

**J.8.3.2 Technical Specification for Model Plant
for 8Ha Coffee Farm (EL ROCIO)**

1. General

The plant is designed for a coffee farm in Armenia, Quindio state of the Republic of Colombia considering circumstances of the said area.

Characteristics of the plant are as follows:

- : Full system consists of facilities for neutralization, anaerobic treatment, aerobic treatment, stabilization pond and dehydration, including tertiary treatment.
- : Lime-stone-aeration method is applied to the neutralization, which is expected to be safe and economical in its running cost for low-income farmers.
- : Not conventional method as in the past but high technology of high speed treatment is applied to anaerobic reactor. The treatment is carried out by two steps, pre-agglomeration treated strong agglomerated anaerobic sludge zone and anaerobic contact filter in one reactor named "SNYMIF. The anaerobic contact filter also has a function to prevent the anaerobic sludge from being washed out by generated methane gas, as SGS (sludge-gas separator), newly divided anaerobic reactor.
- : The aerobic treatment removes offensive smell, specific to anaerobic treatment water, releases no-oxygen condition and at the same time decomposes residual organic compounds furtherly. The contact filter to be applied is a method where organic compound load is higher than that in the conventional activated sludge process for suspending treatment, and can simplify handlings for the activated sludge to be returned. This facility shall be able to be used as an anaerobic filter and the usage, as an aerobic facility or anaerobic facility, is switched by the load accordingly.
- : In the final treatment polishing and stabilization are carried out by an aquatic plants stabilization pond called as "Living filter".

By the above mentioned treatment the quality of the final treated water clears the standard for quality of waste water treatment authorized by the Ministry of Health of the Republic of Colombia, moreover, as to organic compound (CODcr), the target of the removal ratio is higher than 90 per cent which is higher than the standards.

Other remarkable characteristics of this plant is that materials to be applied to the facilities are designed to be obtained easily at the region as far as possible as mentioned below.

- : Acid proof paint produced in Colombia is applied to protection of inner wall of concrete tanks.
- : Raw lime-stone used as material for soil improvement produced in the suburbs of Cali City is used for the facility.
- : Porous mineral carbon produced near around Quindio used for solid fuel is used for the contact filter media - carbon mineral coke.
- : Bamboo growing naturally in Quindio is applied to fence support, wall protection of the stabilization pond and to baffle wall.
- : Abundant rainfall is used as miscellaneous purpose.
- : Buchong de Agua, "Water hyacinth", growing naturally considered an original plant of South America is used as aquatic plant.
- : Lime-stone, mineral carbon and bamboo are very cheap, which can save the initial cost quite a lot, and at the same time these materials are quite easy to obtain.

It is expected that by the installation of the pilot plant, economically and technically appropriate treatment method will be studied, new technological developments will be promoted and that bringing up engineers those who concern will be carried out.

Still more, at present there are several coffee processing waste water treatment pilot plants and sewage treatment pilot plants don't work effectively in this region.

According to data obtained, removal ratio of COD_{cr} of those plants are around 50 per cent, which is not satisfactory.

It is necessary to study about the reasons of troubles of those plants in the next investigation. The main factors of trouble is attributed to anaerobic reactors as follows:

- 1) Acclimatization of anaerobic sludge being not enough
- 2) Anaerobic sludge being washed out, that is, mal-function of SGS
- 3) Shortage of know-how on aerobic treatment
- 4) Shortage of running and controlling engineers' ability
- 5) Shortage of designers' engineering ability

2. Design Criteria

Designed quantity of waste water		
Maximum daily waste water	30 l/kg/Ha/Dry coffee bean	
Average daily waste water	22.5 l/kg/Ha/Dry coffee bean	
Annual days of coffee processing		
Maximum	200 Days	
Average	160 Days	
		Small amount of processing, however, is continuously carried out through out a year.
Temperature		
Maximum	31.7°C	
Average	21.9°C	
Minimum	12.2°C	
Annual Rainfall		
Maximum	283 mm/month	
Average	168 mm/month	
Minimum	96 mm/month	
Insolation Duration		
Maximum	199 hrs./month	
Average	149 hrs./month	
Minimum	133 hrs./month	
Relative Humidity		
Maximum	82%	
Average	80%	
Minimum	73%	
Evaporation		
Maximum	105 mm/month	
Average	85.3 mm/month	
Minimum	70 mm/month	
Coffee Beans Production		
Maximum	18.31 kg/Day/Ha/	(Cosecha season)
	dry coffee bean	
Average	15.0 kg/Day/Ha	
	Dry coffee bean	

Water required for coffee processing

River water (none-treatment)

Coffee cultivation

8 Ha

Amount of waste water

Daily maximum discharge

4.4m³ (0.183m³/hr)

(550 l/Ha/Day)

Daily average discharge

3.3m³ (0.137m³/hr)

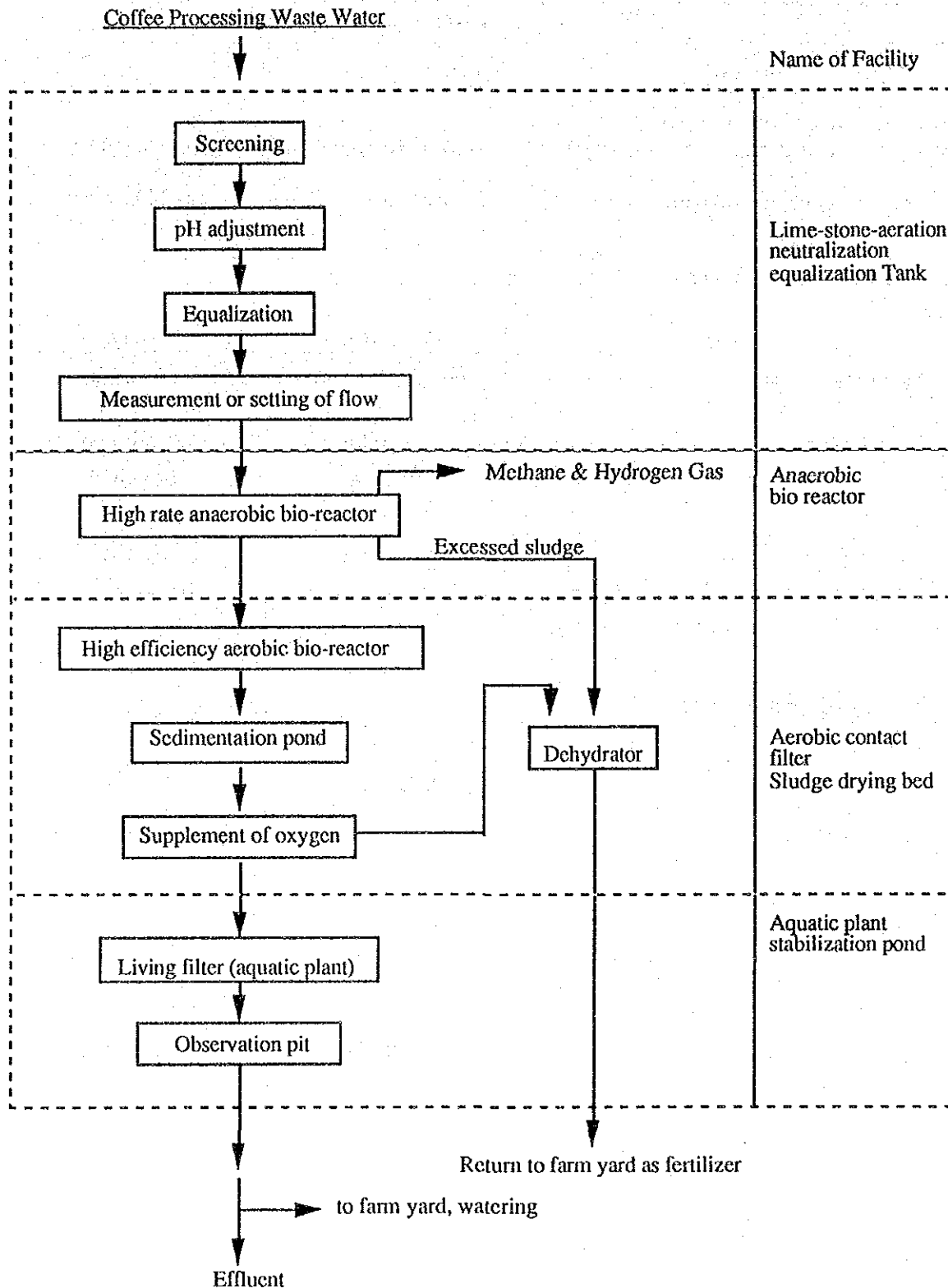
(412 l/Ha/Day)

Quality of Waste Water

Item	Maximum	Average
Water Temperature	normal temperature	normal temperature (18-28°C)
Appearance	turbid yellowish brown	turbid yellowish brown
pH	3.5	4.0
Suspended Solid (SS)	3,000 mg/l	2,000 mg/l
Chemical Oxygen Demand (COD _{cr})	15,000 mg/l	10,000 mg/l
Biochemical Oxygen Demand (BOD ₅)	10,000 mg/l	6,700 mg/l

Quality of Treated Water

Item	Standard of Colombia	Target Value
Appearance		slightly turbid light yellow
pH	5-9	5.8-8.6
Suspended Solid (SS)	400mg/l (80% removal)	30mg/l (98.5% removal)
COD _{cr}	2,000 mg/l (80% removal)	less than 300 mg/l (97% removal)
BOD ₅	1,340 mg/l (80% removal)	less than 200 mg/l (97% removal)



Flow of Coffee Processing Waste Water Treatment

Designed removal ratio and target of CODcr and SS

Item	Treatment	Raw waste water	Pre-treatment	Primary treatment	Secondary treatment	Tertiary treatment	Removal Ratio %
pH			5-6	5.8-8.6	5.8-8.6	5.8-8.6	
CODcr (mg/l)		10,000	-	2,500	600	300	
CODcr removal ratio				75%	75%	50%	97%
SS (mg/l)		2,000	-	-	200	30	
SS removal ratio					90%	85%	98.5%
Name of facility and remarks	Average value	Lime-stone neutrization aeration equalization	SNYMIF anaerobic reactor	Acrobic reactor	Aquatic plant stabilization pond	Standard of Colombia for BOD % SS, 80%	

3. Specification of Equipment

Rain Water Storage Tank

Rain water is collected by rainfall collecting troughs of buildings around the site and stored in this tank of which water is used for washing precipitate in the neutralization tank as required. Excessed water is used for supplying oxygen to the aquatic plant stabilization pond.

Type	Concrete made, open rectangular type
Number of tank	1
Used frequency	Maximum 1 time/week
Capacity of tank	2.5 m ³
Size	1,800 mm (l) x 1,400 mm (w) x 1,000m (Effective depth of water)

Auxiliary equipments

Overflow pipe	PVC 2"	1 set
Rainwater outlet pipe	PVC 2"	1 set
Rain water outlet valve	Stop valve BC 2"	1 pc

Screen

There is no big solid in the waste water since screening is done in coffee beans producing process usually. The screen is installed at the inlet of neutralization tank and basket shaped with net of 10 mesh as a standard. Waste shall be removed manually.

Type	Plastic made, square basket type
Number of screen	1
Net size	10 mmø
Size	300 mm (l) x 300 mm (w) x 280 mm (H)

Lime stone-Aeration Neutralizing Tank

Tank used both for Lime-stone aeration Neutralization and for Equalization.

Coffee processing waste water is discharged ordinary within 2 or 3 hours through out one day process of coffee beans production. The density and flow rate of the waste water are changed with time as a matter of course. Usually the equalization tank for one day is necessary, after then treatment is carried out by fixed flow rate, however, considering minimization of the construction cost and simplification of the facility, the facility serves as equalization tank and neutralization tank at the same time.

3 or 4 hours are required for neutralization by use of alkali. After dosing alkali into the waste water, pH is adjusted to neutral, however, by decomposition of organic matter, pH becomes lower after that again. Usually, neutralization of inorganic matter is accomplished within few minutes level of time, however, it should be careful when neutralization for coffee processing waste water is performed. In this case for one day capacity of equalization tank functions effectively. The use of strong alkali, for example sodium hydroxide, calcium hydroxide etc., seems effective but when used by coffee farm following points becomes fatal disadvantages.

- Dangerously of over dosing of alkali and abnormal pH.
- Chemical cost gives influence upon benefit of coffee production.
- Cost increase by installation of electrical pH meter for pH control.

Neutralizing reaction by lime-stone is moderate and its pH after reaction often comes to an end at about pH 5. Removing dissolved carbon dioxide in the neutralized waste water by air bubbling can make its pH up to about pH 6. This air bubbling is effective in removal of suspended solids which deposit on the surface of lime-stones, which disturb next neutralization and is effective also in removal of sludge retained among lime-stone. This is, of course one of the best method for equalization for coffee farm in Quindio.

Anaerobic treatments at pH 6 is testified to its effectiveness by lime-stone aeration water in 70 days' continuous labo-scale test, and is found no problems in the treatment.

Type	Lime-stone-aeration equalization method, concrete made acid proof coating inside (anti acid tile finishing)
Number of tank	1
Capacity of tank	Bigger than 7 m ³
Size	3,600mm (l) x 1,800 mm(w) x 1,250mm (Effective depth of water)
Lime-stone	Product in Colombia
Basixity	
Appearance	Like crushed stones, yellowish white lime-stone

Specification for packing Size	Volume of Packing	Height of Packing
10 x 10mm	2 m ³	300 mmH
20 x 20mm	2 m ³	300 mmH
40 x 40mm	2 m ³	300 mmH
Total	6 m³	900 mmH

Approximate Weight of Packing 7 Ton
 Surplus materials after packing is stored as spare.

Slope of Bottom	Bigger than 1/100, to neutralized water outlet.	
Air diffusing		
Air volume	0.07 Nm ³ /min (0.01 Nm ³ /m ³ /min)	
Air pressure	Bigger than 1,000 mmAq	
Using condition	Continuous use	
Air generator (common use for aerobic reactor)		
Type	Turbo blower	1 unit
Motor	0.4kw-115V, outdoor type	
Capacity	0.5Nm ³ /min	
Air diffusing pipe	Vinyl pipe	1 set
Size of pipe	3/4"	
Size of nozzle	4 m/m ø	
Auxiliary equipments		
Outlet pipe of neutralized water	Vinyl pipe	1 set
Outlet valve of neutralized water	Vinyl made ball valve 3"	1 pc
Weir for water flow rate	Mild steel plate made, trough type anti-corrosive coating	1 set
Measurement		
Volume of measurement	200 l/hour	
Size of trough	150 mm(w) x 100 mm(D)	
Neutralized water sedimentation pit		
Type	Concrete made, rectangular thickener	
Number of pit	1 pit	
Linear velocity	9 m/day	
Retention time	3.3 hours	
Angle of repose of sludge zone	60° or more	
Volume of pit	0.6 m ³	
Size of pit	700mm x 700mm x 1800mm(D) (Effective Depth)	
Feed well	Mild steel plate made, cylindrical, outlet with baffle plate, anti-corrosive coating	1 set
Size	100 mmø x 1000mmH	
Trough	Mild steel plate made, anti-corrosive coating	1 set
Size	75 mm (w) x 75 mm (D)	
Effluent pipe	Vinyl pipe 2"	1 set
Desludge pipe	Vinyl pipe 3"	1 set
Desludge valve	PVC made, ball value 3"	1 pc

Anaerobic Bio Reactor (SNYMIF)

SNYMIF anaerobic reactor is different from the conventional 30 days thermophilic digestion method in its high speed treatment of 1 or 3 days. UASB method the proto type of high speed anaerobic digester has following disadvantages.

- 1) It takes 3 - 6 months for acclimatization of sludge being granulated under careful running control, which is not appropriate for coffee farmers. And granulated sludge can not be obtained at present in Quindio.
- 2) Mechanism of separating gas from sludge is complicated and difficult, and sludge is seriously washed out with methane gas, therefore, the quality of treated water is degraded in fact.

As to the present method, pre-agglomerated sludge is charged into the reactor for the preparation of heavy sludge zone. Then anaerobic contact filter with crushed mineral carbon is installed above the sludge zone. These make polishing for waste water and stopping sludge carry over by gas generation possible. By these procedures treated water with expected quality is obtained in an early stage after starting running the facility and appropriate treatment of waste water influenced during harvesting period can be controlled.

Type	Up flow agglomerated anaerobic sludge zone, SGS, function anaerobic contact filter reinforced concrete made, rectangular type "SNYMIF"
Number of reactor	1
CODcr load of reactor	3.8kg-CODcr/cm ³ /day
Agglomerated sludge	
Standard volume of sludge	4 m ³
Standard density of sludge	40,000 mg/l
Hydraulic detention time	60 hours
SGS mechanism	
Packing media	Mineral carbon coke (Product in Colombia)
Size	10 x 10mm and 40 x 40mm
Volume of packing	2.2 m ³ (1.1 m ³ + 1.1 m ³)
Height of packing	750 mm
Supporting base for packing media	Mild steel plate made, grating type, all antic corrosive coating
Size of reactor	1700mm x 1700mm x 4000mmD (Effective depth)

Neutralized water distributor

Type	Weir distribution type, mild steel plate made, all anti corrosive coating (3 times)	
Number of distributor	1	
Number of distribution	2	
Distribution pipe	Vinyl pipe 3"	
Size	250mm (l) x 400mm (w) x 500mm(D)	
Sampling rack		1 set
Type	Concrete made	
Size of rack	500mm (l) x 400mm (w) x 300mm (D)	
Sampling valve	Vinyl made ball valve 2"	3 pcs.
Upper water collecting equipment		
Type	All around water collecting trough type, mild steel plate made, with baffle plate all anti-corrosive coating	
Size		
Water collecting part	100mm (w) x 100mm (D)	
Gathering part	300mm (w) x 300mm (D)	
Drain pipe	Vinyl pipe 2"	

Aerobic Contact Filter

Mineral carbon coke obtained the region is used as filter media. In the porous part, aerobic organic matter decomposing bacteria are maintained. The filter is divided into two ponds considering dispersion of load. As to this filter returning sludge is not required, therefore, returning pump facility is not necessary. Since activated sludge is maintained onto the filter, high loading becomes available compared with suspending activated sludge method, and at the same time volume of excessed activated sludge becomes small.

Possibility of bulking is small also. Main operation is air controlling, thus, operation is comparatively easy. The facility is high efficiency and can be used as anaerobic filter during off season and when the load is low.

Type	Aerobic contact filter media packing air diffusing method, concrete made type
CODcr load of the reactor	1.52 kg CODcr/Reactor m ³ /day
Detention time	30 hours
Aeration	
Air volume	0.4 Nm ³ /minute
Air pressure	1000 mm or more
Diffuser	Vinyl pipe, porous pipe
Size of nozzle	4 mm ϕ , zigzag arrangement
Size of the reactor	1800mm x 1700mm x 1800mmD (5.5 m ³)

Packing media	Mineral carbon coke (Product in Colombia)	
Size	10mm x 10mm	
Volume of packing	5m ³	
Aerobic treated water sedimentation pit		1 pit
Type	Concrete made, rectangular type thickener	
Linear velocity	9m/day	
Detention time	3.3 hour	
Angle of repose of sludge zone	60° or more	
Volume of pit	0.6m ³	
Size of pit	700mm x 700mm x 1800mm (Effective depth)	
Feed well		
Type	Mild steel plate made, cylinder type, outlet with baffle plate, all anti corrosive coating	1
Size	100mmø x 1000mmH	
Auxiliary equipments		
Desludge pipe	Vinyl pipe 3"	1 set
Desludge valve	Bronze made, ball valve 3"	1 pc
Water collecting valve	Mild steel plate made, all anti corrosive painting	1 set
Size	75mm(w) x 75mm(D)	
Excessed sludge storage pit		1
Type	Concrete made, rectangular type	
Volume of pit	1m ³	
Size of pit	700mm x 800mm x 1800mmD (Effective depth)	
Sludge drying bed		
<p>As to drying sludge, solar drying method is applied, therefore no power and no chemicals are required. Coffee harvest season is comparatively rainy season, so, drying bed with roof is applied. There are coffee beans drying facilities called "Elva" at the site, but its roof (shelter) should be closed when it rains, therefore, fixed roof is applied to the facility.</p>		
Type	Brick made, mortar finishing, rectangular type, with roof, winds drying	
Capacity	1,850 l/bed x 2	
Water content of sludge	99%	
Water content of cake	85%, or less 1 week drying for 1 bed	
Number of bed	2	
Size of bed pit	1400mm x 4400mm x 1500mm (Effective depth)	
Slope of bottom	1/100 or more, outlet pipe-ward	

Packing media		Size	Packing Height	Volume
Name of packing media				
Gravel		10-20mmø	250mm	1.55m ³
Coarse sand		3-5mmø	250mm	1.55m ³
Sand		0.8-1mmø	250mm	1.55m ³
		Total	750mm	4.65m ³

Auxiliary equipments			
Scraper for cake			1 set
Wood made stop weir			4 sets
2" Drain pipe			2 sets
Shelter	13m ² or more		1 set
Rainfall collecting trough			1 set

Aquatic Plant Stabilization Pond

Highly fertile water hyacinth is applied to this stabilization pond. It is well known that water hyacinth consumes dissolved phosphate and nitrogen as resource of nourishment and can reduce organic matters expressed in COD_r and BOD₅ also. In floating aquatic plant pond dissolved oxygen is consumed rapidly, therefore, some of rainfalls are added into the pond to cope with this. The retention time of the pond shall be 7 days. Water-air mixed solution aerated by air-jet at in-flow part is sprinkled from bell-mouth shaped jet cylinder, which supplies oxygen, and at the same time, considering good appearance. Sediment at the bottom is removed periodically by a spare submersible pump of sewer (once a season).

