CHAPTER 5

IDENTIFICATION, EVALUATION AND IMPACTS PRIORITIZATION

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CHAPTER 5

IDENTIFICATION, EVALUATION AND IMPACTS PRIORITIZATION

For the identification, evaluation and environmental impacts prioritization, the MEL-ENEL methodology was applied, with the result that, through the participation of a multi and interdisciplinary team, cause-effect matrices are generated that allow predicting with great accuracy, the impact that the development of the works might cause on the environment components.

The employed methodology was developed in Costa Rica by the engineer Manuel Enrique López during the 1993-1997 period. The name MEL-ENEL is derived from the author initials (MEL) and from its application on the Empresa Nicaragüense de Electricidad (ENEL). Its application leads to the identification, evaluation, and prioritization of the negative environmental impacts.

As part of the methodology, and to establish an agreement among the team members that participated in the evaluation, a technical terms glossary related to the project and the environment was developed.

Following are developed each of the six phases of the assessment process.

5.1 Work Breakdown Structure

This consists in knowing and analyzing the information related to the construction aspects of project components, to then identify and determine the magnitude of the different works to perform. During the evaluation process, the environmental impact analysis that is related to its development will be performed. The main works to be performed were described on Chapter 3, and they are listed below:

a) Construction Phase

- Expansion, improvement and construction of access roads to the project site
- Construction of temporary installations
- Tunnel excavation for river diversion
- Cofferdam construction
- Foundation Excavation
- Dam construction: spillway, dike, intake work and penstock installation
- Powerhouse construction
- Substation construction
- Relocation of the population located in the future reservoir area
- Exploitation of the vegetation in the reservoir area
- Reservoir filling
- Revegetation of affected areas
- Performance tests
- Dismantling and temporary installations demobilization

b) Operation Phase

- Maintenance of Installations and equipment
- Areas revegetation and vegetation maintenance
- Access road maintenance
- Camp and offices maintenance
- Reservoir operation

- Electricity generation
- Spillway discharges

5.2 Environmental Factors Breakdown

This consists in identifying the environmental components that could be affected by the development of the different project activities, distinguishing the physical, biological and socioeconomic factors described on Chapter 4, and that, in general, are related to the following elements:

- Soil
- Superficial and underground water
- Weather and air
- Vegetation
- Terrestrial and aquatic fauna
- Population
- Local and national economy
- Health
- Historical and cultural heritage
- Landscape

5.3 Project Environment Interaction

The effect of developing a specific activity on an environmental component was determined during this phase, by generating a cause-effect interaction matrix, on which, the main project activities were placed on the columns and the vulnerable environmental factors were placed on the rows.

The process consists in assigning a correlative number each time a project activity is related or causes an impact to a specific environmental element, whether the impact is positive or negative, creating a matrix where a total of 15 activities are interconnected, as shown on Table 5.1.

Table 5.1 Project Activities and Environmental Factor Interaction Matrix

Environmental Factors	Construction Phase									Operation Phase					
	Improvement and expansion of access roads	Temporary and permanent construction	Tunnel excavation	Cofferdam construction	Dam and dike construction	Powerplant construction	Substation construction	Camp revegetation	Reservoir Filling	Equipment maintenance	Vegetation maintenance	Road maintenance	Camp and offices maintenance	Electricity generation	Spillway discharges
Physical															
Soil	1	9	19		27	39	46	52	57	66	67	75	77		
Superficial water (Torola river)															
Quantity					28				58		68				
Quality	2	10	20	24	29	40	47								
Underground water															
Quantity	3	11			30						69		78		
Quality									59						
Weather		12			31						70				
Air	4	13	21		32	41	48	53			71				
Biological															
Vegetation	5	14			33	42	49	54	60						
Fauna															
Terrestrial	6	15			34	43	50		61		72				
Aquatic				25	35				62						
Socioeconomic															
Health	7	16	22		36	44									82
Population									63						83
Local economy	8	17	23	26	37	45	51	55	64		73	76	79	80	84
National economy														81	
Landscape		18			38			56	65		74				

- Negative impacts 52
- Positive impacts 32

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Using the information contained in Table 5.1, and based on an integral analysis of the impact that each activity will cause on the environmental components, Table 5.2 was developed. This table briefly describes and identifies the impacts, determining a total of 84 impacts, of which 32 are positive and 52 negative.

Table 5.2 Impacts Brief Description

No.	Key Name	Sign + / -	Effect	Impact Description
1	Road - Soil	-	Direct (D)	Excavation of 21,600 m^3 of earth for the improvement of 6 km and expansion 5 km of access roads
2	Road – river superficial water	-	Indirect (I)	Pollution caused by the washout of erosion soil
3	Road – underground water	-	I	Contamination risks caused by fuel, oil and machine lubricants spills.
4	Road – air	-	D	Soil particles generation (dust).
5	Road – vegetation	-	D	Elimination of 14,400 m^2 of vegetation cover.
6	Road – terrestrial fauna	-	I	Habitat disturbance and hunting
7	Road– health	-	I	Workers health risk due to dust inhaling.
8	Road– local economy	+	D	Jobs generated for local and national inhabitants.
9	Temporary constructions – soil	-	D	Change in use of soil for 57,500 m^2. Terrace.
10	Temporary constructions – superficial river water	-	I	Superficial water pollution by soil particles due to superficial dragging.
11	Temporary constructions – underground water	-	I	Contamination risks caused by fuel, oil and machine lubricants spills. Contamination risks by sewage water.
12	Temporary constructions – weather	-	I	Alteration at a microclimatic level due to vegetation coverage loss and infrastructure construction.
13	Temporary constructions – air	-	D	Suspended particles generation.
14	Temporary construction – vegetation	-	D	Vegetation clearing for area preparation.
15	Temporary constructions – Fauna	-	D	Natural habitat disturbance and hunting.
16	Temporary constructions – health		I	Workers health risk due to dust inhaling.
17	Temporary constructions – local economy	+	D	Jobs generation for local and national inhabitants.
18	Temporary constructions – landscape	-	D	Natural quality esthetics alteration by the introduction of infrastructure works.
19	Tunnel – soil	-	D	Soil extraction (rock), in a 335 m length, by 8 m of diameter.
20	Tunnel – river water	-	I	Accumulation and dragging risk on the river bed
21	Tunnel – air	-	D	Noise and dust generation by use of drilling machinery and explosives .
22	Tunnel – health	-	I	Accident risks, particles inhaling, remaining in an underground environment.
23	Tunnel –local economy	+	D	Jobs generated for local and national inhabitants.
24	Cofferdam – river superficial water	-	D	Temporary river diversion (only during the construction of the dam).
25	Cofferdam – aquatic fauna	-	D	Aquatic habitat alteration on the affected section of the river.

No.	Key Name	Sign + / -	Effect	Impact Description
26	Cofferdam –local economy	+	D	Jobs generated for local and national inhabitants.
27	Dam – soil	-	D	With the construction of the dam (dike and spillway), earth will be removed for the foundation and construction.
28	Dam – river water quantity	-	D	Temporary flow diversion, causing an increase on the water velocity and its erosive capacity.
29	Dam – river water quality	-	D	Solid waste spillage in the river.
30	Dam – underground water quantity	+	I	There will be underground water recharging.
31	Dam – weather	-	I	Alteration at a microclimatic level due to vegetation covers loss and infrastructure construction.
32	Dam – air	-	D	Dust generation due to excavations. Atmospheric emissions due to operating machinery, noise.
33	Dam – vegetation	-	D	Vegetation cover removal for dike construction.
34	Dam – terrestrial fauna	-	D	Terrestrial habitat alteration and possibility of damaging and/or capturing organisms.
35	Dam – aquatic fauna	-	D	Aquatic habitat alteration. Traffic interruption at the riverbed.
36	Dam– health	-	I	Health risks due to noise, particles and/or toxic substances inhaling, work accidents risks.
37	Dam –local economy	+	D	Goods and services demand, job, food, materials, and basic need articles.
38	Dam– landscape	-	D	Permanent alteration of the natural landscape.
39	Powerhouse - soil	-	D	Soil and rock extraction for the construction.
40	Powerhouse – water river quality	-	I	Excavation materials spillage at the river.
41	Powerhouse – air	-	I	Dust generation during construction.
42	Powerhouse –vegetation	-	D	Vegetation cover removal on the river shore.
43	Powerhouse – terrestrial fauna	-	I	Habitat alteration and damage risks to fauna.
44	Powerhouse – health	-	I	Accidents risks.
45	Powerhouse–local economy	+	D	Jobs generated. Goods and services demand.
46	Substation – soil	-	D	Soil removal and rock extraction for the construction.
47	Substation – river quality	-	I	Materials spillage risk on the riverbed.
48	Substation – air	-	D	Dust generation.
49	Substation – vegetation	-	D	Vegetation coverage removal on the river shore.
50	Substation – fauna	-	I	Habitat alteration and damage risks for fauna.
51	Substation –local economy	+	D	Jobs generated. Goods and services demand.
52	Revegetation - Soil	+	D	Soil protection against erosion.
53	Revegetation – air	+	D	Air quality improvement, oxygen production and carbon dioxide capture.
54	Revegetation – vegetation	+	D	Vegetation cover increase.

No.	Key Name	Sign + / -	Effect	Impact Description
55	Revegetation –local economy	+	D	Jobs generated and agricultural supplies demand increase.
56	Revegetation – landscape	+	D	Improves the aesthetic quality of the area by establishing live barriers that hide part of the structures.
57	Reservoir – soil	-	D	Permanent change of the current land use due to the flooding of 8.6 km^2, including sites of relative cultural importance.
58	Reservoir – river quantity	+	D	Water storage in a dry area, river flows regulation and a guarantee of the ecological flow during the dry season.
59	Reservoir – underground water	+	I	Underground water recharge on the environment.
60	Reservoir – vegetation	-	D	Permanent loss of the vegetation cover on the area to flood.
61	Reservoir – terrestrial fauna	-	D	Permanent loss of the wild life habitat.
62	Reservoir – aquatic fauna	+	D	The area for establishment of aquatic species is increased.
63	Reservoir – Population	-	D	Relocation of 79 families, 2 churches, 1 school. Loss of hot springs in the nearby areas of Carolina and interruption of the passages between the north and south river banks, of importance to the population.
64	Reservoir –Local economy	+	I	The possibility of tourist fishing development.
65	Reservoir – Landscape	+	D	Increase in the natural beauty due to the presence of a body of water at a relatively dry area.
66	Equipment maintenance – Soils	-	I	Contamination risk due to inadequate disposal of solid waste and/or oil and lubricant spillage.
67	Vegetation maintenance– Soils	+	D	Soil preservation due to the adequate maintenance of the vegetation cover.
68	Vegetation maintenance – river quality	+	I	With the conservation of the natural vegetation cover, the contamination of the river water from suspended particles of the eroded soil is avoided.
69	Vegetation maintenance – underground water	+	I	The infiltration of rainwater is encouraged, with the recharge of the water bearings.
70	Vegetation maintenance – weather	+	I	The environmental quality is improved on a microclimatic level.
71	Vegetation maintenance – Air	+	I	Air quality improvement due to the oxygen production and carbon dioxide capture.
72	Vegetation maintenance – Terrestrial fauna	+	I	With the conservation of the vegetation cover an adequate habitat for the establishment and development of wild life is created.
73	Vegetation maintenance – local economy	+	D	Local jobs generated.
74	Vegetation maintenance – Landscape	+	D	Scenic quality improvement. The infrastructure Works are hidden from potential observers.

No.	Key Name	Sign + / -	Effect	Impact Description
75	Vegetation maintenance – Soil	+	D	Avoids soil erosion due to the effects of rain and superficial dragging.
76	Road maintenance – local economy	+	I	Easy accesses for local inhabitants to sites located near the Project, fuel, and time saving due to good roads. Jobs generated.
77	Camp and office – soil	-	I	Risk of solid and liquid waste spillage directly over the soil.
78	Camp and office – underground water.	+	I	The use of septic tanks and absorption wells reduces the possibility of contaminated underground waters.
79	Camp and office –local economy.	+	D	Permanent jobs generated for local inhabitants and goods and services demand.
80	Energy generation –local economy	+	D	Permanent jobs generated for local and national personnel.
81	Energy generation – national economy	+	D	Greater national development possibilities due to the increase in the supply of electric energy.
82	Spillway discharge – health (human lives)	-	D	Discharging instantaneous flows greater than 100 m^3/s downstream into the river could cause injuries to people.
83	Spillway discharge – houses	-	D	Discharging instantaneous flows greater than 100 m^3/s at the river could cause damages to future infrastructure that could be established.
84	Spillway discharge –local economy	-	D	Discharging instantaneous flows greater than 100 m^3/s at the river could cause damages to personal possessions, domestic animals (cattle, pigs, equine and poultry)

Direct : 54
Indirect : 30

5.4 Generic Impacts Classification

Once the impacts were identified, those that turned out to be common to certain environmental factors were group together and ordered, distinguishing the negative and positive impacts, as shown in Table 5.3.

Table 5.3 Impact Classifications

Generic Name	Sign	Identified Impact	General Description
Soil	-	1, 9, 19,27, 39, 46, 57, 66, 77	Earth will be removed for the leveling, foundation, and construction of civil Works: offices and camp, dam, powerhouse, tunnel, cofferdam, substation and access roads. On the borrow area. The greatest impact to soil comes from the permanent change on the current land use due to the flooding of 8.6 km^2.
	+	52,67,75	To mitigate the impact over the soil, activities within the project such as: office and camp area revegetation, roads and drainage maintenance, will be performed; which protects the soil against the effects of erosion. For the expansion and creation of new roads, the construction of energy dissipaters and slopes stabilization are being considered.
Superficial and under ground water	-	2, 3, 10, 11, 20, 24, 28, 29, 40, 47	During the development of the Project there is a risk of water contamination due to the spillage of fuel oil and machine lubricants. There is also the risk of excavation materials spillage in the water.
	+	30, 59, 69, 78	The project includes the construction of temporary latrines, septic tanks with absorption wells and the installation of a sewage treatment plant to avoid the contamination of underground water. The formation of a reservoir with a storage capacity of 189 millions of m^3 will allow the regulation of river flows downstream from the dam, avoiding negative impacts in the rainy season. This consideration does not apply to extraordinary events with reservoir inflows greater than 6,484 m^3/s, because higher volumes than these exceed the reservoir storage capacity. The reservoir filling will be a recharging source of the ground water. Besides, downstream from the dam there will be a permanent 2 m^3/s flow that will allow the preservation of aquatic life and other uses at the river. Without the reservoir, this possibility would be affected during the dry season.
Weather and air	-	4, 12, 13, 21, 31, 32, 41, 48	The construction of the civil works will temporarily generate dust and noise that will affect the air; this works will cause the elimination of vegetation cover, which modifies the environment at a *microclimatic* level.
	+	53,57	The revegetation inside the project and the plantation of 100 hectares in a protection strip around the reservoir perimeter, will have a positive effect on the quality of the air and the microclimate.

