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1 INTRODUCTION

This document represents Volume III of the report on the Review on the Environmental Impact Study at Piedade SHS, requested following alterations to the engineering project following the discovery of geological problems at the water channel construction site, as stated in correspondence submitted to FEAM on 12/02/2007, protocol No. F012420/2007.

The basic, consolidated 2000 design and engineering surveys for Piedade SHS were carried out by RA Engenharia e Consultoria and contacted by Piedade Usina Geradora de Energia SA. The project surveys were prepared according to the instructions issued for developing SHS projects and ANEEL regulations, specific Brazilian regulations and guided by previous studies of the area.

After field investigations and analysis of existing surveys, we can safely say that the location specified for the respective SHS works are in good condition for construction, within the criteria established by ANEEL and FEAM.

The proposed hydroelectric project, to generate electricity, is located on the Piedade river, with a dam 50.40 km from its mouth, in the municipal region of Monte Alegre de Minas, with the dam at latitude 18° 41'20” and longitude 49°03'48”.

The hydroelectric project is characterised as a water level plant with a regulating reservoir with a water level at an elevation of 650 m, covering an approximate area of 1.5 square kilometres with a volume of 17.52 x 10^6 at maximum normal N.A.

This Volume consolidates the impacts which must be monitored during the construction, filling and operational phase of the project as well as the environmental programs required to mitigate, monitor and/or offset such impacts.
2 EVALUATION OF POTENTIAL IMPACTS

According to the document "Review of the Environmental Impact Study – EUA – COPAM Process No. 01403/2002/002/2002 – Piedade SHS – March/2007 – Volumes I and II”, filed with FEAM on 28/03/2007 (Protocol No. F026315/2007), the change to the Piedade SHS layout does not invalidate the environmental impacts identified for the development. Therefore, this chapter will re-evaluate the impacts identified previously and possible new impacts arising from construction of Piedade SHS based and the need to change the engineering design, a fact which has already been reported to FEAM in correspondence - Official Notice of Project Amendment - filed on 12/02/2007, under protocol number 012420/2007.

In order to describe and evaluate possible environmental impacts from Piedade SHS construction and operation, we based our analysis on CONAMA Resolution 01/86, published on 17/02/1986.

The potential effects of the impacts were qualified in line with the following criteria:

- Development phase: Planning, Construction, Reservoir Filling and Operation;
- Effect: Positive or negative;
- Type: Direct or indirect;
- Scope: Local or regional;
- Duration: Short, medium or long term;
- Reversibility: Reversible or irreversible;
- Importance: Important or unimportant;
- Magnitude: Low, medium or high;
- Quantifying the final impact: Significant, moderate, not very significant or insignificant.

2.1 Physical Environment

2.1.1 Appearance of areas of erosion based on the action of rainfall and landslides (CEMA, 2002)

Creation of the work site, construction of access roads and industrial installations, execution of power station civil engineering works, execution of substation assembly and civil engineering works and creation of the waste materials deposit, the main components of the development, will alter the physical geography of the land when they are deployed because of earthworks (removal or addition of earth) which could lead to erosion when the subsoil is exposed to the effects of rainfall.

The excavations also alter the natural flow of rainwater running down natural channels. Construction and execution of the main or support structures will be physical barriers which will also alter the natural path taken by rainwater.
In the new reservoir area, various laminar and linear erosion areas were found forming furrows and ravines, as well as larger land movements which could worsen and subsequently silt the future Piedade SHS lake.

Therefore, the risk of areas of erosion from rainfall and landslides is considered a negative, direct, local, long-term, reversible, important, average magnitude and significant impact.

This impact will be minimised by implementing the "Erosion Control and Monitoring Project For the Area Surrounding the Reservoir" and “Project to Recover Areas Degraded by the Development” and “Project to Remove and Store Stripped Soil”.

2.1.2 Appearance of areas of erosion caused by river flow (CEMA, 2002)

Works located directly on the bed or the banks of the Piedade river will alter the dynamics of the river flow and therefore change the pattern of erosion currently seen on these parts of the river. As observed previously, the natural erosion and sedimentation processes on the river bed are small scale and unimportant.

Along this section, where the hydroelectric station will be built, the Piedade river presents no erosion along the river banks, with solid outcrops of basalt or areas of Litolic soil. There is also little evidence of any sedimentation processes. The river bed is made mainly of solid rock which creates white water and waterfalls. No sedimentation process is seen even in backwater areas which normally appear downstream from white-water areas and waterfalls.

The activities listed below will interfere with the flow dynamics and may change the erosion and silting processes, although in some cases not significantly.

Main construction activities
- Construction of the water channel;
- Construction of the tailrace;
- Construction of the dam and spillway.

Auxiliary construction activities
Some activities, directly related to the river bed, will be carried out on an auxiliary basis to the main works, including
- Disassembling the upstream barrier of the water channel;
- Building a cofferdam on the riverbed, diverting water to the water channel/diversion;
- Removing the cofferdam from the river bed;
- Closing off the channel entry with a cofferdam, diverging water down the spillway;
- Closing the water intake cofferdam floodgates.
Therefore, the risk of areas of erosion appearing because of flow dynamics during the main construction activities is considered a negative, direct, local, long-term, reversible, important, high magnitude and significant impact and during the auxiliary construction activities it is considered a negative, direct, local, short term, reversible, important, high magnitude and significant impact.

This impact will be minimised by implementing the "Erosion Control and Monitoring Project For the Area Surrounding the Reservoir", “Project to Recover Areas Degraded by the Development” and “Project to Remove and Store Stripped Soil”.