Type	Rectangular aeration pond	
Number of pond	1	
Retention time	21 days	
Required volume	86m ³ or more (including inspection pond)	
Water proofing	Plastic sheet and Si Ka-1	
Size of pond	16,000mm(l) x 6,000mm(w) x 900mm (Effective Depth)	
Stabilization pond part	80m ³	
Inspection pond part	6m ³	
Total	86m ³	
Revetment of baffle wall	Bamboo, surface mortar coated	
Aquatic plant		
Name of plant	Water Hyacinth (Buchong de Agua)	
Amount of plant	500kg drip weight	
Inspection pond	6m ³	1 pond
Aeration channel		1 set
Type	U type drainage with baffled stone concrete made	
Size	300mm(w)	
Total length	50m	
Slope	10 - 30°	

4. Various Works

Civil work		1 set
Piling		
Excavation and surplus soil treatment		
Concrete and iron work		
Fence and gate	Mild steel plate made gates with locks Bamboo made pillar, barbed wire painted in light-green	2 sets
Gardening		
Tree planting		
Sod facing		
Maintenance road	Concrete	
Rain water collecting trough		
Clearance and land grading		
Mechanical works		1 set
Installation of rotating machine	Blower	
Machine erection	Feed well, trough, filter bench, distribution pit, air diffuser	
Piping works		1 set
VP	Socket joint	
Electrical works		1 set
Introduction of electrical Source	115V, 20m	
Motor starter	Breaker with push button & Knife switch	
Conduit & wiring		
Lighting		
Painting works		1 set
Painting out side of concrete tank in light-gray		
Naming		
Bamboo (fence etc.) surface in light-green		
Operation room		
Type	Concrete block or brick made, mortar finishing	
Required area	24m ² or more	
Height of room	2.5m or more	
Equipments		
Motor starter	Motor breaker, electric source	1 set
Desk		1 set
Chair		1 set
Lighting		1 set
Desk for analysis		1 set
Sink		1 set
Blower		1 set

Outdoor lighting	
Type	Self standing incandescent electric lamp
Number of lighting	1 lighting
Capacity	200W
Height of pole	3m or more
Pole painting	Navy blue

Fence around the facilities and gate

Fences are installed so that person who does not concern the facilities and domestic animals may not enter the site.

Type	Bamboo made supporting pole with burbed wire	1 set
Scope of works	Around all the facilities, height 1m	
Gate	Mild steel plate made, with locks	2 set
Miscellaneous works		
Charging lime-stone and Carbon	13.2m ³	1 set
Sampling and transporting seed sludge	4.0m ³	1 set
Adjustment and charging of seed sludge	4.0m ³	1 set
Sampling and transporting aquatic plant	0.5ton	1 set
Leakage test for tanks etc. and pipes		1 set
Attendance for inspection		1 set
Spare equipment		
Submersible pump for sewer	0.2kw with cable 10m	1 unit

List for Valves and Instruments (El Rocio)

Name of Instruments & Valves	Installing Place	Type	Size (B)	Material	Joint	Number
Outlet Valve of Rain Water	Outlet of rain water storage tank	Stop	2"	BC	Screw	1
Outlet Valve of Neutralized Water	Outlet of neutralization tank	Ball	3"	PVC	Socket	1
Sedimentation Pond of Neutralized Water						
Desludge Valve	Bottom of neutralization sedimentation pond	Ball	3"	PVC	Screw	1
Anaerobic Reactor	Anaerobic reactor sampling rack					
Sampling Valve		Ball	2"	PVC	Socket	2
		Ball		PVC	Socket	3
Aerobic Reactor	Bottom of aerobic reactor	Ball	3"	PVC	Socket	1
Sedimentation Pit	sedimentation pit					
Desludge Valve	Intake part or neutralization tank	Stop	1"	BC	Screw	1
Air Valve	Aerobic tank	Stop	1"	BC	Screw	1
Air Valve	Outlet of blower	Stop	1"	BC	Screw	1
Blow Valve of Aerobic Reactor	Bottom of aerobic reactor	Ball	2"	PVC	Screw	1
Air Flow Meter	Intake part of aerobic tank	Rotor meter	3/4"	Acryle	Screw	1
Neutralized Water flow Meter	Outlet of neutralization tank	Weir	-	SS-anti corrosive painting	-	1
Pressure Gauge of Blower	Outlet of turbo blower	Bourdon	2"	BC	Screw	1

J.8.3.3 Technical Specification for Construction Work

1. INTRODUCCION

Las especificaciones siguientes suministran las características, los requisitos y la calidad de las obras contratadas.

El contratista sera responsable de todos los costos que se generen de la correcta ejecucion de las obras. LA AGENCIA DE COOPERACION INTERNACIONAL DEL JAPON en coordinacion con LA CORPORACION AUTONOMA REGIONAL DEL QUINDIO seran las encargadas de ejercer la interventoria y la auditoria del proyecto. Estas entidades se reservan el derecho de establecer cantidades, capacidades y calidad de las obras.

Haran parte de estas especificaciones las normas para ensayos, pruebas, construccion, dadas por ICONTEC, ACI, ASTIN, ASME, AASHTO, PCA, AWWA, en su respectivo ramo, asi como tambien las recomendaciones de los fabricantes para la utilizacion y colocacion de sus productos.

El contratista debera tener en cuenta todos los costos directos e indirectos necesarios para la correcta ejecucion de las obras. Los principales costos directos que se deben tener en cuenta en la estimacion son: Materiales, mano de obra, herramientas, equipo, curado, mantenimiento y limpieza, ensayos de control de calidad, desperdicios, y transporte.

Las especificaciones presentadas aqui no son necesariamente completas y deben considerarse como informacion general. Sera responsabilidad absoluta del contratista establecer los costos para cada clase de obra.

JICA se reservan el derecho de aprobar o rechazar cualquier trabajo que a su juicio no cumpla con las normas dadas en estas especificaciones.

2. EXCAVACIONES

2.1 Generalidades

Los siguientes trabajos se consideran incluidos dentro del alcance de las excavaciones:

- Control de aguas durante el proceso de construcción
- Suministro y uso de explosivos si fuere necesario
- Suministro y colocación de señales de seguridad
- Suministro de la mano de obra, herramientas y/o equipos necesarios para la extracción y transporte de los materiales excavados.
- Suministro de la mano de obra, herramientas y materiales para la construcción de cualquier medio de soporte lateral para garantizar la estabilidad de los taludes de las excavaciones.
- Reparación de daños causados a terceros por causas imputables al contratista.
- Transporte de los materiales excavados cuando fuere necesario hasta el sitio de disposición definido por la interventoría.

Antes de empezar los trabajos de excavación, el contratista debe presentar los planos con la línea de corte de las excavaciones para la respectiva estructura y obtener la aprobación del interventor.

2.2 EXCAVACIONES EN TIERRA

Son las ejecutadas en materiales que para su remoción solo se necesitan palas, picas o garlanchas, tales como arena, limos, arcilla, capa vegetal o cualquiera de sus mezclas, con piedras sueltas de diámetro hasta 15 cm. También se considerará dentro de esta clasificación cualquier material que no pueda clasificarse como conglomerado o roca.

2.3 RETIRO DE SOBANTES

Comprende el traslado de materiales que no se necesiten para la construcción de la obra y que sean provenientes de excavaciones, rocería y limpieza y derrumbes a sitios previamente aprobados por la interventoría.

3. RELLENO Y APISONADA

3.1 GENERALIDADES

Se dan las normas para la colocación de materiales compactados para el relleno de zanjas, rellenos alrededor de estructuras, rellenos para conformar taludes de acuerdo con los planos y rellenos para la disposición de sobrantes.

Dentro de este ítem están incluidos los siguientes trabajos:

- Preparación del terreno de construcción
- Esparcida del material en capas uniformes
- Retiro de los sobrantes o materiales objetables
- Control de la humedad del material
- Compactación de capas sucesivas

3.2 MATERIALES

Estarán exentos de basuras, materia orgánica, raíces, escorias y piedras de diámetro mayor de 10 cm. Se requiere utilizar arena debajo de las estructuras contenidas en el contrato y tierra en las demás.

3.3 NORMAS DE CONSTRUCCION

Se extraeran los materiales inadecuados para la construccion hasta las profundidades indicadas por el interventor.

El material usado se extendera en capas de 20cm de espesor como maximo, cuidando que posea la humedad optima y completamente compactadas a satisfaccion del interventor. Se procedera a la compactacion con equipos adecuados para tal fin.

Cuando el relleno sea alrededor de tuberia se debera hacer simultaneamente al lado y lado del tubo con le fin de no producir presiones laterales que dezplacen la tuberia. Se tendra especial cuidado de no golpear la tuberia y que el relleno hasta 40cm por encima de la misma quede libre de piedras.

Los rellenos para conformar los taludes, se efectuaran con equipo manual o mecanico que por sus caracteristicas pueda ser utilizado apropiadamente en el sistema de terrazas y taludes.

4. CONCRETOS

4.1 GENERALIDADES

Las estructuras de concreto se construiran en todo de acuerdo a los planos estructurales.

El concreto consistira en una mezcla de cemento portland, agua, agregado fino, grueso, combinados en las debidas proporciones segun lo estipulado o requerido en los planos de construccion.

El concreto debera ser elaborado con los materiales y en la forma que a continuacion se especifica:

- a. El cemento de todo concreto sera cemento portland de una marca aprobada por la interventoria. Solo una marca de cemento se usara en cada estructura y cemento de la misma marca pero que provenga de distintas fabricas, no se debera mezclar en un mismo elemento estructural a menos que el interventor lo permita.

El cemento no podra utilizarse si ha sufrido un principio de hidratacion, de todos modos los cementos que tengan mas de 20 dias

solo podran ser utilizados previa aprobacion de la interventoria. El cemento en sacos debera almacenarse en una edificacion aprobada por el interventor, y en arrumes de no mas de 12 sacos de altura.

- b. El agregado grueso consistira en piedra triturada o grava de rio y estara compuesto de particulas duras y durables y exento de piedra desintegrada, sales, alcalis, materiales organicos o revestimientos adheridos.

El desgaste del agregado grueso segun normas ICONTEC 93 Y 98 no debera ser superior al 35%, ademas el material debe cumplir la norma ICONTEC 174 "Especificaciones de los agregados para concreto".

- c. El agregado fino consistira en arena. La gradacion del agregado fino debera mantenerse razonablemente uniforme. El agregado fino debera componerse de materiales limpios, duros, fuertes, recios, durables y desprovistos de revestimientos y que sean el producto de la desintegracion de la roca o que provenga de la desintegracion de la roca arenisca o conglomerado friable.

Las sustancias deletereas presentes no podran exceder del 1%, la arena debera estar exenta de cantidades perjudiciales de impurezas organicas.

Las muestras preparadas con el agregado fino deberan tener no menos del 95% de la resistencia a la tension y a la compresion obtenida con mortero de las mismas proporciones y consistencia fabricado con el mismo cemento y arena STANDARD DE OTTAWA, resistencia medida segun el ensayo de resistencia del mortero a las edades de 7 y 28 dias.

Las arenas deberan cumplir con las normas ICONTEC 174 "Especificaciones de los agregados para concreto".

- d. El agua que se utilice en la fabricacion de concreto como tambien en el proceso de curado, debera ser fresca, razonablemente limpia, exenta de cantidades perjudiciales de acidos, alcalis, limos, aceites, materia organica y otras impurezas.

La interventoria podra ordenar por cuenta de los contratistas los

ensayos necesarios para comprobar que los materiales se ajusten a las especificaciones anotadas.

e. Para la utilización de los aditivos, pegantes o químicos para curado, deberá contarse previamente con la autorización escrita del interventor.

f. La dosificación de la arena y la grava se hará por peso o volumen según indicación de la interventoría, la medida de agua por volumen, el cemento se medirá por sacos completos o medios sacos cuando lo autorice el interventor. Dividiendo el saco completo en dos porciones iguales a una sola operación y los aditivos según las instrucciones de los fabricantes. La proporción en que deberá intervenir cada uno de los elementos constitutivos del concreto será fijada por el contratista y aprobada por el interventor de acuerdo con los resultados de pruebas de laboratorio efectuadas por el contratista.

g. El vaciado del concreto de la obra no deberá iniciarse a menos que se pueda garantizar su colocación en forma continua, no se deberá comenzar el vaciado sin que el interventor haya aprobado la profundidad y el carácter de las fundaciones, dimensiones de formaleas, alineamiento, niveles y atraques de las mismas y colocación del hierro de refuerzo.

Cuando se coloque concreto sobre una fundación deberá estar limpia y húmeda pero sin agua estancada en ella o corriendo sobre la misma.

El concreto se deberá hacer en mezcladoras no menores de 1 saco con una duración no menor de 1.5 minutos por mezclada.

El concreto se ha de llevar desde las mezcladoras hasta el sitio de su colocación lo más rápidamente posible haciendo uso de métodos que eviten la segregación o pérdida de los ingredientes.

Todo el concreto se depositará en capas horizontales, no mayores de 30cm de espesor. No se dejará caer el concreto de alturas mayores de 1.50 m sin el uso de la canal cerrada y articulada. Los rumbones tendrán una pendiente adecuada para evitar la segregación

en el concreto. Solo se permitira metalicos o revestidos con lamina y contruidos convenientemente.

No se permitira depositar grandes cantidades en un mismo punto, manipularlo o correrlo a lo largo de las formaletas.

El concreto se consolidara con la ayuda de un equipo mecanico de vibradores, completado por labores manuales.

El equipo de vibracion debera operar por lo menos a 7.000 RPM cuando se sumerja. La duracion de la operacion de vibrado sera la necesaria para obtener la consolidacion debida sin que produzca segregacion de materiales o afecte el fraguado inicial del concreto anteriormente colocado.

Se tendra cuidado de no golpear la formaleta o el herraje que puedan llegar a perjudicar la buena calidad del concreto. Ademas debera evitarse al maximo que la mezcla golpee el herraje a fin de evitar la segregacion y el desplazamiento de aquel.

Eventualmente y con aprobacion del interventor, se podra hacer uso de varillas de hierro para la compactacion del concreto, en ningun caso el diametro de la varilla sera menor de 5/8".

h. El concreto no debera vaciarse hasta que todos los elementos conduits, soportes y pases verticales y horizontales que deban quedar embebidos en el hayan sido inspeccionados y aprobados por el interventor.

i. El concreto fresco debera protegerse del sol, la lluvia y el viento. Debera mantenerse humedo por medio de riegos durante 7 dias por lo menos. El uso de productos destinados a restaurar la evaporacion del agua contenida en el concreto esta sometido al visto bueno de la interventoria.

En el momento de desencofrar, las superficies destinadas a permanecer a la vista o las juntas de contraccion se limpiaran perfectamente de clavos, alambres de anclaje, corrigiendo todas las irregularidades debidas al encofrado.

Si las superficies quedan sin panetar, los alambres y clavos se cortaran a una profundidad de 2 cm de la superficie y se recubriran con mortero de cemento gris y blanco debidamente

dosificado.

J. Durante las operaciones de vaciado se deberan hacer pruebas de asentamiento para determinar la consistencia de la mezcla.

Tales pruebas se deberan hacer sinendose al METODO USUAL DE LA PRUEBA DE ASENTAMIENTOS PARA LA CONSISTENCIA DEL CONCRETO DE CEMENTO PORTLAND. Designacion C 143-39 de la ASIM y normas tecnicas ICONTEC 454 "HORMIGON FRESCO, TOMA DE MUESTRAS".

El contratista o sus delegados cuando lo ordene el interventor tomara las muestras para determinar la resistencia del concreto. En general por cada mezcla vaciada sin interrupcion y sin variar la proporcion de agregado y por cada 150 sacos se tomara tres cilindros (1 muestra). Los materiales utilizados y el valor de los ensayos correran por cuenta del contratista.

Los cilindros de prueba se haran y curaran de acuerdo con el "Metodo corriente de hacer y almacenar muestras para la prueba de compresion de concreto en el campo", designacion C 31-69 de la ASTM.

Dos de los cilindros de cada muestra seran ensayados a los 28 dias de acuerdo con la norma ICONTEC 673, y la tercera sera ensayada cuando el interventor lo considere conveniente.

4.2 CLASES DE CONCRETO

a. CONCRETO REFORZADO

Sera el concreto simple de las diferentes clases de estructuras que asi lo requieran por o ordenado en planos o por el interventor, su resistencia no podra ser menor de 210kg/cm² a los 28 dias de vaciado.

b. CONCRETO SIMPLE

Sera el concreto de menor que el reforzado pero este no podra ser inferior a 175kg/cm² a los 28 dias de vaciado.

c. CONCRETO PARA SOLADOS

Es un concreto con bajo contenido de cemento, mezclado en proporción 1:3:6 aproximadamente que se coloca con el fin de emparejar y mantener limpias las superficies sobre las cuales se van a cimentar las estructuras. La extensión y los espesores de los solados serán los indicados en planos o los autorizados por el interventor. Su resistencia será de 110kg/cm².

5. MORTEROS

El mortero consiste en una mezcla de cemento portland, agregado fino y agua, para obtener una pasta homogénea que se puede moldear y aplicar en las superficies en que se requiere como material de pega y acabado.

Se deberá utilizar agregado fino que pase por la malla no.16 y que cumpla con las normas ICONTEC 127-174 para concreto. El mortero se aplicará en los sitios y con las dosificaciones indicadas en los planos o que ordene el interventor.

Antes de colocarlos, la estructura de concreto debe estar perfectamente limpia de suciedades, escombros, etc., que impidan correctamente la colocación del mortero.

6. FORMALETAS

6.1 MATERIALES

La madera que se use en la construcción de formaletas para las estructuras de concreto a la vista habrá de estar cepillada y machimbrada y su anchura será la determinada por la interventoría. Deberá estar exenta de combas, abultamientos y nudos flojos, deberá ser sana y de espesor uniforme.

La madera sin cepillar de no mas de 20cm de anchura, de bordes sanos y cuadrangulares, podra usarse, para respaldar superficies que no hayan de quedar expuestas al finalizar la obra.

El material de las formaletas se podra usar por segunda vez siempre que se haya limpiado cuidadosamente y no presente abultamiento ni curvaduras.

6.2 DISEÑO

Todas las formaletas y cimbras se disenaran para retener y soportar con seguridad la carga muerta mas una carga de 250kg/cm². La cimbra que se use para soportar las formaletas se debera apoyar en durmientes que se asienten en fundaciones firmes. La cimbra se construira de tal modo que no ocurran asentamientos apreciables, ni defensores de las formaletas cuando el concreto se vacie en ella.

6.3 CONSTRUCCION DE FORMALETAS

Las formaletas habran de ajustarse a la forma, trazo y dimensiones del concreto que se indique en los planos y se les mantendra en un sitio por medio de viguetas, travesanos, largueros y riostras de resistencia adecuada y en numero suficiente. Las formaletas habran de constituirse de manera que sean fuertes y no cedan.

Antes de vaciar el concreto las formaletas deben estar perfectamente limpias e impregnadas con aceite mineral u otra sustancia que no perjudique o manche el concreto.

6.4 REMOCION DE LAS FORMALETAS

Las formaletas deberan permanecer en su sitio hasta que el concreto haya fraguado lo suficiente para evitar deformaciones de la estructura o danos del concreto. Se podra exigir que la formaleta permanezca en su sitio por un tiempo mas largo cuando a juicio del interventor sea necesario.

Las tolerancias en la construcción de las formaletas deberán estar de acuerdo con el manual ACI-347 sobre las formaletas para concreto.