Generic Name	Sign	Identified Impact	General Description
Vegetation	-	5, 14, 33, 42, 49, 60	The civil works involve the removal of the vegetation cover; new access roads, offices and camp, substation, powerhouse, dam. The biggest impact is caused by the elimination of the vegetation cover located on the 8.6 km^2 of flooded area.
	+	54	The revegetation on the hydroelectric plant areas will have the positive impact of increasing the vegetation cover in an orderly manner and with an environmental criterion. On the other hand, part of the Project includes the plantation of 100 hectares of a protection strip around the perimeter of the reservoir, which includes the establishment of a nursery in the area for the production of plants.
Terrestrial and aquatic fauna	-		The development of the different works will cause permanent alteration and loss of the terrestrial and aquatic habitat. There could be impacts on the wild life by direct damage or hunting. There will be an interruption on the free passage of the fauna at the river section affected by the dam.
	+	62, 72	The reservoir filling and vegetation cover allows conditions for the establishment and development of wild life species.
Health	-	7, 16, 22, 36, 44, 82	During the construction, there is the risk of work accidents, as well as the injury of the respiratory tract due to dust inhaling. Another negative health factor is the excessive machinery noise. During the operation of the plant, there is a risk of extreme meteorological events that will force discharges at the dam, putting at risk the human lives located downstream from the plant.
Population	-	63, 83	The reservoir formation will lead to the relocation of 79 families, 2 churches and one school. The loss of hot springs near Carolina and the interruption of the passages between the north and south river bank, of importance to the public.
Local and national economy	-	84	There is a risk of crop losses due to required discharges, because of extraordinary meteorological events.
	+	8, 17, 23, 26, 37, 45, 51, 55, 64, 73, 76, 78, 79, 81	The development of the different works in the construction phase, as well as the operation of the plant, involves the generation of jobs for approximately 500 workers on the construction phase and 40 on the operation phase, which also generates a goods and services demand that will strengthen the local and national economy. There will be the procurement of materials and equipment for the installation of the plant. Besides, the national economy will be strengthened due to the increase in the availability the electric energy.
Landscape	-	18, 38	The landscape will be affected by the introduction of infrastructure works on the natural environment.

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Generic Name	Sign	Identified Impact	General Description
	+	56, 65, 74	The reservoir will create nice esthetic and visual conditions, due to the presence of a body of water in a dry area. The planting of vegetation species will help in the integration of the infrastructures with the natural environment, mitigating the visual impact.

5.5 Impacts Evaluation

The impact groups were evaluated applying the MEL-ENEL method, which uses a modification of the Dean & Nishry Weight Scale Method (Ref: Larry W. Canter. Environmental Impact Assessment, McGraw Hill. 1996) where the relative significance is evaluated and not the relative importance. MEL-ENEL uses a similar matrix to the Dean & Nishry matrix, with the difference that it qualifies the relative significance of each impact, evaluating it through a relative number called Relative Significance Coefficient (RSC).

Based on the previous weights each group of impacts is compared with the others. Unlike the Dean & Nishry Method, that only assigns three possible values or Coefficients of Relative Importance (0.0,0.5,1.0), MEL-ENEL assigns values of RSC that go from 0.0 to 1.0.

Later, the negative impacts were evaluated using the Magnitude, Importance, Extension, Duration and Reversibility concepts of the impacts, establishing the categories of Low, for a range from 10 to 30; Medium, from 31 to 70 and High, from 71 to 100 for each concept. With this process the Table 5.4 was generated, which is presented below.

Table 5.4 *Evaluation of Negative Impacts by Generic Groups*

Generic Group	Magnitude	Importance	Extension	Duration	Reversibility
Soil	100	60	100	100	100
Water	80	80	50	20	20
Weather and air	10	20	30	20	20
Vegetation	100	60	100	100	100
Fauna	30	60	40	50	30
Human population	100	60	30	100	100
Health	30	60	30	20	20
Landscape	20	20	30	20	20

5.6 Prioritization of Impacts by Significance

The prioritization of impacts was performed by linking the assigned values to the different environment components, that were shown on Table 5.4, identifying them as A, the soil; B, the vegetation; C, the water, and so on, obtaining a coefficient for each component, and developing Table 5.5 that is presented below:

Definition of cencept

Magnitude: This refers to the scale or intensity of the impact, For example, to evaluate an sound impact, the magnitude will depend on the sound intensity.
Importance: This refers to the qualitative valorization which is established by interdisciplinal consensus. It is discussed with objective reasons and scientific proof of each specialty.

Estension: This is related to the geographical area, affected m^2, km^2. The larger the area, the greater the assigned valorization

Duration: This refers to the time exposed or permanence of the impact.

Reversibility: This refers to the capacity of the environment to return to its original environmental quality, once the generated impact source has passed or has been elimiated.

Table 5.5 Relative Assessment Matrix between the Element Groups of the Environment

	A	B	A	C	A	D	A	E	A	F	A	G	A	H
Magnitude	56.00	44.00	91.0	9.0	50.0	50.0	77.0	23.0	50.0	50.0	77.0	23.0	83.0	17.0
Importance	43.00	57.00	75.0	25.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	75.0	25.0
Extension	67.00	33.00	77.0	23.0	50.0	50.0	71.0	29.0	77.0	23.0	77.0	23.0	77.0	23.0
Duration	83.00	17.00	83.0	17.0	50.0	50.0	67.0	33.0	50.0	50.0	83.0	17.0	83.0	17.0
Reversibility	83.00	17.00	82.0	18.0	50.0	50.0	77.0	23.0	50.0	50.0	83.0	17.0	83.0	17.0
Sum	**332.00**	**168.00**	**408.0**	**92.0**	**250.0**	**250.0**	**342.0**	**158.0**	**277.0**	**223.0**	**370.0**	**130.0**	**401.0**	**99.0**
Coefficient	0.66	0.34	0.82	0.18	0.50	0.50	0.68	0.32	0.55	0.45	0.74	0.26	0.80	0.20
			B	**C**	**B**	**D**	**B**	**E**	**B**	**F**	**B**	**G**	**B**	**H**
Magnitude			89.0	11.0	44.0	56.0	73.0	27.0	44.0	56.0	72.0	28.0	80.0	20.0
Importance			80.0	20.0	57.0	43.0	57.0	43.0	57.0	43.0	57.0	43.0	80.0	20.0
Extension			63.0	37.0	33.0	67.0	56.0	44.0	62.0	38.0	63.0	37.0	63.0	37.0
Duration			50.0	50.0	17.0	83.0	29.0	71.0	17.0	83.0	50.0	50.0	50.0	50.0
Reversibility			50.0	50.0	17.0	83.0	40.0	60.0	17.0	83.0	50.0	50.0	50.0	50.0
Sum			**332.0**	**168.0**	**168.0**	**332.0**	**255.0**	**245.0**	**197.0**	**303.0**	**292.0**	**208.0**	**323.0**	**177.0**
Coefficient			0.66	0.34	0.34	0.66	0.51	0.49	0.39	0.61	0.58	0.42	0.65	0.35
					C	**D**	**C**	**E**	**C**	**F**	**C**	**G**	**C**	**H**
Magnitude					9.0	91.0	25.0	75.0	9.0	91.0	25.0	75.0	33.0	67.0
Importance					25.0	75.0	25.0	75.0	24.0	76.0	25.0	75.0	50.0	50.0
Extension					23.0	77.0	43.0	57.0	50.0	50.0	50.0	50.0	50.0	50.0
Duration					17.0	83.0	29.0	71.0	17.0	83.0	50.0	50.0	50.0	50.0
Reversibility					17.0	83.0	40.0	60.0	17.0	83.0	50.0	50.0	50.0	50.0
Sum					**91.0**	**409.0**	**162.0**	**338.0**	**117.0**	**383.0**	**200.0**	**300.0**	**233.0**	**267.0**
Coefficient					0.18	0.82	0.32	0.68	0.23	0.77	0.40	0.60	0.47	0.53
							D	**E**	**D**	**F**	**D**	**G**	**D**	**H**
Magnitude							77.0	23.0	50.0	50.0	77.0	23.0	83.0	17.0
Importance							50.0	50.0	50.0	50.0	50.0	50.0	75.0	25.0
Extension							71.0	29.0	77.0	23.0	77.0	23.0	77.0	23.0
Duration							67.0	33.0	50.0	50.0	83.0	17.0	83.0	17.0
Reversibility							77.0	23.0	50.0	50.0	83.0	17.0	83.0	17.0
Sum							**342.0**	**158.0**	**277.0**	**223.0**	**370.0**	**130.0**	**401.0**	**99.0**
Coefficient							0.68	0.32	0.55	0.45	0.74	0.26	0.80	0.20
									E	**F**	**E**	**G**	**E**	**H**
Magnitude									23.0	77.0	50.0	50.0	60.0	40.0
Importance									50.0	50.0	50.0	50.0	75.0	25.0
Extension									57.0	43.0	57.0	43.0	57.0	43.0
Duration									33.0	67.0	71.0	29.0	71.0	29.0
Reversibility									23.0	77.0	60.0	40.0	60.0	40.0
Sum									**186.0**	**314.0**	**288.0**	**212.0**	**323.0**	**177.0**
Coefficient									0.37	0.63	0.58	0.42	0.65	0.35
											F	**G**	**F**	**H**
Magnitude											77.0	23.0	83.0	17.0
Importance											50.0	50.0	75.0	25.0
Extension											50.0	50.0	50.0	50.0
Duration											83.0	17.0	83.0	17.0
Reversibility											83.0	17.0	83.0	17.0
Sum											**343.0**	**157.0**	**374.0**	**126.0**
Coefficient											0.69	0.31	0.75	0.25
													G	**H**
Magnitude													60.0	40.0
Importance													75.0	25.0
Extension													50.0	50.0
Duration													50.0	50.0
Reversibility													50.0	50.0
Sum													**285.0**	**215.0**
Coefficient													0.57	0.43

A Soil
B Water
C Weather-air
D Vegetation
E Fauna
F Infrastructure
G Health
H Landscape

The sum of the coefficients found in the Matrix 5.5 led to determining the RSC. The highest RSC is given an importance of 100 % and based on this value, the Relative Importance (RI) index is determined for the rest of the environment elements, as shown in Table 5.6.

Table 5.6 Matrix for Determining Relative Significance Coefficient (RSC) and Relative Importance (RI)

Components	Soil	Water	Weather	Vegetation	Fauna	Population	Health	Land-scape	Sum	RSC	% RI
Soil		0.66	0.82	0.50	0.68	0.55	0.74	0.80	**4.8**	**0.170**	100.00
Water	0.34		0.66	0.34	0.51	0.33	0.58	0.65	3.4	0.122	**71.79**
Weather	0.18	0.34		0.18	0.32	0.23	0.40	0.47	2.1	0.076	**44.63**
Vegetation	*0.50*	*0.66*	*0.82*		*0.68*	*0.55*	0.74	0.80	**4.8**	**0.170**	100.00
Fauna	0.32	0.49	0.68	0.32		0.37	0.58	0.65	3.4	0.122	**71.79**
Population	0.45	0.61	0.77	0.45	0.63		0.69	0.75	4.4	0.156	91.58
Health	0.26	0.42	0.60	0.26	0.42	0.31		0.57	2.8	0.102	59.79
Landscape	0.20	0.35	0.53	0.20	0.35	0.25	0.43		2.3	0.083	**48.63**
									27.940	1.0	

By arranging the RI values in a descending order, the Table 5.7 which is shown below is generated, where it can be seen in a hierarchic fashion the elements of the natural environment that will be affected by the project development.

Table 5.7 Impact Level According to RI

Priority Levels		
Level I	Component	% of RI
91-100 %	Soil	100.00
	Vegetation	100.00
	Population	91.58
Level II	Water	71.49
71-90 %	Fauna	71.49
Level III		
50-70%	Health	59.79
Level IV	Landscape	48.63
< 50%	Weather	44.63

5.7 Analysis of the Main Negative Impacts

An analysis of the assessment results is performed below:

5.7.1 Physical

a) Soil

Due to the magnitude of the works to be constructed it was determined that during the development phase of the project, the negative impacts will be related mainly to the removal of significant volumes of soil mainly caused by the excavations of the plant structures foundation, the construction and improvement of access roads, and the permanent change in land use because of the flooding of 8.6 km^2 form the reservoir.

The extraction of materials for the construction represents an impact on the soil, however, the site where the materials will be extracted from is located within the area to be flooded by the reservoir, in conclusion, and the impact becomes of little significance.

b) Water

During the construction phase there can be impacts on the water due to the spillage of excavation materials that can be transported by superficial dragging of the riverbed, as well as the residual waters from human activities. The contamination can also occur by spillage of fuel, oil and lubricants used for machinery. During the operation phase, impacts can be observed due to inadequate expulsion of solid wastes, sewage and human biological wastes.

c) Weather

On a microclimatic level, changes can occur due to the elimination of the vegetation cover for the development of the different works, because vegetation creates a regulating effect on temperature.

5.7.2 Biological

a) Flora

Just like in the soil, the impact on flora is determined by the loss of space for the existence of vegetation cover in an area of 8.6 km^2, as well as the elimination of the existing vegetation in the area. There will also be impacts due to the removal of trees in the construction areas.

b) Fauna

The entry of workers to the project site and the construction of works represent an impact on this component of the environment, which will be related to the migration of the terrestrial fauna because of the alteration of its habitat, or possible loss by hunting or annihilation of specific species. The flooding of the area to form the reservoir also involves the irreversible loss of terrestrial and aquatic habitat. Even though the terrestrial fauna can migrate to upstream areas above the flood level, it is at risk while it searches for adequate space for its establishment and protection.

5.7.3 Socioeconomic

a) Population

Socioeconomically, the main negative impact is related to the relocation of 79 houses that live in the direct influence area. Through a program of great social content, the families will be relocated or properly compensated. A rural school and two churches will be conveniently relocated.

Another impact of importance for the area population is the disappearance of hot springs due to the formation of the reservoir on the nearby regions of Carolina city, which is traditionally visited by the population due to its healing properties, as well as other sites as the pool located under the suspension bridge in Carolina and La Poza El Lagarto.

b) Health

The development of the different works may lead to the deterioration of the workers health, may it be due to activities that involve some kind of health risk, as well as the presence of work accidents.

5.7.4 Landscape

The main impacts on this component will be related to the introduction of infrastructure works on a natural environment, as well as the modification of the natural river characteristics, that goes from being a fast following river current a to slow following and still body of water .

CHAPTER 6

ENVIRONMENTAL MANAGEMENT PROGRAM

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Chapter 6

ENVIRONMENTAL MANAGEMENT PROGRAM

On this chapter, a series of actions as described, called Environmental Measures, which constitute the Environmental Management Program (EMP). The purpose of the EMP is to determine and prioritize the prevention, mitigation and compensation measurements of the environmental impacts, and also determine the necessary investments for their implementation.

The purpose of these measures is to avoid, reduce and compensate negative impacts identified in on the previous chapter, ensuring the protection and improvement of the natural resources, as well as the quality of life of the population located in the project area.

The design as well as the performance of the measures requires the supervision of a multi and interdisciplinary team, since not only do the environmental aspects have to be considered but also the technical and economical conditions that affect the development of the project.

Generally, the environmental measures are classified according to the period within the development schedule during which they are proposed. The adopted measures during the last stages of design and development are called preventive, and their purpose is to avoid or reduce the incidence of negative impacts during the development of the works. The measures that are performed once the works are concluded are called corrective and their purpose is to annul or compensate the inevitable impacts that appeared with the development of the project, ensuring the recovery of the general environment conditions to a level equal or better than the original.

The preventive measures are the ones with greater importance for the reduction of potential negative impacts, because the magnitude of the impacts will depend upon the criteria that are selected for the development of the works.

Therefore, the prediction of the potential impacts obtained from the knowledge of the actions that might cause significant negative impacts, along with the knowledge of the environmental elements vulnerable to impacts, allow the preparation of integrated designs with the environment and the development of the works with an environmental criterion.

According to the project development general schedule, the works detailed design will take place from December 2004 to May 2006, and the construction period will start on April 2007 and finish on July 2010. The Reference Terms for the construction will be prepared on the detailed design phase, and will include a technical specifications list, where it is specified in detail the obligatory activities of environmental nature that the contractor must perform.

6.1 Environmental Measures Description

Next are presented a group of measures whose application intend to avoid, minimize or compensate the significant negative impacts that the development of the works may cause on the natural environment of the project area.