2.1.3 Likelihood of the appearance of silting processes (CEMA, 2002)

Changes to erosion patterns and flow dynamics are not very significant along this section of the River Piedade, however the lake formed may give rise to sedimentation processes within the reservoir.

Even considering the fact that potential erosion and natural silting in the region are not very prevalent, the silting process within the reservoir may occur, occupying progressively larger spaces within the lake.

This impact will be minimised and monitored by the "Erosion Control and Monitoring Project For the Area Surrounding the Reservoir” and the “Reservoir Silting Monitoring Project”.

Therefore, the risk of areas of reservoir silting caused by rainfall, landslides and flow dynamics is considered a negative, direct, local, long-term, reversible, important, low magnitude and not very significant impact.

2.1.4 Soil degradation caused by civil construction and access ways (CEMA, 2002).

Areas used to deploy equipment, for construction or to store (indirect) waste materials will change the physical characteristics of the soil.

The area which will be used as the work site will contain buildings used as offices, camps, canteens and other social areas and for machinery and vehicle traffic use during construction and deployment of the plant.

At the end of the works, the work site will be demobilized and the area will be reintegrated and/or recovered to avoid unnecessary erosion processes.

This impact will be minimised by implementing the “Project to Recover Areas Degraded by the Development” and “Project to Remove and Store Stripped Soil”.

__________________________________________________________________________
Therefore, the risk of civil construction works and access road creation is considered a negative, direct, local, short-term, reversible, important, low magnitude and not very significant impact.

2.1.5 Changing underground water levels (CEMA, 2002)

Activities which could change underground water levels are the construction of the dam, creation of the reservoir lake and reduction of Piedade river flows in the section between the dam and the power station when the SHS is in operation.

As presented in Chapter 5 - Environmental Diagnosis of the EIA for the Piedade SHS (CEMA/2002), the soundings carried out to identify the underground areas around the main project components did not detect underground water. The sounding holes do not reach the underground water level. These characteristics indicate that impacts from project construction (building the dam and creating the reservoir lake) will be low magnitude.

This impact will be accompanied by the "Underground Water Level Monitoring Project".

Therefore, the risk of civil construction works and access road creation is considered a negative, direct, local, long-term, irreversible, important, low magnitude and not very significant impact.

6.1.1 Loss of Natural Heritage Locally from Filling the Reservoir and TVR Formation

In the new reservoir area, three waterfalls will be affected by the increased water level, 2 located on the "unnamed" and Boa Vista streams, located on the right bank of the Piedade River and the Erson Waterfall located on the Piedade River, thereby erasing their landscape effects (scenic value). Alongside the waterfalls, 4 springs will also be flooded. This will have a direct, local, long-term, irreversible, important, high magnitude, significant and negative effect.

Downstream from the forecast dam location, the Piedade River creates another two waterfalls, one located on property belonging to Mr Francisco Carols Vieira and another known as Usina Velha or Guimarães Waterfall, located on the property of Mr Roosevelt Guimarães Jr.

By damming the river to retain the water in the reservoir, the volume of water in the existing waterfalls will be restricted to a volume corresponding to the project low flow, compromising their visual effect (scenic value). This will have a direct, local, long-term, irreversible, important, high magnitude, significant and negative effect.

These impacts may be minimised and/or managed by the "Natural Heritage Registration Program", "Project to Recover, Rehabilitate and Revegetate Springs and Watercourses" and "Groundwater Monitoring Program".
2.2 BIOTIC ENVIRONMENT

Changes to the Piedade SHS engineering project will not result in the appearance of further environmental impacts on the biotic environment. Mainly based on the increased reservoir area, some previously identified environmental impacts will be intensified, for example vegetation suppression, however in the newly affected areas we found no different types of vegetation from those described in previous studies based on the original design.

The proposed environmental programs to mitigate any impacts will be maintained, however they will be adapted when implemented based on alterations to the project designs.

2.2.1 WATER QUALITY

As project alterations will not interfere in water quality during the project construction phase, we have already presented the impacts evaluated for the Piedade SHS EIA (Cema Consultoria em Meio Ambiente S/C Ltda, 2002) for this phase.

The impacts occurring during the construction phase will be minimised by the "Worksite Sanitation Infrastructure Project" and accompanied by "Limnologic and Water Quality Monitoring Program".

In order to evaluate the impact of the Piedade SHS during the operational phase and to forecast trends in environmental and sanitation quality for the future reservoir, we used the conclusions obtained from the water quality diagnosis (LIMIAR, 2007), and the new development construction plans as well as morphological characteristics and the dwell time of water in the future reservoir. In this specific aspect, we took into account certain important piece of information on the future reservoir morphology, calculating indices to evaluate susceptibility to stratification and eutrophization, as described by Von Sperling (1999).

The physical and chemical quality of the water in the section of the Piedade river running through the SHS area of influence was found to be very stable throughout the hydrological cycle. There are obviously variations in several of the parameters analysed, but these are mainly due to variations in regional climate conditions throughout the year, and could be considered natural fluctuations based on seasonal variations in temperature and rainfall.

