

CHILE
Chacabuquito Hydroelectric Project
Environmental Assessment
Executive Summary

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Introduction

The proposed run-of-the river Chacabuquito Hydroelectric Project in Chile involves the continued use of tailrace water from Hidroelectrica Aconcagua, S.A.'s existing 39 MW Los Quilos plant (much of this water has been used upstream at the 81 MW Aconcagua hydroelectric plant — the other Hidroelectrica Aconcaqua S.A. asset). Additional electricity production will be supplied to meet industrial and commercial demand from sectors and activities such as electricity distribution (Chilquinta Los Andes – San Felipe), automobile (Automotora Franco Chilena), melting (Fundición Chagres), cement (Cemento Melon) and mining (Codelco-Andina).

The project will require improved access to the south bank of the Rio Aconcagua. Two new bridges will be built, existing "roads" will be upgraded (for example, the existing road to the head of the penstock which is near an existing public quarry), and new roads built (alongside the canals and a .5 km road to the larger of the two spoils or waste disposal sites).

This annex summarizes the findings of the following technical and environmental carried out by Hidroelectrica Guardiavieja, S.A.: environmental studies (Declaration de Impacto Ambiental-Proyecto Central Hidroelectrica Chacabuquito y Proyecto Sub Estacion Electrica y Linea de Alta Tension, EDIC Ingenieros Limitada.); hydrological studies (Estudio Hidrológico Caudales Medios Mensuales Río Aconcagua y Río Colorado; Estudio Hidrológico de Crecidas de Quebradas); geotechnical studies (Estudio Geotécnico para la construcción de los túneles de aducción).

The Environmental Assessment Report (EA) was submitted to the World Bank for review and it conforms fully to Bank policy guidelines regarding environmental and social issues. As designed this category B project complies with the World Bank's environmental and social safeguard policies.

Environmental Assessment Process and Legal Framework

Chilean Law 19.300 of 1994, effective in 1997, established an Environmental Impact Assessment System (SEIA) in the country. This system requires projects to either prepare a full scale EIA or, for projects with lesser or insignificant impacts, an Environmental Impact Statement (DIA) would be required. Review and clearance of all EIAs or DIAs is a prerequisite for an environmental license issued by the National Commission for the Environment (CONAMA).

In 1996, the project was granted a waiver such that it would not be required to follow the SEIA from the Regional CONAMA (Comision Regional del Medio Ambiente de la V Region de Valparaiso). Nevertheless, in October 2000, the project completed an Environmental Impact Statement.

Perhaps the most environmentally and socially sensitive issue associated with the proposed project will be hydrological imbalance along the 10 km stretch of the Aconcagua River between the intake and the plant discharge. Although environmental or ecological considerations are not explicitly included in the current Chilean Water Code (Codigo Nacional de Aguas), during the last five years Chile has introduced the concept of environmental demand in the allocation of water rights. This concept is also included in the Environmental Impact System Law. New initiatives to modify the Water Code have included issues such as "minimum ecological flows" for the preservation of water resources and biodiversity, specially of endangered or endemic species. The General Water Directorate (Direccion General de Agua. DGA) is the public entity in charge of the definition of these minimum ecological flows. A Bank project under preparation (Chile Water Resources Management Project) would support DGA in the definition of methodologies for establishing minimum water flows for the conservation of freshwater biodiversity. DGA requested that the Chacabuquito project sponsors estimate minimum ecological flows for the stretch the Aconcagua River that would be affected by the

