



EL MOLINO AND SAN MATIAS HYDROELECTRIC PROJECTS

ENVIRONMENTAL IMPACT STUDY VOLUME III OF VI CHAPTER 8

DOCUMENT 2148-04-EV-ST-020-08

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8 MONITORING AND EVALUATION PLAN

By means of monitoring and follow-up it will check the efficiency and effectiveness of the programs rose in the Environmental Management Plan, which is introduced in chapter 7 of this report, in order to bring them into line with the actual conditions that may arise during the construction of the facilities.

Table 8-1 presents monitoring, follow-up programs and a cost summary.

Table 8-1 Tracking and monitoring Programs

Programs	Costs (\$)
Monitoring of wastewater management.	31,548,800
Monitoring of surface water	64,545,600
Monitoring of benthic communities	25,200,000
Monitoring air quality and noise	128,000,000
Monitoring of fish fauna	16,200,000
Monitoring of terrestrial habitats	30,733,400
Monitoring of the social environment	12,450,000
Total	308,677,800

8.1 ABIOTIC ENVIRONMENT

8.1.1 Monitoring Program for handling of residual waters.

8.1.1.1 Objectives

Check compliance with the established in the decree 1594 of 1984, on wastewater management

8.1.1.2 Stage:

Construction and operation stages.

8.1.1.3 Impacts to control

- Changes in water quality
- Decrease in the water availability
- Alteration of the river dynamics
- Changes in the physical and chemical properties of the soil

8.1.1.4 Justification

To perform any wastewater discharge to a water current, it must comply with the stipulated in Decree 1594 of 1984, which should be checked during the construction and operation of the plant.

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8.1.1.5 Description of activities

For the monitoring of wastewater, residual water samples should be taken, before and after the treatment, to analyze the required parameters (pH, temperature, fats and oils, suspended solids and DBO₅). The procedure, must comply with the established in the guide for monitoring discharges, surface and groundwater water of the IDEAM.

8.1.1.6 Implementation Schedule

This strategy will begin from the beginning of the works, doing four (4) monitoring in the first year (one per quarter), in order to verify the proper functioning of the treatment.

After the second year, monitoring will take place every six months.

8.1.1.7 Budget (direct, Staff)

Monitoring will take place at the discharge sites, camp offices areas, portals of the tunnels and in the deposits area.

Table 8-2 Budget of direct cost and staff

Item	Unit	Value (\$)	Quantity	Total (\$)
Staff Costs by monitoring				1,500,000
Engineer	H-month	1,500,000	1	1,500,000
Direct Costs by monitoring				2,443,600
Vehicle	Day	350,000	1	350,000
Laboratory Tests	Point	117,600	11	1,293,600
Report	SG			800,000
By monitoring Cost				3,943,600
Annual Cost				15,774,400
Total Cost				31,548,800

8.1.1.8 Responsible

The HMV Engineers will be responsible, as owner of the project

8.1.2 Program for monitoring surface water

8.1.2.1 Objectives

Check that the quality of surface waters in the influence area of the El Molino hydroelectric project is not being affected by the construction or operation.

8.1.2.2 Stage:

Construction and operation stages.

8.1.2.3 Impacts to control

- Changes in water quality and availability

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- Changes in the physical and chemical properties of the soil
- Alteration of the river dynamics

8.1.2.4 Justification

During the construction of the project will be carried out activities such as the removal of vegetation, surface excavations and the operation of camps, which will generate solid and liquid material that can affect the quality of surface waters in the area, which should be verified and in case of happening the necessary corrective action is taken.

In addition, the construction of the conduction tunnel, can affect the resource availability of the different creeks that it crosses.

8.1.2.5 Description of activities

The monitoring and follow up will be conducted in accordance with the IDEAM protocols.

Samples should be taken at the four (4) monitored sites in this study, and will evaluate the following parameters: Dissolved oxygen (DO), pH, electrical conductivity, water temperature, biochemical oxygen demand (BOD), Chemical Oxygen Demand (COD), suspended solids, dissolved solids, total solids, turbidity, total coliforms, fecal coliforms, total nitrogen (NKT), nitrite (NO₂), nitrates (NO₃), ammonium (NH₃), alkalinity, hardness, sulphates (SO₄), Chloride (Cl), total phosphorus, orthophosphates, iron.