The biological communities are also subject to variations depending on the hydrological cycle. Based on the phyto, zooplankton and zoobenthic analysis, we saw no biological loss in terms of species or diversity during the analysis period. The community parameters measured in this water course suggest that the environment is dynamically stable, although there have been previous events which have affected diversity, suggested by the lower levels of phytoplankton. These events may include the construction of upstream dams and modifications to land usage, such as the removal of the original vegetation for farming activities.
2.2.2 Damage to the Piedade river water quality

2.2.2.1 Construction Phase (CEMA, 2002)

Water contamination may occur when transferring diesel from trucks to the storage tanks on the worksite because of leaky connections in tank hoses, hose ruptures, pump leaks, etc. However, all of these events are small magnitude as unloading is conducted manually, therefore it is overseen by an operator who will intervene if an event occurs, avoiding such an event taking on greater proportions. In this case, the impacts will be of little significance.

Ruptures, holes and overflowing tanks and transformers may have a significant impact on water quality. At the site in question, oil tanks and transformers will be installed in containment basins which aim specifically to contain any spills and send them to water and oil separators.

Disposal of sanitary waste generated during project construction and afterwards, during operation, may cause water contamination. However, septic tanks will be built for the sewage generated. Therefore, the impact on water quality from sewage will be small and will depend on disposal of septic tank effluent.

2.2.2.2 Operating Phase

2.2.2.2.1 Reservoir

When a watercourse is dammed the water is held in place for a longer time compared with the free-flowing system. Thomas et al. (1997) states that because of this, there are alterations mainly affecting water temperature, sedimentation levels and circulation of water masses, gas dynamics, nutrient circulation structure of aquatic communities.

These modifications have the most effect on changes in the physical, chemical and biological characteristics of the new water system (Júlio et al., 1997). As a direct consequence, the authors report possible appearance of thermal stratification during certain seasons and/or times of the day, forming the so-called thermocline, specific vertical gradients in the water column, mainly in terms of dissolved oxygen concentration, resulting in limits on aquatic organism distribution. We can observe the formation of three different longitudinal zones (river, intermediate and lake), resulting from contributions from the water source creating the reservoir. These ranges behave differently in relation to factors such as sedimentation rate, concentration and cycling of nutrients, accretion and retention of organic and inorganic material, factors limiting primary production and values of such production (Thomas et al., 1997).
Construction of the Piedade SHS will create a reservoir with a volume of 17,520,000 cubic metres; water surface of 1,499,000 square metres, perimeter of 10400 and 33 m, approximate length of 4420 m, maximum depth of 30 m and average depth of 14.5 m.

Plant reservoir operation will be based on the water level and the length of time (dwell time) that the water remains in the reservoir will be vary according to incoming water flows. At a minimum, monthly average flows observed from fluviometric data (1.4 m$^3$/s) the dwell time will be around 145 days; for average long-term flows (11.9 m$^3$/s), 490 hours or 17 days; and for a maximum average monthly flow (42.7 m$^3$/s), around 114 hours or five days.

In order to better evaluate potential modifications arising from the Piedade SHS reservoirs, we looked at certain important morphological aspects in the system created. We therefore drew up calculations evaluating susceptibility to stratification and eutrophization, as recommended by Von Sperling (1999) and Håkanson (1981), taking into account a variety of morphometric variables. This was used to generate important information on issues linked to limnological dynamics such as water column stratification, inter-relation between the body of water and surrounding areas and the drainage basin, among others, based on the reservoir format.

According to Von Sperling, correct interpretation of morphometric data from lakes and reservoirs can be an important tool in managing bodies of water. However, the author points out that these studies can only be used to determine trends and do not replaced suitable monitoring of water systems. The following indices were therefore adopted: relative depth, Froude densimetry number, coastal region development index and involvement factor.

In the methodology adopted for this type of valuation, the following parameters were used: maximum reservoir depth (M), total surface area of the reservoir (m$^2$), reservoir length (m), reservoir inflows (m$^3$/s), reservoir volume (m$^3$), reservoir perimeter (m) and total drainage area of the reservoir hydrographic basin (m$^2$).

The first index, relative depth, tells us about the stability in stratification of the water column. The value obtained for the future Piedade SHS reservoir was 2.17%. This value shows that the future reservoir has a slight tendency towards meromixis because of morphological limitations, meaning that the environment will only be able to create vertical movement of water masses if there is sufficient incoming external energy, for example high-intensity wind. We therefore estimated that the liquid mass of the reservoir will be subject to periods of low vertical circulation which may result in a vertical stratification forming different metabolic compartments such as epilimnial, metalimnial and hypolimnial. The absence of oxygen at the bottom of the lake not only reduces biological diversity it also leads to resolublization of nutrients, especially phosphorus, which makes it available for assimilation by aquatic plants, and may lead to undersirable formation of eutrophization phenomena.
Calculation of the densimetric Froude number is carried out by evaluating the tendency to mix or stratify water in a reservoir, taking into account key affluent flows in this system. The results obtained showed that at the maximum depth (30 m) the trend revealed by the relative depth of periods of water column stratification in the future reservoir will probably not be restricted only to times of lower flow, because the maximum average flow registered was 0.115 for this index.

The perimeter development index shows how regular the coastal region is, i.e. the number of ramifications. Reservoirs with an extensive coastal region consequently have a high capacity to assimilate pollution and greater resistance to eutrophization. On the other hand, they have a disadvantage in the indentations where water is retained for a longer period of time, thereby favouring an accumulation of material in shallower areas which are exposed to sunlight radiation and subject to little water movement. All of these conditions support decomposition of organic material and the growth of microalgae.

However it would seem that offsetting these two phenomena, in most cases, are the predominant positive conditions for nutrient assimilation. The value obtained from the perimeter development index, 2.39, indicates the low number of reservoir bank ramifications. This means that the inter-relation between immediate bank areas will be low, and possible interference at this level may be incorporated by the water mass of the reservoir. This is an indication of reduced formation of different horizontal zones because of the greater possibility of quickly mixing with the main body of the reservoir. This trend would imply that when adding substantial amounts of nutrients and organic material, the entire reservoir will quickly be subject to the effect of this extra material, with a very small probability of forming horizontal pure zones which remain unaffected.

