

ATTACHMENT 1

ANALYSIS OF ENVIRONMENTAL IMPACTS

1. Project Review and Environmental Impact Statement

A substantial effort has been devoted to understanding the environmental aspects of the Project and assuring that environmental issues have been addressed and programmed to be mitigated as appropriate. All such efforts indicate that the Project is environmentally sound and poses no adverse threat to its surroundings or inhabitants.

In accordance with Chapter 1, Article 10 of the Electric Power Act, proposals for electricity generation must include an environmental impact assessment, based on an environmental impact study. The Project Environmental Impact (EIS) has been completed and approval has been received from the National Environmental Commission (CONAMA, now the MARN), for the original EIS as well as for an Addendum provided one year later. As required by law, each of CONAMA's technical advisory board members has approved the EIS. The advisory board was made up of 13 members representing government offices and Non-government Organizations (NGO).

CONAMA, the Guatemalan body charged with the evaluation of all environmental impact studies, has recently been upgraded to the Ministry of the Environment and Natural Resources, (MARN) (Ministry). All previous approvals are current and valid under the Ministry.

As the Project Company has progressed through permitting and environmental review over the past three years, there have been revisions to the Project design to reduce the impacts. All Project revisions, as presented in an update report to the EIS, represent positive changes in design or operations procedures in response to specific environmental needs and concerns. Revisions include such measures as lowering the dam height in order to assure that the reservoir does not encroach on Protected Area lands, and consideration of a new re-regulating dam downstream of the powerhouse to provide adequate control of river flow for safety and environmental purposes. The updated information provided in the update report does not require any further approvals. In order to assure quality and continuity throughout the permitting and review process, the Project Company has utilized the same environmental consultant for studies and EIS development. HRH commissioned Defensores to prepare a base line of the watershed, including vegetation, mammals, birds, reptiles and insects, including migrating species. This will serve as a control basis to measure the impacts of the construction period in the watershed.

As all issues raised in the EIS have been addressed through design/planning and will be addressed satisfactorily upon initiation of construction, there is significant support for the Project by Defensores, the Ministry, and El Consejo Nacional de Areas Protegidas (CONAP).

HRH is working in conjunction with the Defensores to develop work plans proposed in the EIS report.

2. Studies and Approvals Completed to Date

The table below provides an overview of Project studies and related environmental approvals completed since 1994. All studies and approvals have been developed in cooperation with appropriate permitting agencies and officials.

Study / Approval	Purpose	Prepared By	Approved By	Date
Engineering Feasibility	Feasibility study of the	TAMS / EBASCO	NA	1994

Study	Project.			
Environmental Impact Study	Identification of environmental resources and impacts associated with the Project.	AMBIO	CONAMA	April 30, 1997
Feasibility Study of 1000 meter head – seismology, hydrology and geology.	Evaluation of the feasibility of critical aspects of an expanded project, presenting several capacity options.	Benham Group	NA	1997
Addendum to Environmental Impact Study	Evaluation and proposed mitigation of impacts identified in the original Environmental Impact Study.	AMBIO	CONAMA	December 21, 1998
Geology Study for key project features.	Indepth geologic analysis of specific Project features such as the damsite and powerhouse site.	Swissboring	NA	1994, 1998 and 1999
Engineering Studies	Design studies associated with various Project features	Harza, Cypsa, ENRON, Benham	NA	1995-1999
Hydrology Verification Study	Analyze and confirm Project hydrology.	ENRON / Raytheon	NA	1999
Study for Qualifications on Joint Implementation	Determine the amount of CO2 displacement to the Project related to the base line of Guatemala	ENRON / John Palmisano (an expert in climate change and carbon fixation)	Oficina Guatemalteca de Implementación Conjunta and USIJI	June 25, 1999
Engineering Project Feasibility	Complete Project evaluation including topography, penstock alignment, access road analysis, quarry sites, review of optimal dam types.	ENRON / Harza	NA	1999
NEAST Studies	Electric norms for connection to the transmission system.	Power Technologies Incorporated	CNEE	October 7, 1999
Engineering Design Studies	Preliminary engineering design for preparation of the Project Information Memorandum.	Harza	NA	2000, 2001
Water Rights	Legal formality of the General Electricity Law.	Project Company	Ministry of Energy and Mines	November 2001
Project Registration	Legal formality of the General Electricity Law.	Project Company	Ministry of Energy and Mines	November 2001
Construction Permits	Final construction permit for the Town of Rio Hondo.	Project Company	Municipality of Rio Hondo	February 2005 (est)

Base Line of the Watershed	Basis for environmental impact control and immediate mitigation	Defensores de la Naturaleza	NA	January 2005
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Based upon the level of analysis and consultation that has occurred surrounding this project, the Sponsors believe that if this project was in the United States, that under NEPA guidelines a Finding of No Significant Impact (FONSI) would be made.