Also appraisals will be made in the main currents that cross the conduction tunnel, to detect potential involvement that the construction work is causing. To these flows will also be presented an analysis of environmental isotopes (H₂ and Oxygen 18)

8.1.2.6 Implementation Schedule

Monitoring will take place biannually, running the first one before starting the construction work, covering two hydrological periods (summer and winter).

8.1.2.7 Budget

Table 8-3 presents the budget by monitoring and the total value of the program

8.1.2.8 Responsible

HMV Engineers, as owner of the project.

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Table 8-3 Budget of direct cost and staff

Item	Unit	Value (\$)	Quantity	Total (\$)
Staff Costs by monitoring				1,750,000
Engineer	H-month	1,500,000	1	1,500,000
Appraiser	H-month	1,000,000	0.25	250,000
Direct Costs by monitoring				3,907,600
Vehicle	Day	350,000	2	700,000
Laboratory Tests	Point	426,900	4	1,707,600
Appraiser Equipment Rental	Day	500,000	2	1,000,000
Report	SG			500,000
By monitoring Cost				5,657,600
Sub total				33,945,600
Analysis of environmental isotopes				
Staff Costs				1,600,000
Auxiliary engineering	Day	100,000	1	100,000
Engineer	Day	300,000	5	1,500,000
Direct Costs by monitoring				950,000
Vehicle	Day	350,000	1	350,000
Laboratory Tests	Point	100,000	5	500,000
Report	SG			100,000
By monitoring Cost				2,550,000
Sub total				30,600,000
Total Cost				64,545,600

8.1.3 Program for monitoring the benthic communities

8.1.3.1 Objectives

Evaluate the water quality of the San Matias River through the follow-up of the benthic community's structure in epiphytic algae and invertebrates.

8.1.3.2 Stage:

Construction and operation.

8.1.3.3 Impacts to control

- Changes in water quality
- Changes in water availability

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- Changes in the San Matias River fish community
- Changes in the structure of the aquatic biotope and biocenosis.

8.1.3.4 Justification

This strategy has as its purpose, the monitoring of aquatic communities that develop into the different ecosystems in the project area, which will be useful to assess the evolution of the environment with the presence of the project.

8.1.3.5 Description of activities

Monitoring of epiphytic algae, through the collection of samples by plastics brushes of adhering material to substrate (rocks, logs, leaf litter), who are immersed in the river bed of the San Matias River.

In addition to the analysis of the macro invertebrates, samples should be taken by qualitative manual collection, covering a representative area and removing the vegetation of the shores, the bottom and lifting stones, rocks and submerged plant material.

8.1.3.6 Implementation Schedule

Monitoring will take place biannually, performing the first one before starting the construction of the facilities, covering two hydrological periods (summer and winter).

8.1.3.7 Budget (direct, Staff)

It is monitored in the same three stages that were sampled for the preparation of this study.

Table 8-4 Budget of direct cost and staff

	Unit	Value (\$)	Quantity	Total (\$)
Staff Costs by monitoring				3,000,000
Invertebrate Biologist	H-month	1,500,000	1	1,500,000
Biologist Algae	H-month	1,500,000	1	1,500,000
Direct Costs by monitoring				1,200,000
Vehicle	Day	350,000	2	700,000
Report	SG			500,000
By monitoring Cost				4,200,000
Total Cost				25,200,000

8.1.3.8 Responsible

HMV Engineers, as owner of the project

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8.1.4 Program for monitoring air quality and noise

8.1.4.1 Objectives

Evaluate the air quality in the influence area of the project, making it possible to verify the efficiency of the outlined measures in the management strategies for the control of particulate material, gases and noise.

8.1.4.2 Stage:

Construction and operation stages.

8.1.4.3 Impacts to control

- Increasing the concentration of particulate material and gases
- Increase in sound pressure levels
- Empowerment of conflicts
- Generation of expectations

8.1.4.4 Justification

In the influence area of the project no sources exist that modify the air quality, which can be affected by the construction of the project as it will perform removal of vegetation, will increase the transit of vehicles and there will be land movements, which are elements that can affect parameters such as concentration of particulate material and gases also the noise increase.