Table 6.1 Environmental Management Program

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
6.1.1	**Construction Phase**							
Civil Works								
1	Improvement and creation of access roads.	Vegetation cover elimination in an area of 18,000 m² (3 km by 6 m of width).	Revegetation.	Plantation of 1,800 trees of multiple use, native or adapted to the area, with a space of 10 m between them, at a cost of $1.25 each.	On both sides of the mentioned roads.	CEL-Contractor.	$2,250.00	Recover and enrich the vegetation cover with species of greater ecological and commercial importance. Stabilization and protection of the soil.
		Removal of 21,600 m³ of soil.	Reduce the volume of excess material. Avoid the spill of soil in the riverbed.	Most of the material will be used for compensation in cut filling of the roads. The organic material will be separated for revegetation. The rest will be placed in natural depressions on leveled terraces with stabilization slopes.	On the road sections: 6 km to improve, and 5 km new.	CEL-Contractor.	Project activity.	Adequate handling of removed material, avoiding erosion to natural drainages and the Torola river.
		Soil and superficial water contamination risks due to spillage of machinery oil and fuels, and in shops.	Avoid the spillage of oil and fuel in the soil. Construction of water-oil separator.	Demand a certification from the shop that the machinery does not have oil and fuel leaks. Make reparations and oil changes over impermeable soils. The used oil will be delivered to companies for their disposal. Petroleum derivatives will not be spread to the natural drainage.	Mentioned road sections, shop areas and parking lots.	CEL-Contractor.	Project activity.	Protecting the soil and superficial and underground water from oil and lubricants

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Health risks for workers and population due to dust inhaling.	Reduce dust generation.	Irrigation with water trucks, mainly in areas with the population near the road.	On access roads.	CEL-Contractor.	Project activity.	Protect the workers health and the nearby population.
		Contagious diseases risks.	Establishment of a clinic	There will be a medical clinic. Previous to hiring, a medical health certificate will be required.	On access roads.	CEL-Contractor.	Project activity.	Prevent the transmission of diseases in the area.
		Fauna habitat disturbance. Damages by hunting and annihilation.	Avoid damages to the fauna.	The contractor will give precise instructions to the workers so that they do not damage wild life.	On both sides of the mentioned roads.	CEL-Contractor	No Cost	Wild life protection.

Generally, the revegetation activities will be performed at the beginning of the rainy season.

Table 6.1 Continuation EMP

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
2	Temporary camp and offices construction	Vegetation cut down and change in the use of soil for 57,500 m². (Areas of 37,500 and 20,000 m² each).	Compensate the impact on the vegetation.	Planting 4,000 fast growth and multiple use trees, in a space of 4×4 m, at $ 1.25 each.	In the perimeter and the available interior areas.	CEL-Contractor.	$5,000	Restore the vegetation and improve the environment of the work site.
		Soil removal and risk of removed material spillage at the river	Adequate management of the removed soil.	A part of the soil will be used on the filling of the site earthwork. The organic material will be separated to be used in the revegetation. The rest will be deposited on leveled terraces with stabilized slopes.	In temporary camp and offices areas.	CEL-Contractor.	.	Avoid erosion and the water contamination of the Torola river.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Solid waste generation.	Build a sanitary landfill for the whole project	Preparation of a space for the final disposal of solid waste for the construction and operation phases.	In the nearby areas of the temporary camp and offices.	CEL-Contractor.	Project activity.	Adequate final disposal of solid waste. Population health protection.
		Soil contamination with feces. Health risk	Structures installation for final disposal of sewage.	Initially in the areas where groups of 10-20 workers are staying. Later septic tanks will be built or a sewage treatment plant will be installed.	On the different work areas	CEL-Contractor.	Project activity	Avoid the contamination of soil and water. Avoid diseases.
		Risk of damage to fauna.	Avoid hunting or damage to fauna.	It will be forbidden to workers to harm or hunt wild life fauna.	Around the work areas.	CEL-Contractor.	Measure without cost.	Fauna protection.
		Health risk due to dust inhaling.	Elimination of dust from the air.	Water irrigation with tank trucks in earthwork areas. Use of masks.	In camp and office areas.	CEL-Contractor.	Project activity.	Prevent respiratory diseases in the workers.
		Soil contamination risk with oil, fuel or lubricants.	Avoid the spillage of oil or fuel in the soil.	Parking lots and vehicle and machinery maintenance site waterproofing. Used oils and lubricants will be stored in containers and delivered to companies that reuse it.	In camp and office areas.	CEL-Contractor.	Project activity.	Avoid polluting the soil, and superficial and underground waters with petroleum-derived products.
		Natural scenery alteration.	Integrate the structures with the environment	Barriers will be formed with the revegetation that hides a part of the structures and integrate them into the natural environment.	On the perimeter and interior of the areas.	CEL-Contractor.	Included in the re-vegetation.	Minimize the visual impact due to infrastructure works.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
3	Dam construction: dike and spillway	Vegetation cutting on the river shore.	Revegetation.	Reforestation on both sides of the dam with 500 native and multiple use plants, at 4 x 4 m	Sites near dam.	CEL-Contractor.	$ 625	Compensate the clearing of vegetation
		River spillage risk of excavation materials by drilling, and soil and rock extraction for foundations.	Remove extracted material. Use of machinery and technology to retrieve soil.	The rocks from the excavation will be used as concrete aggregates in the works. The excess will be deposited on leveled terraces with stabilizing slopes.	Dam site	CEL-Contractor.	Project activity.	Usage of materials avoiding its spillage in the river.
		Workers health risks.	Reduce the health risks from exposition to dangerous environments and work accidents.	Work with hygiene and occupational safety regulations established by the Ministerio de Trabajo y Previsión Social.	Dam site.	CEL-Contractor.	Project activity.	Maintain the workers in good health. Avoid work accidents.
		Risk of Damage to wild life.	Avoid damages to the fauna. Environmental education.	There will be precise instructions to avoid any type of damage to the environment fauna.	Entire project area.	CEL-Contractor.	Without cost.	Fauna conservation.
		Habitat alteration for macro fauna species.	Encourage the maintenance of the aquatic fauna communities.	Young fish will be grown once the reservoir is filled, to increase the species abundance used as food for the population.	In the reservoir.	CEL in coordination with CENDE-PESCA.	$10,000 in three years.	Increase the macro fauna with the formation of the reservoir.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Normal flow interruption of the river.	Maintain a flow in the riverbed.	The interruption will be temporary, while the dike is constructed. However, the flow of the river will be maintained through a tunnel.	Dam construction site.	CEL-Contractor.	Project activity.	Maintain the aquatic life conditions downstream.
		Normal flow interruption of the river.	Maintain a flow in the riverbed.	The interruption will be temporary, while the dike is constructed. However, the flow of the river will be maintained through a tunnel.	Dam construction site.	CEL-Contractor.	Project activity.	Maintain the aquatic life conditions downstream.
4		Solids accumulation on the riverbed due to the extraction of 20,000 m^3 of rock.	Removal of the extracted material.	The extracted rock will be used as a concrete aggregate in the works.	Dam site	CEL-Contractor.	Project activity.	Materials usage, avoiding its spillage in the river that could alter its morphology downstream from the site.
		Workers health risks. Accident risks.	Reduce the health risks from exposition to closed environments and work accidents.	Work with hygiene and occupational safety regulations established by the Ministerio de Trabajo y Previsión Social. Hire an explosives management specialist.	Tunnel site.	CEL-Contractor.	Project activity.	Maintain the workers in good health conditions. Avoid work accidents.
5	Cofferdam construction	Riverbed diversion.	Maintaining the flow.	The diversion will be temporary, while the dam is being constructed. However, the flow of the river will be kept through a tunnel.	Cofferdam and tunnel construction sites.	CEL-Contractor.	Project activity.	Maintain the conditions for the aquatic life, at the dam site and downstream.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
6	Powerhouse construction.	Vegetation cover removal.	Revegetation. Use of the vegetation cleared..	25 trees will be planted at spaces of 5x5 m. The harvested trees will be used as wood and timber. $1.25 each	At revegetation areas.	CEL-Contractor.	$ 32.00	Recover the cleared vegetation.
		Removal and accumulation of soil in the riverbed. Water contamination risk with excavation materials.	Removal or use of the extracted material.	The material from the excavations will be used as a concrete aggregate.	Powerhouse site	CEL-Contractor.	Project activity.	Protect the Torola river water from solid waste contamination.
		Risk of damage to wild life.	Avoid damages to the fauna.	There will be precise instructions to avoid any type of damage to the fauna.	At the whole project area.	CEL-Contractor.	No cost.	Fauna protection.
		Workers health risks.	Reduce the health risks from exposure to closed environments and work accidents.	Work with hygiene and occupational safety regulations established by the Ministerio de Trabajo y Previsión Social	Powerhouse site.	CEL-Contractor.	Project activity.	Maintain the workers in good health conditions. Avoid work accidents.
		Water contamination risk with sewage waters. Population health risk.	Installation of a sewage treatment plant.	The installations include a sewage treatment plant that meets the discharge regulations.	Powerhouse site.	CEL-Contractor.	Project activity.	Avoid the contamination of river water and protecting the health of the workers and the population.
7	Substation construction.	Vegetation cover removal.	Revegetation and use of the vegetation to be cut.	50 trees will be planted at the area perimeter with spaces of 5x5 m. $1.25 each. The harvested trees will be used as wood and timber	At substation area.	CEL-Contractor.	$ 65.00	Recover the vegetation cover on the proximities of the substation area.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Soil removal and river contamination risk with excavation materials.	Protection works at adequate sites.	Prepare a stockpile site for residual material from the excavations so that they are not spilled in the river.	Substation site.	CEL-Contractor.	Project activity.	Avoid materials spillage in the river.
		Risk of damage to wild life.	Avoid damages to fauna.	There will be precise instructions to avoid any type of damage to the fauna.	Entire project area.	CEL-Contractor.	Without cost	Fauna protection.
		Workers health risks.	Reduce the health risks and work accidents.	Work with hygiene and occupational safety regulations established by the Ministerio de Trabajo y Previsión Social.	Substation site.	CEL-Contractor.	Project activity.	Maintain the workers in good health conditions. Avoid work accidents.
		Accumulation of rock from the excavations.	Use of the rock.	The material from the excavations will be used as a concrete aggregate.	Excavation and dam area.	CEL-Contractor.	Project activity.	Avoid the accumulation of excavation material at the riverbed.
		Natural scenery alteration.	Integrate the structures with the environment	Barriers will be formed with the revegetation that hide a part of the structures and integrate them into the natural environment.	On the perimeter of the substation.	CEL-Contractor.	Included in the re-vegetation.	Minimize the visual impact due to infrastructure works.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
Mechanical and Electric Works								
8	Mechanical and electrical equipment transportation from the port to the dam site.	Traffic jam and accident risk in the highway. Risk of crossing through a bridge.	Coordination of activities with proper authorities. Evaluation of the capacity of the bridges in the El Triunfo-San Luis de La Reina routes.	The hours and routes for the transportation of the machinery and equipment will be coordinated with the PNC and the MOP, in the night shift and with proper road signaling.	Highway from the unloading site to the dam site.	CEL-Contractor.	Project activity.	Avoid traffic jams and accidents due to the transportation of machinery and equipment.
9	Electrical and mechanical equipment installation	Generation of solid waste from transportation.	Recollection, separation, reuse and an adequate final disposal.	The waste will be separated; the renewable waste will be used. The rest will be properly disposed at the landfill.	Plant component areas.	CEL-Contractor.	Project activity.	Avoid the contamination of the soil, and superficial and underground water.
		Workers health risks.	Avoid accidents.	Work with hygiene and occupational safety regulations established by the Ministerio de Trabajo y Previsión Social	Plant component areas	CEL-Contractor.	Project activity.	Avoid work accidents.
10	Reservoir Filling	Flooding of 8.6 km^2 of lands.	Purchase of lands	The flooded areas will be purchased, to compensate for the caused damages.	On the reservoir formation site.	CEL-Contractor.	Project activity.	Compensate for loss of lands.
		Loss of vegetation cover. Permanent loss of the terrestrial life habitat. Change at the microclimatic level.	Reforestation. Use of the wood.	114 hectares will be planted with native and multiple use trees. 400 trees/hectare, at $ 1.25 each. The wood will be used in the surrounding future area.	The reforestation in the reservoir perimeter. The usage in the reservoir future area.	CEL	$57.000 ($500/ he)	Maintain the vegetation cover at the perimeter and reestablishing the habitat for the terrestrial life and favorable climatic conditions.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Flooding of the area with 79 houses, 1 school and 2 praying houses.	Relocation of approximately 420 persons.	CEL, according to a relocation program to be designed, will compensate the residents in the reservoir area. Family chief will receive a minimum salary for the first 6 months and a half salary for the following 6 months. A school and churches will be relocated.	In the area next to Carolina city.	CEL-Contractor.	Project activity.	Compensate the population directly affected. Help them to get accustomed to the new life.
		Permanent change in the soil use of an 8.6 km^2 area.	Generate productive and local job activities.	Support to the institutions in the establishment of productive projects. Increase of the fishing production, touristic and recreative development, and agricultural irrigation.	In the reservoir area.	CEL	No cost.	Improvement in the population quality of life.
		Fire risk	Avoid burning off.	Avoid the burning off as a method of clearing.	In the reservoir area	CEL-Contractor.	No cost.	Not provoking fires in the are
		Flooding of sites with cultural value: hot springs and Carolina archeological site.	Recovery of sites with similar value.	Another site with similar properties to the hot springs will be prepared. A detailed study of the site with archeological and paleontologic resources will be performed.	Aguas Calientes site, at the end of the reservoir. Vado Ancho at Carolina.	CEL-Contractor.	$ 20,000	That the population recovers a space for hot springs and documents the historical heritage sites.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Loss of communication routes from north-south sectors	New routes rehabilitation.	Vehicular bridges will be constructed in two narrow reservoir sites, and the dike will be enabled as a bridge. The creation of 11 km and improvement of 33 km of public roads in the reservoir proximities. There will be navigation for the passage from one side of the bank to the other. A pedestrian bridge will be constructed above the Champate river.	At the reservoir.	CEL-Contractor.	Project activity.	Recover the population passages for the north-south sectors.
		Change in the water quality of the Torola river at the reservoir section.	Cleaning the 8.6 km^2	The vegetation will be extracted to reduce the organic material quantity that affects the water quality. The water quality analysis will be included in the supervision that CEL performs in the reservoirs.	At 8.6 km^2 where the reservoir will be formed.	CEL-Contractor.	A specific project will be developed for this purpose.	Not affecting the reservoir water quality.
11	Relocation	Vegetation cover removal.	Revegetation.	Multiple use vegetation species will be planted: 5 trees per house. The harvested trees will be used as wood and timber.	At the new relocation center.	CEL-Contractor.	$ 495	Recovery of harvested trees and improvement of the natural environment at the relocation site
				The land preparation will be done in leveled terraces with stabilized slopes. Soil conservation works will be performed, such as drainage and discharge basins.	At new housing areas.	CEL-Contractor.	Project activity.	Avoid the erosion of removed soil.
		Soil removal for the preparation of household areas, in 15,800 m^2.	Cut and filling. Soil protection.					

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Soil contamination with residual material from the construction.	Proper management of residual material.	Prepare a site for residual material recollection. Final disposal at the landfill.	At new housing areas.	CEL-Contractor.	Project activity.	Protect the water quality of the Torola river, avoiding soil erosion.
		Population relocation.	Relocation Plan implementation	Relocate the population to a designed housing development, with the necessary conditions for normal coexistence, trying to improve their quality of life and recovering from emotional problems related to the feeling of abandoning their birthplace.	At the relocation core.	CEL-Contractor	Project activity.	Improve significantly the quality of life of the population, generating a feeling of wellbeing and commodity at the relocation core.
		Demand for Goods and services.	Supply of Basic services.	Basic services will be supplied to each house. They will have: electric energy, water, sanitary landfill, sewage treatment plant, clinic, school, soccer field, telephone, and social gathering areas.	At the relocation center.	CEL-Contractor	Project activity.	Well-being of the population.
		Productive activities interruption.	Supplying an agricultural plot and economical compensation.	Within the relocation plan agricultural plots will be selectively included for the head of the family with an average area of 2 Mz, equal to the average planting per family the area, and a monetary compensation equal to the minimum wage during 6 months, or the income derived from an agricultural season.	At the relocation center.	CEL-Contractor.	Project activity.	Facilitate the adaptation process to the new living conditions that relate to relocation from their birthplace.