3. The Sierra de las Minas Biosphere Reserve and Protected Area

The Project is located in the area of the Sierra de las Minas Biosphere Reserve and Protected Area. The Biosphere Reserve totals 4,374 km² and is zoned into a nuclear area (1057 km²), which contains 81% of the existing cloud forests; sustainable-use zone (346 km²); experimental forest recovery zone (42 km²); and buffer zone (920 km²). The reserve was created by legislative decree in October 1990 and is managed by the Fundacion Defensores de la Naturaleza (Defensores). The Defensores is the first non-profit private organization (NGO) that has been given the management of a major Guatemalan reserve. The Defensores sponsors an innovative relationship with local communities, which share in overseeing the management process

The Sierra de las Minas is part of UNESCO's Man and the Biosphere (MAB) program and is also on the United Nations list of Protected Areas, classified as an International Union for Conservation of Nature and Natural Resources (IUCN) Category VI Zone. According to data provided by Defensores, nearly 70% of all reported birds, mammals, fish, amphibians, and reptiles of Guatemala and Belize are present in this natural reserve (approximately 885 species).

As an example, the golden-cheeked Warbler, designated as a US Endangered Species in 1990, nests in central Texas and migrates to Central America to winter. The Biosphere Reserve is critical wintering habitat for the golden-cheeked Warbler. The Project Company supports the long term preservation of this critical habitat, and is compliant with all guidelines and principles set forth by UNESCO, the IUCN, the Manager of the Sierra de las Minas, and Defensores, as they apply to the area.

As reported by others (<http://nmnhwww.si.edu/botany/projects/centres/minas.htm#F>), the Biosphere Reserve faces a number of threats:

- 1 Deforestation with consequent erosion constantly threatens. Indiscriminate timber extraction has resulted in a removal rate beyond the system's capacity for sustainable management, with probable germplasm degradation. There also are insufficient reforestation projects.
- 2 On the Motagua Valley slopes, fire destroys large areas of forest every year as the agricultural frontier advances. Moreover, this devastation occurs as well on steep slopes that are not adequate for agriculture, and their natural regeneration is very slow.
- 3 Colonization by displaced Q'eqch'is is a potential threat because of their non-sustainable cut, slash and burn monoculture and lack of soil conservation practices. Vegetable cultivation on a large scale is being promoted by development agencies, but is not necessarily a good idea because insufficient attention has been given to erosion control and soil degradation in these fields and to loss of water quality. Indiscriminate hunting for subsistence and recreation is a problem. Large-scale community education is needed, as well as ongoing studies on the effects of agricultural practices on soil structure.

4. Coordination with Fundacion Defensores de la Naturaleza

The uppermost portions of the Project enter into the sustainable-use and buffer zones of the Biosphere Reserve. The Project Company has worked closely with the Fundacion Defensores de la Naturaleza (Defensores) in all aspects of environmental review and consideration for the Project. Defensores fully supports the Project as a very positive proposal that does not adversely affect the environment and will provide several environmental benefits as follows:

- The Project acts as an entry barrier to public access in the environmentally sensitive nucleus zone of the Reserve,
- The access road associated with the Project provides Defensores with better access for observation, research and fire fighting,
- The Project will build within its construction camp, a Centre for Investigation that after the project is built, will be donated to Defensores and CONAP to work together with Universidad el Valle de Guatemala for studies in the protected area.
- The Project reservoir provides water for fire fighting, regulating the control of water for irrigation and promotion of bio-diversity,
- The Project offers opportunities for cooperative programs for conservation of forests/soils as well as reforestation and recovery of degraded lands.
- As part of the socioeconomic and environmental aspects of the Project, programs will be developed to support general education needs, infrastructure, and environmental education in the local area.
- The Project Company has a planned a reforestation program, which will recuperate large extensions in the sustainable buffer zone areas.

The Project Company and Defensores signed an Agreement on September 6, 2001 committing to cooperation and joint action to develop specific work plans for the conservation of bio-diversity and sustainable development. In general, the parties have agreed to work together toward:

- 1 Conservation, protection and management of forests and soils;
- 2 Safe and timely fire control and prevention;
- 3 Reforestation and recovery of degraded lands; and
- 4 Control of human access to the Project area of Sierra de las Minas Biosphere Reserve.