8.1.4.5 Description of activities

Monitoring will take place in the points at which the study was developed for the base line.

- The parameters on which monitoring must be performed are:
- Particulate material. It will analyze the levels of total suspended particulates (TSP). The monitoring will be carried out according to what is established in Resolution 601 of April of 2007.
- Environmental noise. There will be a monitoring of ambient noise levels. The monitoring will be carried out based on the guidelines set forth in the resolution 627 of April of 2007.
- Gases. Shall be sampled CO, NO₂, SO₂, in accordance with the established procedures in Resolution 601 of April of 2007.

8.1.4.6 Implementation Schedule

According to the progress of the work activities, monitoring will be carried out on the air quality, gases and noise, at least once a year, as described below:

First monitoring: will begin a month before starting the construction of the project, to update the terms of the base line,

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Second monitoring: in the second quarter of the first year of construction, where will be the starting of activities of the Construction phase, such as access roads, the weir and the collection facilities, tunnel and tubing, excavations of the power house.

Third monitoring : in the second quarter of the second year of construction where there will be a medium advance in the activities implemented in the Construction phase, such as access roads, the weir and the collection facilities, tunnel and piping, excavations of the power house.

Fourth monitoring: in the first quarter of the third year of construction where the construction of the project is already culminated.

If there is some delay in the implementation of the project construction activities, the performance of the monitoring of air quality and noise will be subject to the implementation of the activities described above.

8.1.4.7 Budget (direct, Staff)

By monitoring the costs it includes the value of the staff and the equipment to be used for monitoring. The cost is presented in Table 8-5 is for monitoring in the construction stage, 4 monitoring programs are proposed.

Table 8-5 Budget of direct cost and staff

Item	Unit	Total value (\$)	Comments
Displacement	Global	2,000,000	For 4 sampling points
Air Quality (PM10, PST, SO2, NO2, CO, meteorological station)	Global	25,000,000	
Noise (day and night)	Global	5,000,000	
Cost		32,000,000	
Total Cost		128,000,000	

8.1.4.8 Responsible

HMV engineers, as owner of the project

8.2 BIOTIC ENVIRONMENT

8.2.1 Monitoring Program of fish fauna.

8.2.1.1 Objectives

Assess the changes that are occurring in the Ichthyic fauna in the tier where there will be a reduction in flow, between collection and discharge.

8.2.1.2 Stage:

Construction and operation stages.

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8.2.1.3 Impacts to control

- Changes in water quality
- Decrease in the water availability
- Changes in the fish community of San Matias River.
- Changes in the structure of the aquatic biotope and biocenosis.

8.2.1.4 Justification

For the El Molino hydroelectric project it was established an Instream flow, which seeks to diminish the effects on the aquatic fauna, in the stretch where there is a reduction in flow. With the monitoring of the Ichthyic fauna, will analyze the changes that have been presented in it.

8.2.1.5 Description of activities

Stretches of 100 m were sampled, in the same sampling sites that were used for the characterization of the base line of this study, in order to assess the greatest amount of meso habitats (pools, rapids, ponds) present in the stretch that has suffered reduction in flow.

8.2.1.6 Implementation Schedule

Monitoring will take place biannually, performing the first one before starting the construction of the facilities, covering two hydrological periods (summer and winter).

8.2.1.7 Budget (direct, Staff)

Monitored the same three stages that were sampled for the preparation of this study.

	Unit	Value (\$)	Quantity	Total (\$)
Staff Costs by monitoring				1,500,000
Fish Biologist	H-month	1,500,000	1	1,500,000
Direct Costs by monitoring				1,200,000
Vehicle	Day	350,000	2	700,000
Report	SG			500,000
By monitoring Cost				2,700,000
Total Cost				16,200,000

8.2.2 Monitoring Program for terrestrial habitats

8.2.2.1 Objectives

- Monitor the existing vegetation covering in the influence area of the project.
- Evaluate and monitor some biotic groups in its composition and structure.

