational viewpoints. Accordingly, it is recommended that a high priority should be given to the Project for its implementation in the early stage.