The Agreement also includes a process that will allow for programs that will support economic development in neighbouring communities and promote continuing environmental education and research. Each program will be planned and developed cooperatively with Defensores and others as appropriate. The entire Agreement can be found in the Reference section of this report. Work to implement this Agreement has already begun.

5. Hydrology and Ecosystems

The Project does not adversely disrupt hydrology and does not require inundation of large land areas. The reservoir created by the regulating dam serves to store water during seasonal high runoff periods for a subsequent controlled release. Due to the limited size of the reservoir, the Project cannot provide complete flood control but will dampen the effects of a flood.

The most beneficial aspect of the reservoir will be to provide a programmed release of stored water during the dry season. Control of the releases during the dry season will increase the

efficiency of the irrigation and water supply withdrawal systems downstream of the Project.

Upstream effects will be limited to an inundation area of 13.5 hectares of land, none of which encroach upon the Nucleus area of the Biosphere Reserve. As a reference, the World Bank/IUCN Guidelines established in 1997 cite that a ratio of >200 kilowatts per hectare of inundation characterizes a low impact storage facility. By this measure, the Project would be considered exceptional, as the Project provides 32,000 kW per 13.5 hectares, a ratio of 2,370.

None of the Project area is inhabited. There will be no negative social impacts related to relocation.

Due to the solid rock geology in the area between the reservoir and powerhouse site, little or no groundwater infiltration is expected to occur in the bypass reach of the Project. Also, due to the Project's inability to alter the hydrograph on a large scale basis, there are no expected impacts to groundwater supplies downstream of the Project. An ecological flow release has been incorporated into the Project's design to further mitigate any unexpected impacts that might occur as a result of altering the flow regime in the bypassed reach of the stream.

6. Environmental Compliance During Construction

In order to assure appropriate environmental oversight during construction, an environmental compliance team will be funded by the Project Company and managed by Defensores in cooperation with the Project Company.

7. Mitigation and Enhancement Measures

As a result of the studies conducted in association with the Project and the development/approval of the EIS, the Project Company has committed to carry out appropriate and meaningful mitigation measures that address environmental impacts related to the construction and operation of the Project. The table below summarizes the mitigation measures resulting from review and approval of the EIS. The Project will rely on a comprehensive environmental mitigation strategy and plan to be implemented during and after construction. This plan will be prepared by the Project Company and Defensores once a start of construction date has been confirmed.

In addition, several enhancement measures are planned where the Project creates opportunities to provide support and improvements to existing or proposed programs.

Suggested Actions and Mitigation Measures Proposed in the Environmental Impact Study

Issue to be Addressed	Description of Issue	Planned Response or Mitigation Measure
PLANNING PHASE		
Dam Height	The dam height should be reduced to a level where it is certain that the reservoir does not encroach on the Protected Area.	The dam height design has been reduced by 12 meters in order to assure that the reservoir does not encroach on the Protected Area.
Forest Regeneration	In the multiple use zones, Project cooperation is requested in the establishment of a natural regeneration forest.	Based upon extensive discussion and planning with several levels of Defensores, it has been agreed that the Project will implement a program to address this concern upon initiation of construction. The first phase of the program will include funding for graduate students of the Universidad del Valle for initiation of forest coverage evaluation

		and recommendations.
Agreement with Municipality	In order to assure that concerns of the local community are addressed, it is requested that the Project Company enter into an agreement with the Rio Hondo Municipality, stating the intent to preserve the natural resources. A detailed work plan should be drafted with Defensores and CONAP.	An Agreement has been signed between Defensores and the Project Company. There have been several visits to the Rio Hondo Municipality, and the agreements will be formalized at the start of construction.
Control of Wild Fires	The potential for wild fires in the area is a concern, with fires occurring annually. It is requested that preventive measures be taken, especially during March and April.	Based upon extensive discussion with Defensores on this subject, a plan has been developed to install fire watch towers in appropriate locations when construction starts. The towers will be operated by Defensores under a budget provided by the Project.
Land/soil conservation	To assure appropriate land and soil conservation, the development of a plan to address erosion control for slopes and steep areas will be necessary.	An erosion control and management plan will be developed in cooperation with Defensores prior to initiation of construction. Coordination of the plan will include involvement of graduate students preparing theses in related subject areas.
CONSTRUCTION PHASE		
Rock quarry Restoration	Upon completion of excavation of the rock quarry, restoration of the topsoil and re-vegetation with local plant species is suggested.	A rock quarry site restoration and re-vegetation plan will be included in the mitigation measures for the Project.
Penstock access roads	Due to the high gradient of the land it is expected that, if penstock access roads are installed, there will be large amounts of earth movement.	Optimal routing of access roads will be evaluated with the goal of minimizing earth movement. The feasibility of installation of a rail system will be reviewed. A final decision to determine the best alternative will be made based on environmental considerations and a cost-benefit analysis.
Roads	Access roads required for Project construction and operation could facilitate the access of unwanted persons into the protected areas of the Biosphere Reserve.	The original plan was to access the upper regions of the Project through the village of Jones. Access now will be through the marble quarry which will restrict access and provide better fire fighting response coverage.
Use of Dynamite	It is recommended that caution be used with explosives in order avoid damage or landslides.	If dynamite needs to be used, a professional contractor will be hired to assure careful planning and implementation.
Slopes	When the height of a slope exceeds 3 meters, it should be stabilized. Also, vegetation with large roots should not be removed in order to avoid landslides.	All engineering studies will include appropriate safety measures for roadwork.
Ditches adjacent to roads	High velocity flow in ditches with high gradients may cause damage or erosion.	Applicable engineering techniques, such as placement of rock in ditches or use of other appropriate measures to reduce flow velocities, will be implemented to assure