7. ACERO DE REFUERZO

7.1 GENERALIDADES

Consiste esta especificación en el trabajo que se refiere al suministro del acero y a la ejecución de las operaciones de corte, doblado, colocación y amarrado de las varillas de refuerzo en las estructuras de concreto.

7.2 MATERIAL

Se aceptará el acero de refuerzo fabricado por Paz de Río o cualquier otro que cumpla con las normas ICONTEC 161-245-248 sobre barras de acero al carbono para hormigón armado (37.000 PSI = 2.590 kg/cm² mínimo). El acero deberá ser del tipo que especifiquen los planos para cada tipo de obra.

7.3 DOBLADO

Se deben doblar en frío las varillas de acero y no se permitirá doblar las varillas salientes del concreto una vez que este haya sido colocado. El doblaje de varillas deberá estar cenido a las especificaciones del fabricante en cuanto a radios mínimos y métodos de trabajo, estos deberán ser aprobados por escrito por el interventor.

En el acero delata resistencia no se permitirá enderezar los doblajes ya ejecutados.

7.4 COLOCACION Y FIJACION

Todo el acero de refuerzo se colocara en su debido sitio y de tal manera que durante el vaciado del concreto se mantenga firmemente en las posiciones indicadas en los planos. Al colocarlo en la estructura ha de estar libre de mugre, polvo, exceso de oxido, escamas, aceite u otro material extrano.

El espacio entre acero y formaleta se debe mantener mediante soportes, bloques, amarres, silletas u otros elementos aprobados por el interventor.

Antes de empezar el vaciado del concreto todo acero de refuerzo de cualquier seccion debera estar en su sitio y haber sido revisado y aprobado por el interventor.

Todos los empalmes se efectuaran de acuerdo con los detalles mostrados en planos; cuando no figure se determinaran las longitudes de acuerdo a la norma ICONTEC 2.000. El recubrimiento para el refuerzo debera hacerse como se indica en los planos; si no estuviere indicado se hara como sigue:

1. En concreto depositado directamente en contacto con el suelo 6 cm
2. En superficie formaleteada que ha de quedar en contacto con el suelo y en superficies que han de quedar expuestas a la interperie o permanentemente sumergidas 5cm.

7.5 PRUEBAS DE ENSAYO

El interventor podra ordenar pruebas de peso, tension y doblado cuando lo juzgue necesario. Los costos que estos ensayos ocasionen correran por cuenta del contratista.

Las especificaciones del acero son las siguientes:

Varillas	Diametro Nominal Pulgada	Peso Kg/m
2	1/4	0.25
3	3/8	0.56
4	1/2	1.00
5	5/8	1.56
6	3/4	2.24
7	7/8	3.05
8	1	3.98
9	1.1/8	5.06
10	1.1/4	6.40
11	1.3/8	7.91

8. PUNTOS SANITARIOS PVC

8.1 GENERALIDADES

Incluye todos los accesorios, tuberías PVC, sanitarias, herramientas y mano de obra necesarias para la correcta ejecución de la obra con la complacencia de la interventoría y referenciadas en los planos hidráulicos y sanitarios.

8.2 COLLARIN 3" x 1"

Se refiere al suministro e instalación de collares de PVC donde lo indiquen los planos hidráulicos o la interventoría.

8.3 LLAVES DE PASO

En este numeral están incluidos el suministro y colocación de llaves de paso de primera calidad, accesorios secundarios, herramientas y mano de obra necesarias para la correcta ejecución y puesta en funcionamiento con la aceptación del interventor y en concordancia con los planos hidráulicos y las recomendaciones de los fabricantes de los siguientes accesorios:

Llaves de paso de 3".

9. TUBERIA H. G 1"

Se refiere al suministro e instalacion de tuberia de 1" de hierro galvanizado y todos los accesorios necesarios para su correcto funcionamiento y en concordancia con los planos hidraulicos.

10. CAJAS PARA VALVULAS

De seccion cuadrada de 0.3 x 0.3 x 0.3 de profundidad en ladrillo tolete pegado con mortero 1:3 con tapa de concreto 1:2:3 con hierro de refuerzo de 1/4 cada 15cm en ambos sentidos. La tapa superpuesta. No se debe incluir la excavacion en el analisis de precios.

11. TUBERIA DE CEMENTO 6", 8", 10", 12"

Se empleara tuberia de cemento de extremo campana. La tuberia sera colocada en las zanjas niveladas y con las pendientes especificadas en los planos o dadas por la interventoria. La pega se hara con mortero 1:4 tanto interior como exteriormente. Las excavaciones y rellenos se haran de acuerdo a las especificaciones dadas en este pliego en el item de excavaciones y rellenos.

J.8.4 Operation Manual for Model Plant

**J.8.4.1 Operation Manual for Model Plant
for 25Ha Coffee Farm (SEBASTOPOL)**

**J.8.4.2 Operation Manual for Model Plant
for 8Ha Coffee Farm (EL ROCIO)**

**J.8.4.1 Operation Manual for Model Plant
for 25Ha Coffee Farm (SEBASTOPOL)**

Contents

1. Preface
2. Introduction of the plant
3. Basis of design
4. Outline of equipments
5. Flow of treatment method
6. Maintenance and warning

Flow sheet

Lay out

Vender list

Table of water analysis result

1. Preface

This operation manual for 25 Ha coffee farm Sebastopol is simply described on coffee waste water treatment plant and its site operators.
We hope that the plant will be performed without any troubles for a long time using this procedure.

2. Introduction of the Plant

The plant is designed for 25 Ha coffee farm Sebastopol considering circumstances of the Cristales catchment.

Characteristics of the plant are as follow;

- : Full system consists of facilities for neutralization, anaerobic treatment, aerobic treatment, stabilization pond and dehydration, including tertiary treatment.
- : Lime-stone-aeration method is applied to the neutralization, which is expected to be safe and economical in its running cost for low-income farmers.
- : Not conventional method as in the past but high technology of high speed treatment is applied to anaerobic reactor. The treatment is carried out by two steps, pre-agglomeration treated strong agglomerated anaerobic sludge zone and anaerobic contact filter in one reactor named "SNYMIF". The anaerobic contact filter also has a function to prevent the anaerobic sludge from being washed out by generated methane gas, as SGS (sludge-gas separator), newly devised anaerobic reactor.
- : The aerobic treatment removes offensive smell, specific to anaerobic treatment water, releases no-oxygen condition and at the same time decomposes residual organic compounds furtherly. The contact filter to be applied is a method where organic compound load is higher than that in the conventional activated sludge process for suspending treatment, and can simplify handlings for the activated sludge to be returned. This facility shall be able to be used as an anaerobic filter and the usage, as an aerobic facility or anaerobic facility, is switched by the load accordingly.
- : In the final treatment polishing and stabilization are carried out by an aquatic plants stabilization pond called as "Living filter".

By the above mentioned treatment the quality of the final treated water clears the standard for quality of waste water treatment authorized by the Ministry of Health of the Republic of Colombia, moreover, as to organic compound (COD_{cr}), the target of the removal ratio is higher than 90 per cent which is higher than the standards.

3. Basis of Design

1) Amount of waste water

Daily maximum	13.75m ³	0.573m ³ /HR
Daily average	10.30m ³	0.43m ³ /HR

2) Quality of raw waste water

Item	Maximum	Average
Water Temperature	normal temperature	normal temperature (18-28°C)
Appearance	turbid yellowish brown	turbid yellowish brown
pH	3.5	4.0
Suspended Solid (SS)	3,000 mg/l	2,000 mg/l
Chemical Oxygen Demand (COD _{cr})	15,000 mg/l	10,000 mg/l
Biochemical Oxygen Demand (BOD ₅)	10,000 mg/l	6,700 mg/l

3) Quality of treated water

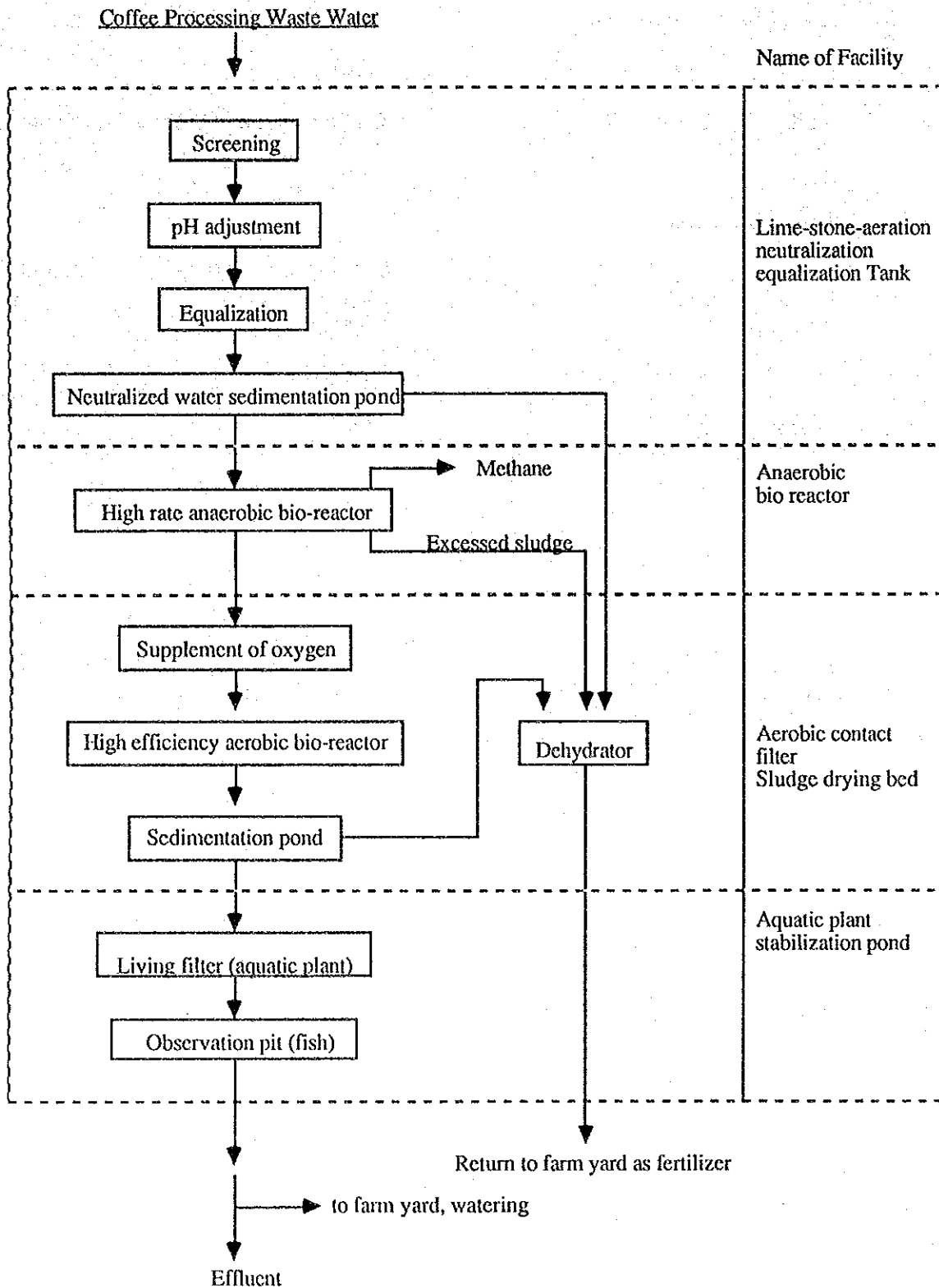
Item	Standard of Colombia	Target Value
Appearance		slightly turbid light yellow
pH	5 - 9	5.8 - 8.6
Suspended Solid (SS)	400 mg/l (80% removal)	30 mg/l (98.5% removal)
COD _{cr}	2,000 mg/l (80% removal)	less than 300 mg/l (97% removal)
BOD ₅	1,340 mg/l (80% removal)	less than 200 mg/l (97% removal)

4. Outline of Equipments

- (1) Neutralization tank 6,600mmL x 3,000mmW x 1,250mmD
 - 1) Effective volume 20 m³
 - 2) Lime-stone 21 tons
- (2) Air blower 0.75 KW - 115V
- (3) Neutralized water sedimentation pit 1,400mmL x 1,400mmW x 1,800mmD
 - Effective volume 2.5m³
- (4) Anaerobic bio reactor 3,000mmL x 3,000mmW x 4,000mmD
 - Effective volume 36m³
- (5) Aerobic contact filter
 - 1) Primary filter 3,000mmL x 1,600mmW x 1,800mmD
 - Effective volume 8.6m³

2)	Secondary Filter Effective volume	3,000mmL x 1,500mmW x 1,800mmD 8.1m ³
6)	Aerobic water sedimentation pit Effective volume	700mmL x 700mmW x 1,800mmD 0.6m ³
7)	Sludge drying bed Area	3,000mmW x 6,000mmL x 1,500mmD 18m ²
8)	Aquatic stabilization Pond Effective volume Aquatic plant	6,000mmW x 20,000mmL x 900mmD 100m ³ 1,500kg
9)	Forced draft aeration tower	0.1KW - 115V
10)	Rain water pit	6.0m ³

5. Flow of Treatment Method



Flow of Coffee Processing Waste Water Treatment

6. Maintenance and Warning

(1) Receiving Coffee Waste Water

- 1) The operator shall confirm the coffee production schedule of this week/next week by asking farms at the end of a week or at the beginning of a week. All the preparations for the treatment facilities in accordance with the said schedule shall be carried out properly so that there may not be any trouble in the operation of the waste water treatment facilities.
- 2) Especially, the neutralization tank shall be well treated as far as possible before receiving coffee waste water and kept empty.

(2) Rain Water Storage Tank

- 1) Rain Water is important particularly as cleaning water for the neutralization tank, therefore, the operator shall always try to fill up the rain water storage tank.
- 2) Overflowed water from the tank owing to affluent rainfall shall be introduced to the aquatic plant stabilization pond.
- 3) The tank shall be cleaned once a season, and muddy/sandy sediment at the bottom of the tank shall be removed by shovels, etc. and buried in the earth, not flushed away into the neutralization tank and the aquatic plant stabilization pond.

(3) Neutralization Tank

- 1) The received waste water must be treated within 24 hours, since the capacity of the neutralization tank is same as the amount of waste water from one time coffee production. In a period when the coffee production is carried out not everyday, it would be better to put many hours in the treatment until receiving the next waste water. For example, if waste water is discharged every other day, the waste water shall be treated with fixed flow rate in around 40 hours.
- 2) The limestone bed shall be turned up to a depth of 30 - 50 cm to check its dirtiness, and when it is found that the surface of the limestone layer is covered with yellowish brown sediments of coffee waste water, the bed shall be washed with water in the rain water storage tank.
- 3) The limestone bed shall be washed on a day when there is no discharge of coffee waste water, and the washing shall be finished within 12 hours (in half a day). The procedure of washing is as follows.
 - i) Introducing water from the rain water storage tank to the neutralization tank.
 - ii) Aerating and mixing the water for 1 or 2 hours by air.
 - iii) Discharging the water to the neutralized water sedimentation pit at a normal flow rate.
- 4) Limestone shall be supplied to the tank from the reservation bunker of limestone for ullage once a season or year.

(4) Neutralized Water Sedimentation Pit

- 1) The ball valve mounted at the outlet of the neutralization tank shall be adjusted so that the neutralized water may flow into the sedimentation pit with a flow rate of around 0.43 l/hour.

- 2) In case that scum occurs on the surface of water in the sedimentation pit and the scum is accumulated thick and stiff, the scum shall be scooped up, conveyed to the sludge drying bed and dried.
- 3) When the facility is operated continuously, accumulated sediment at the bottom of the sedimentation pit shall be blown away by opening the blow valve at the bottom of the pit properly, conveyed to the sludge drying bed and dried. Opening and shutting of the valve shall be within 5 - 10 counts at one time, and much care shall be paid not to blow off water only, but to blow off and send only concentrated sediment to the drying bed to the best of the operator's ability.

(5) Anaerobic Reactor

- 1) The operator shall observe whether bubbles of gas are generated vigorously or not. If the generation of gas is considerably poor, it is considered that the inner conditions of the reactor are mal-controlled (e.g. wrong pH value, shortcircuit flow, etc.), consequently, pH value of the water and the inner water level of the neutralized water distribution pit shall be checked.
- 2) The operator shall sample and observe the colour of overflow water whether the colour is light yellow or not. If the colour is black, the inner conditions of the reactor is considered mal-controlled, the same checks shall be performed. In case of low pH, the condition shall be improved by washing inside the neutralization tank and mixing by aeration. In case of the water flow being disturbed, sludges inside the reactor shall be circulated and equalized.
- 3) The amount of accumulated sludges shall be measured through the sampling cock 2 - 3 times a season properly. Generally speaking, the accumulation of sludges is slow, however, when the accumulation is considerable, the sludges shall be emitted to the excessed sludge storage pit or conveyed to the sludge drying bed to be dried.
- 4) After a long term of operation suspension, the sludge zone in the anaerobic reactor shall be agitated by a spare submersible pump for 2 - 3 minutes in the beginning of a season. This procedure is just the same operation as the sludge circulation mentioned in the paragraph 2) above.

(6) Tower

The blower for the aeration tower shall be operated during the treatment of waste water only, and shall not be operated when there is no inflow of waste water.

(7) Aerobic Reactor

- 1) The DO value kept around 0.1 ppm - 1.0 ppm in the aerobic reactor may be tolerable.
- 2) Air volume to be sent shall be 0.5 Nm³/min. to the primary pond and 0.4 Nm³/min to be secondary pond.
- 3) Aeration blower
 - i) Maintenance

No lubrication is necessary as all bearings are sealed. Dirt and dust should be kept off the unit, to prevent abnormal temperature rise.

Always keep the air filter clean for the least amount of inlet air restriction. Clean the air filter by "swishing" it in soapy dish water. Gently rinse, then shake out excess water. Do not scrub or use high pressure air as this will separate the filter fibers. You may re-install the filter while it is still wet. Keeping a replacement filter on hand is recommended.

No other routine maintenance is needed. Replacement of the motor bearings after 24 months of continuous operation is recommended to prevent an unscheduled blower repair. This may be done by your local electric motor repair shop.

ii) Warning

Electric rotating machinery, and high voltage can cause serious or fatal injury if improperly installed, operated or maintained.

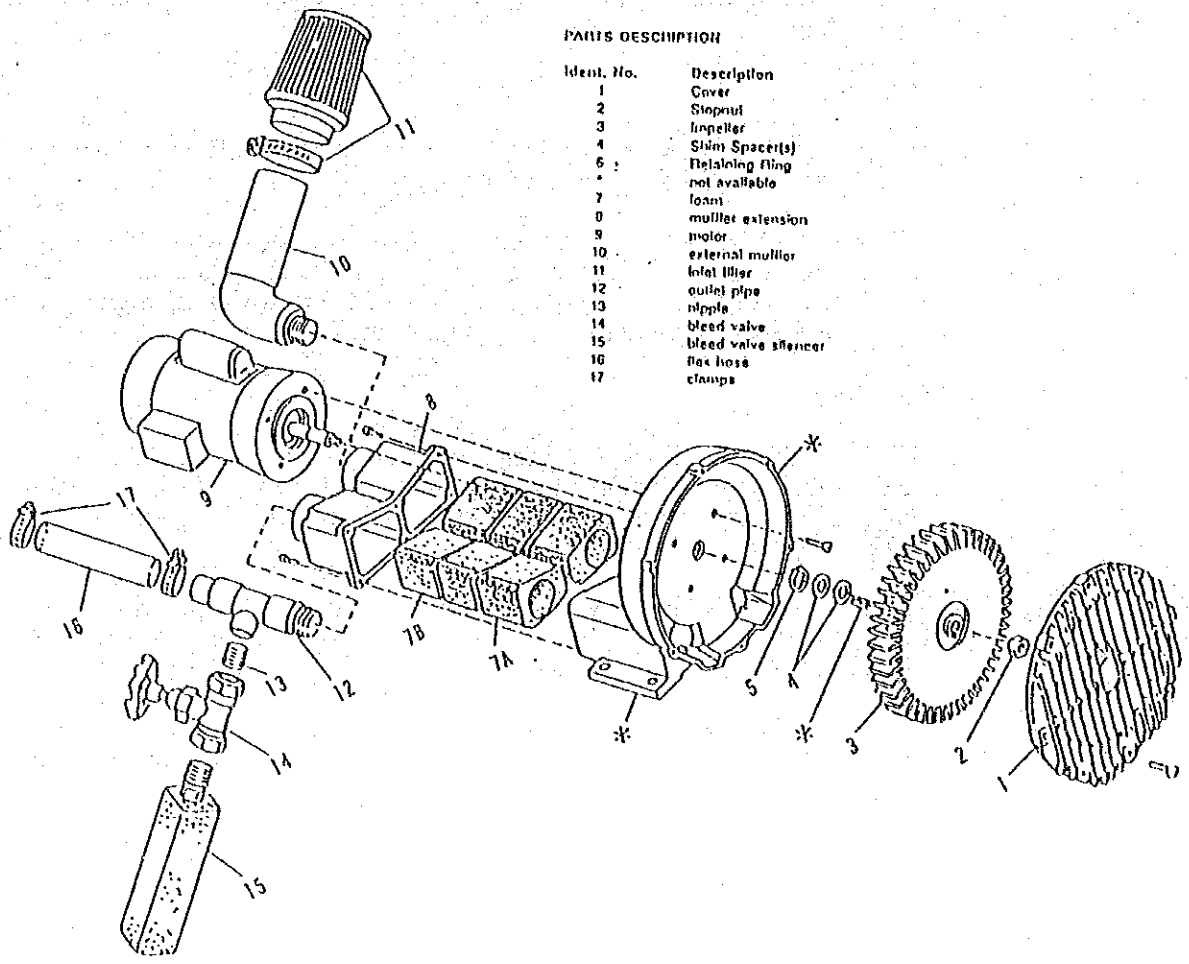
When servicing, all power sources to the blower should be de-energized and/or disconnected. All rotating parts should be at a standstill. Caution should always be used when working around your blower, as high velocity air is entering and exiting the blower and the air lines.

iii) Guarantee

All SWEETWATER™ Air Pumps are unconditionally guaranteed for two years from date of shipment from Aquatic Eco-Systems, Inc. Units returned within two years will be rebuilt or replaced *REGARDLESS OF REASON FOR FAILURE*.