No.	Activity	Generated Impact	Mitigation Measure	Measure Description	Measure Location	Responsible for Implementation	Estimated Cost	Expected Result
		Need for Orientation demand to be able to thrive in the new situation.	Perform social work with the community.	Social development training with speeches, workshops, demonstrative tours and activities determined at the final design.	At the relocation center and reservoir proximities.	CEL in coordination with institutions and NGAOs.	$3,000 per year for three years: 9,000 total	Training for acquiring abilities and skills, improving their quality of life.
		Solid and liquid waste generation.	Health risk for inhabitants and for the environment.	Establish an integral solid and liquid waste management program. There will be a sewage treatment plant and sanitary landfill. Training in basic rural sanitation.	At new housing areas.	CEL-Contractor.	Project activity.	Avoid soil contamination, as well as the introduction and proliferation of diseases.
		Cost for environmental measures subject to finance: US$159,567.00, plus 20% for contingency equivalent to : US$ 192,000 **Cost for environmental measures inherent to the project, included in the direct cost of the project: US$ 7,288,000** **Total cost for environmental measures: US$ 7,420,000**						

* In the construction phase, the vegetation maintenance will be performed by the contractor, through a company or NGA, with Project funds.

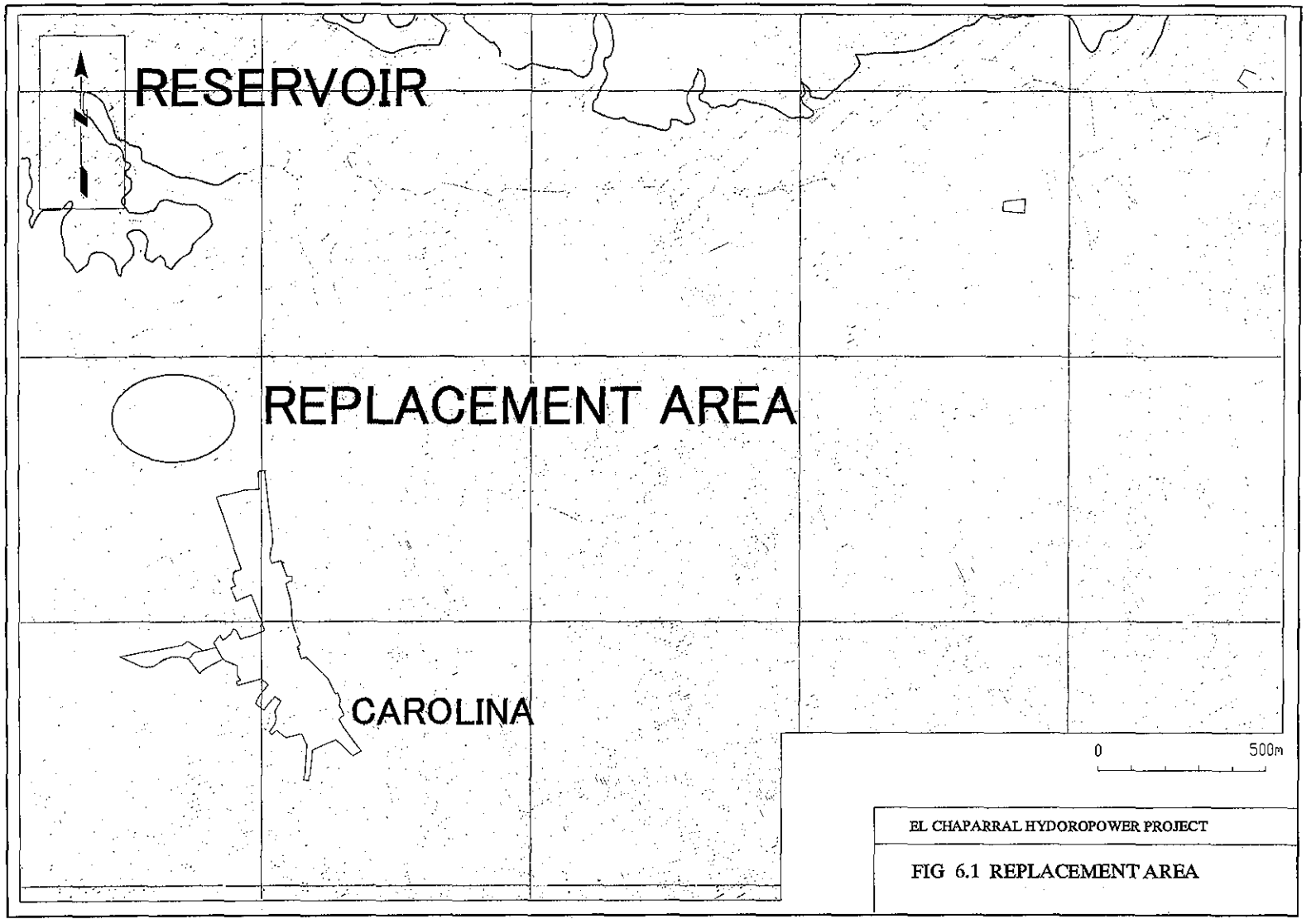
The Fig. 6.1 Shows the area where a center of resettlement will be established.

6.1.2 Operation phase								
	Activity	**Generated Impact**	**Mitigation Measure**	**Measure Description**	**Measure Location**	**Responsible for Implementation**	**Estimated Cost**	**Expected Result**
1	Camp and offices routine maintenance.	Soil, and superficial and underground water contamination risk due to solid and liquid wasted spillage.	Adequate solid and liquid waste management.	Recollection and separation of solid waste. Adequate final disposal at the landfill. Sanitary landfill, septic tanks or sewage treatment plant and septic tanks adequate maintenance.	Camp and offices area.	CEL	Plant activity.	Avoid soil, and superficial and underground water contamination with solid and liquid waste.
2	Generation equipment maintenance.	Soil and water contamination risk due to oil, lubricants and fuel spillage.	Adequate management of those products. Use of water-oil separator.	Work in waterproof areas. Recollection of used oil, lubricants and fuels to companies that reuse them. There will be no spillage at rain drainages.	Shop and vehicles parking area.	CEL	$100.00 monthly.	Avoid soil, and superficial and underground water contamination.
3	Dangerous substances usage.	Environment contamination and workers health risk.	Adequate management.	Adequate Warning and storage of substances with dangerous characteristics that are used in the plant.	Hydroelectric plant warehouse.	CEL	Plant activity.	Avoid contamination of the environment. Protect the workers health.
4	Electricity generation.	Work accidents risk.	Avoid accidents.	Work with hygiene and occupational safety regulations established by the Ministerio de Trabajo y Previsión Social. Establish an Environmental Management System that is maintained through all the project activities.	El Chaparral Hydroelectric Plant.	CEL	$55,000 in 1½ year. Establish an Environmental Management System.	Creation of a total quality concept in different areas: Human development. Environmental protection. Irrigation management. Accidents reduction.

6.1.2 Operation phase								
	Activity	**Generated Impact**	**Mitigation Measure**	**Measure Description**	**Measure Location**	**Responsible for Implementation**	**Estimated Cost**	**Expected Result**
5	Spillway discharge	Risks due to sudden increases of flow downstream from the dam site.	Avoid or reduce risks.	CEL-COEN-Population will work downstream in joint effort to establish and operate a full Early Warning System to avoid property damages and loss of human lives. Real time monitoring of the precipitation and water flow upstream from the Plant.	From El Chaparral Hydroelectric plant to 15 de Septiembre Hydroelectric Plant and the Torola river upstream basin.	CEL-COEN-Communities CEL-SNET.		Avoid damages to resources and human lives downstream from the Plant. Knowledge in real time of the precipitation values and water flows upstream from the plant.

Note: In the construction phase, the vegetation maintenance will be performed by the plant, through a company or NGA, with their own funds.

* Involves the hiring of consultations and training to perform environmental aspects analysis, as well as of the activities that are performed and procedures to be followed to work in harmony with the environment. Application of the system and verification of its effectiveness. Improvement of the analysis and decision-making. Ongoing improvement process.



EL CHAPARRAL HYDOROPOWER PROJECT

FIG 6.1 REPLACEMENT AREA

6.2 Environmental Monitoring Plan

The environmental monitoring plan (EMP), also known as the follow up and vigilance plan, has the purpose of establishing a system that guarantees the adequate performance of the environmental measures proposed at the EMP, and that also allows correcting imprecise interpretations related to what has to be done to prevent impacts that could be avoided.

The fulfillment of the EMP is of great importance because with the construction of the works and mainly, the reservoir formation, areas with different characteristics and ecological values are affected.

The EMP has the function of controlling the magnitude of specific impacts that have not being foreseen on the current study, as well as identifying and recommending additional corrective measures, in case that the corrected measures established are insufficient, and it must be understood as a technical assistance for the environmental area, to be provided during the different development phases of the works.

Due to the complexity and magnitude of the activities to be performed, the Contractor will maintain a group of Environmental Inspectors or Supervisors, specialized in work areas such as: road and terrace construction; civil works construction, as camp and offices, dam, tunnel, cofferdams, powerhouses and substation; machinery and mechanical and electrical equipment assembly and installation, as well as for the population relocation and clearance tasks of the area to be flooded, which will be under the supervision of the appropriate Unidad de Gestion Ambiental (UGA) personnel of the CEL, which has to be reinforced with a similar number of specialists, and necessary resources, and will have the purpose of assuring the application of the EMP at each phase and activity of the project. The figure 6.2 shouws the monitoring schedule.

Below are described the main activities that will be supervised by the mentioned inspectors.

a) The Inspector for the improvement and construction of roads will:

- Monitor the collection and proper final disposal of the removed residual materials.
- Monitor the conservation of the removed organic layer or fertile soil, so that is used in the revegetation.
- Monitor that the soil protection works, like slopes, superficial drainages, gutters and rain discharges, are adequately built.
- Monitor the appropriate water irrigation to avoid dust generation.
- Monitor that the machinery does not have lubricant oil and fuel leaks.
- Monitor that during the development of the works that the nearby vegetation is not damaged.
- Monitor that there are no damages to private property and crops and avoid the theft of agricultural products.
- Monitor the protection of all of the terrestrial fauna.

- Verify that the burn off is not applied as a method for clearing.
- Verify the availability of pit or portable latrines, as well as their proper use.
- Identify possible negative impacts to the environment that have not been foreseen at the EIA and recommend the corresponding mitigation measures.

b) The Inspector for the civil works construction: camp, offices, dam, tunnel, cofferdams, powerhouse and substation will:

- Monitor that no removed material from the excavations is spilled in the river.
- Monitor the appropriate recollection and final disposal of residual materials.

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- Monitor the conservation of the removed organic layer or fertile soil, so that is used in the revegetation.
- Monitor the use of rock that comes from the excavations.
- Monitor that the soil protection works, like slopes, superficial drainages, gutters and rain discharges, are adequately built.
- Monitor the appropriate water irrigation to avoid dust generation.
- Monitor that the machinery does not have lubricant oil and fuel leaks.
- Monitor that the parking lots, and vehicle and machinery maintenance is performed on sites with no free draining soils.
- Avoid unnecessary damage to the vegetation located near the works site.
- Monitor that there are no damages to private property and crops, and avoid the theft of agricultural products.
- Monitor that the workers do not capture or harm species of fauna.
- Verify that the burn off is not applied as a method for clearing.
- Verify the availability of pit or portable latrines, as well as their proper usage.
- Identify possible negative impacts to the environment that have not been foreseen at the EIA and recommend the corresponding mitigation measures.

c) The Inspector for the assembly and installation of machinery and mechanical and electrical equipment will:

- Monitor for the adequate machinery and equipment transportation from the unloading port to the installation site.
- Monitor the adequate unpacking, management, and equipment installation.
- Monitor that the spillage in the soil and water of pollutant materials does not occur.
- Monitor the adequate collection and final disposal of solid wastes.
- Identify possible negative impacts to the environment that have not been foreseen at the EIA and recommend the corresponding mitigation measures.

d) The Inspector for relocation and clearance of the reservoir area will:

- Guide and supervise the transportation of the families to the relocation site.

- Monitor that the biomass is properly used according to the species.
- Determine if in the biomass usage, it is possible to rescue the species with greater relative importance, so that they are transported with the appropriate conditions for their establishment and proliferation. For example, orchids and bromeliaceous.
- Monitor that the clearing is limited to the area flooded by the reservoir, and not causing damages in nearby properties.
- Verify that the burn off is not applied as a method for clearing.
- Identify possible negative impacts to the environment that have not been foreseen at the EIA and recommend the corresponding mitigation measures.

The environmental supervision objective, frequency, method and interpretation that have to be performed are presented below. For each activities, respective report with observations and recommendations shall be prepared.

6.2.1 Construction Phase

a) Access Roads and Stormwater Drainage

Objective: Verify the roads physical state, the proper superficial drainage stormwater discharge works, and the slopes stability on the sides of the road.

Frequency: Permanent supervision

Method: Visual

Interpretation: if there is any deterioration on the road surface or in the drainage system, and slopes erosion is observed, it will be necessary to suggest the appropriate corrective measures. It will be the Contractor responsibility to perform the maintenance and/or repair works.

b) Camp and Offices:

Objective: Supervise the construction and operation works of the camp and offices, including the final disposal system of solid waste, sewage, and stormwater.

Frequency: Permanent supervision

Method: Maintain the application of hygiene and occupational safety regulations in the development of the construction works; the collection and final disposal of solid waste; provisional latrines; sewage treatment plant, septic tanks and absorption wells, operation through direct inspection and analysis of effluent.

Interpretation: In case of negative results, it will be necessary to recommend that the corresponding corrective measures be applied. It will be the Contractor responsibility to perform the maintenance and correction works.

c) Plant Structures Construction

Objective: Supervise the construction works for the different structures that comprise the hydroelectric plant: Tunnel, cofferdams, powerhouse, and substation. Includes the supervision of the final disposal system for the solid and liquid waste, and stormwater.

Frequency: Permanent supervision

Method: Monitor the application of hygiene and occupational safety regulations in the development of the construction works; the recollection and final disposal of solid waste; provisional latrines; sewage treatment plant, septic tanks and absorption wells, operation through direct inspection and analysis of effluent.

Interpretation: In case of negative results, it will be necessary to recommend that the corresponding corrective measures be applied. It will be the Contractor responsibility to perform the maintenance and correction works.

d) Roads and Camp Revegetation

Objective: Verify the density and physical state of the planted species.

Frequency: Permanent supervision

Method: Visual

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Interpretation: If a smaller density of species than the planted one was found, or if the vegetation shows settling and growth problems, it will be necessary to apply the corresponding corrective measures. It will be the Contractor responsibility to perform the maintenance or replant other types of species, if necessary.

e) Reservoir Filling

Objective: Verify the normal development of the activities related to the reservoir filling, which basically consist in the relocation of the area population, relocation of usable infrastructures, and clear or extraction of vegetation.

Frequency: Permanent supervision

Method: Visual, through field reconnaissance, coordination with the activities responsible and consultation with the relocated population.

Interpretation: If any deficiencies were observed in any of these activities, depending on the particular case, the corresponding corrective measures must be recommended. It will be the Contractor responsibility to adequately perform the recommended activities.

f) Reservoir Perimeter Reforestation

Objective: Verify the efficiency in the reforestation activities in this area, determining the plantation density and current density and the physical state of the planted species.

Frequency: Permanent supervision.