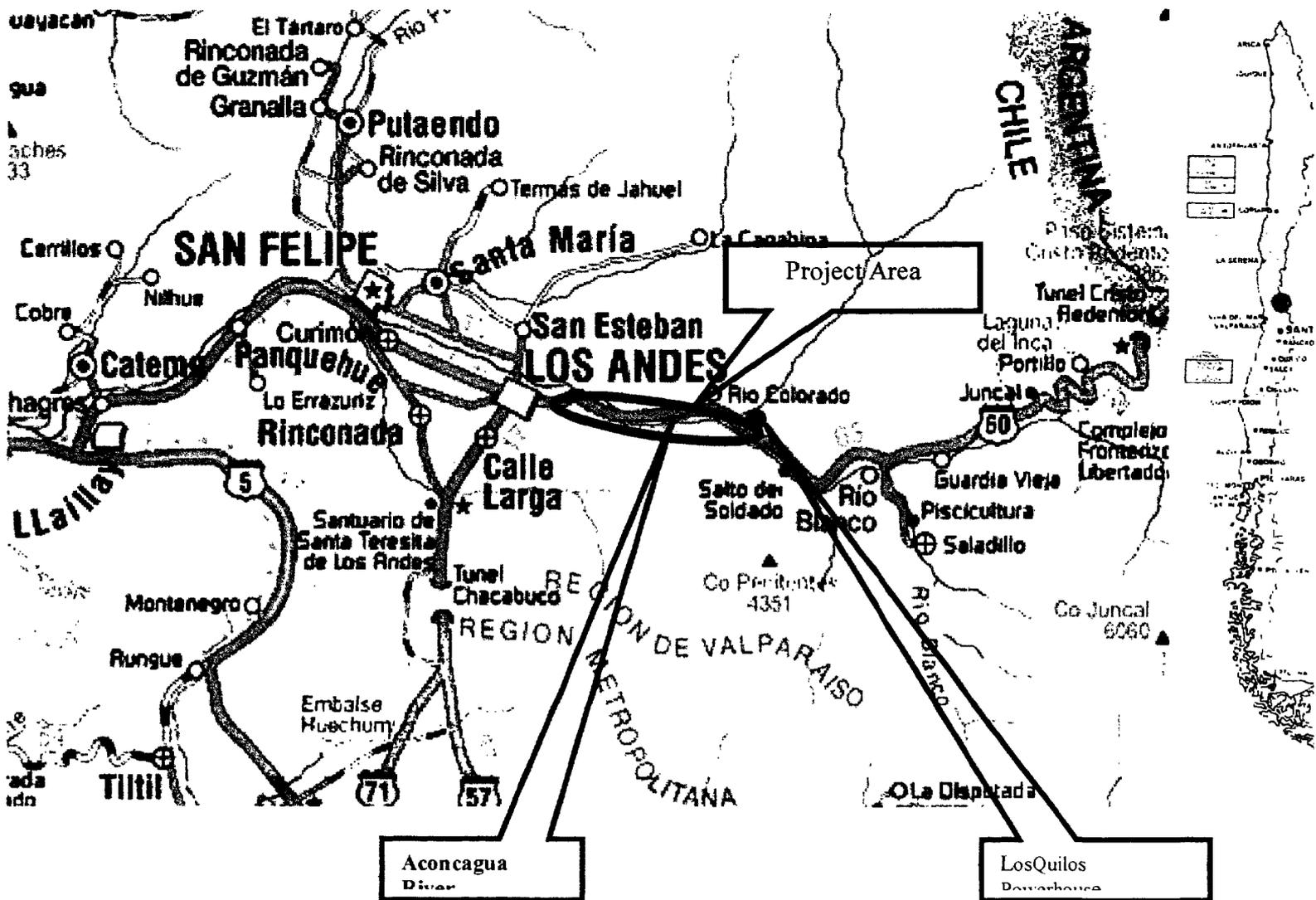
project. In-depth hydrological analysis was carried out and minimum ecological flows were determined using a wide range of methodologies. DGA established a minimum of 3 m³/s as a minimum flow for that stretch of the river .

Environmental Setting

The project will be located on the Rio Aconcagua, 10 km upstream of Los Andes (Region V), Chile (see Figure 1). A necessary and important element of the EA was the baseline research that analyzed the physical, ecological, and social characteristics of the project area. Although the project area is not highly complex particularly from the socio-economic and ecological perspectives, an environmental baseline was needed to highlight locations of highest potential impact.

The watershed has been long intervened by human settlements, mining activities and hydroelectric projects that date over 40 years. The region is served by an international highway with heavy traffic (3600 vehicles per day on average). Camp sites, hotels and other recreational areas have sprawled along the highway. In addition to the highway, the area is crisscrossed by power transmission lines, a railroad from the copper mines upstream, and irrigation canals that feed agricultural activities in the valley downstream. The most relevant characteristics of the project’s area of influence which supports the assurance of minimum potential impacts are:

Figure N° 1: Project and Watershed Location



Hydrology : The Aconcagua River Watershed raises up to 6.140 m to the Nevado del Juncal. The watershed is enclosed in a steep canyon that lowers to a 190 km long valley before its discharge into the Atlantic Ocean. Snow melting in the spring and summer influences the large fluctuations in river flows that are characteristic of the river (see Figure 2).