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8.2.2.2 Stage:

Construction and operation

8.2.2.3 Evaluation of impact

- Changes in vegetation covering
- Loss or fragmentation of habitats
- Death and displacement of fauna species
- Modification of the landscape

8.2.2.4 Justification

In the influence area of the project are located vegetation covering in different succession stages and degrees of involvement. With the construction of the project, many of them will be supervised, some of which represent key habitats for the biota of the region, so there must be a follow-up to the changes that appear.

8.2.2.5 Description of activities

The monitoring program is intended to track vegetation covering and assess both spatially and temporarily, particular aspects such as structure, composition and dynamics of their communities and the population status of endangered species and with conservation priorities, the following activities are proposed.

Monitoring parcels: Shall be established in permanent parcels that will be monitored every two years; in them shall be measured the diametric increase of the initially registered individuals, will include the new recruited individuals with diameter greater than 10 cm DAP, and at the same time will register the mortality of trees.

Follow-up of plant species: In inventories conducted by the RAP, general collections and the permanent parcels will determine the presence and location of species with conservation priorities. It is intended to make a population-based study and ecologic data of these species from methods that determine its population structure, density, phenology, pollination, seed dispersal, soils, slopes and reliefs where they grow and relations with the fauna.

8.2.2.6 Timetable

The first monitoring will take place before construction begins, once the land is negotiated, which will run every two years

8.2.2.7 Budget

Table 8-6 shows the costs of this monitoring program

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Table 8-6 Budget of direct cost and staff

Item	Unit	Value:	Quantity	Total (\$)
Personal Cost				6,816,700
Forest Engineer	Month	1,500,000	1	1,500,000
Biologist	Month	1,500,000	1	1,500,000
Auxiliary engineering	Month	1,000,000	1	1,000,000
Workers	Month	566,700	1	566,700
Extra expenses	Day	50,000	45	2,250,000
Direct Costs				8,550,000
Vehicle	Day	350,000	15	5,250,000
Expendable Items	SG			1,200,000
Report	SG			1,000,000
Equipment Rental	SG			1,100,000
Cost of one monitoring				15,366,700
Total Cost				30,733,400

8.2.2.8 Responsible

HMV Engineers, as owner of the project.

8.3 SOCIAL ENVIRONMENT, STRATEGIES FOR MONITORING AND TRACKING

8.3.1 Objectives

- Perform a periodic follow-up on the implementation programs of the defined Environmental Management Plan.
- Use the verification tools proposed in each program of the Environmental Management Plan -PMA.
- Identify the relevant variables of the zone where the project is inserted, which can submit changes by the presence of El Molino hydroelectric project.
- Establish indicators that can carry out monitoring, associating external variables with the scope and activities raised within each program of the management plan.

8.3.2 Stage:

Construction and operation stages.

8.3.3 Impacts to control

- Changes in governance levels
- Effects on the cultural heritage

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- Empowerment of conflicts
- Displacement of infrastructure and housing
- Changes in population dynamics
- Increase in the demand for goods and services
- Changes in employment levels
- Modification of the municipal finances and environmental corporations
- Generation of expectations.

8.3.4 Justification

The follow-up of each program of the Environmental Management Plan of the social environment, with the review of the proposed verification tools, will ensure a good socio-environmental management, which promotes the permanence and security of the project.

Equally by performing a periodic follow up on the Environmental Management Plan, associated with the identified environmental impacts, expedite and updated assessment processes by the environmental authority at the time when needed.

The presence of a project in which have been identified significant impacts, long-term and even permanent, brings with it changes and externalities, both positive and negative, whose variables are important for its measurement at certain periods.

8.3.5 Description of activities

In the social areas monitoring has been taken over as the follow-up of the implementation plans, programs and projects. World Bank (1989) defines the monitoring as a continuous evaluation of the programs and projects, with regard to the timetable of implementation, the use of the resources and infrastructure and the use of services by the beneficiaries ¹

While monitoring contributes to the follow up and evaluation of the Management Plan implementation, they cannot be confused, because every one of them demands strategies, resources, and different approaches for its development.