The last index considered, the involvement factor, reached a value of 645, which shows a less accentuated relationship between the drainage basin area and the reservoir area. This means that potential erosion of nutrients into the body of water is lower and the dilution effect on these nutrients will be high.

We therefore believe, based on the morphometric indices analysed, that the future reservoir will have undefined horizontal space patterns with horizontal circulation, and a trend towards vertical stratification periods in deeper regions of the lake. It will not be especially affected by the drainage basin because of the large volume of water in the reservoir. The time the water remains in the reservoir will determine the principal longitudinal flow with a certain uniformity in each transversal section.

Eutrophization is the excessive growth of aquatic plants because of the wide availability of nutrients. This phenomenon can lead to lower water quality because it reduces sunlight penetration and the concentration of dissolved oxygen, which is used to decompose dead algae.
In terms of the level of atrophy, lakes and reservoirs can be classified according to the concentration of phosphorus and water (table 2.1).

<table>
<thead>
<tr>
<th>Type of trophy</th>
<th>Total phosphorous concentration (mg P/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultraligotrophy</td>
<td>&lt; 0.005</td>
</tr>
<tr>
<td>Oligotrophy</td>
<td>0.01 – 0.02</td>
</tr>
<tr>
<td>Mesotrophy</td>
<td>0.01 – 0.05</td>
</tr>
<tr>
<td>Eutrophy</td>
<td>0.025 – 0.1</td>
</tr>
<tr>
<td>Hypereutrophy</td>
<td>&gt; 0.1</td>
</tr>
</tbody>
</table>

Source: Adapted from Von Sperling, 1995. The overlapping values between two ranges indicates a difficulty in establishing specific ranges.

Slight increases in the level of nitrates and phosphates in waters and rivers often lead to aspiration phenomena (eutrophization) or an increased number of organisms of specific species. Algae adopt this type of behaviour and do so in relation to other types of elements such as sulphur, potassium, magnesium and other elements. The elevation only of nitrogen or phosphorus in natural water produces an increased number of organisms revealing that this water normally contains sufficient quantities of other elements.

Despite the fact that much more nitrogen is required by organisms than phosphorus, in terms of pollution, phosphorus is of much greater importance because even though there is an insufficient nitrogen supply, it can be obtained from the atmosphere, while it is impossible to control levels in water.

Phosphorus, mainly produced by waste water, can be better controlled when preventing pollution. Phosphorus is a highly reactive element and in well oxygenated water it forms insoluble compounds which tend to precipitate, with a large number of metallic cations including calcium. Furthermore, it is widely known that phosphate is absorbed in iron hydroxide (III) and aluminium hydroxide flakes, settling at the bottom of the reservoir. This means that the quantity of phosphate available in waters depends on the concentration of iron III and aluminium in the water, as well as its hardness.

According to the results of the water analysis carried out for this study, the Piedade River presents a concentration of phosphorus at a point close to the dam which, in lakes and reservoirs, would be classified as mesotrophic. However, as the flow system in lakes allows sedimentation of phosphates adsorbed by other particles or as small precipitates, the effective dissolved phosphorus concentration in water will be lower than that present in river water.

The ammonia nitrogen concentration in the Piedade River, in the ADA, was lower than the 3.7 mg/L N level for pH levels below 7.5 (as specified in CONAMA Resolution No. 357, from March 2005). The nitrates and nitride results in the diagnosis indicate their concentration in the Piedade River is below that established by environmental legislation for class 2 water.
Complementing the evaluation on the risk of developing eutrophization processes in the future SHS reservoir, phosphorus concentrations were estimated using an empirical model known worldwide, created by Vollenweider (1976), developed mainly for temperate lakes (Von Sperling, 1995). Sala and Martino (1991) analyzed experimental data from 40 lakes and reservoirs in Latin America and the Caribbean obtaining, from linear regression, the corrected ratio of Ks (coefficient for phosphate loss from sedimentation) for the environments.

The mathematical expression of the model is:

Where:
- $P$: Is the phosphorous concentration in the reservoir, in gP/m$^3$ or mg/L;
- $L$: Is the affluent phosphorous load in KgP/year;
- $V$: Is the reservoir volume in m$^3$;
- $t$: Is the time in years
- $K_s$: Is the coefficient for phosphorous lost through sedimentation, in year$^{-1}$.

The empirical expression for $K_s$ obtained by Sala and Martino (1991) is:

$$K_S = \sqrt{\frac{2}{t}}$$

Sperling stated that because it was based on regional data (including Brazilian data), the empirical model developed by Salas and Martino (1991) should be the model used for planning and managing lakes and reservoirs under our conditions. He also added that a critical eye and the experience of the researcher must always be present to avoid distortions, given the specific nature of each reservoir or lake.

Considering the amount of phosphates reaching the SHS as the amount from the river and reservoir drainage area, we can state that the inflowing phosphorous level of the future reservoir is at a critical level, 0.11 mg P-PO$_4$/L or 0.035 mg P/L, calculated from monitoring in December 2003, the rainy season. Knowing the average long term flow of the Piedade river, 11.9 m$^3$/s, we can estimate the phosphorous flowing into the river at 13,471 kg P/year.