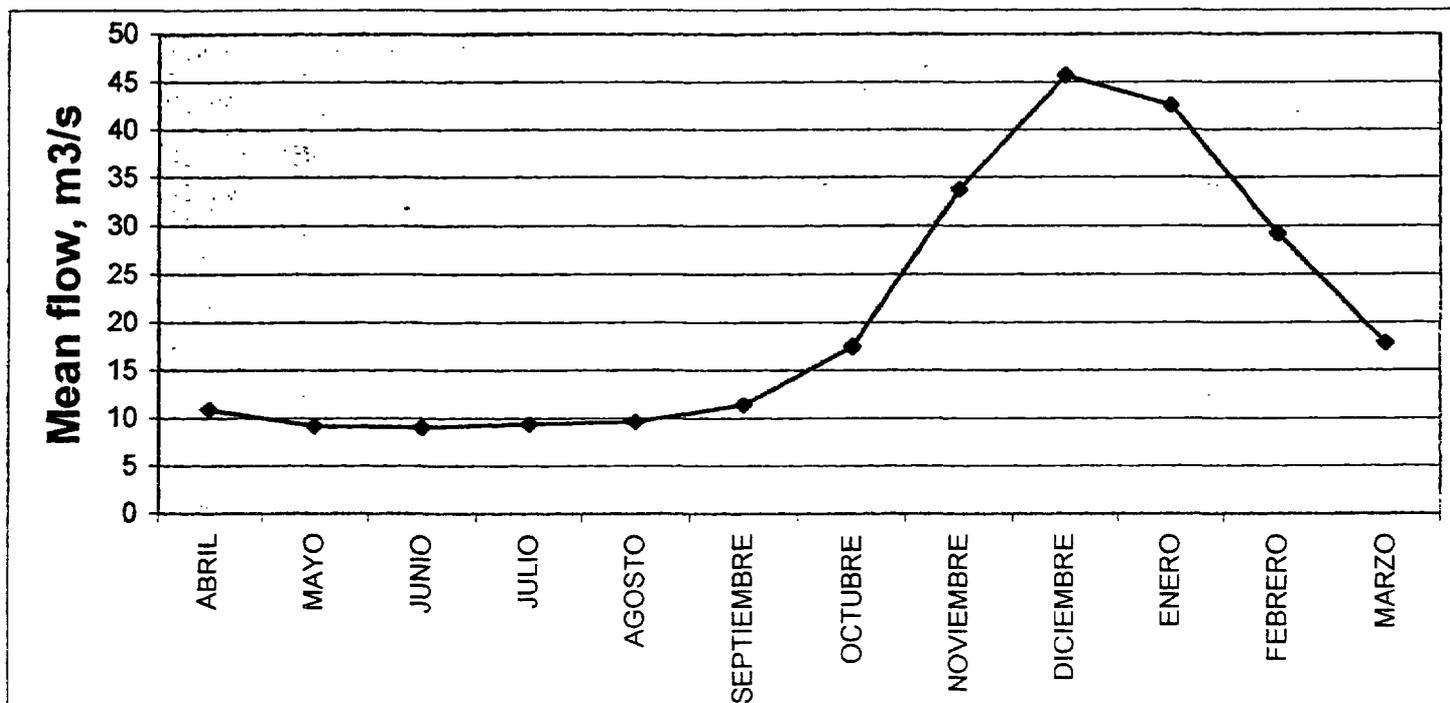


Figure N° 2 Mean water flows – Aconcagua River at Los Quilos
Source: DGA

The Juncal and Colorado rivers are the main upstream streams affluent to the Aconcagua. They present abundant water flows and are currently being used for the Los Quilos and the Guardia Vieja run-of-the-river power plants. The Colorado stream has excellent water quality while the Juncal presents symptoms of copper pollution from mining activities upstream. All of the flow of the Juncal is almost completely used up downstream of the Guardia Vieja for the Los Quilos Plant. However, the river recovers rapidly because of a series of streams and groundwater recharge.

Flora and Fauna: The vegetation of the area of the project has been reduced to a few patches of riverine vegetation and some scrubs of dry forest with some remnants of native vegetation. Foreign species have also been introduced along the area. There are no known critical natural habitats in the area of the project. The project will not dam any part of the river, consume water through the process or affect by construction activities or operation the overall surface water balance, groundwater recharge areas, wetlands or any other aquatic ecosystem. There will not be any transbasin transfer of water.

Only two species of concern (as defined by the National Forestry Commission, CONAF) still can be seen in the area, specially on the southern side of the river: Guayacán (*Porlieria chilensis*) and Algarrobo (*Prosopis chilensis*). Some individuals were identified in the area of the proposed tunnels.

Because of the continuous disturbances in river flows from the existing power plants and specially pollution from the Codelco copper operations upstream, the Rio Aconcagua is devoid of any fish life. Native species such as Pocha, Bagre and Pejerrey have all but disappeared from the area. The introduction of foreign species (Trucha café, Trucha arcoiris,

Dorado and Carpa) for aquiculture has also contributed to the loss of freshwater biodiversity of all rivers in the watershed. Trout can still be found in the stagnant areas and bends of the Colorado river upstream.