Method: Visual and measurements of migration and species development level.

Interpretation: If any deficiencies were observed in the reforested area, it will be necessary to recommend corrective measures, like replanting, use different species, which adapt better to the environment or monitor the appearance of plagues and diseases. It will be the Contractor responsibility to perform the recommended tasks.

6.2.2 Operation Phase

The Plant must establish an Environmental Management System, under a total quality concept that includes areas such as: Human development, Environmental protection, Risk management, and Accidents elimination, and in coordination with UGA, will maintain species Environmental Audits to verify and supervise the normal operation of the Plant within environmental conditions.

The activities to supervise are:

a) Stormwater Runoff System

Objective: Verify the adequate operation of the superficial drainage system, as well as the stormwater discharge works and soil stabilization slopes in the area of direct influence.

Frequency: Permanent supervision

Method: The work for the stormwater discharges will be visually inspected, as well as the works related to the soil protection in the construction areas, evaluating their effectiveness.

Interpretation: In case that, during the inspections, any deficiency is found in the drainage system, the corresponding corrective measures will be recommended. It will be the Plant Main Office responsibility to perform the maintenance and/or correction works.

b) Camp and Offices

Objective: Supervise the operation and maintenance works in the camp and offices area, including the final disposal system of solid waste, sewage, and stormwater.

Frequency: Permanent supervision

Method: Observe the order and cleanness, as well as the collection and final disposal of solid waste, septic tanks and absorption wells, through direct inspection and effluent water quality analysis.

Interpretation: In the case deficiencies are observed, the corresponding corrective measures will be recommended. It will be the Plant's Main Office's responsibility to perform the maintenance and/or correction works.

c) Powerhouse and Appurtenant Works

Objective: Supervise the operation and maintenance works in the powerhouse, substation and annexed areas, including the camp. Besides, the collection and final disposal of solid and liquid waste system will be supervised.

Frequency: Permanent supervision

Method: Observe the order and cleanness of the mentioned areas, as well as the used system for the recollection and final disposal of solid waste; verify the sewage plant operation through direct inspection and effluent water quality analysis.

Interpretation: In case deficiencies are found, the corresponding corrective measures will be recommended. It will be the Plant Main Office responsibility to perform the maintenance and/or correction works.

d) Evaluation of the Relocated Population's Social Development

Objective: Find and measure the economical and social development level achieved by the population that lives at the relocation core.

Frequency: Twice a year. During 5 years.

Method: Performing household surveys to investigate aspects related to socioeconomic indicators like: health, education, occupation, family income, population growth, population expectations and aspirations, opinions related to their current situation.

Interpretation: The social and economical development achieved by the inhabitants of the relocation site will be evaluated. This will allow continuing with the development activities that are performed and support or develop other projects in coordination with CEL-Municipalities Mayor Office's -Relocation inhabitants. The social investigation cost will be US$ 1,000 per year.

e) **Monitoring of the Social and Economic Development in the Area**

Objective: *Find and measure the economical and social development level achieved by the* population that lives at reservoir proximities, including the population located downstream from the plant.

Frequency: Once a year, for 5 years.

Method: Household surveys, Municipalities consultations, general observation.

Interpretation: The general development level achieved in the hydroelectric plant influence area will be evaluated, both upstream and downstream from the installations. Among the aspects that will be evaluated are: the crop type and production, cattle raising development, touristy and fishing development, observe the houses establishment and soil use downstream from the plant.

f) **Revegetation Maintenance and Reforestation**

Objective: Verify the density and physical state of the planted species.

Frequency: Twice a year, in May and November

Method: Visual and distance and height measurements of the planted species. Three years after the plantation the diameter at chest height will be measured.

Interpretation: In any loss was found in the planted species, or if the vegetation shows settling and development problems, it will be necessary to apply the corresponding corrective measures, like planting and applying pest and disease control. It will be the Plant Main Office *responsibility to perform the maintenance works.*

g) **Aquatic Vegetation**

Objective: Observe the presence and propagation of aquatic vegetation.

Frequency: Twice a year, in May and November

Method: Visual

Interpretation: *Inspections on the reservoir will be performed, with an emphasis in the* tributaries mouth, to observe the presence of large aquatic plants or macrophages, like the "jacinto acuatico". Faced with the presence of these plants, an eradication process through their manual extraction must be started immediately.

h) **River, Reservoir and Aquatic Life's Quality**

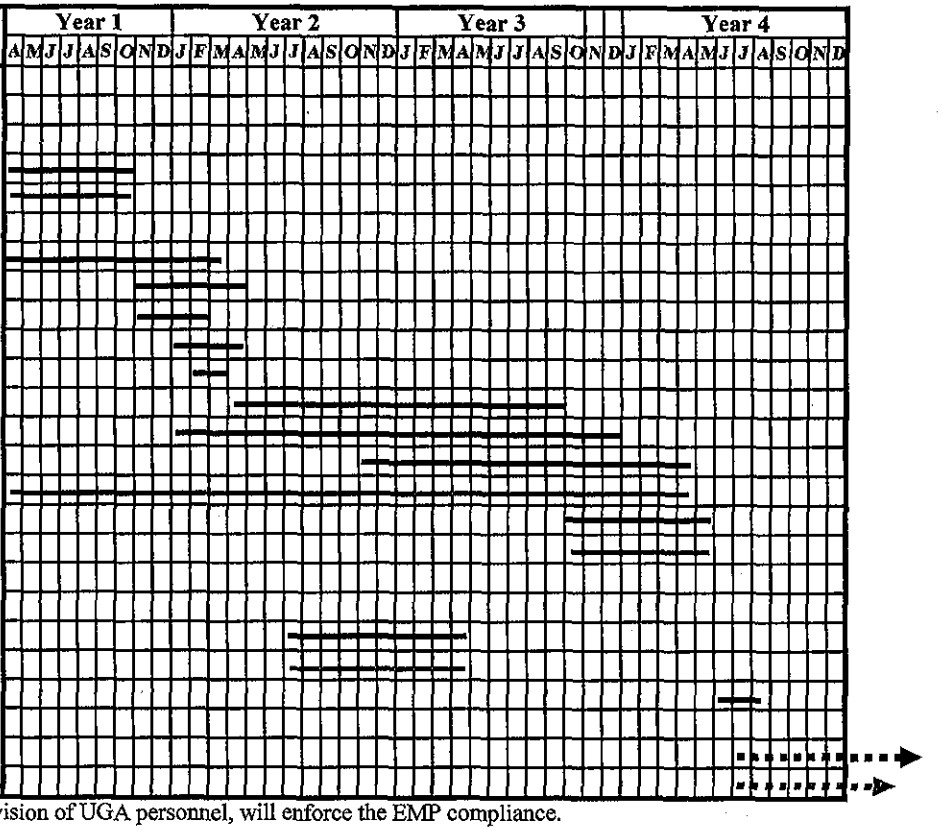
Objective: Verify the water quality from the reservoir and downstream from the Plant and also the aquatic life quality.

Frequency: Twice a year, in March and October.

Method: Through the taking of samples and physical, chemical and microbiological factors analysis. Four sampling points are established in the reservoir: next to the dike, north of Carolina and in the Paso Agua Caliente, as well as in Vado Nuevo, upstream from the Plant.

Interpretation: The water quality will be analyzed, and reports will be generated with the results, which will determine the evolution of the water quality in the river and in the reservoir. This activity includes investigating aquatic life aspects such as: species quantity and diversity. It will be the Plant Main Office responsibility to perform the necessary programs for the improvement of the water and aquatic life quality in the reservoir.

No.	Description	Responsible
	Construction phase	
1	**Civil works**	
	1.1 Access roads (improvement and road construction)	
	Environmental Monitoring	Environmental Inspector A
	1.2 *Provisional installations* (camp and offices)	
	1.3 Riverbed works	
	Tunnel diversion	
	Upstream cofferdam	
	Downstream cofferdam	
	Dam (dike and spillway)	
	Powerhouse	
	Substation	
	Environmental Monitoring	Environmental Inspector B
2	Reservoir filling	
	Environmental Monitoring	Environmental Inspector D
3	**Mechanical and electrical works**	
	3.1 Procurement and installation of mechanical and electrical equipment	
	Environmental Monitoring	Environmental Inspector C
	1.2 Working tests	
	Operation phase	
1	1.1 Start of operation	
	Environmental Management System	*UGA hydroelectric plant*



The Contractor will have 4 environmental inspectors that under the supervision of UGA personnel, will enforce the EMP compliance.
In the operation phase an Environmental Management System will be established in the plant, supervised by UGA

Fig. 6.2 Environmental Monitoring General Schedule.

CHAPTER 7

RISK STUDY AND CONTINGENCY MEASURES

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Chapter 7
RISK STUDY AND CONTINGENCY MEASURES

7.1 Risk Study

The preparation of the risk study represents an important contribution towards guaranteeing the useful life of the works, as well as the population and environment protection, at the same time fulfilling that established in the Ley del Medio Ambiente, which in its Article 21 refers to the activities or projects that must present an Environmental Impact Assessment previous to their development and in letter "n" establishes which specific activities must include a Risk Study. Also, the General Regulations of the Ley del Medio Ambiente, in Article 28, make reference to the article and letter of the Ley del Medio Ambiente, previously mentioned, and provides guidelines for the preparation of the study.

The risk analysis is fundamental for every infrastructure work, mainly for works such as hydroelectric powerplants. Therefore, as part of the Environmental Impact Assessment of the El Chaparral Hydroelectric Project (Project), the study and analysis of the environmental risks that could occur during the construction and operation phases of the plant, including a hypothetical closure of operations or abandonment of the infrastructures has been performed.

For the adequate identification and appraisal of the potential risks, it is necessary to know in detail the constructive characteristics of the Project's different components, their physical location, as well as the global operation of the hydroelectric plant, which enables the evaluation of the risk level and its relative importance within the group of structures in the construction, operation and a hypothetical closure of operations or abandonment phases.

The risk study involves exploring and visualizing the possible causes that may lead to the presence of a specific risk and, at the same time, will allow the owner of the Project to identify other risks that may emerge in the process of plant operation so that they are included in the prevention plan.

The study has been performed through the active participation of a technical team with knowledge in the characteristics of the different works and their operation, as well as the environment where they will be located, analyzing the possibility of risk occurrence, presenting the most probable and less probable events and evaluating these risks.

Along with the identification and appraisal of the potential risks, a corresponding contingency plan has been prepared, on which a series of actions are proposed with the purpose of offering the project owner an instrument that allows him to give an effective response the possibility of such risks.

7.1.1 Risk Study Objectives

- Identification and determination of the activities that present risks or threats to the populations health and the ecosystem structures.
- Identifying dangerous materials or substances that will be use during the construction, operation and closing of operations phases.
- Identifying environment and population risks due to possible failures during the construction, operation and the closing of operations phases.
- Identifying possible causes that may lead to failures.
- Determining the occurrence probability of the identified failures and their consequences.

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7.1.2 Description of the Main Activities to Perform

The description of the activities to perform for the construction of the different Project components, as well as the materials and substances to be used that represent a risk or threat for the population or environment, were presented in Chapter 3 .

7.1.3 Identification and Determination of Environmental Risks

Based on that expressed in Chapter 6 relating to the level of supervision that will be exercised during the construction of the works, significant risks are not expected, mainly because of the following:

1) The result of the geological and seismic studies shows that the dam site has adequate characteristics for the placement of the structures.

2) For the design of the works, the hydrologic study has considered the maximum probable flood so that the presence of an extraordinary meteorological phenomenon does not represent a significant risk.

3) The construction activities will be performed following safety and occupational health regulations established by the Ministerio de Trabajo y Previsión Social.

4) Plant operation will be administered by procedures established and applied by the project owner in its hydroelectric plants located on the Lempa River.

5) The Project owner has experience of more than 50 years operating hydroelectric plants of great magnitude without the presence of significant risks.

Regardless of the above, an analysis has been performed to determine the presence of possible risks. The activity consisted of imagining different scenarios from a negative point of view, identifying the possible causes that could generate a risk, then establish the cause-effect relationship.

It was determined that during the construction phase the potential risks will be generated by machinery and equipment handling and maintenance, by the storage and management of dangerous substances, by the occurrence of work accidents, due to worker neglect or lack of awareness, and by the occurrence of natural events.

During the operation phase, the risks will be related to eventual spills or discharges of chemical substances or of residual wastes that contaminate the soil and water, by the occurrence of extraordinary meteorological events that could cause floods downstream from the installations, seismic events that could cause damages to the population and infrastructures, work accidents, and by the neglect and lack of awareness in the operation of the plant.

7.2 Contingency Measures

The contingency measures have the purpose of identifying and providing the actions that must be performed to prevent or minimize the presence of identified risks and, at the same time, allow those responsible for the execution of the works and the operation of the plant, the planning of responses to the presence of threats to the population and the environment. And it must be understood as a process of continuous improvement within an environmental management system that will be applied at the different development phases of the Project.

The risks that may occur during the Project phases and the contingency measures to avoid or neutralize those risks are identified in Table 7.1.

Table 7.1 Identification of Potential Risks and their Corresponding Contingency Measures

Phase	Activity	Threat	Risk	Contingency Measures
Construction	Construction and improvement of access roads and construction of plant structures	Inadequate maintenance and management of machinery and equipment; solid and liquid waste generation	- Soil, water and air contamination - Equipment deterioration - Work accidents - Causing Fires - Labor hours loss - Works development delay - Workers and population health damage	- The shop areas must be impervious - Recollection and adequate disposal of used oils - Certification of the good state of machinery and equipment - Establish a shop with qualified personnel and appropriate tools - Preventive and corrective maintenance of machinery and equipment - Hire operators with certified experience - Having fire protection equipment
	Fuel Storage	Fuel inadequate storage	- Soil and water contamination - Causing fires - Economic losses - Damage to workers and population	- Fuel containments located in impervious areas - Berm construction for capturing and collection of possible spills
	Explosives and materials storage	Inadequate storage and management of explosives	- Damage to workers - Damage to work equipment - Temporary interruption of work - Costs increase	- Procurement of certified products with their corresponding safety sheets - Signing of storage and management areas - Hiring an explosives specialist - Storage and management according to safety sheets - Supervise product quality
	Work development	Solid and liquid waste generation	- Soil and water contamination - Workers and population health damage	- Adequate management and final disposal of solid wastes - Portable and pit latrines installation - Camp sewage treatment plant maintenance
		Work accidents	- Workers damage and medical attention extra costs - Works development delay	- Apply health and occupational safety regulations according to the Ministerio de Trabajo y Previsión Social - Occupational safety training - Strict supervision for labor regulations - Establish an insurance for the workers

Continuation Table 7.1 (Construction Phase)

Phase	Activity	Threat	Risk	Contingency Measures
Construction	Works development	Sabotage	- Damages and loss of machinery, equipment and materials - Damage to workers and works - Delay in the works development	- Having real information regarding the population attitude towards the project - Safety in the installation to protect the works - Establish fenced installations with effective supervision - Perform activities that increase the social acceptance of the project
	Presence of meteorological and seismic events	Maximum flood in the river; hillside and slopes collapse; damage to the works	- Physical damage to workers - Damages to the constructed works - Loss or damage of machinery, equipment, tools and materials - Cave in - Delay in work development	- Maintain a coordination with SNET to obtain real time forecasts regarding the presence of maximum precipitation - Acquire an insurance policy for the structures - Internet service availability - Certain works must be performed during the dry season: tunnel, cofferdams - Supervise the foundations of the protection structures - Personnel training, establish evacuation paths - Adequate signling of work areas