Based on the fact that the reservoir volume is 17,520,000 m$^3$, we can determine the dwell time as approximately 0.047 years and a $K_s$ coefficient of 9.3 year$^{-1}$.

Application of the Vollenweider (1976) empirical model, adapted by Salas and Martino (1991), indicated that the phosphorous concentration in the future Piedade SHS reservoir is characteristic of mesotrophic lakes. Note that this model was mainly developed for temperate lakes and, even with correction for the $K_s$ coefficient proposed by Salas and Martino, it must be used with caution.
The pH influence on the eutrophization process is mainly based on the fact that at higher pH values (> 0.8) phosphates adsorbed by iron (III) and aluminum hydroxides are released again, enriching the water’s nutrients. pH above 8.0 can occur naturally in reservoir water during sunny periods because of photosynthesis involving algae, removing CO2 and changes in the carbonate system (Boers, 1991).

Average pH values on site at the location of the future reservoir, close to the dam, vary between 7.21 and 7.95. The water retention period in the reservoir is characteristic of intermediate environments according to CONAMA 357;05, at affluent flow rates above 5.1 m$^3$/s. During lower flow periods (dry season) there may be excessive proliferation of algae and excessively high pH. However, we can only evaluate the interaction of this parameter with phosphorous enrichment in the reservoir after it has been created.

In light of this, we can see that there are factors which are favourable and others unfavourable for eutrophization in the reservoir. Morphometric index analysis shows that the reservoir is not highly influenced by the drainage basin, a fact corroborated by diagnostics conducted in the area. Therefore, the trends that have been presented showed that it is unlikely that there will be any eutrophization in the reservoir, although this is related to the interaction between physical and chemical phenomena and subject to external influences. The synergy between different phenomena occurring in the reservoir after it has been formed will be accompanied by the Limnologic and Water Quality Monitoring Program.

In terms of plankton communities, please note that there will be a trend towards a substantial reduction in organism densities because of reservoir stabilization, which may be followed by a slight rise in population. This means that communities will develop based on plankton organisms and present a composition more similar with lake environments.

Benthic communities will be subject to variation in depth mainly because of light penetration and sediment composition. We therefore estimate that these communities will be more abundant in peripheral areas of the future reservoir. We also believe that in these areas, the main substrate will be clay based, favoring the appearance of organisms more suited to these substrates. Typical rock based substrates will be more restricted because of the loss of these habitats and the substantial reduction of water flow speeds over the surface, whereas these organisms are adapted to faster currents.

Organic material reaching the water course undergoes a natural neutralization process which mainly includes diulotion, sedimentation and biochemical stabilization, a process called self-purification (Branco, 1996). When a pollutant is introduced into this body of water, a specific quantity of oxygen is required mainly to oxidize.
the organic material, based on aerobic digestion processes carried out by microorganisms. This process is called deoxygenation.

On the other hand, when the oxygen is consumed by bacteria, this creates a deficit in relation to saturation concentration. This deficit leads to a diffusive flow of oxygen from the air into the body of water. This diffusion will occur faster the more turbulent the water is, because in still waters diffusion mainly occurs through molecular diffusion (slower) and in turbulent water this mechanism is mainly turbulent diffusion (faster). Additionally, the algae use photosynthesis to contribute towards oxygenation of natural water. This process is called reoxygenation.

Oxygen concentration in the future reservoir was estimated using the mathematical model from Streeter-Phelps (Von Sperling, 1995), which takes into consideration the following factors:

- Only atmospheric reaeration
- Oxygen consumption from biological demoposition of organic material; and
- Piston flow, i.e. looking at the body of water as a continuous reactor, mixing downstream water with upstream water.

This model is restricted to the aerobic conditions of the body of water, not including or modeling the anaerobic decomposition of organic material. The mathematical expression of the model is:

\[
C_t = C_s - \left[ \frac{K_1 L_0}{K_2 - K_1} (e^{-K_1 t} - e^{-K_2 t}) + D_0 e^{-K_2 t} \right]
\]

Where:

- \(C_t\): Is the concentration of dissolved oxygen in mg/L, in time “t”, in days;
- \(C_s\): Is the saturation concentration of dissolved oxygen in mg/L;
- \(K_1\): Is the deoxygenation coefficient in day\(^{-1}\);
- \(K_2\): Is the reoxygenation coefficient;
- \(L_0\): Is the DBO\(_5\) concentration in mg/L, at initial time (t = 0); and,
- \(D_0\): Is the oxygen deficit (\(C_s - C_0\)) in t = 0.

The study looked at some of the results obtained from the sampling point on the Piedade river (PIE-01) and data in bibliographic references, cited in Table 2.2. We chose to use data collected in December which represents the most critical period.

**Table 2.2**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>PIE-01 – December/03</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBO(_5) (mg O(_2)/L)</td>
<td>1.51</td>
</tr>
<tr>
<td>Dissolved Oxygen (mg O(_2)/L)</td>
<td>7.21</td>
</tr>
<tr>
<td>Reiver Piedade Temperature (ºC)</td>
<td>22.0</td>
</tr>
<tr>
<td>Height above sea level (m)</td>
<td>6.39</td>
</tr>
<tr>
<td>Reservoir length (km)</td>
<td>4.42</td>
</tr>
<tr>
<td>Deoxygenation constant (day(^{-1}))</td>
<td>0.30</td>
</tr>
<tr>
<td>Physical reaeration constant (day(^{-1}))</td>
<td>0.37</td>
</tr>
</tbody>
</table>
Considering the long term average flow of the Piedade river, 11.9 m³/s, we obtain a water dwell time of approximately 17 days.