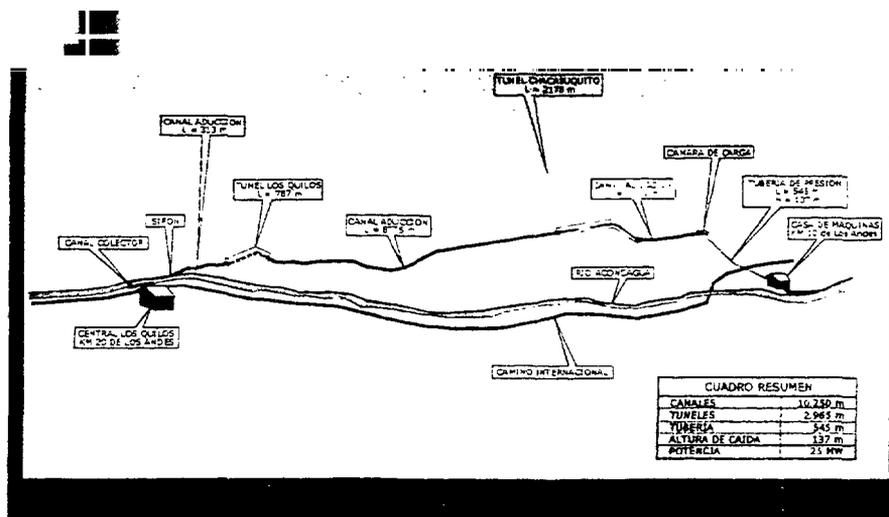
Social Aspects: The host environment is semi-arid, scrub forest and thinly populated with the exception of the narrow river valley. No extensive agriculture is practiced in this area and there are no indigenous people. Communities along the river have a piped potable water supply system from a rural system that takes water from the upper watershed. Rural electrification is almost 100 % in the area. Hence, the removal of 21 m³/sec of water from the Rio Aconcagua for an additional 10 km will not result in any significant ecological or social impact. The water rights for the Chacabuquito project (issued by DGA) include the obligation to release 18 m³/sec to the Rio Aconcagua to meet the water requirement for an existing downstream power plant and to provide water in the river to satisfy downstream agricultural needs (a program separate from that of the Los Quilos Canal). The project includes a water supply program for the downstream agricultural community fashioned after the existing program at the Los Quilos project.

Project Description

The schematic of Figure 2 presents the proposed project. Except for the new regulating reservoir (Las Vizcachas), all project facilities will be on the south bank of the Rio Aconcagua downstream of the existing Los Quilos plant. Canals and tunnels and the penstock will take the 21.5 m³/sec from the Los Quilos plant through a series of canals and tunnels over a distance of approximately 10 km to a 440 m long and 137 meter head penstock to the 25 MW Chacabuquito power house. From the power house, the 21.5 m³/sec will be discharged back to the Rio Aconcagua at Chacabuquito to meet the project's water right requirement to supply 18 m³/sec to a downstream existing hydro plant and to satisfy irrigation users. The diversion works will be above an existing railway (Codelco) and the higher Los Quilos Canal (1.25 m³/sec maximum; 0.5 m³/sec average) which takes Rio Aconcagua water at Los Quilos to agricultural communities downstream (the project canals and tunnels will transport the 1.25 m³/sec maximum; 0.5 m³/sec average now carried by the Los Quilos Canal to the vicinity of the penstock where it will be returned to the Los Quilos Canal).

The project includes a new 500 meter, 110 kV transmission line to the existing transmission line connecting the two existing projects to the Sistema Inter-conectado Central (SIC) west of Los Andes. Two new bridges to the south bank to access the project, are under construction and short new roads will need to be constructed and existing roads upgraded (for example, the existing road up to the head of the penstock). The project's main characteristics are summarized in the following Box.