		safety and environmental considerations.
Construction residues	Residues of construction should not be placed near the rivers or streams in the region. Specific sites for residue disposal should be identified, compacted and mixed with organic material. Upon completion of construction, an additional .5 meter of organic material should be placed over the sites and appropriate re-vegetation should be completed. Maintenance of the sites to ensure restoration of the vegetation should be provided for at least 4 years.	Engineering studies will address the residue disposal issue in order to provide environmentally acceptable disposal and treatment of sites. The restoration of vegetation will be provided and maintained for five years.
Extraction of raw materials	Extraction of raw materials will be allowed outside of the nucleus zone. Based upon site evaluations of the flora and fauna of the feasible extraction sites, relocation of specific species may be necessary.	A plan to address the selection and treatment of extraction sites will be drafted with Defensores once road construction starts.
Reservoir clearing	Before filling the reservoir, trees and biomass should be removed in order to maintain water quality.	Although the inundation area is very rocky, a plan for removal of trees and biomass where necessary will be drafted in cooperation with Defensores.
Campsites	By preferences, small campsites are desirable, and located near land that has been modified by men, near the powerhouse or Talisquite.	All engineering studies will be made to place campsites in the less disturbing sites.
Information to Local Citizens	Local citizens should be kept informed regarding Project activities, such as the use of dynamite.	Information will be provided to local citizens periodically as needed for updates on key Project activities.
Environmental Education	An environmental briefing to assure environmental measures and commitments related to the Project should be provided to all permanent and temporary employees, contractors and other personnel associated with the Project.	Prior to start of construction, an environmental briefing and training program will be provided for employees and others associated with the Project.
Evidence of old cultures	Prior to initiation of construction, the Project Owner should contact the Instituto de Antropología y Historia) IDAEH for an inspection to determine whether there is evidence of old cultures within the Project site.	A letter will be sent to IDAEH asking for an expert to review the site prior to start of construction. If evidence of old cultures is found within the Project site, it will be removed utilizing appropriate techniques and transferred to another location for protection as necessary. In general it is unlikely that any evidence will be found, as local flooding caused by Hurricane Mitch is believed to have washed away any meaningful evidence of old cultures.
Periodic Inspections	Periodic inspections should be conducted in the reservoir area to control landslides.	All engineering inspections will be carried out according to the best engineering practices.
Control of activities not allowed in the project area	The Project Owner should take actions to assure that there will be no hunting, use of trees for fires, sale of archaeological treasures, or sale of flora and fauna during	This will be included in the training program for all employees, and supervision will be established during the construction and operation phases.

	construction.	
Control of roads	Control of access roads should be provided in order to reduce the possibility of wood-cutting.	Security will be placed at specific locations on roads as appropriate.
Operation Phase		
Ecological flow	In order not to impact the riverbed life, a 70 L/sec of ecological flow should be established.	An ecological flow of 70 L/sec has been provided for in the design of the dam and in the operations plan.
Sedimentation	Sedimentation should be controlled in the reservoir area.	Engineering studies will be implemented to address this measure.
Air in tunnel	Air should be allowed in the tunnel to avoid contamination of methane and hydrogen sulfuric.	Engineering studies will be implemented to address this measure.
Preventive and corrective maintenance program	All construction features and installations should be inspected according to their characteristics as appropriate. Inspections should also include the areas surrounding the hydro project, such as re-vegetated areas and adjacent woods.	A maintenance plan will be implemented to comply with this requirement.