Exceptions may be made by AE-S in writing on particular applications where experience has indicated that conditions are so unusual or severe that premature failure can be expected.

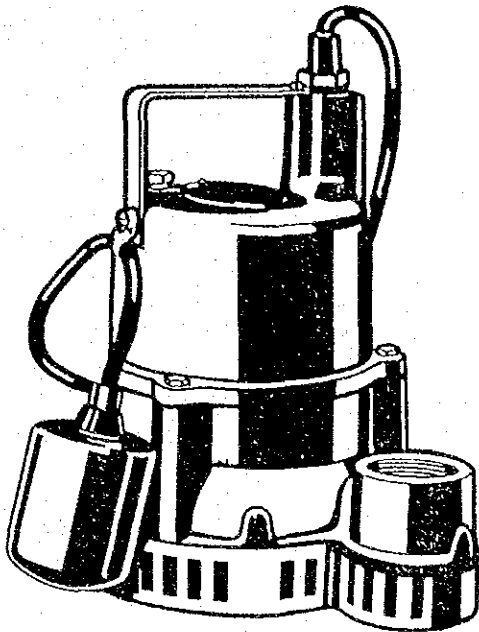
Prior to returning a unit, call or write to AE-S for a return authorization number. In all instances, transportation charges will be at customer expense.



PARTS DESCRIPTION

Ident. No.	Description
1	Cover
2	Impeller
3	Impeller
4	Slits Spacer(s)
5	Relating fling
6	not available
7	foam
8	muller extension
9	motor
10	external muller
11	inlet filler
12	outlet pipe
13	nipple
14	bleed valve
15	bleed valve spacer
16	flax loss
17	clamps

PARA LAGUNA



BULLETIN 118.9

SW25A/SW33A
SD25A/SD33A
SW25M/SW33M
Owner's
Manual

HYDROMATIC
PUMPS



Before operation, read the following instructions carefully. Reasonable care and safe methods should be practiced. Check local codes and requirements before installation. Servicing should be performed by knowledgeable pump service contractors or authorized service stations.

WARNING: Read all instructions before starting any operation on pump.

Always disconnect the pump and controls from its power source before handling.

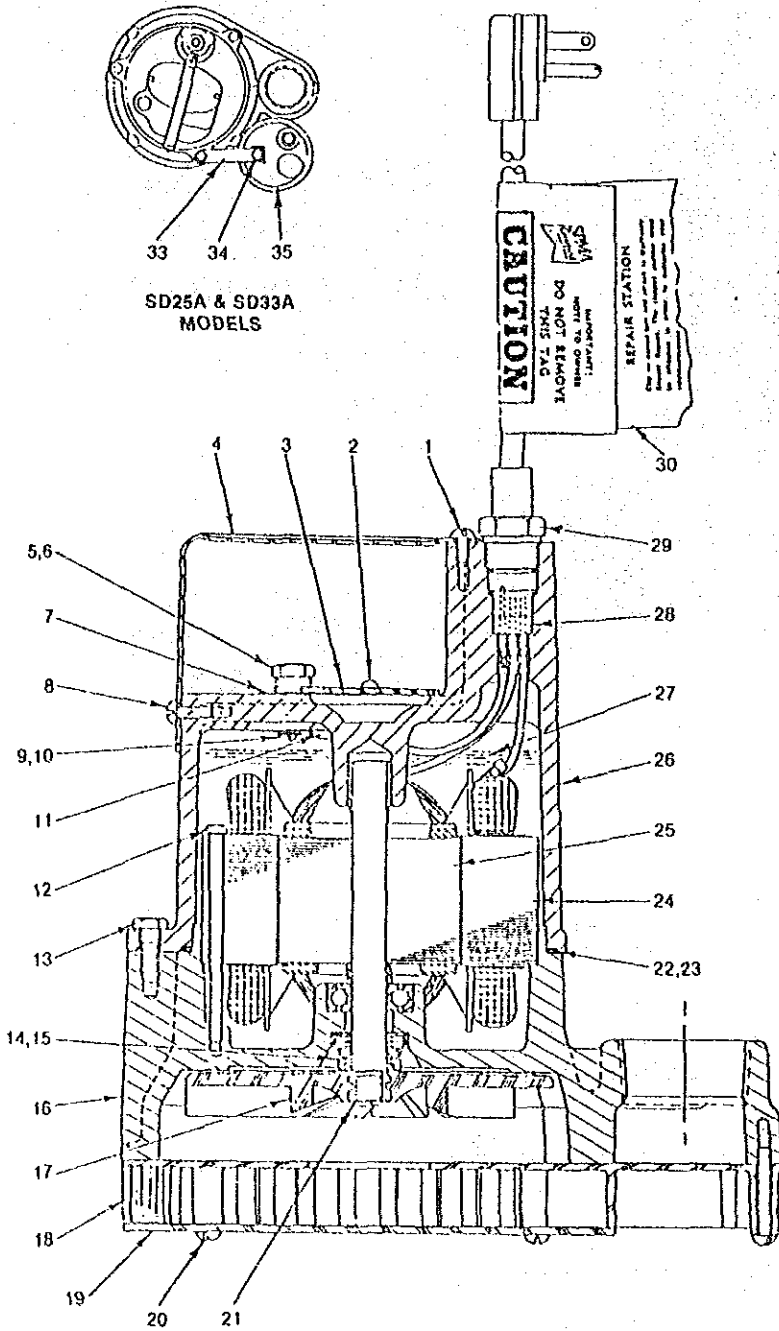
Do not smoke or use sparkable electrical devices or flame in a septic (gaseous) or possible septic sump.

A septic sump condition may exist and if entry into sump is necessary, then 1) provide proper safety precautions per OSHA requirements and 2) do not enter sump until these precautions are strictly adhered to.

Always operate on grounded circuit or outlet.

Failure to heed above cautions could result in injury or death.

PARTS LIST
SW25A/SW33A
SD25A/SD33A
SW25M/SW33M



SD25A & SD33A
 MODELS

SW25A & SW33A
 MODELS

Ref. No.	Description	Qty.
1	Screw #10-32 x 1/4 LG	1
2	Screw - Drive	2
3	Nameplate	1
4	Handle - Pump	1
5	Plug - Pipe	1
6	Sealant - Thread	.01
7	Tag - Approval	1
8	Screw #10-32 x 1/2 LG	1
9	Washer - Lock	1
10	Screw - #6-32 x 1/4 LG	1
11	Wire - Ground	1
12	Screw - #10-24	2
13	Screw - 1/4-20 x 3/4 LG	3
14	Seal - Shaft (Stationary Seat)	1
15	Seal - Shaft (Rotating Seal)	1
16	Case - Volute	1
17	Impeller	1
18	Base - Pump	1
19	Plate - Bottom	1
20	Screw	5
21	Loctite	1
22	Ring - Seal	1
23	Lub 'O' Ring	.01
24	Stator	1
25	Rotor, Shaft & Bearing Assembly	1
26	Housing - Motor	1
27	Oil	1
28	Connector Assembly	1
29	Cord - Power	1
30	Label - Warranty	1
31	Tie - Float Cord	1
32	Switch - Wide Angle Float	1
33	Bracket - Diaphragm Switch	1
34	Screw - 1/4-20 x 1/4 LG	1
35	Switch - Diaphragm	1

WARNING: to reduce risk of electrical shock.
 1. Risk of electrical shock—this pump has not been investigated for use in swimming pool areas.
 2. Risk of electrical shock—connect only to a PROPERLY grounded, grounding-type receptacle.

INSTALLATION INSTRUCTIONS:

THESE IMPORTANT INSTRUCTIONS MUST BE FOLLOWED FOR SATISFACTORY PERFORMANCE OF YOUR PUMP:

1. Provide proper sump (minimum sump diameter of 12" required if using SW25/33 model with "piggy-back float switch). Fill bottom with 2" to 3" of cement.
2. DO NOT set pump directly on the bottom of sump if it is NOT solid. Raise the pump by using bricks or concrete blocks underneath it.
3. For proper automatic operation, make sure the pump power cord is plugged into the "piggy-back" receptacle on the float/diaphragm switch cord.
4. Connect to separate electrical circuit taken directly from main switch.
5. Use 3-prong ground-type receptacle for maximum safety.
6. Use steel or plastic pipe for all connecting lines between pump and sewer outlet.
(NOTE: Some city regulations do not allow installing a sump pump with plastic pipe. Check local regulation.)
7. Hydromatic check valve should be installed in discharge pipe.
8. MAKE SURE SUMP IS FREE OF STRING, CLOTH, NAILS, GRAVEL, ETC. BEFORE INSTALLING PUMP.
9. MAKE SURE FLOAT (IF USED) HANGS FREE. IT SHOULD NOT REST ON THE BOTTOM OF THE SUMP.

TOOLS REQUIRED FOR SERVICING:

General shop tools including socket wrenches and an ohmmeter to thoroughly check the motor and wiring. We recommend the Simpson No. 372 which is available through The Marley Pump Company.

SERVICING:

1. Before removing pump from the sump, check to be sure the problem is not a blown fuse, tripped circuit breaker or a power cord not completely inserted into the receptacle.
2. If the unit is being operated by the optional float control or diaphragm switch, unplug the pump from the "piggyback" receptacle and plug the pump directly into the power source. If the pump starts each time it is plugged directly into the receptacle and does not start each time when plugged into the piggyback switch with the float raised up (or the diaphragm switch pressed in) to a start position, replace the complete piggy-back switch assembly and retest with new assembly.
3. If pump fails the above two steps, unplug and pull the pump from the sump by the handle. Sandblast, if possible, any dirt or trash from the outside of the pump before dismantling.
4. Check for an obstruction in the impeller cavity by laying the pump on its side and removing the 5 screws (20) to remove the plastic base (18 & 19). If the impeller does not rotate freely, clear the impeller and cavity walls before reassembling the base. Repeat Step 2.

NOTE: Number in parenthesis refers to part number on drawing on page 2.

5. If the above tests have not resolved the problem, it may be in the electrical components of the pump. Starting with the power cord, inspect for cuts or nicks in the insulation. If the cord is damaged — replace it!

6. Using the ohmmeter, check the resistance of the motor windings by connecting one lead clip to each electric "flat" prong on the power cord plug. The ohmmeter should be on R x 1 setting. Normal readings are as follows:

¼ HP 115V 1ø	2.2/2.3
½ HP 115V 1ø	1.10/1.27

To check for ground, place the ohmmeter on R x 100k, connect one lead clip to the "round" ground prong on the power cord and touch the other lead clip to each "flat" prong individually. If the reading is other than infinity (on the ohmmeter scale), a leakage through stator insulation or moisture in the windings is occurring and the stator must be removed, dried out and rechecked. A reading at zero indicates a dead short and the stator will have to be replaced.

7. To check to see if water has entered the motor cap, remove the pipe plug (5) at the top of the pump and drain the oil into a bucket. A milky appearance to the oil indicates that water has entered through either worn or damaged seals or O-rings and replacement is necessary.

WARNING! If oil contains water, do not plug into electricity as there is a danger of shock.

If the unit needs further disassembly, dismantle per the following instructions.

8. Remove the 3 hex head screws (13) from the motor cap (26) and lift the motor cap off carefully as a grounding wire is attached to the inside of the motor cap. Remove the ground screw and set motor cap to one side.
9. Remove the 5 slotted-head cap screws holding the base to the volute (16).
10. To remove the impeller, hold the rotor shaft (25) with a screwdriver and tap off the shaft carefully with a plastic or rubber hammer. Threads are right hand.
11. Insert a screwdriver under the edge of the ceramic seal (15) and lift it off.
12. Press or tap the rotor and shaft assembly out with a plastic or rawhide hammer. Note that the lower ball bearing will come out with the shaft and rotor assembly. If the bearing is rusted or feels rough when turned, it should be replaced as in Step 16.
13. Remove the stator. Note that the stators have 2 pull bolts 180 degrees apart.
14. Remove the seal (14) by inserting a screwdriver into the seal housing from the top of the volute and, tapping lightly with a hammer, clean the seal area of the volute with a cloth.
15. Coat the replacement seal with a thin oil coating and use a plastic pusher to install the seal into the housing. Do not use any sharp instruments that may damage the seal. Do not chip, scratch or mar the carbon face.
16. If ball bearing replacement is necessary as determined by Step 12, press the bearing on the shaft, pushing only on the inner race. If a press is not available, the bearing can be tapped on using a sleeve that bears only on the inner race. **PRESSING ON THE OUTER RACE WILL BRINELL THE BEARING AND CAUSE EARLY FAILURE.**
17. Push the new rotor, shaft and ballbearing assembly into the housing. Note that the replacement rotor must be of the same manufacture as the existing stator or vice-versa.
18. Press the new ceramic seal in place with the rubber ring facing the impeller. This should have a thin oil coating.
19. Add a drop of Locktite 222 to shaft thread and screw the

Impeller on hand tight. The impeller will force the ceramic seal into position. **NOTE: Locktite overrun into the seal or bearing will result in shaft seizure.**

20. Remove the old seal ring (22) from the volute and stretch on a new ring coated with O-ring lube. **DO NOT ROLL THE RING ONTO THE VOLUTE OR WATER LEAKAGE INTO THE MOTOR CAP WILL RESULT.**
21. Install the replacement stator, making sure that the wires are in proper position with respect to the discharge. Tighten down the pull bolts (12) evenly and firmly to prevent cocking of the stator. Pull bolts must be 180 degrees apart.
22. Fasten ground wire inside the motor cap and tuck wires up into housing to prevent rubbing on the rotor; then install motor cap.
23. Fill the motor cap with high-grade transformer oil such as Sohio Factopure SE 40 Oil or equivalent to at least 1/4" over motor windings. **DO NOT FILL THE MOTOR CAP COMPLETELY. ALLOW AIR SPACE FOR EXPANSION. Re-**

place oil pipe plug. Recheck with ohmmeter before applying electricity to motor.

24. Plug the power cord into a grounded outlet and check pump running. Motor should run smoothly and be free of vibration.

YOUR PUMP WARRANTY IS VOID

- IF . . . Power cord has been cut or spliced.
- IF . . . Pump has been used to pump mud, cement, mortar, plaster, heavy oils, grease, tar, abrasives or chemicals.
- IF . . . Pump has been used for continuous pumping of hot water (above 130 degrees F.)
- IF . . . Pump has been dismantled by customer. (Dealer only can dismantle pump for field service.)

WARRANTY

Aurora/Hydromatic Pumps, Inc. warrants to the original purchaser of each Hydromatic product(s) that any part thereof which proves to be defective in material or workmanship within one year from date of installation or 18 months from manufacture date, whichever comes first, will be replaced at no charge with a new or remanufactured part, F.O.B. factory. Purchaser shall assume all responsibility and expense for removal, reinstallation and freight. Any item(s) designated as manufactured by others shall be covered only by the express warranty of the manufacturer thereof. This warranty does not apply to damage resulting from accident, alteration, design, misuse or abuse.

If the material furnished to the Buyer shall fail to conform to this contract or to any of the terms of this written warranty, Aurora/Hydromatic Pumps, Inc. shall replace such nonconforming material at the original point of delivery and shall furnish instruction for its disposition. Any transportation charges involved in such disposition shall be for the Buyer's account. The Buyer's exclusive and sole remedy on account or in respect of the furnishing of material that does not conform to this contract, or to this written warranty, shall be to secure replacement thereof as aforesaid. Aurora/Hydromatic Pumps, Inc. shall not in any event be liable for the cost of any labor expended on any such material or for any incidental or consequential damages to anyone by reason of the fact that such material does not conform to this contract or to this written warranty.

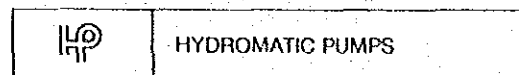
ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, ARE DISCLAIMED TO THE SAME EXTENT AS THE EXPRESS WARRANTY CONTAINED HEREIN. Some States do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

MANUFACTURER EXPRESSLY DISCLAIMS AND EXCLUDES ANY LIABILITY FOR CONSEQUENTIAL OR INCIDENTAL DAMAGES FOR BREACH OF ANY EXPRESS OR IMPLIED WARRANTY ARISING IN CONNECTION WITH THIS PRODUCT, INCLUDING WITHOUT LIMITATION, WHETHER IN TORT, NEGLIGENCE, STRICT LIABILITY CONTRACT OR OTHERWISE. Some States do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from State to State.

NOTE Aurora/Hydromatic Pumps, Inc. reserves the right to make revisions to its products and their specifications, and to this bulletin and related information without notice. Most models are UL Listed and CSA Approved.

Bulletin 118.9
Rev. 7-90
Part No. 5625-195-1



1840 Baney Road, Ashland, OH 44805

(8) Sedimentation Pit for Aerobic Reactor

When the facility is operated continuously, sediment accumulated at the bottom of the sedimentation pit shall be blown away by opening the blow valve at the bottom of the pit properly, conveyed to the sludge drying bed and dried. Opening and shutting of the valve shall be within 5 - 10 counts at one time, and much care shall be paid not to blow off water only, but to blow off and send only concentrated sediment to the drying bed to the best of the operator's ability.

(9) Lagoon

- 1) A pump for the waterworks in the lagoon shall be operated 5 - 6 hours a day, and DO of the water shall be controlled more than 2 ppm.
- 2) Since sludge accumulate at the bottom of the lagoon after long time of use, the bottom, especially the inflow pond, shall be cleaned during continuous fine days, and the sediment shall be dried on the sludge drying bed.

(10) Sludge Drying Bed

- 1) After one drying bed is filled with sludges, following sludges shall be treated by the next spare bed.
- 2) The drying bed filled with sludges can be transacted within about 7 days. After dried and become easy to be scratched off by a shovel, the sludges shall be scratched off on the surface and supplied to the coffee field as a fertilizer or buried.

(11) Analysis of Water Quality

- 1) Raw waste water shall be analyzed its quality 1 - 2 times a month.
- 2) Treated water shall be analyzed its quality once a week or every other week. Items and points of sampling are as follows.