Figure 2: Project Scheme



Project Details Physical Infrastructure <ul style="list-style-type: none"> ■ 11 km of open channel ■ 2 tunnels (in total 3 km) ■ Pressure Penstock: 400m ■ Water Fall: 137m ■ 4 Francis turbines ■ 500 m of 100kV High Voltage Line (interconnection with HGV System) ■ Upgrade of existing transmission system ■ Construction Timing: 15 months 	Generation <ul style="list-style-type: none"> ■ Power: 25 MW (4 x 5.5 MW nominal, 7.5 MW maximum Francis turbines) ■ Annual Net Generation: 160 GWh ■ Flow: 21,5 m³/s ■ Placed at 13 Km down river from Los Quilos Budget <ul style="list-style-type: none"> ■ Total Budget: US\$ 37,1 million including 5% of contingencies
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Two disposal sites for construction wastes, earth cuts and tunnel materials (approximately 600.000 m³ total, of which 350.000 m³ will be used as earth fill and base material for the project's main infrastructure) have been identified: one close to the Los Quilos Powerhouse and a second one near the Chacabuquito powerhouse. The Los Quilos site covers an area of 3.5 has. On top of a soccer field belonging to the Los Quilos Plant (the field would be rehabilitated after raising the level up to 3 meters). The second site covers an area of 3.3 has. belonging to the municipality. A site restoration and revegetation program will be implemented at this site.

The international Road from Los Andes – to Mendoza in Argentina is the main road in the entire area in addition to some secondary and rural roads that connect settlements and camps along that highway. Most of these roads will be used during construction of the project. However, the construction and future maintenance of canals and other infrastructure on the southern side of the Aconcagua river will require the construction of two bridges across the river and the upgrading of some of these roads. The selection of bridge sites was based on technical considerations (stability of river embankments), the needs of the project (access to sites) and the requests of local population living on the southern part of the river that saw these bridges as an improvement to their mobility.

Environmental Impacts

Water Quality and Quantity: Run-of-the river projects are considered benign to water quality. No major changes in water quality are expected from the Chacabuquito plant. In addition, ongoing agricultural practices in the valley and pollution from upstream mines are the main cause of the deterioration of water quality for the entire watershed.

The water intake needed for the project and the proposed further use of the Los Quilos power plant discharge, will affect water flows and water levels in approximately a 13 Km stretch of the Aconcagua River between the Los Quilos Plant and the Chacabuquito power plant discharge. Chilean legislation now require the definition of a minimum ecological flow to avoid or minimize severe impacts on aquatic ecosystems. Existing regulations would not allow for a completed drying up of any segment of the river right now.