Below is a calculation for the self-purification study on the Piedade SHS stretch of the river.

**SELF-PURIFICATION STUDY**

**Reservoir section**

\[
\begin{align*}
DBOr &= 1,51 \quad \text{River Piedade DBO (mg/L)} \\
Tr &= 22 \quad \text{River Piedade Temperature (°C)} \\
ODr &= 7,21 \quad \text{River Piedade OD (mg/L)} \\
K1 &= 0,3 \quad \text{Deoxygenation constant (1/day)} \\
K2 &= 0,37 \quad \text{Physical reaeration constant (1/day)} \\
H &= 639 \quad \text{Height above sea level (m)} \\
v &= 0,26 \quad \text{River surface flow speed (kilometres/day)} \\
Dist &= 4, 420 \quad \text{Distance from the lake to the dam (kilometres)}
\end{align*}
\]

Cálculo da OD de saturação (mg/L)

\[
Cs_l = (14,652 - 0,41022 \cdot Tr) + 0,799 \cdot 10^{-3} \cdot Tr^2 - 0,77774 \cdot 10^{-4} \cdot Tr^3
\]

\[Cs_l = 8,67\]

\[
Cs = \left(1 - \frac{H}{9450}\right) \cdot Cs_l
\]

\[Cs = 8,08\]

Cálculo da DBO carbonácea (mg/L)

\[
L_r = \frac{DBOr}{1 - e^{-K1 \cdot v}}
\]

\[L_r = 1,9\]

Cálculo do déficit inicial de oxigênio (mg/L)

\[Dr = Cs - ODr\]

\[Dr = 0,87\]

Correção de K1 e K2

\[K1T = K1 \cdot 1,047^{Tr-20}\]

\[K1T = 0,33\]

\[K2T = K2 \cdot 1,029^{Tr-20}\]

\[K2T = 0,39\]
According to the results of the mathematical mode, oxygen concentration will always be above 7.03 mg/L O₂ (critical point) along the reservoir water course (Figure 2.1). It is important to note that all of the calculations were based on data from the physical and chemical analysis of the Piedade river, and the mathematical model used is widely acknowledged worldwide.
Figure 2.1 Dissolve oxygen deficit curve in the Piedade SHS reservoir at the most critical point (December 2003).

Based on the surveys conducted, we believe that the water course will contain sufficient quantities of dissolved oxygen for oxygenation of nutrients and organic material in this basin, which leads us to estimate a low probability of any processes compromising the environmental and sanitary quality of the future system.

2.2.2.2 Low flow section

Construction of the Piedade SHS will have a direct consequence on the reduction of the river flow which will fall from an average long-term value of 11.9 m$^3$/s to 0.65 m$^3$/s soon after the dam has been built. However, we know that along the low flow section there will be an additional 0.75 m$^3$/s following incorporation of tributaries along this section, the most significant of which is the Onça or Retiro stream and a stream cutting through the property of Mr Roosevelt, both located in the first half of the low flow section. Furthermore, during the rainy season, when incoming flows exceed turbine capacities, the overflow will result in higher flow volumes.

The quality of the water in the low flow section is directly related to the quality of the water which will flow through the dam of the future reservoir. Looking at the biological communities, we believe that the flow reduction may result in the loss of habitat for benthic communities because of a reduction in the river level.

Greater attention must be given to the areas of still water which may form a longer section, because stagnant water encourages the proliferation of insects. Furthermore, periphytic algae may grow in stagnant water and between blocks of stone as it takes longer for the water to renew. However, these alterations will be seasonal and are also based on variations in the river channel widths, which are also seasonal, which will be more evident in this section of the river. We must also consider the fact that any variation will likely require control on-site of populations of aquatic organisms which are vectors for disease.
In terms of usage of the Piedade river water, note that none of the properties surveyed and located on the low flow section use the river for water consumption or domestic use, therefore the reduced flow will not have an effect in the section between the dam and the power station. Water sources for human consumption are springs, tributaries of the Piedade river and wells.

The sewage on most of the properties surveyed is sent to septic tanks and only one property pumps its waste directly into the pasture, untreated. The other properties do not have sanitation installations, indicating that they are not often visited by their owners.

In relation to animal drinking water, the properties located on the low flow section will have access to water from the Piedade river restricted to a minimum 0.65 m$^3$/s or 650 L/s. However, according to the survey conducted on properties owned by Messrs Leri Diniz, Dalgiza Teodoro, Leonardo Ferreira and José de Menezes, the cattle have no access to the Piedade river and use only springs or streams for drinking water because of the steep slopes along the sides of the river.

The landowner Mrs Valda was not found and therefore not interviewed, however her property, located on the right-hand bank of the Piedade river, does not have access to it. The only animal drinking water point on the property is an intermittent spring which will be affected by the water channel. Gomes Lourenço has already verbally promised to build a cistern which will provide water all year round.

The following is a calculation of the quantity of water required to meet the needs of the properties located along the low flow section, whose cattle use the Piedade river for drinking water:

- Cattle herds along the low flow section using the Piedade river for drinking water = 660 head;
- Specific water consumption = 80 L/head/day;
- Period used for drinking water by cattle = 16 h/day.