Sampling point

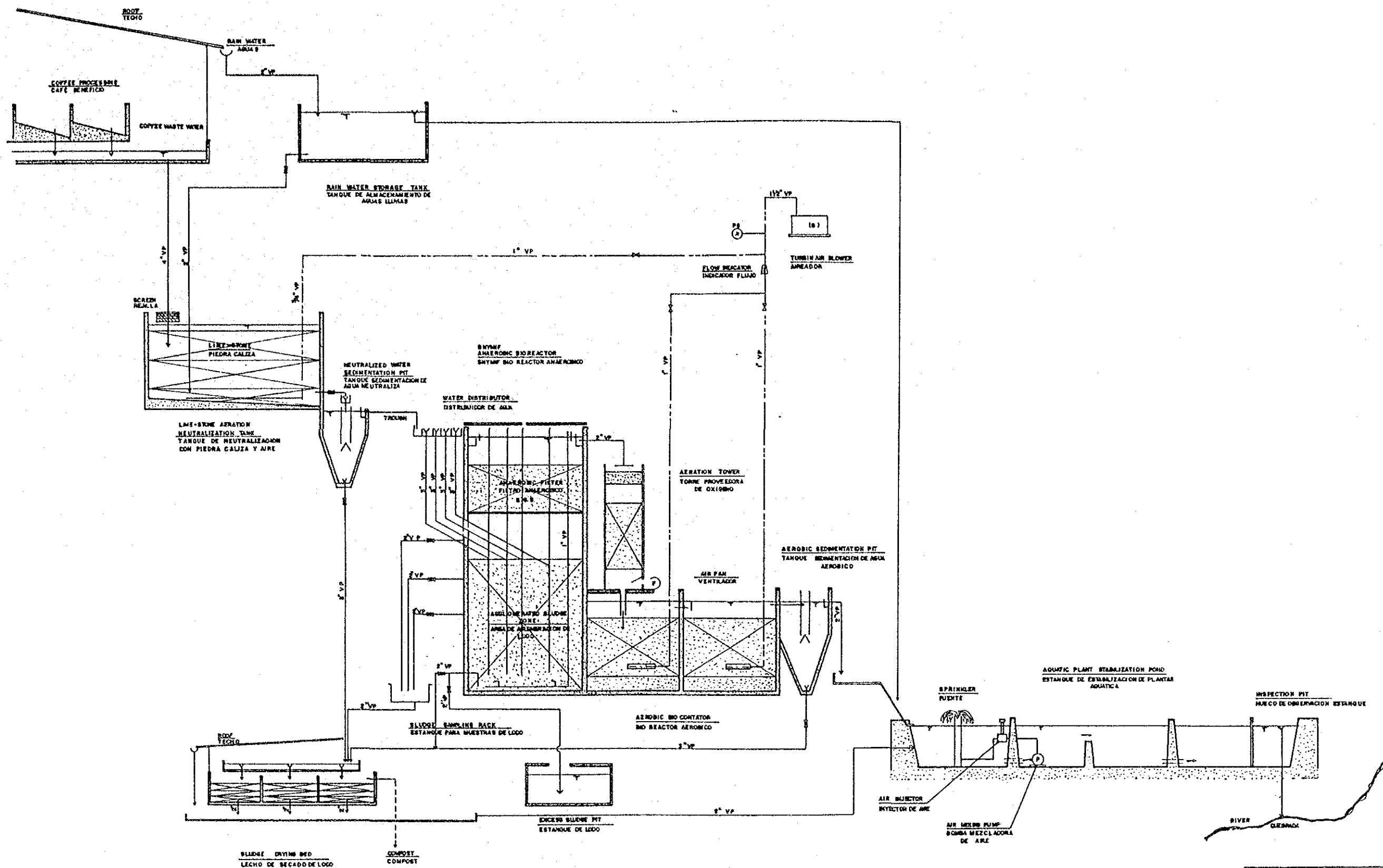
- 1) Raw waste water
 - 2) Outflow water from neutralized water sedimentation pit
 - 3) Outflow from anaerobic reactor
 - 4) Outflow water from aerobic reactor sedimentation pit
 - 5) Inflow water to lagoon
 - 6) Water in the middle part of lagoon
 - 7) Outflow water from lagoon
 - 8), 9) Water from upstream of the discharge point of treated water in the river
 - 10) Water from downstream of the discharge point of treated water in the river
- 3) Attached tables may be of good use for recording.

Vender List

PLANTAS PILOTO SEBASTOPOL Y EL ROCIO

LISTA DE PROVEEDORES (VENDER LIST)

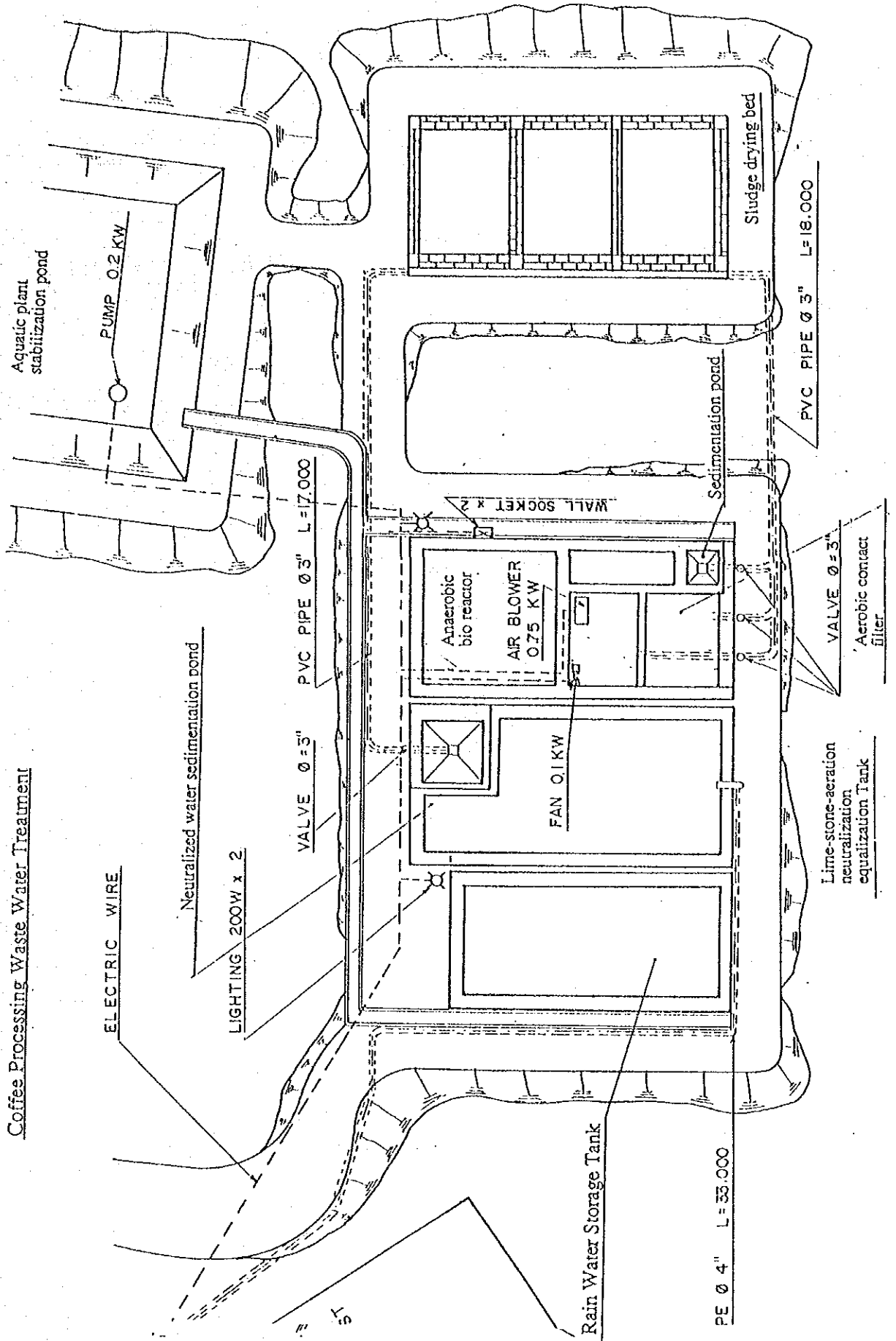
NOMBRE	TRABAJO	DIRECCION	CIUDAD	TELEFONO
HC ACUACULTURA	TURBINAS	CLLE. 123 No 53A-52	BOGOTA	2713298
GILYCO	VENTILADOR	CRA. 46 No 18-62	BOGOTA	2691576
FERRETERIA SICAR LTDA	VALVULAS	CRA. 25 No 15-36	BOGOTA	2779691
ELECTRO BOMBAS	BOMBA SUMERG.	CRA. 68 No 6-78	BOGOTA	2613512
SURTIBOMBAS	BOMBAS SUMERG.	CRA. 19 No 11-43	ARMEN.	456470
HERMES VALENCIA	PARRILLAS Y TAPAS METAL.	CALLE 3A No 21-48	ARMEN.	453256
ACABADOS DECORATIVOS	CANALES LAMIN.	CALLE 22 No 14-32	ARMEN.	440191
TALLER RURAL EL TRONCAL	TORRE AIREACION- CILINDRO	FINCA EL TRONCAL	P. TAPA DO	450634
AGROCALES HELVECIA LTDA	PIEDRA CALIZA	CRA. 15 No 12-07	CALI	831861



PLANO No.	SEBASTOPOL - 6/6
TITULO:	FLOW SHEET
PROYECTO DE DESARROLLO AGRICOLA INTEGRADO DE LA CUENCA DEL QUINDIO	
FECHA:	FEB. 25 - 1991
APROBADO	
J.I.C.A.	C.R.O.

25Ha SCALE COFFEE FARM (SEBASTOPOL)

Coffee Processing Waste Water Treatment



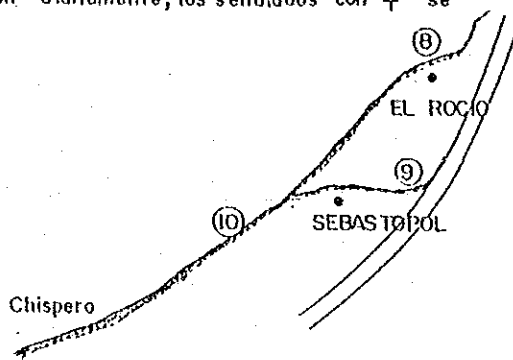
CONTROL DE LA CALIDAD DE AGUA EN LAS PLANTAS DE TRATAMIENTO SNY MIF

FECHA:	HORA:	OBSERVADOR:
FINCA:	CAFE BENEFICIADO:	g Kg
TIPO DE MUESTRA:	CAUDAL:	Lt/min M³/Hora M³/Dia

PARAMETROS		PUNTO											
		1	2	3	4	5	6	7	8	9	10	11	
* DQO	mg/Lt												
+ DBO ₅	mg/Lt												
* OXIGENO DISUELTO	mg/Lt												
* SOLIDOS TOTALES S.T.	mg/Lt												
* SOLIDOS SUSPENDIDOS VOLATILES													
* SOLIDOS SUSPENDIDOS TOTALES													
* P.H.													
* ACIDEZ	mg/Lt												
* ALCALINIDAD	mg/Lt												
+ NITROGENO AMONIAICAL	mg/Lt												
+ NITROGENO KJELDAHL	mg/Lt												
+ FOSFORO TOTAL	mg/Lt												
+ COLIFORMES	NMP/100ml												
+ FECALES	NMP/100ml												

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

- PUNTOS:**
- 1- Aguas sin tratar
 - 2- Agua Neutralizada y Sedimentada.
 - 3- Salida del Sistema Anaeróbico.
 - 4- Salida del Sistema de Aireación y Sedimentación.
 - 5- Entrada a Laguna de Estabilización.
 - 6- Interior de la Laguna.
 - 7- Salida de la Laguna.
 - 8-9- Quebrada Arriba
 - 10- Quebrada Abajo



OPINION:

**J.8.4.2 Operation Manual for Model Plant
for 8Ha Coffee Farm (EL ROCIO)**

Contents

1. Preface
2. Introduction of the plant
3. Basis of design
4. Outline of equipments
5. Flow of treatment method
6. Maintenance and warning

Flow sheet

Lay out

Vender list

Table of water analysis result

1. Preface

This operation manual for 8 Ha coffee farm El Rocio is simply described on coffee waste water treatment plant and it's site operators.
We hope that the plant will be performed without any troubles for a long time using this procedure.

2. Introduction of the Plant

The plant is designed for 8 Ha coffee farm El Rocio considering circumstances of the Cristales catchment.

Characteristics of the plant are as follow;

- : Full system consists of facilities for neutralization, anaerobic treatment, aerobic treatment, stabilization pond and dehydration, including tertiary treatment.
- : Lime-stone-aeration method is applied to the neutralization, which is expected to be safe and economical in its running cost.
- : Not conventional method as in the past but high technology of high speed treatment is applied to anaerobic reactor. The treatment is carried out by two steps, pre-agglomeration treated strong agglomerated anaerobic sludge zone and anaerobic contact filter in one reactor named "SNYMIF". The anaerobic contact filter also has a function to prevent the anaerobic sludge from being washed out by generated methane gas, as SGS (sludge-gas separator), newly devised anaerobic reactor.
- : The aerobic treatment removes offensive smell, specific to anaerobic treatment water, releases no-oxygen condition and at the same time decomposes residual organic compounds furtherly. The contact filter to be applied is a method where organic compound load is higher than that in the conventional activated sludge process for suspending treatment, and can simplify handlings for the activated sludge to be returned. This facility shall be able to be used as an anaerobic filter and the usage, as an aerobic facility or anaerobic facility, is switched by the load accordingly.
- : In the final treatment polishing and stabilization are carried out by an aquatic plants stabilization pond called as "Living filter".

By the above mentioned treatment the quality of the final treated water clears the standard for quality of waste water treatment authorized by the Ministry of Health of the Republic of Colombia, moreover, as to organic compound (CODcr), the target of the removal ratio is higher than 90 per cent which is higher than the standards.

3. Basis of Design

1) Amount of waste water

Daily maximum	4.4m ³	0.183m ³ /HR
Daily average	3.3m ³	0.137m ³ /HR

2) Quality of raw waste water

Item	Maximum	Average
Water Temperature	normal temperature	normal temperature (18-28°C)
Appearance	turbid yellowish brown	turbid yellowish brown
pH	3.5	4.0
Suspended Solid (SS)	3,000 mg/l	2,000 mg/l
Chemical Oxygen Demand (COD _{Cr})	15,000 mg/l	10,000 mg/l
Biochemical Oxygen Demand (BOD ₅)	10,000 mg/l	6,700 mg/l

3) Quality of treated water

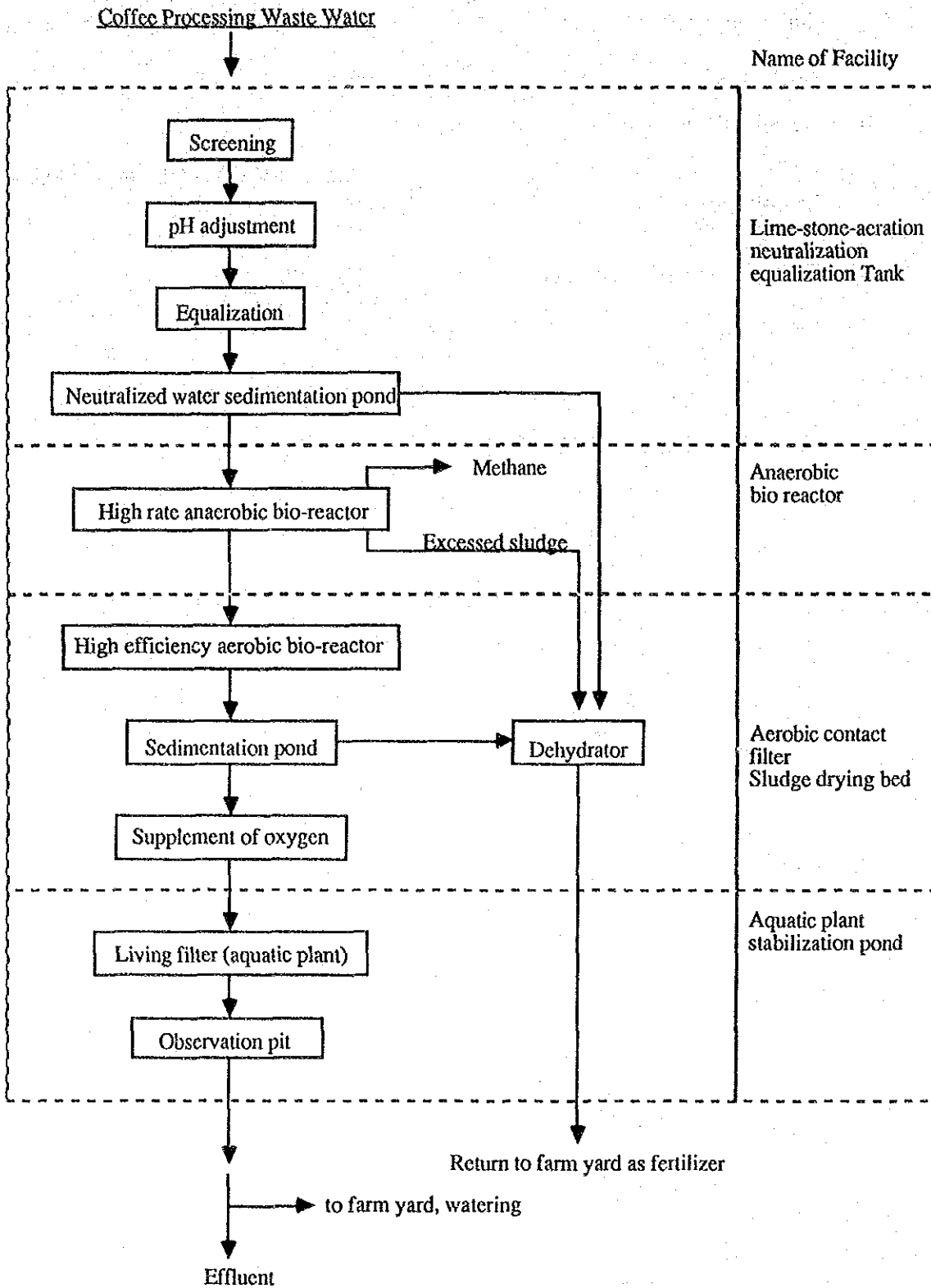
Item	Standard of Colombia	Target Value
Appearance		slightly turbid light yellow
pH	5 - 9	5.8 - 8.6
Suspended Solid (SS)	400 mg/l (80% removal)	30 mg/l (98.5% removal)
COD _{Cr}	2,000 mg/l (80% removal)	less than 300 mg/l (97% removal)
BOD ₅	1,340 mg/l (80% removal)	less than 200 mg/l (97% removal)

4. Outline of Equipments

- (1) Neutralization tank 3,600mmL x 1,800mmW x 1,250mmD
 - 1) Effective volume 7 m³
 - 2) Lime-stone 7 tons
- (2) Air blower 0.4 KW - 115V
- 3) Neutralized water sedimentation pit 1,400mmL x 1,400mmW x 1,800mmD
 - Effective volume 0.6m³
- (4) Anaerobic bio reactor 1,700mmL x 1,700mmW x 4,000mmD
 - Effective volume 11.0m³
- (5) Aerobic contact filter
 - Primary filter 1,800mmL x 1,800mmW x 1,800mmD
 - Effective volume 5.8m³

(6)	Aerobic water sedimentation pit	700mmL x 700mmW x 1,800mmD
	Effective volume	0.6m ³
(7)	Sludge drying bed	1,400mmW x 4,400mmL x 1,500mmD
	Area	6m ²
(8)	Aquatic stabilization	
	Pond	6,000mmW x 16,000mmL x 900mmD
	Effective volume	86m ³
	Aquatic plant	500kg
(9)	Oxygen supplement channel	300mmW x 50m
(10)	Rain water pit	2.5m ³

5. Flow of Treatment Method



Flow of Coffee Processing Waste Water Treatment

6. Maintenance and Warning

(1) Receiving Coffee Waste Water

- 1) The operator shall confirm the coffee production schedule of this week/next week by asking farms at the end of a week or at the beginning of a week. All the preparations for the treatment facilities in accordance with the said schedule shall be carried out properly so that there may not be any trouble in the operation of the waste water treatment facilities.
- 2) Especially, the neutralization tank shall be well treated as far as possible before receiving coffee waste water and kept empty.

(2) Rain Water Storage Tank

- 1) Rain Water is important particularly as cleaning water for the neutralization tank, therefore, the operator shall always try to fill up the rain water storage tank.
- 2) Overflowed water from the tank owing to affluent rainfall shall be introduced to the aquatic plant stabilization pond.
- 3) The tank shall be cleaned once a season, and muddy/sandy sediment at the bottom of the tank shall be removed by shovels, etc. and buried in the earth, not flushed away into the neutralization tank and the aquatic plant stabilization pond.