Continuation Table 7.1

Phase	Activity	Threat	Risk	Contingency measures
Operation	Installation operation	Inadequate maintenance and management of machinery and equipment	- Soil and water contamination due to lubricants and fuels spills - Equipment deterioration - Damage to workers - Causing fires - Loss of labor hours - Delay in the works development	- The shop and machinery repair areas must be waterproof - Adequate management and final disposal of solid and liquid wastes - Establish a shop with qualified personnel and appropriate tools - Give preventive and corrective maintenance to *machinery and equipment* - Establish permanent training programs - Have fire protection equipment - Use procedure manuals established by the owner for the operation of his hydroelectric plants on the Lempa River
	Use of dangerous materials and substances	Inadequate maintenance and use	- Damage to workers - Soil and water contamination	- Acquiring certified products and their corresponding safety sheets - Substances properly signaled and stored - Management according the safety sheets - Adequate final wastes disposal
	Operation tasks	Solid and liquid waste generation	- Soil and water contamination - Damage to the workers and population health - Damage to the environment	- Adequate management and use of sanitary landfill - Sewage treatment plant maintenance - Training and supervision of workers regarding their hygiene habits
		Work accidents	- Damage to workers - Occupational diseases	- Establish and perform hygiene and occupational safety according to the Ministerio de Trabajo y Previsión Social - *Installation of equipment and implements* for assistance in emergencies - Permanent Training
		Lack of warning or negligence	- Causing personal and material damages - Damages to generation equipment and machinery	- Personnel permanent training - Avoid working extra shifts

Continuation Table 7.1 (Operation Phase)

Phase	Activity	Threat	Risk	Contingency measures
Operation	Extraordinary meteorological events	Maximum river floods	- Physical damage to workers - Damages and loss in plant infrastructures and equipment - Damages to the population and their possessions	- Maintain a coordination with SNET to obtain real time forecasts regarding the presence of maximum precipitations - Internet access - Establish a qualified committee to give an answer for natural phenomena, with sections for: first aid, fire control and evacuation - Establishment of an early warning system - Information to the population downstream of the plant instant discharge system when it goes into operation. Proper signing - Planned development and territorial management of the areas downstream from the plant
	Seismic events	Earthquakes of dangerous *magnitude and intensity*	- Damages to the plant infrastructures - Damages to workers, population and their possessions	- Maintain coordination with COEN, SNET and institutions and organizations with irrigation management activities - Emergency signaling - Evacuation routes establishment - Establish in the plant a qualified committee to face natural phenomena - Proper area signaling according the the potential risk level
	Plant operation	*Sabotage*	- Damages and loss of machinery, *equipment and materials* - Damage to workers and works	- Establish fenced installations and effective supervision - Perform activities that increase the social acceptance of the project
Abandon-ment or closure	Dismantling and removal of structures. Cleaning areas.	Work accidents. Personal damage. Environmental contamination	- Accidents of workers responsible of dismantling the structures - Damages to health and the environment by dangerous materials and substances stored in the plant - Soil and water contamination - Negative alteration of the natural landscape due to structures abandonment	- Present the Environmental Form to the proper authority to perform the activity - Inform institutions like MARN, SIGET, Ministerio de Trabajo y Previsión Social, so they regulate and supervise the dismantling activities - Apply hygiene and occupational safety regulations according to the Ministerio de Trabajo y Previsión Social - Adequate transportation and storage of used materials

Phase	Activity	Threat	Risk	Contingency measures
				- Adequate final disposal of unused products - Removal of all material or structures that may cause accidents or contaminate the environment - Installation of guiding signals regarding the risk of getting near abandoned structures

7.3 Responsibility for Performing the Contingency Measures

During the construction phase, the performance of the contingency measures will be the Contractor's responsibility, who will assign qualified personnel for their execution. The Plan will be performed in coordination with project engineering personnel and the Environmental Management Unit, and a committee of workers will de organized with sections properly trained to assist every emergency that may occur in the execution of the works.

During the operation phase, it will be the Superintendent's or Plant Chief's responsibility to establish and operate a risk management system, through the creation of a committee organized in sections to attend to the different contingencies that may present themselves in the plant.

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ANNEX

ANNEX 1

GLOBAL RESULT OF PLANKTON SAMPLE

TABLA 1 Resultados de la Comunidad de Algas, Reportadas para la Estación Carolina
Río Torola, 9 de Octubre de 2001

División	celulas por litro	Frecuencia	Categoria	Indicador Biológico
Cyanophyta		**Relativa %**	**de Presencia**	
Algas verdes azules				
Lyngbya sp 1	50	0 21	Esporádica	Tolerante a contaminación orgánica
lyngbya sp 2	50	0 21	Esporádica	
Subtotal División	**100**	**0 43**		
Euglenophyta				
Euglenas				
Phacus sp	150	0.64	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**150**	**0.64**		
Chrysophyta				
Diatomeas				
Amphora ovalis	300	1 28	Esporádica	Aguas Limpias
Cocconeis diminuta	50	0 21	Esporádica	
Cocconeis placentula	1,400	5 96	Poca Presencia	Aguas Limpias
Cymatopleura solea	250	1 06	Esporádica	Tolerante a contaminación orgánica
Cymbella cistula	150	0 64	Esporádica	
Denticula sp	50	0 21	Esporádica	
Diploneis sp	50	0 21	Esporádica	
Ephitemia sp	50	0 21	Esporádica	
Fragilana brevistnata	8,100	34 47	Presencia Moderada	Tolerante a contaminación orgánica
Fragilana capucina	9,250	39 36	Presencia Moderada	Tolerante a contaminación orgánica
Gomphonema olivaceum	100	0 43	Esporádica	Tolerante a contaminación orgánica
Gomphonema parvulum	100	0 43	Esporádica	Tolerante a contaminación orgánica
Gyrosigma kutzingii	100	0 43	Esporádica	Tolerante a contaminación orgánica
Mastogia sp	50	0 21	Esporádica	Aguas Limpias
Navicula gracilis	2,000	8 51	Poca Presencia	Aguas Limpias
Navicula radiosa	100	0 43	Esporádica	Aguas Limpias
Navicula sp	200	0 85	Esporádica	Tolerante a contaminación orgánica
Nitzchia sigma	100	0 43	Esporádica	Tolerante a contaminación orgánica
Ophephora sp	100	0 43	Esporádica	
Pinnulana borealis	150	0 64	Esporádica	Aguas Limpias
Stauroneis phoenicentron	150	0 64	Esporádica	
Sunrella ovalis	100	0 43	Esporádica	
Synedra ulna	100	0 43	Esporádica	Tolerante a contaminación orgánica
Tabellana sp	50	0 21	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**23,050**	**98.09**		
Chlorophyta				
(algas verdes)				
Euastrum sp	50	0 21	Esporádica	
Micrasterias radians	50	0 21	Esporádica	
Cosmarium sp	50	0 21	Esporádica	Aguas Limpias
Subtotal División	**150**	**0 64**		
Pyrrhophyta				
Dinoflagelados				
Gymnodinium sp	50	0 21	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**50**	**0 21**		
Total en Muestreo	**23,500**	**100.00**		

Frecuencia Relativa Porciento (F R. %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60.99	Abundante
61 - 100	*Dominante*

TABLA 2 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Carolina
Río Torola, 9 de Octubre de 2001

Phylum	Organismos por ml	Frecuencia	Categoria	Indicador Biológico
Phylum Flagellata		**Relativa %**	**de Presencia**	
Flagelados				
Anisonema sp	3	5 45	Poca Presencia	Tolerante a contaminación orgánica
Peranema sp	8	14 55	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum Sarcodina	**11**	**20 00**		
"Amibas"				
Hyalosphenia sp	7	12 73	Poca Presencia	Tolerante a contaminación organica
Amoeba radiosa	5	9 09	Poca Presencia	Tolerante a contaminación orgánica
Arcella vulgans	3	5 45	Poca Presencia	Tolerante a contaminación orgánica
Vahlkampfia limax	3	5 45	Poca Presencia	
Subtotal Phylum	**18**	**32 72**		
Phylum Ciliophora				
Ciliados				
Aspidisca sp	11	20 00	Poca Presencia	Tolerante a contaminación orgánica
Colpidium colpoda	7	12 73	Poca Presencia	Tolerante a contaminación orgánica
Vorticella sp	6	10 91	Poca Presencia	Tolerante a contaminación orgánica
sei	**24**	**43 64**		
Phylum Rotifera				
Rotiferos				
Lecane sp				
Lepadella sp	2	3 64	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**2**	**3 64**		
Total en Muestreo	**55**	**100.00**		

Frecuencia Relativa Porciento (F R %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 3 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estación Carolina
Río Torola, 9 de Octubre de 2001

Orden	Número de Organismos	Frecuencia Relativa %	Categoría de Presencia	Indicador Biológico
Orden Diptera				
Chironomidae	3	6 12	Poca Presencia	Tolerante a contaminación orgánica
Syrphidae	1	2 04	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**4**	**8.16**		
Orden Coleoptera				
Subtotal Orden	**0**	**0.00**		
Orden Megaloptera				
Corydalidae	3	6 12	Poca Presencia	Aguas limpias
Subtotal Orden	**3**	**6.12**		
Orden Ephemeroptera				
Ephemeridae	35	71 43	Dominante	Tolerante a contaminación orgánica
Subtotal Orden	**35**	**71 43**		
Orden Trichoptera				
Hydropsychidae	5	10 20	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**5**	**10 20**		
Orden Odonata				
Suborden Anisoptera	0	0 00	Esporádica	Tolerante a contaminación orgánica
Suborden Zigoptera	2	4 08	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**2**	**4.08**		
Orden Hemiptera				
		0 00	Esporádica	Aguas limpias
Subtotal Orden	**0**	**0.00**		
Total en Muestreo	**49**	**100.00**		

Frecuencia Relativa Porciento (F R. %)	**Presencia de Organismos Categoría**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	*Abundante*
61 - 100	Dominante

TABLA 4 Resultados de la Comunidad de Algas, Reportadas para la Estación Carolina
Río Torola, 23 de Octubre de 2001

División	celulas por litro	Frecuencia	Categoria	Indicador Biológico
Cyanophyta		Relativa %	de Presencia	
Algas verdes azules				
Lyngbya sp	50	1 52	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**50**	**1.52**		
Euglenophyta				
Euglenas				
Synura uvella	50	1 52	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**50**	**1.52**		
Chrysophyta				
Diatomeas				
Cocconeis placentula	150	4 55	Poca Presencia	Aguas Limpias
Fragilana brevistriata	100	3 03	Poca Presencia	Tolerante a contaminación orgánica
Fragilana capucina	1,000	30 30	Presencia Moderada	Tolerante a contaminación orgánica
Gyrosigma kutzingii	50	1 52	Esporádica	Tolerante a contaminación orgánica
Navicula sp	150	4 55	Poca Presencia	Tolerante a contaminación orgánica
Nitzchia sigma	1,000	30 30	Presencia Moderada	Tolerante a contaminación orgánica
Pinnulana borealis	100	3 03	Poca Presencia	Aguas Limpias
Synedra ulna	450	13 64	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**3,000**	**90.91**		
Chlorophyta				
(algas verdes)				
Cosmarium sp	50	1 52	Esporádica	Aguas Limpias
Oedogonium sp	50	1 52	Esporádica	Aguas Limpias
Clostenum lunula	50	1 52	Esporádica	Aguas Limpias
Stigeoclonium sp	50	1 52	Esporádica	Aguas Limpias
Subtotal División	**200**	**6.06**		
Total en Muestreo	**3,300**	**100.00**		

Frecuencia Relativa Porciento (F.R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 5 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Carolina
Río Torola, 23 de Octubre de 2001

Phylum	Organismos por ml	Frecuencia	Categoria	Indicador Biológico
Phylum Flagellata		**Relativa %**	**de Presencia**	
Flagelados				
Peranema sp	3	10 34	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum Sarcodina	3	10 34		
"Amibas"				
Hyalosphenia sp	4	13 79	Poca Presencia	Tolerante a contaminación orgánica
Amoeba radiosa	5	17 24	Poca Presencia	Tolerante a contaminación orgánica
Vahlkampfia limax	3	10 34	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	12	41.38		
Phylum Ciliophora				
Ciliados				
Aspidisca sp	2	6 90	Poca Presencia	Tolerante a contaminación orgánica
Litonotus fasciola	6	*20 69*	*Poca Presencia*	*Tolerante a contaminación orgánica*
Vorticella sp	2	6 90	Poca Presencia	Tolerante a contaminación orgánica
Haltena grandinella	1	3 45	Poca Presencia	
Spirostomus ambigoum	1	3 45	Poca Presencia	Aguas limpias
Subtotal Phylum	12	41.38		
Phylum Rotifera				
Rotiferos				
Lepadella sp	2	6 90	Poca Presencia	
Subtotal Phylum	2	6.90		
Total en Muestreo	29	100.00		

Frecuencia Relativa Porciento (F R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 6 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estación Carolina Río Torola, 23 de Octubre de 2001

Orden	Número de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Orden Ephemeroptera				
Ephemeridae	15	83 33	Dominante	Tolerante a contaminación orgánica
Subtotal Orden	**15**	**83.33**		
Orden Trichoptera				
Hydropsychidae	2	11 11	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**2**	**11 11**		
Orden Hemiptera				
Naucoridae	1	5 56	Poca Presencia	Aguas limpias
Subtotal Orden	**1**	**5 56**		
Total en Muestreo	**18**	**100 00**		

Frecuencia Relativa Porciento (F.R %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 7 Resultados de la Comunidad de Algas, Reportadas para la Estación Carolina
Río Torola, 8 de Noviembre de 2001

División	celulas por litro	Frecuencia	Categoria	Indicador Biológico
		Relativa %	de Presencia	
Euglenophyta				
Euglenas				
Phacus sp	50	0 06	Esporádica	Tolerante a contaminación orgánica
Synura uvella	200	0 22	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**250**	**0 28**		
Chrysophyta				
Diatomeas				
Cocconeis placentula	150	0 17	Esporádica	Aguas Limpias
Fragilaria capucina	87,500	96 63	Dominante	Tolerante a contaminación orgánica
Gomphonema parvulum	100	0 11	Esporádica	Tolerante a contaminación orgánica
Navicula sp	1,800	1 99	Esporádica	Tolerante a contaminación orgánica
Pinnularia borealis	100	0 11	Esporádica	Aguas Limpias
Stauroneis phoenicentron	100	0 11	Esporádica	Aguas Limpias
Shephanodiscus sp	50	0 06	Esporádica	Aguas Limpias
Synedra ulna	150	0 17	Esporádica	Tolerante a contaminación orgánica
Rhopalodia gibba	50	0 06	Esporádica	Aguas Limpias
Subtotal División	**90,000**	**99 39**		
Chlorophyta				
(algas verdes)				
Closterium lunula	50	0 06	Esporádica	Aguas Limpias
Cosmarium sp	150	0 17	Esporádica	Aguas Limpias
Stiegeoclonium sp	50	0 06	Esporádica	Tolerante a contaminación orgánica
Spirogyra sp	50	0 06	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**300**	**0 33**		
Total en Muestreo	**90,550**	**100.00**		

Frecuencia Relativa Porciento	*Presencia de Organismos*
(F.R %)	**Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 8 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Carolina
Río Torola, 8 de Noviembre de 2001

Phylum	Organismos por ml	Frecuencia	Categoria	Indicador Biológico
Phylum Flagellata		**Relativa %**	**de Presencia**	
Flagelados				
Anisonema sp	3	10 71	Poca Presencia	Tolerante a contaminación orgánica
Peranema sp	8	28 57	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Phylum Sarcodina	**11**	**39.29**		
"Amibas"				
Arcella vulgaris	1	3 57	Poca Presencia	Tolerante a contaminación orgánica
Hyalosphenia sp	3	10 71	Poca Presencia	Tolerante a contaminación orgánica
Vahlkampfia limax	4	14 29	Poca Presencia	
Subtotal Phylum	**8**	**28.57**		
Phylum Ciliophora				
Ciliados				
Chilonella sp	3	10 71	Poca Presencia	Tolerante a contaminación orgánica
Vorticella sp	3	10 71	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**6**	**21 43**		
Phylum Rotifera				
Rotiferos				
Lecane sp	2	7 14	Poca Presencia	
Philodina sp	1	3 57	Poca Presencia	
Subtotal Phylum	**3**	**10 71**		
Total en Muestreo	**28**	**100.00**		