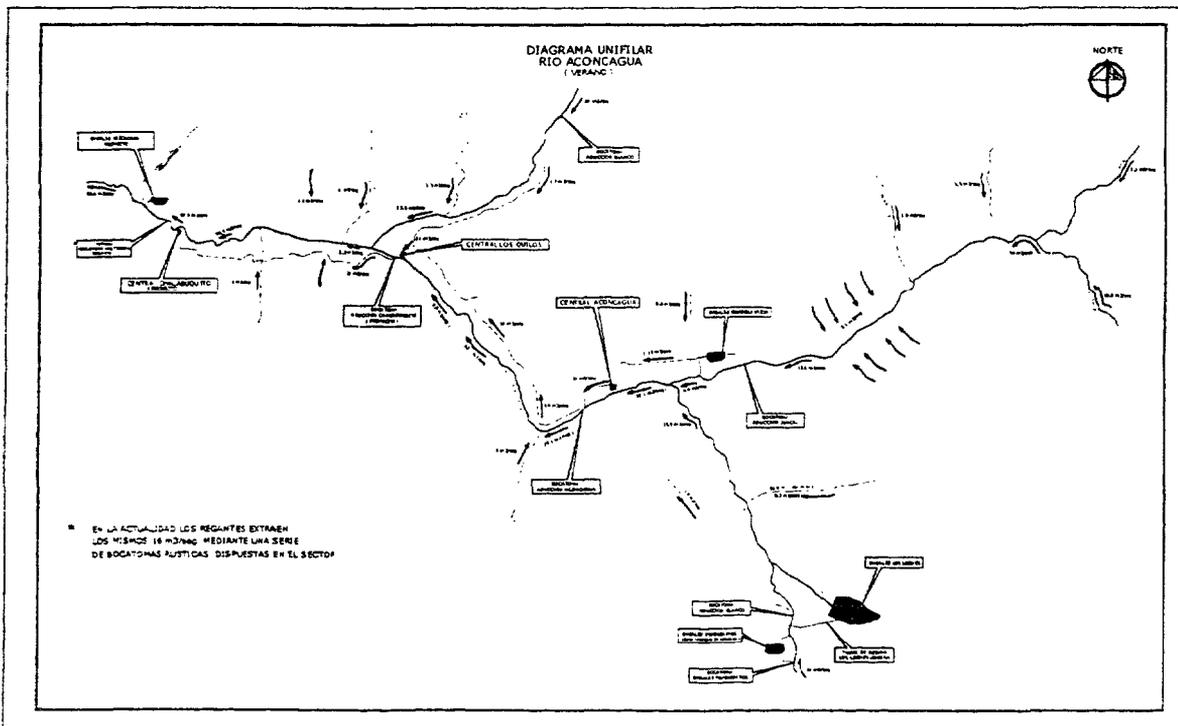
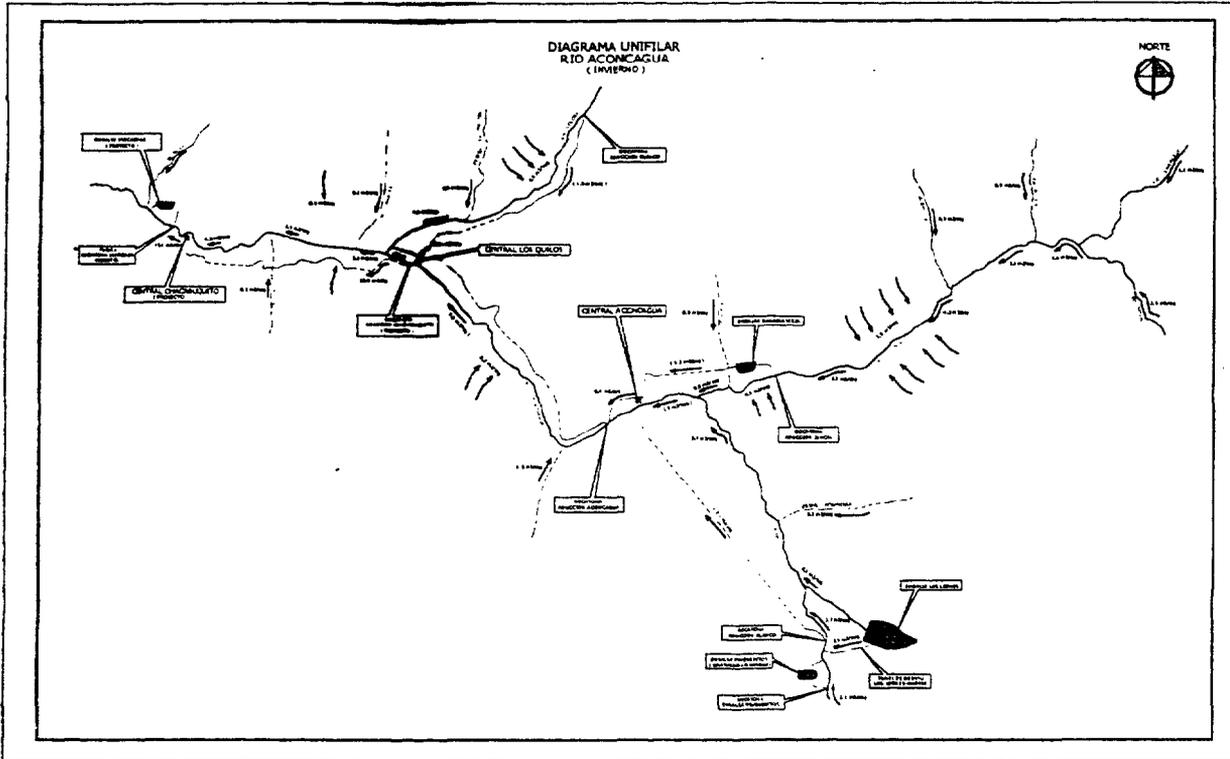
The project commissioned a specific study to analyze and propose minimum ecological flows in that stretch of the Aconcagua river. Although there is limited experience in the application of methodologies for determining minimum ecological flows in any river, it is generally accepted that minimum ecological flows represent those flows that maintain the 'sustainability' of a given aquatic ecosystem and its biological functions. Though with certain limitations, several methodologies, based on a wide diversity of criteria and mathematical models, have been tried both nationally and internationally. These methodologies still suffer from a high degree of uncertainty and subjectivity and are further limited by the complex interactions between water flows and the functions of aquatic ecosystems. However, these methodologies have proved to be useful in many similar situations. The following table presents the estimated minimum ecological flows for the Aconcagua River Based on the most commonly used methodologies, in addition to estimates carried out by DGA in 1993.