(3) Neutralization Tank

- 1) The received waste water must be treated within 24 hours, since the capacity of the neutralization tank is same as the amount of waste water from one time coffee production. In a period when the coffee production is carried out not everyday, it would be better to put many hours in the treatment until receiving the next waste water. For example, if waste water is discharged every other day, the waste water shall be treated with fixed flow rate in around 40 hours.
- 2) The limestone bed shall be turned up to a depth of 30 - 50 cm to check its dirtiness, and when it is found that the surface of the limestone layer is covered with yellowish brown sediments of coffee waste water, the bed shall be washed with water in the rain water storage tank.
- 3) The limestone bed shall be washed on a day when there is no discharge of coffee waste water, and the washing shall be finished within 12 hours (in half a day). The procedure of washing is as follows.
 - i) Introducing water from the rain water storage tank to the neutralization tank.
 - ii) Aerating and mixing the water for 1 or 2 hours by air.
 - iii) Discharging the water to the neutralized water sedimentation pit at a normal flow rate.
- 4) Limestone shall be supplied to the tank from the reservation bunker of limestone for ullage once a season or year.

(4) Neutralized Water Sedimentation Pit

- 1) The ball valve mounted at the outlet of the neutralization tank shall be adjusted so that the neutralized water may flow into the sedimentation pit with a flow rate of around 0.137l/hour.

- 2) In case that scum occurs on the surface of water in the sedimentation pit and the scum is accumulated thick and stiff, the scum shall be scooped up, conveyed to the sludge drying bed and dried.
- 3) When the facility is operated continuously, accumulated sediment at the bottom of the sedimentation pit shall be blown away by opening the blow valve at the bottom of the pit properly, conveyed to the sludge drying bed and dried. Opening and shutting of the valve shall be within 5 - 10 counts at one time, and much care shall be paid not to blow off water only, but to blow off and send only concentrated sediment to the drying bed to the best of the operator's ability.

(5) Anaerobic Reactor

- 1) The operator shall observe whether bubbles of gas are generated vigorously or not. If the generation of gas is considerably poor, it is considered that the inner conditions of the reactor are mal-controlled (e.g. wrong pH value, shortcircuit flow, etc.), consequently, pH value of the water and the inner water level of the neutralized water distribution pit shall be checked.
- 2) The operator shall sample and observe the colour of overflowed water whether the colour is light yellow or not. If the colour is black, the inner conditions of the reactor is considered mal-controlled, the same checks shall be performed. In case of low pH, the condition shall be improved by washing inside the neutralization tank and mixing by aeration. In case of the water flow being disturbed, sludges inside the reactor shall be circulated and equalized.
- 3) The amount of accumulated sludges shall be measured through the sampling cock 2 - 3 times a season properly. Generally speaking, the accumulation of sludges is slow, however, when the accumulation is considerable, the sludges shall be emitted to the excessed sludge storage pit or conveyed to the sludge drying bed to be dried.
- 4) After a long term of operation suspension, the sludge zone in the anaerobic reactor shall be agitated by a spare submersible pump for 2 - 3 minutes in the beginning of a season. This procedure is just the same operation as the sludge circulation mentioned in the paragraph 2) above.

(6) Aerobic reactor

- 1) The DO value kept around 0.1 ppm - 1.0 ppm in the aerobic reactor may be tolerable.
- 2) Air volume to be sent shall be 0.5 Nm³/min. to the pond.
- 3) Aeration blower
 - i) Maintenance

No lubrication is necessary as all bearings are sealed. Dirt and dust should be kept off the unit, to prevent abnormal temperature rise.

Always keep the air filter clean for the least amount of inlet air restriction. Clean the air filter by "swishing" it in soapy dish water. Gently rinse, then shake out excess water. Do not scrub or use high pressure air as this will separate the filter fibers. You may re-install the filter while it is still wet. Keeping a replacement filter on hand is recommended.

No other routine maintenance is needed. Replacement of the motor bearings after 24 months of continuous operation is recommended to prevent an unscheduled blower repair. This may be done by your local electric motor repair shop.

ii) Warning

Electric rotating machinery, and high voltage can cause serious or fatal injury if improperly installed, operated or maintained.

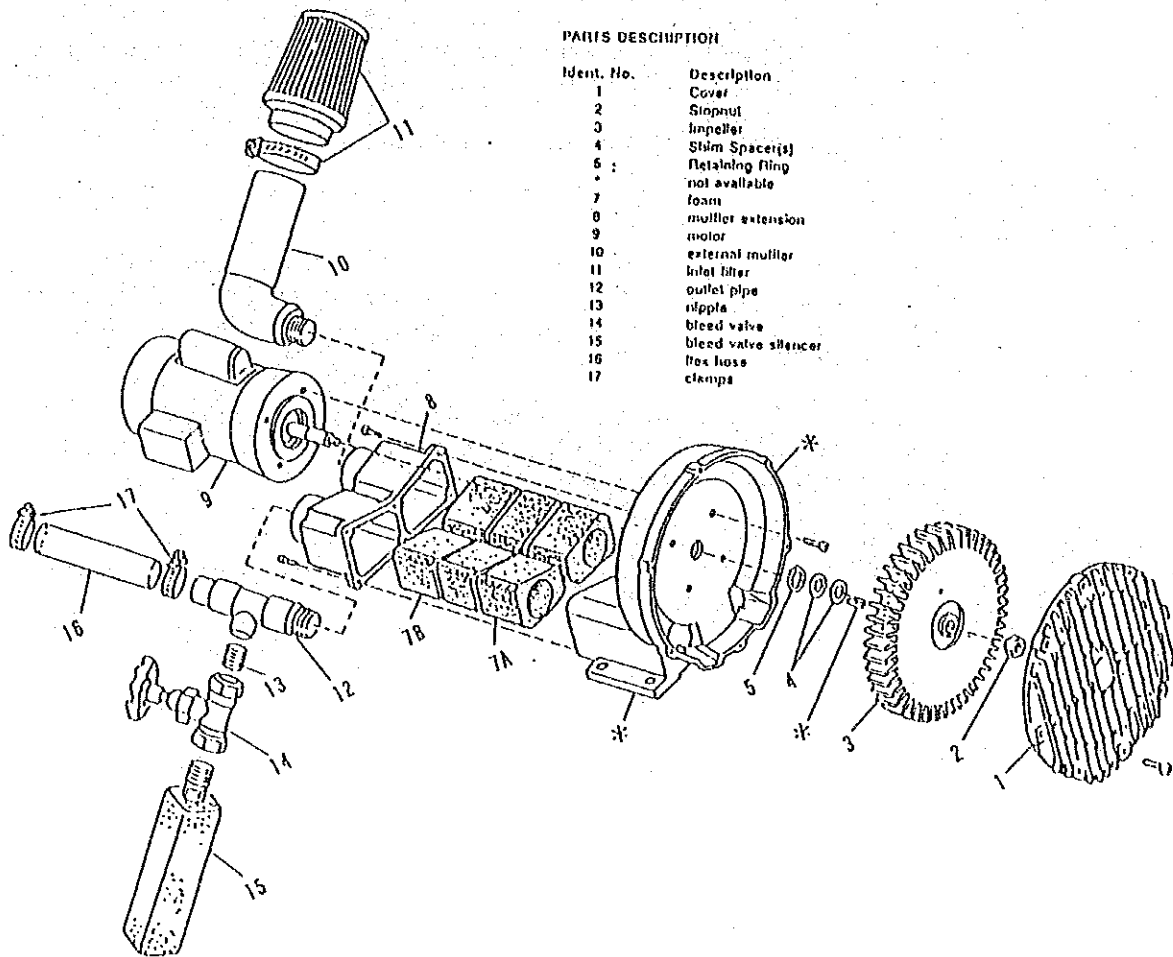
When servicing, all power sources to the blower should be de-energized and/or disconnected. All rotating parts should be at a standstill. Caution should always be used when working around your blower, as high velocity air is entering and exiting the blower and the air lines.

iii) Guarantee

All SWEETWATER™ Air Pumps are unconditionally guaranteed for two years from date of shipment from Aquatic Eco-Systems, Inc. Units returned within two years will be rebuilt or replaced *REGARDLESS OF REASON FOR FAILURE*.

Exceptions may be made by AE-S in writing on particular applications where experience has indicated that conditions are so unusual or severe that premature failure can be expected.

Prior to returning a unit, call or write to AE-S for a return authorization number. In all instances, transportation charges will be at customer expense.



PARTS DESCRIPTION

Ident. No.	Description
1	Cover
2	Stopnut
3	Impeller
4	Stator Spacer(s)
5	Retaining fling
6	foam
7	muller extension
8	motor
9	external muller
10	inlet filter
11	outlet pipe
12	ripple
13	bleed valve
14	bleed valve silencer
15	flex hose
16	clamp
17	clamps

(7) Sedimentation Pit for Aerobic Reactor

When the facility is operated continuously, sediment accumulated at the bottom of the sedimentation pit shall be blown away by opening the blow valve at the bottom of the pit properly, conveyed to the sludge drying bed and dried. Opening and shutting of the valve shall be within 5 - 10 counts at one time, and much care shall be paid not to blow off water only, but to blow off and send only concentrated sediment to the drying bed to the best of the operator's ability.

(8) Lagoon

- 1) A pump for the waterworks in the lagoon shall be operated 5 - 6 hours a day, and DO of the water shall be controlled more than 2 ppm.
- 2) Since sludge accumulate at the bottom of the lagoon after long time of use, the bottom, especially the inflow pond, shall be cleaned during continuous fine days, and the sediment shall be dried on the sludge drying bed.

(9) Sludge Drying Bed

- 1) After one drying bed is filled with sludges, following sludges shall be treated by the next spare bed.
- 2) The drying bed filled with sludges can be transacted within about 7 days. After dried and become easy to be scratched off by a shovel, the sludges shall be scratched off on the surface and supplied to the coffee filed as a fertilizer or buried.

(10) Analysis of Water Quality

- 1) Raw waste water shall be analyzed its quality 1 - 2 times a month.
- 2) Treated water shall be analyzed its quality once a week or every other week. Items and points of sampling are as follows.

Sampling point

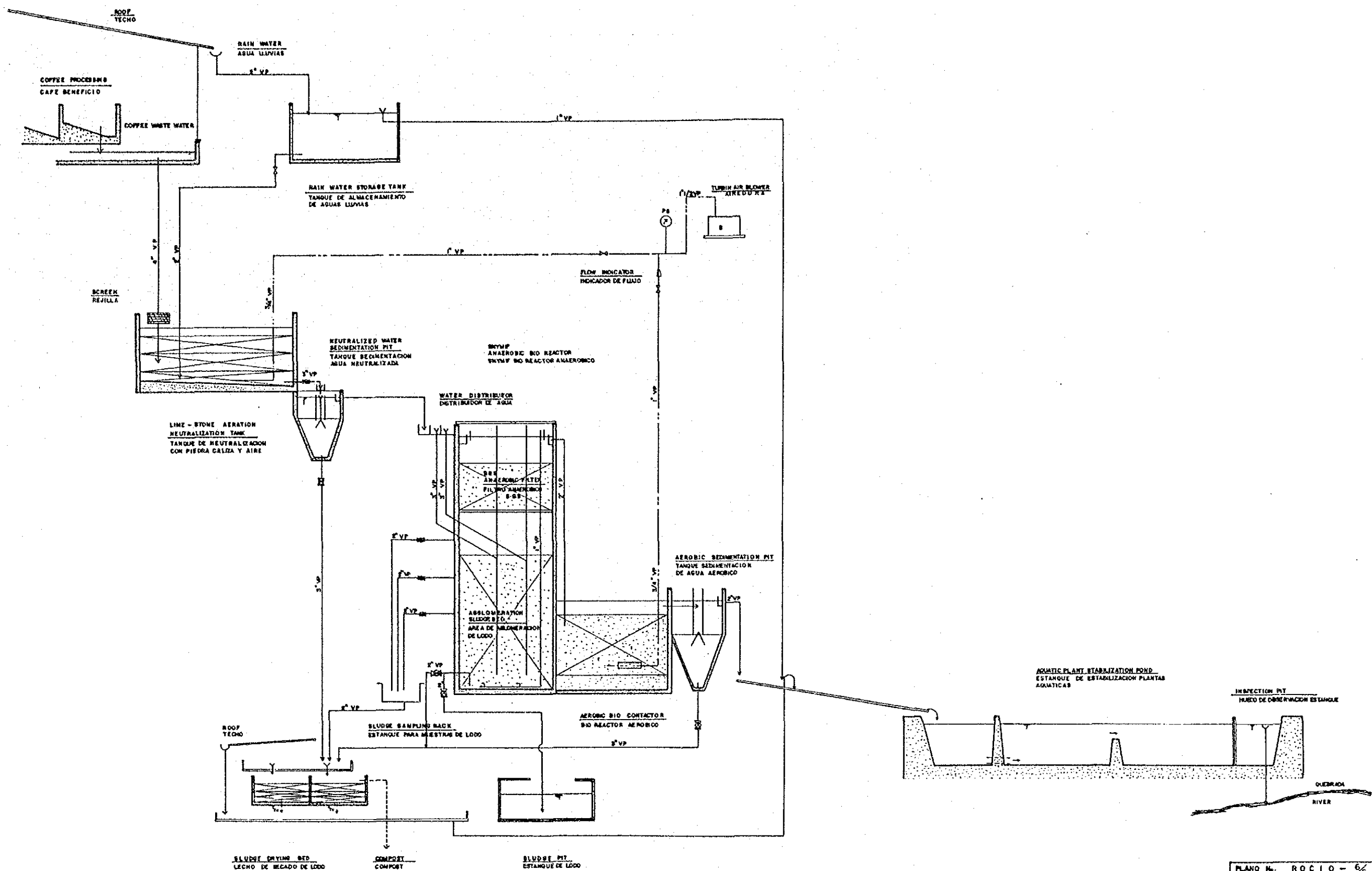
- 1) Raw waste water
 - 2) Outflow water from neutralized water sedimentation pit
 - 3) Outflow from anaerobic reactor
 - 4) Outflow water from aerobic reactor sedimentation pit
 - 5) Inflow water to lagoon
 - 6) Water in the middle part of lagoon
 - 7) Outflow water from lagoon
 - 8), 9) Water from upstream of the discharge point of treated water in the river
 - 10) Water from downstream of the discharge point of treated water in the river
- 3) Attached tables may be of good use for recording.

Vender List

PLANTAS PILOTO SEBASTOPOL Y EL ROCIO

LISTA DE PROVEEDORES (VENDER LIST)

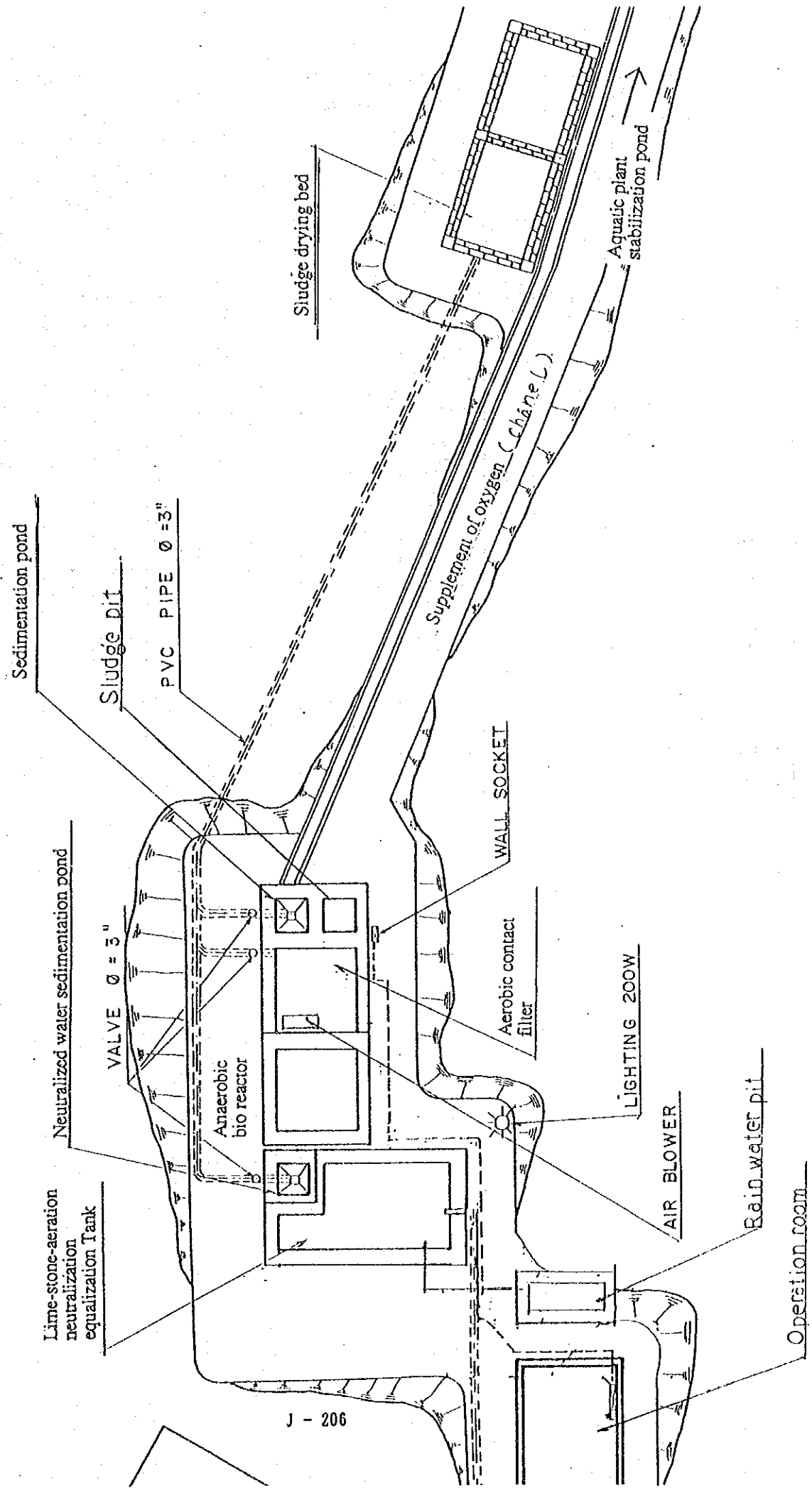
NOMBRE	TRABAJO	DIRECCION	CIUDAD	TELEFONO
HC ACUACULTURA	TURBINAS	CLLE. 123 No 53A-52	BOGOTA	2713298
GILYCO	VENTILADOR	CRA. 46 No 18-62	BOGOTA	2691576
FERRETERIA SICAR LTDA	VALVULAS	CRA. 25 No 15-36	BOGOTA	2779691
ELECTRO BOMBAS	BOMBA SUMERG.	CRA. 68 No 6-78	BOGOTA	2613512
SURTIBOMBAS	BOMBAS SUMERG.	CRA. 19 No 11-43	ARMEN.	456470
HERMES VALENCIA	PARRILLAS Y TAPAS METAL.	CALLE 3A No 21-48	ARMEN.	453256
ACABADOS DECORATIVOS	CANALES LAMIN.	CALLE 22 No 14-32	ARMEN.	440191
TALLER RURAL EL TRONCAL	TORRE AIREACION- CILINDRO	FINCA EL TRONCAL	P. TAPA DO	450634
AGROCALES HELVECIA LTDA	PIEDRA CALIZA	CRA. 15 No 12-07	CALI	831861



PLANO N. ROCIO - 6/6
TITULO: FLOW SHEET
PROYECTO DE DESARROLLO AGRICOLA INTEGRADO DE LA CUENCA DEL QUNDO
FECHA: FEB. 28 - 1981
APROBADO:
JICA C.R.O.

8Ha SCALE COFFEE FARM (EL ROCIO)

Coffee Processing Waste Water Treatment



CONTROL DE LA CALIDAD DE AGUA EN LAS PLANTAS DE TRATAMIENTO
SNY MIF

FECHA:	HORA:	OBSERVADOR:
FINCA:	CAFE BENEFICIADO:	g Kg
TIPO DE MUESTRA:	CAUDAL:	Lt/min M³/Hora M³/Dio

PUNTO		PARAMETROS												
		1	2	3	4	5	6	7	8	9	10	11		
*	DDO	mg/Lt												
+	DBOs	mg/Lt												
*	OXIGENO DISUELTO	mg/Lt												
*	SOLIDOS TOTALES S.T.	mg/Lt												
*	SOLIDOS SUSPENDIDOS VOLATILES													
*	SOLIDOS SUSPENDIDOS TOTALES													
*	P.H.													
*	ACIDEZ	mg/Lt												
*	ALCALINIDAD	mg/Lt												
+	NITROGENO AMONIAICAL	mg/Lt												
+	NITROGENO KJELDAHL	mg/Lt												
+	FOSFORO TOTAL	mg/Lt												
+	COLIFORMES	NMP/100ml												
+	FECALES	NMP/100ml												

OBSERVACIONES: Los Parámetros Señalados con * se tomarán diariamente, los señalados con + se tomarán una vez por semana.