Frecuencia Relativa Porciento (F R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 9 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estación Carolina Río Torola, 8 de Noviembre de 2001

Orden	Número de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Orden Diptera				
Chironomidae	9	13 64	Poca Presencia	Tolerante a contaminación orgánica
Simulidae	6	9 09	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**15**	**22 73**		
Orden Coleoptera				
Psephenidae	2	3 03	Poca Presencia	Aguas limpias
Subtotal Orden	2	3 03		
Orden Ephemeroptera				
Ephemeridae	44	66 67	Dominante	Tolerante a contaminación orgánica
Subtotal Orden	**44**	**66 67**		
Orden Trichoptera				
Hydropsychidae	5	7 58	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**5**	**7.58**		
Total en Muestreo	**66**	**100.00**		

Frecuencia Relativa Porciento (F R. %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 10 Resultados de la Comunidad de Algas, Reportadas para la Estación Carolina
Río Torola, 21 de Noviembre de 2001

División	Celulas por litro	Frecuencia	Categoria	Indicador Biológico
		Relativa %		
Euglenophyta				
Euglenas				
Synura uvella	300 00	1 10	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**300 00**	**1 10**		
Chrysophyta				
Diatomeas				
Amphora ovalis	150 00	0 55	Esporádica	Aguas limpias
Cocconeis placentula	400 00	1 47	Esporádica	Aguas limpias
Cymbella cistula	150 00	0 55	Esporádica	Aguas limpias
Fragilaria capucina	23,400 00	85 87	Dominante	Tolerante a contaminación orgánica
Gomphonema parvulum	350 00	1 28	Esporádica	Tolerante a contaminación orgánica
Gyrosigma sp	150 00	0 55	Esporádica	Tolerante a contaminación orgánica
Pinnularia borealis	250 00	0 92	Esporádica	Aguas limpias
Synedra ulna	1,800 00	6 61	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**26,650 00**	**97 80**		
Chlorophyta				
(algas verdes)				
Closterium lunula	100 00	0 37	Esporádica	Aguas limpias
Cosmarium sp	50 00	0 18	Esporádica	Aguas limpias
Oedogonium sp	100 00	0 37	Esporádica	Aguas limpias
Spirogyra sp	**50.00**	0 18	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**300.00**	**1.10**		
Total en Muestreo	**27,250.00**	**100.00**		

Frecuencia Relativa Porciento (F.R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 11 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Carolina
Río Torola, 21 de Noviembre de 2001

Phylum	Organismos por ml	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Phylum Sarcodina				
"Amibas"				
Acanthocystis turfacea	1	12 50	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**1**	**12.50**		
Phylum Ciliophora				
Ciliados				
Chilonella sp	1	12 50	Poca Presencia	Tolerante a contaminación orgánica
Vorticella sp	2	25 00	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Phylum	**3**	**37.50**		
Phylum Rotifera				
Rotiferos				
Lecane sp	2	25 00	Presencia Moderada	
Lepadella sp	2	25 00	Presencia Moderada	
Subtotal Phylum	**4**	**50.00**		
Total en Muestreo	**8**	**100 00**		

Frecuencia Relativa Porciento (F R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60.99	*Abundante*
61 - 100	Dominante

TABLA 12 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estación Carolina
Río Torola, 21 de Noviembre de 2001

Orden	Número de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Orden Diptera				
Chironomidae	26	27 37	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Orden	**26**	**27.37**		
Orden Coleoptera				
Psephenidae	5	5 26	Poca Presencia	Aguas limpias
Subtotal Orden	**5**	**5.26**		
Orden Ephemeroptera				
Ephemendae	58	61 05	Dominante	Tolerante a contaminación orgánica
Subtotal Orden	**58**	**61.05**		
Orden Odonata				
suborden Anizoptera	1	1 05	Esporadica	
Suborden Ziogoptera	3	3 16	Poca Presencia	
Subtotal Orden	**4**	**4 21**		
Orden Trichoptera				
Hydropsychidae	2	2 11	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**2**	**2 11**		
Total en Muestreo	**95**	**100.00**		

Frecuencia Relativa Porciento (F R. %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 13 Resultados de la Comunidad de Algas, Reportadas para la Estación Vado Nuevo
Río Torola, 9 de Octubre de 2001

División	Celulas por Litro	Frecuencia	Categoria	Indicador Biológico
Cyanophyta		**Relativa %**	**de Presencia**	
Algas verdes azules				
Lyngbya sp1	100	0 04	Esporádica	Tolerante a contaminación orgánica
Lyngbya sp2	100	0 04	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**200**	**0 09**		
Chrysophyta				
Diatomeas				
Achnanthes heterovalvata	1,700	0 74	Esporádica	Aguas limpias
Anomoeoneis sphaerophora	1,200	0 52	Esporádica	Aguas limpias
Amphora ovalis	350	0.15	Esporádica	Aguas limpias
Cocconeis diminuta	250	0 11	Esporádica	Aguas limpias
Cocconeis placentula	850	0 37	Esporádica	Aguas limpias
Cyclotella sp	100	0 04	Esporádica	Tolerante a contaminación orgánica
Cymatopleura solea	50	0 02	Esporádica	
Cymbella ventricosa	200	0 09	Esporádica	Aguas limpias
Cymbella cistula	50	0 02	Esporádica	Aguas limpias
Diatoma sp	50	0 02	Esporádica	Tolerante a contaminación orgánica
Denticula sp	150	0 07	Esporádica	
Fragilana brevistnata	13,300	5 79	Poca Presencia	Tolerante a contaminación orgánica
Fragilana capucina	190,800	83 01	Dominante	Tolerante a contaminación orgánica
Gomphonema olivaceum	500	0 22	Esporádica	Tolerante a contaminación orgánica
Gyrosigma kutzingii	150	0 07	Esporádica	Tolerante a contaminación orgánica
Navicula sp	100	0 04	Esporádica	Tolerante a contaminación orgánica
Navicula gracilis	150	0 07	Esporádica	Aguas limpias
Navicula radiosa	150	0 07	Esporádica	Aguas limpias
Nitzchia sigma	200	0 09	Esporádica	Tolerante a contaminación orgánica
Pinnulana borealis	50	0 02	Esporádica	Aguas limpias
Stauroneis phoenicentron	550	0 24	Esporádica	Aguas limpias
Sunrella ovalis	300	0 13	Esporádica	
Synedra ulna	18,050	7 85	Poca Presencia	Tolerante a contaminación orgánica
Tercipnoe sp	50	0 02	Esporádica	Aguas limpias
Tabellana sp	300	0 13	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**229,600**	**99.89**		
Chlorophyta				
(algas verdes)				
Closterium lunula	50	0 02	Esporádica	Aguas limpias
Subtotal División	**50**	**0.02**		
Total en Muestreo	**229,850**	**100.00**		

Frecuencia Relativa Porciento	**Presencia de Organismos**
(F R. %)	***Categoria***
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 14 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Vado Nuevo, Río Torola, 9 de Octubre de 2001

Phylum	Organismos por ml	Frecuencia	Categoria	Indicador Biológico
Phylum Flagellata		**Relativa %**	**de Presencia**	
Flagelados				
Anisonema sp	5	12 20	Poca Presencia	Tolerante a contaminación orgánica
Peranema sp	7	17 07	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum Sarcodina	**12**	**29 27**		
"Amibas"				
Hyalosphenia sp	5	12 20	Poca Presencia	Tolerante a contaminación orgánica
Amoeba radiosa	2	4 88	Poca Presencia	Tolerante a contaminación orgánica
Aecella vulgaris	2	4 88	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**9**	**21 95**		
Phylum Ciliophora				
Ciliados				
Aspidisca sp	7	17 07	Poca Presencia	Tolerante a contaminación orgánica
Coleps sp	2	4 88	Poca Presencia	Tolerante a contaminación orgánica
Vorticella sp	6	14 63	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**15**	**36 59**		
Phylum Rotifera				
Rotíferos				
Lecane sp	3	7 32	Poca Presencia	
Lepadella sp	2	4 88	Poca Presencia	
Subtotal Phylum	**5**	**12.20**		
Total en Muestreo	**41**	**100 00**		

Frecuencia Relativa Porciento (F R %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 15 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estación Vado Nuevo Río Torola, 9 Octubre de 2001

Orden	Número de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Orden Diptera				
Chironomidae	8	15 38	Poca Presencia	Tolerante a contaminación orgánica
Simuliidae	15	28 85	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Orden	**23**	**44.23**		
Orden Coleoptera				
Psephenidae	2	3 85	Poca Presencia	Aguas Limpias
	1	1 92	*Esporádica*	Aguas Limpias
Subtotal Orden	**3**	**5.77**		
Orden Megaloptera				
Corydalidae	1	1 92	Esporádica	Aguas Limpias
Subtotal Orden	**1**	**1.92**		
Orden Ephemeroptera				
Ephemendae	19	36 54	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Orden	**19**	**36 54**		
Orden Trichoptera				
Hydropsychidae	4	7 69	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**4**	**7 69**		
Orden Odonata				
Suborden Anisoptera	1	1 92	Esporádica	Tolerante a contaminación orgánica
Suborden Zigoptera	1	1 92	Esporádica	Tolerante a contaminación orgánica
Subtotal Orden	**2**	**3 85**		
Orden Hemiptera				
Naucondae	0	0 00	Esporádica	
Subtotal Orden	**0**	**0.00**		
Total en Muestreo	**52**	**100.00**		

Frecuencia Relativa Porciento (F R. %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	*Abundante*
61 - 100	Dominante

TABLA 16 Resultados de la Comunidad de Algas, Reportadas para la Estación Vado Nuevo
Río Torola, 23 de Octubre de 2001

División	Celulas por Litro	Frecuencia	Categoria	Indicador Biológico
Cyanophyta		Relativa %	de Presencia	
Algas verdes azules				
Anabaena constricta	100	5 00	Poca Presencia	Tolerante a contaminación orgánica
Oscillatoria sp	100	5 00	Poca Presencia	Tolerante a contaminación orgánica
Oscillatoria limosa	100	5 00	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**300**	**15 00**		
Euglenophyta				
Euglenas				
Euglena sp	100	5 00	Poca Presencia	Tolerante a contaminación orgánica
Synura uvella	150	7 50	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**250**	**12 50**		
Chrysophyta				
Diatomeas				
Anomoeoneis sphaerophora	50	2 50	Poca Presencia	Aguas Limpias
Amphipleura pellucida	50	2 50	Poca Presencia	Aguas Limpias
Cocconeis placentula	50	2 50	Poca Presencia	Aguas Limpias
Fragilaria brevistriata	300	15 00	Poca Presencia	Tolerante a contaminación orgánica
Fragilaria capucina	200	10 00	Poca Presencia	Tolerante a contaminación orgánica
Gomphonema olivaceum	50	2 50	Poca Presencia	Tolerante a contaminación orgánica
Gyrosigma kutzingii	100	5 00	Poca Presencia	Tolerante a contaminación orgánica
Navicula sp	200	10 00	Poca Presencia	Tolerante a contaminación orgánica
Navicula gracilis	150	7 50	Poca Presencia	Aguas Limpias
Surirella ovalis	50	2 50	Poca Presencia	Aguas Limpias
Synedra ulna	150	7 50	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**1,350**	**67 50**		
Chlorophyta				
(algas verdes)				
Cosmarium sp	50	2 50	Poca Presencia	Aguas Limpias
Closterium lunula	50	2 50	Poca Presencia	Aguas Limpias
Subtotal División	**100**	**5 00**		
Total en Muestreo	**2,000**	**100 00**		

Frecuencia Relativa Porciento (F.R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 17 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Vado Nuevo
Río Torola, 23 de Octubre de 2001

Phylum	Organismos por ml	Frecuencia	Categoria	Indicador Biológico
Phylum Flagellata		**Relativa %**	**de Presencia**	
Flagelados				
Entosiphon sulcatum	2	3 13	Poca Presencia	Tolerante a contaminación organica
Peranema sp	2	3 13	Poca Presencia	Tolerante a contaminación orgánica
Rhodomonas sp	*28*	*43 75*	*Abundante*	*Tolerante a contaminación orgánica*
Subtotal Phylum	**32**	**50 00**		
Phylum Sarcodina				
"Amibas"				
Amoeba radiosa	1	1 56	Esporádica	Tolerante a contaminación orgánica
Arcella vulgans	1	1 56	Esporádica	Tolerante a contaminación orgánica
Hyalosphenia sp	3	4 69	Poca Presencia	Tolerante a contaminación orgánica
Mayorella sp	1	1 56	Esporádica	Tolerante a contaminación orgánica
Naeglena sp	1	1 56	Esporádica	
Subtotal Phylum	**7**	**10 94**		
Phylum Ciliophora				
Ciliados				
Cynetochilum margantaceum	2	3 13	Poca Presencia	Tolerante a contaminación orgánica
Dileptus anser	2	3 13	Poca Presencia	Tolerante a contaminación orgánica
Haltena grandinella	6	9 38	Poca Presencia	Tolerante a contaminación orgánica
Litonotus fasciola	*1*	*1 56*	*Esporádica*	*Tolerante a contaminación orgánica*
Stylosnychia mytilus	5	7 81	Poca Presencia	Tolerante a contaminación orgánica
Urostyla sp	2	3 13	Poca Presencia	Tolerante a contaminación orgánica
Vorticella sp	*1*	*1 56*	*Esporádica*	Tolerante a contaminación orgánica
Subtotal Phylum	**19**	**29 69**		
Phylum Rotifera				
Rotíferos				
Lecane sp				
Lepadella sp	2	3 13	Poca Presencia	
Subtotal Phylum	**2**	**3 13**		
Gastrotricho				
Gastrotricho	4	6 25	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**4**	**6 25**		
Total en Muestreo	**64**	**100 00**		

Frecuencia Relativa Porciento	**Presencia de Organismos**
(F R. %)	***Categoria***
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 18 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estación Vado Nuevo
Río Torola, 23 Octubre de 2001

Orden	Número de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Orden Diptera				
Chironomidae	3	25 00	Presencia Moderada	Tolerante a contaminación orgánica
Simulidae	0	0 00	Esporádica	Tolerante a contaminación orgánica
Subtotal Orden	**3**	**25 00**		
Orden Coleoptera				
Psephenidae	1	8 33	Poca Presencia	Aguas limpias
Coleoptero larva	1	8 33	Poca Presencia	Aguas limpias
Subtotal Orden	**2**	**16 67**		
Orden Megaloptera				
Corydalidae	0	0 00	Esporádica	Aguas limpias
Subtotal Orden	**0**	**0 00**		
Orden Ephemeroptera				
Ephemeridae	6	50 00	Abundante	Tolerante a contaminación orgánica
Subtotal Orden	**6**	**50.00**		
Orden Trichoptera				
Hydropsychidae	0	0 00	Esporádica	Tolerante a contaminación orgánica
Subtotal Orden	**0**	**0.00**		
Orden Odonata				
Suborden Anisoptera	0	0 00	Esporádica	Tolerante a contaminación orgánica
Suborden Zigoptera	0	0 00	Esporádica	Tolerante a contaminación orgánica
Subtotal Orden	**0**	**0.00**		
Orden Hemiptera				
Naucoridae	1	8 33	Poca Presencia	Aguas limpias
Subtotal Orden	**1**	**8 33**		
Total en Muestreo	**12**	**100.00**		

Frecuencia Relativa Porciento (F R %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 19 Resultados de la Comunidad de Algas, Reportadas para la Estación Vado Nuevo
Río Torola, 7 de Noviembre de 2001