Minimum Ecological Flows for the Aconcagua River

Methodology	Estimated Minimum Ecological Flow, Q (m ³ /s)
Tennant Method Establishes a minimum of 10% of mean annual flow in order to guarantee fish survival	2,00
Wet Perimeter Based on flow and wet perimeter of the river which guarantees sufficient aquatic habitat for fish (spawning, migrations, feeding, etc.)	1,30
Swiss Legislation Establishes Q ₃₄₇ or mean annual flow that is overcome 347 times per year	2,29
Minimum depth for fish survival Based on predominant species; in this case a 20 cm minimum depth was established for endemic species (that have but all disappeared from the river); 20 cm has been commonly used in Chile and	0,84
DGA study, 1993 Stretch of the Aconcagua River: Rio Colorado – San Felipe	3,70

Based on the above referenced DGA study and their own analysis, and considering the baseline conditions of the river (low biodiversity, multiple users, sources of pollution) the DGA established a minimum ecological flow of 3 m³/s (Official resolutions in project files). This minimum flow is considered adequate and any potentially negative impacts on aquatic biodiversity are further minimized by the presence of a major affluent to the Aconcagua downstream from the intake. In addition to several minor streams, the Colorado River has a mean monthly flow of 11.6 m³/s, and discharges water of excellent quality just 1 km downstream from the Chacabuquito intake. A favorable impact from this situation would be the improvement of water quality in that stretch of the river as the higher polluted discharge from the Los Quilos plant would be delivered further downstream. Hydrological balances for the entire watershed for the winter and summer seasons are presented in the figures of the following page and provide assurance that hydrological impacts will be kept at a minimum and the stretch of the river will always have sufficient water.

Biodiversity Impacts: three potential impacts were identified: (i) clearing of native vegetation; (ii) clearing of trees of some ecological concern; and (iii) increasing hydrological imbalance in the river. With the exception of clearance of some vegetation (18 has ha in the right of way of canals), which includes some species of concern, the impact of the project on biodiversity will be minimal. Freshwater biodiversity will not be affected (almost non-existent anyway) while that minimum ecological flow required by the DHA will guarantee that riverine vegetation remains unchanged along the 10 km stretch. watershed to the lagoon. Impact on fisheries was also deemed of low magnitude and importance as native species have all but disappeared from the watershed. Although scarce, most trout(an introduced species) takes place in areas upstream of the project. Biological activity along the Aconcagua river is almost non-existent.



Social Impacts: Careful selection of Right-of-Way (ROW) alignments for all canals, penstock and transmission line avoided any major need for resettlement of families. Most of the ROW traverse steep slopes of the canyon on the southern part of the river. Only one dwelling will have to be relocated and the project will build a new house on a site within the

same lot. The construction of the two access bridges over the Aconcagua is seen by all communities (specially Villa Aconcagua) as perhaps the most positive impact of this project. Existing crossings only allow for pedestrian traffic while the new ones will allow all modes of transportation. The new short access roads from the bridges to the canals will be maintained by the project sponsors.

Construction of civil works will not entail significant inflow of new workers to the area. Project constructors will have to hire local workers as possible and no worker's camps will be allowed. Bus transportation from villages and Los Andes to work sites will be the responsibility of the contractor. Food services will also be contracted with local restaurants near the work sites.

Land uptake has been kept to a minimum. In addition to land already owned by Hidroelectrica Aconcagua, S.A., land had to be either acquired or compensated for from four private landowners and a Region V holding (.5 hectares). All agreements have been completed in accordance with the Electricity Act (all were negotiated without the involvement of the courts). One individual in the vicinity of the penstock will be moved 100 meters. His "lean-to" shack will be replaced with a brick house. There are no indigenous people in the project area.

On the north bank, just downstream of the Los Quilos plant there is a regulating reservoir. At this point, water is stored at night and released in early morning to offset the impact of the peaking plant on river flow and to meet the Los Quilos water right obligation to satisfy downstream agricultural water requirements. This practice will be continued when the Chacabuquito plant is complete. In agreement with water users downstream, an additional regulating reservoir will be constructed (Vizcachas) on the north bank just downstream of the Chacabuquito plant, and an additional intake direct water from the Rio Aconcagua to an existing 1.8-km canal terminating at the new reservoir. It will operate similar to the existing reservoir upstream near Los Quilos. The company and the "Junta de Vigilancia Rio Aconcagua" have extended their existing agreement in this area (Agreement in project files).

Construction Impacts. The construction of civil works (channels, penstock, power plant) will entail potentially negative impacts on communities and surrounding natural habitats however of temporary nature. The proper management of excavation materials, river and drainage crossings, and the reduction of nuisances such as dust, noise, increased traffic, pedestrian safety, will necessitate careful engineering planning, closed supervision, and a continuous and intense community information program. All environmental requirements for construction will be part of an Environmental Construction Manual which will be enforced by the engineering supervision firm. These specifications will be disseminated and explained to local communities.