PUNTOS:

- 1- Aguas sin tratar
- 2- Agua Neutralizada y Sedimentada.
- 3- Salida del Sistema Anaeróbico.
- 4- Salida del Sistema de Aereación y Sedimentación.
- 5- Entrada a Laguna de Estabilización.
- 6- Interior de la Laguna.
- 7- Salida de la Laguna.
- 8, 9- Quebrada Arriba
- 10- Quebrada Abajo

OPINION:

ANNEX K : COST ESTIMATION

Table of contents

K.1 Assumption of Cost Estimation	K-2
K.2 Project cost	K-5
K.3 Cost Estimation	K-7

List of Table

Table K.3.1 Construction Cost(Total Area)	K-8
Table K.3.2(1) Construction Cost (Circasia Area)	K-9
Table K.3.2(2) Construction Cost (Circasia Area)	K-10
Table K.3.3 Construction Cost (Salento Area)	K-11
Table K.3.4(1) Construction Cost (Quindio river Right Margin Area)	K-12
Table K.3.4(2) Construction Cost (Quindio river Right Margin Area)	K-13
Table K.3.5(1) Construction Cost (Quindio river Left Margin Area)	K-14
Table K.3.5(2) Construction Cost (Quindio river Left Margin Area)	K-15
Table K.3.6 Construction Cost (Pijao Area)	K-16
Table K.3.7 Construction Cost (Genova Area)	K-17
Table K.3.8(1)(2)(3) Construction Cost of Coffee Waste Water Treatment Plant	K-18
Table K.3.9 Construction Cost of Storage Center and Child Plant	K-21
Table K.3.10 O/M Equipment Cost	H-22
Table K.3.11 Administration Cost	H-23
Table K.3.12 O/M Cost	H-24

ANNEX K : PROJECT COST ESTIMATION

K.1 Assumption on Cost Estimation

The Project cost has been estimated on the following assumption.

K.1.1 Means of Execution

Civil engineering work will be executed by the contract entered into between the promoter and the contractor. The machinery and equipment required for construction works will be provided by the contractors.

K.1.2 Basic Rate

The basic rate of labor, materials, construction machinery and equipment on the cost estimation are adopted the actual rates in Colombia in September 1990 as shown Tables K.1.1, K.1.2 and K.1.3.

K.1.3 Exchange Rate

U.S.\$ 1.00 equals to Col.\$ 527.73 (the average official exchange rate in September 1990)

K.1.4 Overhead and Profit

Overhead and profit, which equal to 30 % of direct cost in total is included in each unit price.

K.1.5 Contingency Allowance

The physical contingency allowance is calculated applying the following rates.

For construction work : 15% of accumulated direct costs
For engineering fee : 5% of accumulated direct costs
For O/M cost : 5% of accumulated direct costs

Table K.1.1 Labor Rates

Description	Rate/Day(Col.\$)
General Foreman	4,500
Skilled Laborer	3,500
Laborer	2,700
Carpenter	3,500
Steel man	3,500
Driver (heavy equip.)	5,500
Driver (general)	3,500
Watchman	3,500
Operator(mixing plant)	4,500

Table K.1.2 Unit Price of Construction Materials

Description	Unit	Unit Price(Col.\$)
Portland Cement	kg	35.2
Reinforcing bar	kg	270
Sand	m3	4,000
Gravel	m3	4,000
Timber	m3	40,000
Gasoline	gl	301
Diesel	gl	302
RC Pipe Dim. 4"	m	550
RC Pipe Dim. 24"	m	3,500
RC Pipe Dim. 36"	m	13,000
PVC Pipe Dim. 3"	m	1,797
PVC Pipe Dim. 4"	m	2,640
PVC Pipe Dim. 6"	m	5,298
Asphalt mixture	m3	49,575
Asphalt emulsion	l	320

Table K.1.3 Cost of Construction Machinery and Equipment

Description	Hourly Cost (Col. \$)
Bulldozer D5H	25,000
D6H	38,500
D7H	48,660
D8N	59,900
D9N	78,300
Wheel loader 988B 5.35m ³	159,700
966C 3.00m ³	64,900
950B 2.28m ³	52,100
936 1.90m ³	40,900
930 1.52m ³	31,300
920 1.33m ³	23,600
910 0.95m ³	19,900
Back hoe UH12 1.20m ³	57,060
UH10 0.60m ³	28,910
Vibrating roller 0.6T	4,390
SD40 3.8T	21,500
SP48 6.0T	25,800
SP56 8.8T	31,100
compressor 5m ³ /min	5,400
Grader 12G	44,300
14G	66,000
16G	95,500
Crane 20T	42,680
Dump truck 8T	12,230
3.8m ³	12,600
15T	14,000
Pile Driver 15HP	17,600
30HP	97,800
Trailer 20T	32,000
Pump car 40m ³ /h	36,040
Submersible motor pump 4"	990

K.2 Project Cost

K.2.1 Unit Price

Based on the basic rate mentioned above, the unit price of construction were estimated as shown in Table K.2.1.

K.2.2 Price of Land for Rural Construction

The price of land for rural construction of the project Area in September 1990 are shown in Table K.2.2.

K.2.2 The Price of Land for Rural Construction

Descriptin	Price (Col.\$/m2)
Circasia and Salento	
Grazing land	118.00
Coffee land	352.00
Quindio River Right Margin and left Margin	
Grazing land	937.50
Coffee land	1,172.00
Pijao and Genova	
Grazing land	235.00
Coffee land	469.00

Table K.2.1 Unit Price (Col.\$ in Sep./1990)

Description	Unit	Unit Cost
Excavation (manual to 1m of depth)	m3	660
Excavation (manual from 1m to 2m)	m3	848
Excavation in the water (manual to 2m)	m3	2,235
Excavation in the water (manual from 2m to 3m)	m3	2,822
Excavation (machine)	m3	1,000
Embankment (manual)	m3	1,361
Embankment (machine)	m3	1,250
Backfill (manual)	m3	1,361
Surplus Soil (2km)	m3	1,594
Land clearing	m2	85
Stripping	m3	165
Levering concrete	m3	28,840
Plain concrete (including form)	m3	57,000
Reinforced concrete (including form)	m3	75,240
Mortal(1:3)	m3	25.017
Stone masonry (30%)	m3	18,698
Gravel	m3	6,000
Gravel surfacing (t=100)	m2	893
Land reclamation	m2	110
Concrete pipe (8")	m	4,645
Concrete pipe (12")	m	8,469
PVC pipe (3")	m	5,500
PVC pipe (4")	m	9,100
Bamboo (l=3000)	pc	696
Wooden board	m3	36,750
Clay lining (t=20)	m2	118
U-type concrete canal 300*200	m	8,438

K.3 Cost Estimation

Table K.3.1 Construction Cost (Total Area)

Description	Area	(Unit: Col. \$1,000)									
		Circasia	Salento	Quindio Right M.	Quindio Left M.1	Quindio Left M.2	Piiao	Genova	Sub-Total	Fristales Basin	Total
1. Agricultural Development											
1) Farm Road	F/C	355,710	138,580	178,050	74,090	16,550	162,390	148,640	1,074,010		1,074,010
	L/C	212,800	82,340	106,250	43,470	9,790	95,090	87,970	637,710		637,710
	Total	568,510	220,920	284,300	117,560	26,340	257,480	236,610	1,711,720		1,711,720
2) Irrigation Facilities	F/C	414,590		323,770					738,360		738,360
	L/C	248,940		203,220					452,160		452,160
	Total	663,530		526,990					1,190,520		1,190,520
3) Agro-industry Facilities	F/C	11,310	6,710				6,710	6,710	31,440		31,440
	L/C	5,090	3,180				3,180	3,180	15,630		15,630
	Total	17,400	9,890				9,890	9,890	47,070		47,070
2) Reserch Center	F/C								46,500		46,500
	L/C								15,500		15,500
	Total								62,000		62,000
Sub-Total	F/C	781,610	145,290	501,820	74,090	16,550	169,100	155,350	1,890,310		1,890,310
	L/C	467,830	86,520	309,470	43,470	9,790	98,270	91,150	1,121,000		1,121,000
	Total	1,249,440	231,810	811,290	117,560	26,340	267,370	246,500	3,011,310		3,011,310
2. Coffee Waste Water Treatment											
1) Coffee Waste Water Treatment Facilities	F/C								408,880		408,880
	L/C								252,130		252,130
	Total								661,010		661,010
Sub-Total	F/C								408,880		408,880
	L/C								252,130		252,130
	Total								661,010		661,010
3. Land Acquisition											
3. Land Acquisition	F/C	2,000	1,000				1,000	1,000	5,000		5,000
	L/C	2,000	1,000				1,000	1,000	5,000		5,000
	Total	4,000	2,000				2,000	2,000	10,000		10,000
4. O/M Equipment											
4. O/M Equipment	F/C								377,180		377,180
	L/C										
	Total								377,180		377,180
5. Administration Cost											
5. Administration Cost	F/C								0		0
	L/C								38,080		38,080
	Total								38,080		38,080
6. Engineering Services											
6. Engineering Services	F/C	0	0				0	0	1,468,330		1,468,330
	L/C	2,000	1,000				1,000	1,000	91,510		91,510
	Total	2,000	1,000				1,000	1,000	1,559,840		1,559,840
Sub-Total	F/C	0	0				0	0	1,845,510		1,845,510
	L/C	2,000	1,000				1,000	1,000	134,590		134,590
	Total	2,000	1,000				1,000	1,000	1,980,100		1,980,100
Total	F/C	781,610	145,290	501,820	74,090	16,550	169,100	155,350	3,735,820		3,735,820
	L/C	467,830	86,520	309,470	43,470	9,790	99,270	92,150	1,255,590		1,255,590
	Total	1,249,440	231,810	811,290	117,560	26,340	268,370	247,500	4,991,410		4,991,410
7. Physical contingency											
7. Physical contingency	F/C								375,810		375,810
	L/C								174,870		174,870
	Total								550,680		550,680
Ground Total	F/C								4,111,930		4,111,930
	L/C								1,430,460		1,430,460
	Total								5,542,390		5,542,390

Table K.3.2(1) Construction Cost (Circasia Area)

Item	Spec.	Unit	Q'ty	Unit Price			Amount				
				F/C	L/C	Total	F/C	L/C	Total		
1) Farm Road Work		LS	1								
Preparatory Work	Type A	km	1.70	3,980	2,148	6,128	6,766	2,244	2,244	2,244	2,244
Main Farm Road(N)	Type B	"	0.40	10,743	5,791	16,534	4,297	3,652	3,652	3,652	10,418
ditto	Type C	"	2.10	7,456	4,020	11,476	15,658	8,442	8,442	8,442	6,614
Main Farm Road(R)	Type A	"	2.80	3,568	2,047	5,615	9,990	5,732	5,732	5,732	24,100
ditto	Type B	"	0.70	3,568	2,047	5,615	2,498	1,433	1,433	1,433	3,931
ditto	Type C	"	3.60	3,480	1,999	5,479	12,528	7,196	7,196	7,196	19,724
Branch Farm Road(N)	Type A	"	14.80	3,125	1,687	4,812	46,250	24,968	24,968	24,968	71,218
ditto	Type B	"	3.70	8,975	4,838	13,813	33,208	17,901	17,901	17,901	51,108
ditto	Type C	"	18.40	5,797	3,126	8,923	106,665	57,518	57,518	57,518	164,183
Branch Farm Road(R)	Type A	"	9.60	2,742	1,602	4,344	26,323	15,379	15,379	15,379	41,702
ditto	Type B	"	2.40	2,742	1,602	4,344	6,581	3,845	3,845	3,845	10,426
ditto	Type C	"	11.90	2,653	1,554	4,207	31,571	18,493	18,493	18,493	50,063
Cross Drain	Main	Unit	113	68	61	130	7,720	6,913	6,913	6,913	14,634
ditto	Branch	"	608	64	54	117	38,635	32,544	32,544	32,544	71,179
Bridge Work	C.Pipe	"	3	273	222	495	820	665	665	665	1,485
ditto	Culvert	"	1	2,481	1,336	3,817	2,481	1,336	1,336	1,336	3,817
Miscellaneous		LS	1				3,719	2,224	2,224	2,224	5,943
Sub Total							355,710	212,800	212,800	212,800	568,510

Col. \$1,000

Table K.3.2(2) Construction Cost (Circasia Area)

Item	Spec.	Unit	Q'ty	Unit Price		Total	Amount		Total
				F/C	L/C		F/C	L/C	
2) Irrigation Works									
Preparatory Work		LS	1					354	354
Intake Weir		Unit	3	36	21	57	108	63	171
Pump Station		"	3	91	52	143	273	156	429
Ram (Pump)	D=150	"	2	3,150		3,150	6,300	0	6,300
"	D=150	"	1	1,050		1,050	1,050	0	1,050
Supply Pipe Line	SP150mmx10m	"	2	136	107	243	272	214	486
"	SP200mmx10m	"	1	199	134	333	199	134	333
Outlet pipe line	VP75	m	180	8	4	12	1,440	720	2,160
"	VP50	"	250	4	3	7	1,000	750	1,750
"	VP40	"	100	3	3	6	300	300	600
Farm Pond		"	3				16,807	8,776	25,583
Irrigation pipe Line		ha	38	631	560	1,191	23,978	21,280	45,258
Portable Pump		Unit	3	396	44	440	1,188	132	1,320
Sprinkler	D=150	set	12	449	242	691	5,388	2,904	8,292
Miscellaneous		LS	1				577	357	934
Sub Total							58,880	36,140	95,020
TOTAL							414,590	248,940	663,530

Col. \$1,000

Table K.3.3 Construction Cost (Salento Area)

Item	Spec.	Unit	Q'ty	Unit Price			Amount					
				F/C	L/C	Total	F/C	L/C	Total			
Farm Road Work		LS	1.00									
Preparatory Work	Type A	km	0.70	3,980	2,148	6,128	2,786	807	807			807
Main Farm Road(N)	Type B	"	0.20	10,743	5,791	16,534	2,149	1,504	1,504			4,290
"	Type C	"	0.90	7,456	4,020	11,476	6,710	3,618	3,618			3,307
Main Farm Road(R)	Type A	"	2.50	3,568	2,047	5,615	8,920	5,118	5,118			10,328
"	Type B	"	0.60	3,568	2,047	5,615	2,141	1,228	1,228			3,369
"	Type C	"	3.20	3,480	1,999	5,479	11,136	6,397	6,397			17,533
Branch Farm Road(N)	Type A	"	6.40	3,125	1,687	4,812	20,000	10,797	10,797			30,797
"	Type B	"	1.60	8,975	4,838	13,813	14,360	7,741	7,741			22,101
"	Type C	"	7.90	5,797	3,126	8,923	45,796	24,695	24,695			70,492
Branch Farm Road(R)	Type A	"	0.60	2,742	1,602	4,344	1,645	961	961			2,606
"	Type B	"	0.20	2,742	1,602	4,344	548	320	320			859
"	Type C	"	0.70	2,653	1,554	4,207	1,857	1,088	1,088			2,945
Cross Drain	Main R.	Unit	81.00	68	61	130	5,534	4,956	4,956			10,490
"	Branch R.	"	174.00	64	54	117	11,057	9,314	9,314			20,370
Bridge Work	C.Pipe	"	6.00	273	222	495	1,638	1,332	1,332			2,970
"	Submerged	"	1.00	948	510	1,458	948	510	510			1,458
Miscellaneous		LS	1.00			0	1,354	797	797			2,151
Total							138,580	82,340	82,340			220,920

Col. \$1,000

Table K.3.4(1) Construction Cost (Quindio river Right Margin Area)

Item	Spec.	Unit	Q'ty	Unit Price			Amount				
				F/C	L/C	Total	F/C	L/C	Total		
1) Farm road work		LS	1								
Preparatory Work	Type A	Km	1.00	3,980	2,148	6,128	3,980	2,148	6,128	1,042	1,042
Main Farm Road(N)	Type B	"	0.30	10,743	5,791	16,534	3,223	2,148	6,128	2,148	6,128
"	Type C	"	1.30	7,456	4,020	11,476	9,693	1,737	4,960	1,737	4,960
Main Farm Road(R)	Type A	"	1.60	3,568	2,047	5,615	5,709	5,226	14,919	3,275	8,984
"	Type B	"	0.40	3,568	2,047	5,615	1,427	819	2,245	819	2,245
"	Type C	"	1.90	3,480	1,999	5,479	6,612	3,798	10,410	3,798	10,410
Branch Farm Road(N)	Type A	"	7.20	3,125	1,587	4,812	22,500	12,146	34,646	12,146	34,646
"	Type B	"	1.80	8,975	4,838	13,813	16,155	8,708	24,863	8,708	24,863
"	Type C	"	9.10	5,797	3,126	8,923	52,753	28,447	81,199	28,447	81,199
Branch Farm Road(R)	Type A	"	4.20	2,742	1,502	4,344	11,516	6,728	18,245	6,728	18,245
"	Type B	"	1.10	2,742	1,502	4,344	3,016	1,762	4,778	1,762	4,778
"	Type C	"	5.20	2,553	1,554	4,207	13,796	8,081	21,876	8,081	21,876
Cross Drain	Main	Unit	65	68	61	130	4,441	3,977	8,418	3,977	8,418
"	Branch	"	286	64	54	117	18,174	15,308	33,482	15,308	33,482
Bridge Work	C.Pipe	"	3	273	222	495	820	665	1,485	665	1,485
"	Culvert	"	1	2,481	1,336	3,817	2,481	1,336	3,817	1,336	3,817
Miscellaneous		LS	1				1,754	1,046	2,800	1,046	2,800
Sub Total							178,050	106,250	284,300	106,250	284,300

Col. \$1,000

Table K.3.4(2) Construction Cost (Quindio river Right Margin Area)

Item	Spec.	Unit	Q'ty	Unit Price			Amount			Total
				F/C	L/C	Total	F/C	L/C	Total	
2) Irrigation Work		LS	1			57			951	951
Preparatory Work		Unit	7	36	21	143	252	147	399	399
Intake Weir		"	7	91	52	143	637	364	1,001	1,001
Pump Station		"	4	3,150		3,150	12,600	0	12,600	12,600
Ram(Pump)	D=150	"	1	1,050		1,050	1,050	0	1,050	1,050
"	D=200	"	2	2,100		2,100	4,200	0	4,200	4,200
"	D=300	"	4	136	107	243	544	428	972	972
Supply Pipe Line	SP150mmx10m	"	1	199	134	333	199	134	333	333
"	SP200mmx10m	"	2	346	213	559	692	426	1,118	1,118
"	SP300mmx10m	"	530	6	7	13	3,180	3,710	6,890	6,890
Outlet Pipe Line	VP75	m	330	3	4	7	990	1,320	2,310	2,310
"	VP50	"	330	2	4	6	560	1,320	1,980	1,980
"	VP40	"	7				31,021	16,198	47,219	47,219
Farm Pond		Unit	112	631	560	1,191	70,672	62,720	133,392	133,392
Irrigation Pipe Line		ha	7	396	44	440	2,772	308	3,080	3,080
Portable Pump	D=50mm	Unit	33	449	242	691	14,817	7,986	22,803	22,803
Sprinkler		Set	1				1,435	959	2,394	2,394
Miscellaneous		шт					145,721	96,971	242,692	242,692
Sub Total							323,770	203,220	526,990	526,990
TOTAL										

Col. \$1,000

Table K.3.5(1) Construction Cost (Quindio river Left Margin Area)

Item	Spec.	Unit	Q'ty	Unit Price		Amount		Total
				F/C	F/C	F/C	F/C	
Farm road Work		LS	1				415	415
Preparatory Work	Type A	"	2.00	3,558	2,047	5,615	4,094	11,230
Main Farm Road(N)	Type D	"	9.90	5,550	2,990	8,540	29,601	84,546
Branch Farm Road(N)	Main	Unit	20	68	61	130	1,224	2,590
Cross Drain	Branch	"	99	64	54	117	5,299	11,590
"	C.Pipe	"	6	273	222	495	1,332	2,970
Bridge Work		M	900	2.2	1.2	3.4	1,080	3,060
Drainage Canal		LS	1				734	1,159
Miscellaneous								
Total						74,090	43,470	117,560

Col. \$1,000

Table K.3.5(2) Construction Cost (Quindio river Left Margin Area)