División	Celulas por Litro	Frecuencia	Categoria	Indicador Biológico
Cyanophyta		**Relativa %**	**de Presencia**	
Algas verdes azules				
Anabaena constricta	1	1 75	Esporádica	Tolerante a contaminación orgánica
Oscillatoria sp	4	7 02	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**5**	**8 77**		
Euglenophyta				
Euglenas				
Euglena sp	1	1 75	Esporádica	Tolerante a contaminación orgánica
Synura uvella	3	5 26	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**4**	**7 02**		
Chrysophyta				
Diatomeas				
Cymbella cistula	2	3 51	Poca Presencia	Aguas limpias
Fragilaria brevistriata	3	5 26	Poca Presencia	Tolerante a contaminación orgánica
Fragilaria capucina	8	14 04	Poca Presencia	Tolerante a contaminación orgánica
Gomphonema olivaceum	2	3 51	Poca Presencia	Tolerante a contaminación orgánica
Surirella sp	2	3 51	Poca Presencia	Tolerante a contaminación orgánica
Navicula sp	25	43 86	Abundante	Tolerante a contaminación orgánica
Navicula gracilis	2	3 51	Poca Presencia	Aguas limpias
Stauroneis sp	2	3 51	Poca Presencia	Aguas limpias
Pinnularia sp	1	1 75	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**47**	**82.46**		
Chlorophyta				
(algas verdes)				
Cosmarium sp	1	1 75	Esporádica	Aguas limpias
Subtotal División	**1**	**1.75**		
Total en Muestreo	**57**	**100 00**		

Frecuencia Relativa Porciento (F.R %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 20 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Vado Nuevo Río Torola, 7 de Noviembre de 2001

Phylum	Organismos por ml	Frecuencia	Categoria	Indicador Biológico
Phylum Flagellata		**Relativa %**	**de Presencia**	
Flagelados				
Entosiphon sulcatum	0	0 00	Esporádica	Tolerante a contaminación orgánica
Peranema sp	0	0 00	Esporádica	Tolerante a contaminación orgánica
Rhodomonas sp	0	0 00	Esporádica	Tolerante a contaminación orgánica
Subtotal Phylum	**0**	**0 00**		
Phylum Sarcodina				
"Amibas"				
Amoeba radiosa	2	11 11	Poca Presencia	Tolerante a contaminación orgánica
Arcella vulgaris	4	22 22	Presencia Moderada	Tolerante a contaminación orgánica
Hyalosphenia sp	5	27 78	Presencia Moderada	Tolerante a contaminación orgánica
Amoeba proteus	1	5 56	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**12**	**66 67**		
Phylum Ciliophora				
Ciliados				
Cothurnia sp	1	5 56	Poca Presencia	Tolerante a contaminación orgánica
Litonotus fasciola	1	5 56	Poca Presencia	Tolerante a contaminación orgánica
Stylosnychia mytilus	1	5 56	Poca Presencia	Tolerante a contaminación orgánica
Vorticella sp	2	11 11	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**5**	**27.78**		
Phylum Rotifera				
Rotiferos				
Lepadella sp	1	5 56	Poca Presencia	
Subtotal Phylum	**1**	**5 56**		
Gastrotricho				
Gastrotricho	0	0 00	Esporádica	Tolerante a contaminación orgánica
Subtotal Phylum	**0**	**0.00**		
Total en Muestreo	**18**	**100.00**		

Frecuencia Relativa Porciento (F.R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 21 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estacion Vado Nuevo Río Torola, 7 de Noviembre de 2001

Orden	*Número de Organismos*	*Frecuencia* Relativa %	*Categoria* de Presencia	*Indicador Biológico*
Orden Diptera				
Chironomidae	37	23 42	Presencia Moderada	Tolerante a contaminación orgánica
Simulidae	78	49 37	Abundante	Tolerante a contaminación orgánica
Subtotal Orden	**115**	**72.78**		
Orden Coleoptera				
Psephenidae				
Coleoptero larva	*5*	3 16	*Poca Presencia*	Aguas limpias
Subtotal Orden	**5**	**3.16**		
Orden Megaloptera				
Corydalidae	0	0 00	Esporadica	
Subtotal Orden	**0**	**0.00**		
Orden Ephemeroptera				
Ephemeridae	33	20 89	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**33**	**20 89**		
Orden Trichoptera				
Hydropsychidae	5	3 16	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	***5***	***3 16***		
Orden Odonata				
Suborden Anisoptera	0	0 00	Esporádica	
Suborden Zigoptera	0	0 00	Esporádica	
Subtotal Orden	**0**	**0.00**		
Orden Hemiptera				
Naucoridae	0	0 00	Esporádica	
Subtotal Orden	**0**	**0 00**		
Total *en* Muestreo	**158**	**100.00**		

Frecuencia Relativa Porciento (F R. %)	*Presencia de Organismos* Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 22 Resultados de la Comunidad de Algas, Reportadas para la Estación Vado Nuevo
Río Torola, 21 de Noviembre de 2001

División	Celulas por Litro	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Chrysophyta				
Diatomeas				
Achnanthes heterovalvata	150	0 09	Esporádica	
Amphipleura pellucida	4,150	2 46	Poca Presencia	
Amphora ovalis	3,000	1 78	Esporádica	
Anomoeoneis sphaerophora	150	0 09	Esporádica	
Cocconeis placentula	5,300	3 14	Poca Presencia	Aguas limpias
Cymbella venticrosa	3,000	1 78	Esporádica	
Fragilaria capucina	108,000	63 94	Dominante	Tolerante a contaminación orgánica
Gomphonema parvulum	1,200	0 71	Esporádica	Tolerante a contaminación orgánica
Pleurosigma sp	1,950	1 15	Esporádica	Aguas limpias
Navicula sp	4,150	2 46	Poca Presencia	Tolerante a contaminación orgánica
Navicula gracilis	6,000	3 55	Poca Presencia	Aguas limpias
Nitszchia ignorata	550	0 33	Esporádica	
Gyrosigma	250	0 15	Esporádica	Tolerante a contaminación orgánica
Pinnularia borealis	100	0 06	Esporádica	Aguas limpias
Surirella sp	50	0 03	Esporádica	
Shephanodiscus sp	21,000	12 43	Poca Presencia	Aguas limpias
Synedra ulna	9,600	5 68	Poca Presencia	Tolerante a contaminación orgánica
Subtotal División	**168,600**	**99 82**		
Chlorophyta				
(algas verdes)				
Closterium lunula	100	0 06	Esporádica	Aguas limpias
Cosmarium sp	50	0 03	Esporádica	Aguas limpias
Oedogonium sp	50	0 03	Esporádica	Aguas limpias
Rhizoclonium sp	50	0 03	Esporádica	Aguas limpias
Spirogyra sp	50	0 03	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**300**	**0 18**		
Total en Muestreo	**168,900**	**100 00**		

Frecuencia Relativa Porciento (F R %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 23 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Vado Nuevo Río Torola, 21 de Noviembre de 2001

Phylum	Organismos por ml	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Phylum Sarcodina				
"Amibas"				
Amoeba radiosa	3	33 33	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Phylum	**3**	**33 33**		
Phylum Ciliophora				
Ciliados				
Coleps	3	33 33	Presencia Moderada	Tolerante a contaminación orgánica
Vorticella sp	2	22 22	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Phylum	**5**	**55 56**		
Phylum Rotifera				
Rotiferos				
Lepadella sp	1	11 11	Poca Presencia	
Subtotal Phylum	**1**	**11 11**		
Total en Muestreo	**9**	**100**		

Frecuencia Relativa Porciento (F R %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 24 Resultados de la Comunidad de Insectos Acuáticos, Reportados para la Estacion Vado Nuevo Río Torola, 21 de Noviembre de 2001

Orden	Número de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Orden Diptera				
Chironomidae	60	60 61	Dominante	Tolerante a contaminación orgánica
Culicidae	2	2 02	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**62**	**62 63**		
Orden Coleoptera				
Psephenidae				
Coleoptero larva	1	1.01	Esporádica	*Aguas limpias*
Subtotal Orden	**1**	**1 01**		
Orden Ephemeroptera				
Ephemendae	31	31 31	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Orden	**31**	**31 31**		
Orden Trichoptera				
Hydropsychidae	5	5 05	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Orden	**5**	**5 05**		
Total en Muestreo	**99**	**100 00**		

Frecuencia Relativa Porciento (F.R %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 25 Resultados de la Comunidad de Algas, Reportadas para la Estación Nuevo Edén de San Juan
Rio Torola, 8 de Noviembre de 2001

División	celulas por litro	Frecuencia	Categoria	Indicador Biológico
Cyanophyta		Relativa %	de Presencia	
Algas verdes azules				
Anabaena constricta	300 00	1 03	Esporádica	Tolerante a contaminación orgánica
Anabaena sp	150 00	0 52	Esporádica	Tolerante a contaminación orgánica
Anabaena spiroides	*400 00*	*1 38*	*Esporádica*	*Tolerante a contaminación orgánica*
Lyngbya limnetica	150 00	0 52	Esporádica	Tolerante a contaminación orgánica
Lyngbya sp	150 00	0 52	Esporádica	Tolerante a contaminación orgánica
Microcystis holsatica	250 00	0 86	Esporádica	Tolerante a contaminación orgánica
Oscillatona	2,850 00	9 81	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Division	**4,250.00**	**14.63**		
Euglenophyta				
Euglenas				
Phacus tortus	100 00	0 34	Esporádica	Tolerante a contaminación orgánica
Phacus longicaudus	150 00	0 52	Esporádica	Tolerante a contaminación orgánica
Rhodomonas sp	250 00	0 86	Esporádica	Tolerante a contaminación orgánica
Subtotal División	**500 00**	**1 72**		
Chrysophyta				
Diatomeas				
Cymbella ventricosa	50 00	0 17	Esporádica	Aguas Limpias
Diploneis sp	100 00	0 34	Esporádica	Aguas Limpias
Melosira granulata	*15,450 00*	*53 18*	*Abundante*	*Tolerante a contaminación orgánica*
Navicula gracilis	250 00	0 86	Esporádica	Aguas Limpias
Navicula sp	250 00	0 86	Esporádica	Tolerante a contaminación orgánica
Nitzchia sigma	100 00	0 34	Esporádica	Tolerante a contaminación orgánica
Sunrella sp	100 00	0 34	Esporádica	Aguas Limpias
Tabellana sp	100 00	0 34	Esporádica	Tolerante a contaminación orgánica
Subtotal Division	**16,400.00**	**56 45**		
Chlorophyta				
(algas verdes)				
Actinastrum gracillimum	2,600 00	8 95	Poca Presencia	Aguas Limpias
Ankistrodesmus falcatus	300 00	1 03	Esporádica	Aguas Limpias
Coelastrum sp	250 00	0 86	Esporádica	Aguas Limpias
Cosmanum sp	50 00	0 17	Esporádica	Aguas Limpias
Gleobotrys limnetica	450 00	1 55	Esporádica	
Micrastenas radiata	100 00	0 34	Esporádica	
Oocystis sp	150 00	0 52	Esporádica	
Pediastrum simplex	*250 00*	*0 86*	*Esporádica*	*Tolerante a contaminación orgánica*
Radiococcus nimbatus	450 00	1 55	Esporádica	
Scenedesmus java	50 00	0 17	Esporádica	
Scenedesmus quadricauda	100 00	0 34	Esporádica	Tolerante a contaminación orgánica
Sphaerocystis sp	2,950 00	10 15	Poca Presencia	
Staurastrum leptocladium	200 00	0 69	Esporádica	Tolerante a contaminación orgánica
Subtotal Division	**7,900.00**	**27.19**		
Total en Muestreo	**29,050.00**	**100.00**		

Frecuencia Relativa Porciento (F.R. %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60.99	Abundante
61 - 100	Dominante

TABLA 26 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Nuevo Edén de San Juan, Río Torola, 8 de Noviembre de 2001

Phylum	Numero de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Phylum Sarcodina				
"Amibas"				
Amoeba radiosa	3	15 79	Poca Presencia	Tolerante a contaminación orgánica
Thecamoeba sp	1	5 26	Poca Presencia	Tolerante a contaminación organica
Arcella discoide	2	10 53	Poca Presencia	
Hyalosphenia sp	3	15 79	Poca Presencia	
Vahlkampfia limax	3	15 79	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**12**	**63 16**		
Phylum Ciliophora				
Ciliados				
Coleps hirtus	3	15 79	Poca Presencia	Tolerante a contaminación orgánica
Vorticella sp	1	5 26	Poca Presencia	Tolerante a contaminación orgánica
Litonotus fasciola	1	5 26	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**5**	**26.32**		
Phylum Rotifera				
Rotifera				
Dicranophorus sp	2	10 53	Poca Presencia	
Subtotal Phylum	**2**	**10 53**		
Total Muestreo	**19**	**100.00**		

Frecuencia Relativa Porciento (F R %)	Presencia de Organismos Categoria
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 27 Resultados de la Comunidad de Algas, Reportadas para la Estación Nuevo Edén de San Juan, Río Torola, 21 de Noviembre de 2001

División	celulas por litro	Frecuencia	Categoria	Indicador Biológico
Cyanophyta		**Relativa %**	**de Presencia**	
Algas verdes azules				
Oscillatona sp	1,800	0 23	Esporádica	Tolerante a contaminación orgánica
Subtotal Division	**1,800**	**0 23**		
Euglenophyta				
Euglenas				
Phacus tortus	50	0 01	Esporádica	Tolerante a contaminación orgánica
Subtotal Division	**50**	**0.01**		
Chrysophyta				
Diatomeas				
Melosira granulata	768,000	97 91	Dominante	Tolerante a contaminación orgánica
Synedra sp	1,250	0 16	Esporádica	
Subtotal Division	**769,250**	**98.07**		
Chlorophyta				
(algas verdes)				
Actinastrum gracillimum	2,400	0 31	Esporádica	
Ankistrodesmus falcatus	100	0 01	Esporádica	
Closterium lunula	100	0 01	Esporádica	
Cosmarium sp	100	0 01	Esporádica	
Gleobotrys limnetica	7,200	0 92	Esporádica	
Oocystis sp	3,000	0 38	Esporádica	
Pediastrum simplex	100	0 01	Esporádica	Tolerante a contaminación orgánica
Radiococcus nimbatus	250	0 03	Esporádica	
Scenedesmus java	50	0 01	Esporádica	Tolerante a contaminación orgánica
Subtotal Division	**13,300**	**1 70**		
Total en Muestreo	**784,400**	**100 00**		

Frecuencia Relativa Porciento (F.R. %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante

TABLA 28 Resultados de la Comunidad de Protozoos y Zooplancton Reportados para la Estación Nuevo Edén de San Juan, Río Torola, 21 de Noviembre de 2001

Phylum	Numero de Organismos	Frecuencia Relativa %	Categoria de Presencia	Indicador Biológico
Phylum Sarcodina				
"Amibas"				
Arcella discoide	2	15 38	Poca Presencia	
Hyalosphenia sp	2	15 38	Poca Presencia	
Vahlkampfia limax	3	23 08	Presencia Moderada	Tolerante a contaminación orgánica
Subtotal Phylum	**7**	**53 85**		
Phylum Ciliophora				
Ciliados				
Coleps hirtus	3	23 08	Presencia Moderada	Tolerante a contaminación orgánica
Vorticella sp	1	7 69	Poca Presencia	Tolerante a contaminación orgánica
Chilodonella sp	2	15 38	Poca Presencia	Tolerante a contaminación orgánica
Subtotal Phylum	**6**	**46.15**		
Total Muestreo	**13**	**100.00**		

Frecuencia Relativa Porciento (F.R. %)	**Presencia de Organismos Categoria**
0 - 1 99	Esporádica
2 - 20 99	Poca Presencia
21 - 40 99	Moderada
41 - 60 99	Abundante
61 - 100	Dominante