Cultural Heritage: Neither channels and transmission lines alignments nor the power plant site affect sites of historical or archaeological value. An archaeological survey carried out for those sites did not identify any evidence of potential or chance findings. The report was validated by the Chilean Archeological Agency. The projects will not generate visual impacts that could affect the tourist or scenic value of the area. The proposed channels are aligned in parallel to existing linear projects (railroad, irrigation canals, transmission lines). Canals will be located on the southern part of the river, quite a distance from the well traveled international road. The powerhouse facilities will be located at a site scarcely visible from the international highway.

Community and Stakeholder Consultation

Extensive consultation and negotiations have taken place with downstream water users (Asociacion de Usuarios del Rio Aconcagua, and Asociacion de Regantes) concerning the need to relocate the compensatory reservoir. An agreement (in project file) was reached to build a new compensatory reservoir downstream the Chacabuquito power plant. Hidroelectrica Guardia Vieja SA will cover the cost of construction and maintenance of this compensating reservoir. Individual agreements were reached with each property owner (also in project files). All in all, consultations have been extensive with the owners of the Los Quilos Canal, the downstream farmers, and the affected landowners. The latter consultations resulted in several reroutes for the canals (for example, at entrance to the "Tunnel Chacabuquito").

Environmental Management Plan

The EA report recommends a number of measures to mitigate environmental impacts during the construction and implementation phases.

Minimum Ecological Flow: Perhaps the most important environmental measure for the project. Guardia Vieja S.A. is required by law to keep this minimum flow in the stretch of Aconcagua River affected by the project. This requirement will be monitored by DGA.

Land Acquisition and Compensation: The land acquisition/compensation process has been completed. Details are shown in Box 2.

Box 2: Details of land acquisition and compensation plan

- 15 hectares of land owned by Señor C. Schiess will be impacted by the canals (he owns 50,000 hectares in the area);
- 9 hectares of land owned by Señor San Nicolas will be impacted by the canals (he owns 200 hectares in the area, and 2,000 hectares elsewhere);
- 0.5 hectare of land belonging to Region V will be impacted by the canals;
- along the penstock, one individual (Señor Casanova) will be relocated. He will be moved 100 meters to a site selected by his family and a brick home will replace his existing "lean-to", within his own parcel;
- at the power house site, 3 hectares were bought from a private owner (and a new road built to their existing house); and,
- 3 hectares for the large spoils area is privately owned (the spoils will be resoiled and the restored area will be suitable for agriculture). (The restored small spoils area will become a soccer pitch).

Reforestation Plan : In addition, any tree removed due to construction activity needs to be compensated for by adhering to the "Corporacion Nacional Forestal (CONAF) requirement of planting three trees for every tree cut. However, the density of trees is quite low. A Management Plan for Clearing of Vegetation and Reforestation for the Chacabuquito Project (Plan de Manejo de Corata dy Reforestacion en Obras Civiles, Proyecto Chacabuquito, January 2001) was approved by CONAF in February, 2001 (the Plan and the Official resolution are in project files). The Plan requires the reforestation of 18 has. in an area owned by the project's sponsors but selected by CONAF within the Los Andes municipality. All reforestation will be with native vegetation, including species of concern, for a total estimated of 28.000 trees to be planted. The Plan establishes the protection of riverine vegetation along two streams that cannot be cleared during construction activities. Cutting of algarrobo and guayacan will be avoided as possible, and these trees will have to be clearly identified prior to initiation of construction activities.

Environmental Management during Construction: Environmental and social mitigatory measures to be implemented during the construction phase: are included in technical specifications that will be included in bidding documents and Supervision of the Construction as part of the civil works supervision contract. These specifications have already been prepared for all construction activities (burrow pits, transportation of materials, river crossings, protection of properties and include specific prohibitions for: (i) cutting of trees outside the approved ROW for construction purposes, firewood or for any other purposes; (ii) hunting of birds, mammals or any fauna in the area; (iii) oil changes, maintenance of equipment, vehicles will not be allowed in or near streams and can only be carried out in maintenance yards (, the contractor will included his bid how he will deal with contingencies from oil or lubricant spills) ; (iv) depositing earth cuts and any other construction waste outside the two approved disposal site; (v) prohibition of fires and the need to have fire control equipment in each front. Before the closing of any work front the specifications require the implementation of a site restoration and revegetation plan, clean up, repair of any damage to fences or other infrastructure, revegetation of riverine vegetation, and decompacting of soils.

Implementation Capacity

The EMP will be implemented by Guardia Vieja through its contractors and will be enforced by a construction inspection firm contracted by the project sponsors. Environmental specialists will be hired as needed. All activities will be controlled by the Chief Engineer of Guardia Vieja.