Item	Spec.	Unit	Q'ty	Unit Price			Amount					
				F/C	L/C	Total	F/C	L/C	Total			
Farm Road Work		LS	1									
Preparatory Work	Type A	km	0.60	3,125	1,687	4,812	1,875	1,012	2,887	87	2,887	
Branch Farm Road(N)	Type B	"	0.20	8,975	4,838	13,813	1,795	968	2,763		2,763	
"	Type C	"	0.70	5,797	3,126	8,923	4,058	2,188	6,246		6,246	
Branch Farm Road(R)	Type A	"	0.60	2,742	1,602	4,344	1,645	961	2,606		2,606	
"	Type B	"	0.20	2,742	1,602	4,344	548	320	869		869	
"	Type C	"	0.70	2,653	1,554	4,207	1,857	1,088	2,945		2,945	
Crossing Drain	Branch	Unit	30	64	54	117	1,906	1,606	3,512		3,512	
Bridge Work	Submerge	"	1	948	510	1,458	948	510	1,458		1,458	
Drainage Canal		m	800	2.2	1.2	3.4	1,760	960	2,720		2,720	
Miscellaneous		LS	1				157	90	247		247	
Total							16,550	9,790	26,340		26,340	
計							16,550	9,790	26,340		26,340	

Col. \$1,000

Table K.3.6 Construction Cost (Pijao Area)

Col. \$1, 000

Item	Spec.	Unit	Q'ty	Unit Price		Amount		Total
				F/C	L/C	F/C	L/C	
Farm Road Work		LS	1					932
Preparatory Work	Type A	km	1.60	3,980	2,148	6,128	6,368	9,805
Main Farm Road(N)	Type B	"	0.40	10,743	5,791	16,534	4,297	6,614
"	Type C	"	1.90	7,456	4,020	11,476	14,166	21,804
Main Farm Road(R)	Type A	"	0.80	3,568	2,047	5,615	2,854	4,492
"	Type B	"	0.20	3,568	2,047	5,615	714	1,123
"	Type C	"	1.20	3,480	1,999	5,479	4,176	6,575
Branch Farm Road(N)	Type A	"	8.00	3,125	1,687	4,812	25,000	38,496
"	Type B	"	2.00	8,975	4,838	13,813	17,950	27,626
"	Type C	"	9.90	5,797	3,126	8,923	57,390	88,338
Branch Farm Road(R)	Type A	"	1.00	2,742	1,602	4,344	2,742	4,344
"	Type B	"	0.30	2,742	1,602	4,344	823	1,303
"	Type C	"	1.20	2,653	1,554	4,207	3,184	5,048
Cross Drain	Main R.	Unit	61	68	61	130	4,168	7,900
"	Branch R.	"	224	64	54	117	14,234	26,224
Bridge Work	C.Pipe	"	2	273	222	495	546	990
"	Culvert	"	1	2,165	1,166	3,331	2,165	3,331
Miscellaneous		LS	1				1,613	2,535
Sub total							162,390	257,480
Total							95,090	257,480

Table K.3.7 Construction Cost (Genova Area)

Item	Spec.	Unit	Qty	Unit Price			Amount			Total
				F/C	L/C	Total	F/C	L/C	Total	
Farm Road Work		LS	1							862
Preparatory Work	Type A	km	0.70	3,980	2,148	6,128	2,786	1,504	4,290	4,290
Main Farm Road(N)	Type B	"	0.20	10,743	5,791	16,534	2,149	1,158	3,307	3,307
"	Type C	"	0.90	7,456	4,020	11,476	6,710	3,618	10,328	10,328
Main Farm Road(R)	Type A	"	0.90	3,568	2,047	5,615	3,211	1,842	5,054	5,054
"	Type B	"	0.20	3,568	2,047	5,615	714	409	1,123	1,123
"	Type C	"	2.20	3,480	1,999	5,479	7,656	4,398	12,054	12,054
Branch Farm Road(r)	Type A	"	6.90	3,125	1,687	4,812	21,563	11,640	33,203	33,203
"	Type B	"	1.70	8,975	4,838	13,813	15,258	8,225	23,482	23,482
"	Type C	"	8.70	5,797	3,126	8,923	50,434	27,196	77,630	77,630
Branch Farm Road(N)	Type A	"	2.30	2,742	1,602	4,344	6,307	3,685	9,991	9,991
"	Type B	"	0.60	2,742	1,602	4,344	1,645	961	2,606	2,606
"	Type C	"	2.90	2,653	1,554	4,207	7,694	4,507	12,200	12,200
Cross Drain	Main R.	Unit	41	68	61	130	2,801	2,508	5,310	5,310
"	Branch R.	"	231	64	54	117	14,679	12,365	27,043	27,043
Bridge Work	C.Pipe	"	4	273	222	495	1,092	888	1,980	1,980
"	Culvert	"	1	2,481	1,336	3,817	2,481	1,336	3,817	3,817
Miscellaneous		LS	1				1,462	868	2,330	2,330
Total							148,640	87,970	236,610	236,610

Col. \$1,000

Table K.3.8(1) Construction Cost of Coffee Waste Water Treatment Facilities
Col. \$1,000

Description	Unit	Qty	Unit Price		Total	Amount		Total	Remark
			F/C	L/C		F/C	L/C		
Type A (50 ha)	Unit	4	29,040	18,270	47,310	116,160	73,080	189,240	
Type B (20 ha)	Unit	13	12,250	6,260	18,510	159,250	81,380	240,630	
Type C (10 ha)	Unit	8	5,850	4,750	10,600	46,800	38,000	84,800	
Type D (5 ha)	Unit	27	3,210	2,210	5,420	86,670	59,670	146,340	
Total		52				408,880	252,130	661,010	

Table K.3.8(2)

Construction Cost of Coffee Waste Water Treatment Plant
(for 5ha and 10ha)

Item	Spec.	Unit	Q'ty	5 ha			10 ha			Total	Remarks
				F/C	L/C	Total	F/C	L/C	Total		
1) Civil Works											
Preparatory Works		LS	1		6	6			135		135
Neutralization Tank		Unit	1	420	225	645		850	458		1,308
Anaerobic Tank		"	1	432	232	664		865	465		1,330
Aerobic Tank		"	1	143	77	220		288	155		443
Stabilization Pond		"	1	122	66	188		245	135		380
Sludge Drying Bed		"	1	143	77	220		288	155		443
Miscellaneous		LS	1	10	7	17		254	357		611
Sub Total				1,270	690	1,960		2,790	1,860		4,650
2) Equipment Works											
Water-level Meter		Unit	1	136	74	210		136	74		210
Air Pump		Unit	1								
Volmetric Pump		Unit	1	130	70	200		130	70		200
Lime Stone		LS	1	60	240	300		60	240		300
Contact Filter		LS	1	17	157	174		35	315		350
Wiring Supply		Unit	1	114	61	175		114	61		175
Valves		LS	1	114	61	175		114	61		175
Sand Pump		Unit	1	72	40	112		72	40		112
Installation Works	D40mm	LS	1	192	210	402		198	258		456
Sub Total				835	913	1,748		859	1,119		1,978
3) Electric/instrument Work											
Flow Meter		Unit	1					34	18		52
PH Meter		Unit	1								
Distribution Box		Unit	1	35	140	175		35	140		175
COD Meter		Unit	1								
Installation Works		LS	1	10	42	52		20	47		67
Sub Total				45	182	227		89	205		294
Miscellaneous Work		LS	1	322	267	589		560	477		1,037
Sub Total				322	267	589		560	477		1,037
5) Over Head				738	607	1,345		1,282	1,089		2,371
TOTAL				3,210	2,210	5,420		5,580	4,750		10,330

Col. \$1,000

Table K.3.8(3)

Construction Cost of Coffee Waste Water Treatment Plant
(for 20ha and 50h)

Col. \$1,000

Item	Spec.	Unit	Q'ty	20 ha		50 ha		Remarks
				F/C	L/C	F/C	L/C	
1) civil Work								
Preparatory Work	1%	LS	1		27		135	
Neutralization Tank		Unit	1	1699	915	2614	2289	6,540
Anaerobic tank		Unit	1	1,706	918	2624	4,320	6,640
Aerobic Tank		Unit	1	575	310	885	1,440	2,210
Stabilization Pond		Unit	1	466	250	716	250	715
Sludge Drying Bed		Unit	1	575	310	885	1,140	1,750
Miscellaneous	1%	LS	1	50	27	77	63	179
Sub Total				5,071	2,757	7,828	11,733	18,170
2) Equipment Work								
Water Level Meter		Unit	1	340	183	523	560	860
Air Pump		Unit	1				340	180
Volmetric Pump		Unit	1	200	110	310	270	140
Lime Stone		LS	1	60	240	300	60	240
Contact Filter		LS	1	70	630	700	180	1,580
Wiring Supply		Unit	1	114	61	175	114	61
Valves		LS	1	220	120	340	230	120
Sand Pump	D40mm	Unit	1	72	40	112	72	40
Installation Works	30%	LS	1	322	415	737	547	798
Sub Total				1,398	1,799	3,197	2,373	3,459
3) Electric/Instrument Work								
flow Meter		Unit	1	34	18	52	70	40
p H Meter		Unit	1	1,260	140	1,400	1,260	140
Distribution Box		Unit	1	35	140	175	35	140
COD Meter		Unit	1					
Installation Work	30%	LS	1	398	89	487	2,730	4,200
Sub Total				1,727	387	2,114	1,228	1,765
4) Miscellaneous Work	15%	LS	1	1,229	741	1,970	5,323	7,650
Sub Total				1,229	741	1,970	2,914	4,747
5) Overhead	30%			2,825	1,704	4,529	2,914	4,747
Total				12,250	6,260	18,510	29,040	47,310

Table K.3.9 Construction Cost of Storage Center and Child Plant

(Unit: Col. \$1,000)

Description	Area						Total	Remarks
	Storage Center	Circesia	Salento	Pilajo	Genova	Total		
1. Storage Center								
	F/C	300	150	150	150	150	750	
	L/C	700	350	350	350	350	1,750	
	Total	1,000	500	500	500	500	2,500	
2) Vehicle	F/C	2,000	2,000	2,000	2,000	2,000	8,000	
	L/C	0	0	0	0	0	0	
	Total	2,000	2,000	2,000	2,000	2,000	8,000	
3) Furniture & Equipment	F/C	300	210	210	210	210	830	
	L/C	700	490	490	490	490	2,170	
	Total	1,000	700	700	700	700	3,100	
Sub-Total	F/C	2,600	2,360	2,360	2,360	2,360	9,680	
	L/C	1,400	840	840	840	840	3,920	
	Total	4,000	3,200	3,200	3,200	3,200	13,600	
2. Child Center								
1) Child Center	F/C							
	L/C							
	Total							
Sub-Total	F/C	8,710	4,355	4,355	4,355	4,355	21,770	
	L/C	4,690	2,345	2,345	2,345	2,345	11,720	
	Total	13,400	6,700	6,700	6,700	6,700	33,490	
Total	F/C	11,310	6,715	6,715	6,715	6,715	31,450	
	L/C	6,090	3,185	3,185	3,185	3,185	15,540	
	Total	17,400	9,900	9,900	9,900	9,900	47,090	

Table K.3.10 O/M Equipment Cost

(Unit : Col. \$1,000)

Description	Spec.	Unit	Q'ty	Unit Price		Amount		Remarks
				F/C	L/C	F/C	L/C	
1. Grader	Grade 2.2m	Unit	1	51,510		51,510	51,510	51,510
2. Back Hoe	0.6m ³	Unit	1	125,300		125,300	125,300	125,300
3. Dump Truck	10 ton	Unit	1	67,370		67,370	67,370	67,370
4. 4-Wheel Drive vehicle	2,300cc	Unit	2	14,000		14,000	28,000	28,000
5. Trailer	20 T	Unit	1	105,000		105,000	105,000	105,000
Total						377,180	377,180	377,180

Table K.3.11 Administration Cost

(Unit: Col. \$1., 000)

Description	Unit	Q'ty	F/C		Unit Price		Total		F/C		Amount		Remarks
			F/C		L/C		Total		F/C	L/C	Total		
1. Office	Month	48			0	0	0	0			0	0	
2. Office Equipment	L.S	1			2,000	2,000	2,000	2,000			2,000	2,000	
3. Salaries													
Civil Engineer	M/M	48			250	250	250	250			12,000	12,000	
Asst. Civil Engineer	M/M	48			200	200	200	200			9,600	9,600	
Secretary	M/M	48			70	70	70	70			3,360	3,360	
Driver	M/M	48			80	80	80	80			3,840	3,840	
4. General Expence	Month	48			100	100	100	100			4,800	4,800	
5. 0/M cost of Vehicle	Month	48			250	250	250	250			12,000	12,000	
Total											47,600	47,600	

Table K.3.12 O/M Cost

(Unit: Col. \$1,000)

Description	Unit	Q'ty	Unit Price		Amount		Remarks
			F/C	L/C	F/C	L/C	
1. Agro-industry Facilities							
Director	Month	48				5,760	5,760
Marketing Specialist	Month	48				3,840	3,840
Secretary	Month	48				2,400	2,400
Assistants	Month	60				4,320	4,320
Fuel & Consumables	Month	12				2,100	2,100
Sub-Total						18,420	18,420
2. Research Center							
Director	Month	12		200	200	2,400	2,400
Engineer	Month	36		180	180	6,480	6,480
Secretary	Month	12		50	50	600	600
Assistants	Month	108		80	80	8,640	8,640
Driver	Month	36		60	60	2,160	2,160
Labor	Month	120		40	40	4,800	4,800
Fuel & Consumables	Month	12			25,000	25,080	25,080
Sub-Total						50,160	50,160
3. O/M Equipment							
	Month	12				20,000	20,000
Sub-Total						20,000	20,000
Total						88,580	88,580

ANNEX L : PROJECT EVALUATION

Table of Contents

L.1	Principles for Evaluation	L-1
L.2	Economic Evaluation	L-3
L.2.1	Project Benefit	L-3
L.2.2	Project Cost	L-3
L.2.3	Economic Feasibility of the Project	L-4
L.2.4	Sensitivity Analysis	L-5
L.3	Financing Plan	L-6
L.3.1	Disbursement Schedule	L-6
L.3.2	Amortization Schedule of Foreign Loan	L-7
L.4	Financial Analysis of Model Farmers	L-44

List of Table

Table L.1.1	Estimation of Export Parity Price	L-8
Table L.1.2	Estimation of Import Parity Price	L-11
Table L.1.3	Economic Price and Cost for Crops and Cattle(1) - (9)	L-13
Table L.2.1	Comparison of Benefits "WITH" and "WITHOUT" Project	L-22
Table L.2.2	Agricultural Benefits "WITH" Project	L-23
Table L.2.3	Agricultural Benefits "WITHOUT" Project ...	L-25
Table L.2.4	Benefits with Road Construction	L-27
Table L.2.5	Economic Internal Rate of Return (Total Project Area)	L-28
Table L.2.6	Estimation of NPV and B/C	L-29
Table L.2.7	Economic Internal Rate of Return (1) - (7)	L-30
Table L.2.8	Sensitivity Analysis (1) - (6)	L-37
Table L.3.1	Disbursement Schedule (1)-(3)	L-59
Table L.3.2	Amortization Schedule of Foreign Loan	L-43

ANNEX L : PROJECT EVALUATION

L.1 PRINCIPLES FOR EVALUATION

The Feasibility Study for the Quindio Basin Integrated Agricultural Development Project consists of two major components: the agricultural development and coffee wastes treatment. The former shall be evaluated its feasibility for implementation by means of an economic analysis (Cost-benefit analysis), while the latter shall be justified by taking account of its efficiency and social aspects, because the benefits expected by treatment of coffee wastes (improvement of water quality) are intangibles.

The economic analysis of the present study has been conducted by identifying and valuing the costs and benefits that will arise "with" the proposed project and to compare them with the situation as it would be "without" the project. Thus values costs and benefits have been adjusted to economic ones and then these internal rate of return (IRR), net present value (NPV), and costs-benefits ratio (B/C) have been calculated as means for evaluating the feasibility of the proposed project. In addition, in view of testing what happens to the value of IRR and other factors if events differ from guesses to have been made to them in this time of the feasibility study, a sensitivity analysis has been carried out. Furthermore discussions shall be made relative to secondary and social effects of the project implementation such as the synergy to adjacent areas and creation of more job opportunities as well as an ecological impact on the faunas and floras.

The economic analysis followed general procedure employed by HIMAT, DNP and other concerned agencies; in particular, shadow prices were estimated referring to the document-"Estimacion de precios de cuenta para Colombia" prepared by DNP in collaboration with IDB (Inter-American Development Bank) in February 1990, and in accordance with

the following assumptions.

1. The costs and benefits for the project shall be calculated for 50 years starting from the inauguration of the project. Works and equipment to be expired their durable period shall be replaced in the period and expenses accrued to it shall be included in the costs of the project.

2. The exchange rate between the US\$ and Colombian peso (Col\$) shall be US\$ 1 = Col\$ 527.73, which is an averaged rate for the month of September 1990, and the shadow exchange rate shall be US\$ 1 = Col\$ 527.73 x 1.18.

3. Prices of agro-products shall base on their farm-gates prevailed for the latter semester in 1990; parity prices are applied to the following traded commodities (Refer to Table L.1.1 & L.1.2)

Export products: coffee, passion fruit, beef

Import products: soybean, sorghum

4. Construction costs of facilities shall be estimated based on their market prices in September 1990, while production costs of products shall be obtained with reference made to "BASES TECNOLOGICAS COSTOS E INGRESOS DE ACTIVIDADES AGROPECUARIAS DE DIVERSIFICACION 1990" (Fedecafe), documentation of Caja Agraria, and information collected by the Study Team through the field survey. Of costs relevant to facilities and agro-products, shadow factors shall be applied to the following costs.

Wage rate of non-skilled laborers: current wage rate x 0.7

Chemicals: it is assumed that 40% of the total cost is represented by imported materials and this portion shall be calculated applying shadow exchange rate.

Equipment: it is assumed that 80% of the total cost is represented by imported materials and this portion shall be calculated applying shadow exchange rate.

The farm-gate price and production cost thus adjusted to the economic price are as per Table L.1.3.

L.2 ECONOMIC EVALUATION

L.2.1 Project Benefits

The agricultural development project envisages an establishment of new agricultural research center and an installation of irrigation system. The development of these facilities is expected to contribute to an increase in agricultural output due to expansion of cultivated area and attainment of higher unit yield. At the same time, new irrigation system will permit crop cultivation even in the dry season that will benefit farmers to practice more stable crop farming.

The total incremental benefits of agricultural production shall be Col\$ 117,105 million, which is as much as 1.89 time in comparison with "without" project situation (Col\$ 61,823 million) (Refer to Table L.2.1. And the benefits respective crops both for "With" and "Without" project situation are as listed in Table L.2.2 & L.2.3). The development of road network, on the other hand, will facilitate better marketing of commodities to be produced in the project area and contribute to cost-saving in transporting them accordingly. Benefits accrued to road development are estimated to be Col\$ 2,387 million. In sum, the total incremental benefits shall reach Col\$ 57,669 million.

L.2.2 Project costs

Of components forming the project costs, construction and O/M costs of works, general administrative expenses, consulting service fees and physical contingency. Marketing prices of these components were calculated at first and they were adjusted to economic prices taking account of conversion factors. The total project costs converted to economic prices are Col\$ 11,450 million.

L.2.3 Economic Feasibility of the Project

(1) Net return to the project in general

On the basis of costs and benefits estimated above, values of IRR, NPV and B/C are obtained in the following manner (See Table L.2.5 & L.2.6 for further information).

IRR : 14.5 %

NPV : Col\$ 1,121,074 thousand (Discount rate of 12%)

B/C : 1.15 (Discount rate of 12%)

The IRR value is superior to the common rate of the opportunity cost in Colombia (12%), and figures expressed in NPV and B/C show an economic soundness of the project. It is thus justified that the project is feasible from economic viewpoint.

(2) Net returns to respective area of the project

The IRR is also calculated in connection with respective area of the project, and the result of which is presented below and Table L.2.7.

IRR BY AREA

<u>GROUP</u>	<u>AREA</u>	<u>IRR (%)</u>
1	Circasia	28.4
2	Quindio River Right Margin	10.7
	Quindio River Left Margin (2)	20.4
3	Quindio River Left Margin (1)	10.5
4	Salento	23.3
	Pijao	21.2
	Genova	17.9

The above calculation has disclosed that more economic return is expected to areas corresponding to Group 1 and Group 4 in which agricultural development projects and programs are under-developed at present. On the other hand, an implementation of the project will bring less return to the areas belonging to Group 2 and Group 3 that are considerably developed up to date. This intimates that it is advisable that priority in order of project implementation should be given to groups 1 and 4.

L.2.4 Sensitivity analysis

Sensitivity analysis has been conducted relative to changes of three components consisting costs and benefits: construction cost, farm-gate price or yield, and delay in generation of benefits. The result of the sensitivity analysis is as given in the table below and in the Table L.2.8.