We therefore need to guarantee a minimum flow of 0.917 L/s to provide water to the current herd along the low flow section with access to the Piedade river. As the sanitary flow which the project needs to guarantee will be 650 L/s, we conclude that in terms of providing drinking water for the existing herd, construction of the Piedade SHS will not affect the landowners in the ADA.

\[
Q_{\text{consumo}} = \frac{660 \text{ cabeças} \times 80 \text{ litros}}{16 \text{ h/dia} \times 3600 \text{ s/h}} = 0.917 \text{ litros/s}
\]

1 Source: Milk Production Technology - Aristeu Mendes Peixoto e outros - Fealq/Fundação Cargill - 1985
We should note that along the low flow section animals may cross from one bank to the other where the river is shallower. In these cases, at an opportune time, the developer will survey these locations where crossing is possible and Gomes Lourenço will be responsible for ensuring that cattle do not cross from one property to another because flow in this section has been reduced.

In terms of water usage for irrigation, only three of the properties survey have irrigated crops and infrequently used water from the Piedade river for this purpose. However, according to the owners, the streams flowing into the river through the property are capable of meeting irrigation requirements, because irrigation is only conducted twice a year during the dry seasons to accelerate the formation of fruit. We therefore conclude that flow reduction in the low flow section will not affect productivity on existing plantations.

In terms of leisure usage of the Piedade river, we are aware that flow reduction may affect the number of fish in the body of water and therefore affect fishing, which is a leisure activity for some of the owners and inhabitants in this region. However, this impact will be studied and monitored separately.

In relation to use of the river for bathing and rapelling, flow reduction will not affect these activities.

Therefore, the risk of water usage and water quality being compromised along the low flow section during works construction and operation is considered a negative, direct, local, short-term, reversible, important, low magnitude and not very significant impact. Any impact will be accompanied by the “Limnologic and Water Quality Monitoring Program” and “Macrophyte Control and Monitoring Program”.

### 2.2.2 Loss of Habitats for Martin Species (STREPTOPROCNE ZONARIS and CYPSELOIDES SENEX)

Reservoir filling or flow reduction (TVR) in areas around the waterfalls may destroy habitats for two species of martin, registered in the project area. Two species of martin (*Streptoprocne zonaris* and *Cypseloides senex*) have a highly specific connection with this habitat because of shelter and nesting, with colonies located around the sites.

During on-site visits to adapt to the EIA to the new engineering design, the waterfalls which will be flooded by the reservoir were visited, but this species was not present in the area. However, the time of year that the inspections were made was unsuitable for observing martins, because the reproductive phase of most neotropical birds had ended. Furthermore, the flows observed in the bodies of water were higher, which is an important factor in dispersing species of martin.
The effects of this impact, if the presence of martins is confirmed around the waterfalls, may be considered direct, regional, negative, long-term, irreversible, important, high magnitude and significant. The effects can be mitigated by executing the "Martin (Cypseloides senex and Streptoprocne zonaris) Monitoring Program" already proposed in the PCA (LIMIAR, 2004), in order to confirm the presence of the species in this locations and draw up measures for conservation and effective control. The aforementioned program will be adapted to the new areas affected by the project however the methodological procedures and objectives will remain the same.

### 2.2.4 Suppression of native vegetation (CEMA/2002)

This based on the size of the development, suppression of vegetation will take place in very restricted areas comprising the borders of secondary riparian forest, along all or part of the areas bordering the dam axis, reservoir margins, the worksite area, the power station and the tailrace. Based on the route and area of the water channel and subsequently the low flow section which will be created, most of the affected area is pasture land (table 2.3).

Some of the properties will be affected, like a portion of the forest on a property owned by Mrs Dalgisa, which will be intersected by the water channel and will affect the local habitat. Based on local conditions, the area required will not significantly interfere with the environment, as it is narrow and most of the environment is secondary. Along the water channel area, there are anthropized herbaceous and tree formations as well as isolated trees.

Despite the poor form and composition of the flora, these formations are part of the regional landscape and interact with other types of native vegetation such as crop and pasture areas and they are involved in the survival of wildlife, providing protection for the soil and water resources and provide the region with an esthetic identity.

We must also consider the fact that reduction in native vegetation, interrupting the vegetation regeneration process in what is already a very poor region, is undesirable, to whatever extent it takes place. This is why it is important to plant native species in areas that which are deforested when building the works.

According to the ADA map, including all of the areas affected by the development, only 10 ha of riparian forest were identified as being affected by the SHS construction works.

Suppression of riparian forest to construct the Piedade SHS and support structures will result in the loss of vegetation species and individuals, changing the structure and composition of the flora and modifying the population dynamics in affected locations. However, these areas have already been subject to major alterations and under the potential anthropic pressure which reduces the relative impact in terms of the original vegetation on site.
Table 2.3
Phytofisionomy distribution in the surrounding area and directly affected area (ADAE)

<table>
<thead>
<tr>
<th></th>
<th>Surrounding Area (AE) (ha)</th>
<th>Directly Affected Area (ADA) (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pasture</td>
<td>3008</td>
<td>113</td>
</tr>
<tr>
<td>Crops</td>
<td>377</td>
<td></td>
</tr>
<tr>
<td>Cerrado</td>
<td>105</td>
<td></td>
</tr>
<tr>
<td>Riparian forest</td>
<td>23</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>3515</td>
<td>123</td>
</tr>
</tbody>
</table>

Therefore, the risk of degradation to native vegetation, especially riverside forests, is considered a negative, direct, local, short-term, irreversible, important, low magnitude and not very significant impact.

In order to minimise the effects of this impact, the following projects will be carried out: “Project to Recover Flora, Germoplasm and Replace Epiphytes”, “Flora Reconstruction Project”, “Project to Recover, Rehabilitate and Revegetate Springs and Water Courses”, “Project to Remove Vegetation Affected by the Development”, “Program to Negotiate Land and Improvements”, “Project to Recover Degraded Areas” and the “Worksite Environmental Control Program”.