The follow-up consists in the observation, recording and systematizing the implementation of the activities and tasks of a social project in terms of resources, carried out activities, the time and planned budgets, as well as their modifications, in such a way to know the progress of the project and the corrective measures that must be performed.

The monitoring of social aspects requires identifying the relevant variables in the region, on which it is considered that there may be altered by the presence of the facilities, or which are considered significant to measure and evaluate as the socio-economic state, cultural and political structure of a region.

¹ Quoted by: CORREA, Elena. Socio-economic impacts of large-scale projects. National Energy Financial -fund FEN, 1999.

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In the following monitoring and evaluation plan it is emphasized that their approach is toward the topics and the variables that derive from a Plan of Social Management by the effects that the construction and operation of the hydroelectric project The Popal caused to the environment in a social dimension.

8.3.5.1 Follow up

The activities to be carried out during follow up include:

- **Pursuit of goals.**

For each one of the specified goals the Management Plan programs are responsible, will follow the proposed goals in the programs with the indicated frequency for each one of them.

- **Evaluation of applications, complaints and claims**

With the format presented in section 7.4.1 of this study, the information program and community participation, are recorded complaints, requests and claims made by the community. These will be channeled through the social staff of the Environmental Management Group, who will route the request to the employee that is responsible, and shall establish a time limit for responding to the community. In this process, collate the number and cause of the complaints and claims and will generate an indicator on the conclusion of each request (i.e., a response where you have finalized the process).

Table 8-7 presents the verification list of compliance with the Environmental Management Plan programs for the social aspects.

8.3.5.2 Monitoring

The monitoring of the socio-economic aspects associated with the construction and operation of the project requires identifying relevant variables in the area, on which it is considered that they may be altered by the presence of the facilities.

This is to build reliable indicators that can measure changes in the time of some variables that may be modified by the management measures of the project.

Among the variables that may be used to perform these annual monitoring, are:

- Number of jobs generated each year by the project.
- Unemployment rate in the municipalities of Cocorná and Granada.
- Economic activities carried out by the population of the project influence area.
- New economic activities, which emerged after the construction of the initiated project.

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Table 8-7 List of verification

ENVIRONMENTAL MANAGEMENT PLAN EL MOLINO HYDROELECTRIC PROJECT ENVIRONMENTAL MONITORING CHART: Management Plan Programs.			
Interventionist Company:			
Issue date:			
SUBJECT	Yes:	NO	COMMENTS
Was it reported to 100% of the communities in the influence area of the project?			
The response to 100% of the requests, complaints and claims of the community, has been timely?			
Has the evaluations been made to the meeting attendants?			
Has the environmental education program trained all the staff that has entered?			
Has the trained staff completed the evaluation survey?			
Is the staff satisfied with the training?			
Has local staff been hired in regard to unskilled labor?			
Has totality of the sites required for the construction of the project been negotiated?			
Is the population satisfied with the carried out negotiation process?			
Has it been assessed the changes in residence places of the population, was their resettlement negotiated?			
Was a methodology established for the payment of homes, businesses and recognition of the economic activities that have been affected by the project?			
Are the complaints and claims documented with respect to the negotiation of houses and infrastructure once completed?			
_____	_____		
Vo. Bo. Supervision	Vo. Bo. Responsible		

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Coverage of the public services in the influence area of the project.

Housing conditions, in terms of quality and overcrowding

8.3.6 Implementation Schedule

Follow-up activities will be carried out monthly and the monitoring will be annually

8.3.7 Budget (direct, Staff)

The costs for follow-up activities are included within the cost of the Supervision Group.

For monitoring should be hired a person to collect the information for the evaluation of the indicators and development reports.

	Unit	Value (\$)	Quantity	Total (\$)
Staff Cost				1,900,000
Social Area Professional	H-month	1,500,000	1	1,500,000
Extra expenses	Day	50,000	8	400,000
Direct Costs				2,250,000
Vehicle	Days	350,000	5	1,750,000
Report	SG			500,000
Cost of one monitoring				4,150,000
Cost during construction				12,450,000

8.3.8 Responsible

The owner of the project