2.2.5 Terrestrial fauna (CEMA, 2002).

The areas around the power station and reservoir that will be most affected by suppression are a portion of secondary riverside forests, at a median stage of succession. The riverside forests, despite being highly degraded, connect with vegetation formations along rain water drainage lines on both the left and right banks of the Piedade river. However, because of the scale of the project and local relief, these areas will be greatly restricted.

Having said that, even though only a small portion of vegetation will be lost, this will also destroy shelter and food sources for certain species of bird and mammal, such as the martin and capivara, forcing them to migrate to other areas. This means that the diversity of local terrestrial fauna may be compromised.

Certain species may also be forced away or killed following direct contact with machinery and workers involved in the SHS construction.

Therefore, voluntary fauna transposition to adjoining areas is considered a negative, direct, local, short-term, reversible, important, average magnitude and moderate impact. Fauna mortality caused by vehicle traffic, contact with machinery and workers is considered a negative, direct, local, short-term, irreversible, unimportant, low magnitude and not very significant impact. Fauna mortality following competition for food and shelter caused by voluntary transposition is considered a negative, direct, local, short-term, irreversible, important, average magnitude and significant impact. The effects can be minimised through the "Fauna Conservation Program” and "Project to Rescue Fauna during the Deforestation and Reservoir Filling”.
2.2.6 Fragmentation of riparian forests on tributaries on the right bank

An important aspect in the anthropic modification process in natural environments is fragmentation. Organism populations which were in contact are isolated in small fragments and/or separated from one another. This isolation process may increase the possibility of local populations disappearing as their size tends to fall along with genetic variations, either because of increased endogamy or reduced genetic flow.

Existing riparian forests along tributaries on the right bank, downstream from the dam, will therefore be fragmented when building the water channel. These forests are corridors that species use for travelling and dispersion.

At least two animal species with forest habitats were registered using this area to reach the farm owned by Mr Roosevelt Guimarães and Mr Diogenes, the macaco prego and the mutum de penacho.

Fragmentation of the vegetation in riparian forests will have a negative, direct, local, medium to long term, irreversible, important, average magnitude and fairly insignificant effect.

The negative effects can be minimised by the "Flora Reconstitution Projects" and "Mutum-de-Penacho Monitoring Program".

2.2.7 Increased risk of wild animals being run over on access roads

In order to build the dam, vehicle traffic will increase significantly thereby increasing the risk of accidents involving wild animals.

On the highway linking Monte Alegre de Minas and the dam, dead animals as were animals travelling along the road, such as the tamanduá bandeira (*Myrmecophaga tridactyla*). While the works are in progress they will be extremely susceptible to being run over.

Fauna mortality caused by vehicle traffic is considered a negative, direct, local, short-term, irreversible, unimportant, low magnitude and not very significant impact.

In order to minimise the effects of this impact of the "Safety and Warning Project” will be implemented.

2.2.8 Hunting and domestication

Many mammal and bird species are hunted. The people involved in construction work may hunt, even though it is illegal. Some animals are also
domesticated. Although the sale of animals is illegal, it is still a source of income.

People involved with construction, directly or indirectly, may encourage capture of certain species among local residents.

The hunting and capture of fauna species is considered a negative, direct, local, short-term, irreversible, unimportant, low magnitude and not very significant impact.

This impact can be minimised by the "Environmental Education Project".

2.2. 9 Icthyofauna (CEMA, 2002).

The reduction in the quantity and quality of the habitat is the most serious aspect of the SHS construction work. As highlighted previously, however, we are unable to evaluate the scope of this impact on existing fish populations; we can only present certain considerations regarding habitat usage and the natural history of species collected. In this situation, we can infer that the most affected species will be those using the high-speed flow habitat, rockier substrate (blocks, rubble) and lower depths, as well as those frequently inhabiting the area around the banks of the River such as Characidium gomesi, Apareiodon ibitiensis, Neoplecostomus paranaensis, Hypostomus sp. and the Astyanax species.

The other impacts taken into account will have a much lesser effect than those discussed above. These are localised impacts which, in terms of the size of the basin, are less important. The dam construction will have no additional impact on fish migration, as the existing waterfalls already act as a barrier for fish migration. Death of fish in the water channel will be minimal especially if the mitigating measures suggested below are followed. Therefore, fish death caused by the emission of toxic substances can be minimised by following rational principles for waste and effluent treatment during plant construction and operation.

We must point out that the possible use of pesticides in the area around SHS dam, especially on pineapple plantations, could cause harm when the river flow is reduced as pesticides carried to the riverbed will be less diluted and have a greater effect on fish and the aquatic biota.

Reduction and alteration to habitats because of lower flow is considered a negative, direct, local, short-term, irreversible, important, average magnitude and significant impact. Habitat destruction caused by SHS construction is considered a negative, direct, local, short-term, irreversible, important, average magnitude and significant impact. The possibility of fish migration or destruction is considered a negative, direct, local, short-term, irreversible, unimportant, negligible and insignificant impact based on the existence of the natural barrier to fish migration already in place. The possibility of fish retention within SHS structures is considered a
negative, direct, local, long-term, irreversible, important, low magnitude effect of little significance.

In order to reduce the negative effects of these impacts, the following project will be carried out: "Project to Monitor Ichthyofauna prior to Dam Construction", "Project to Monitor Ichthyofauna after Dam Construction", "Project to Evaluate the Need for Intervention in the Low Flow Section to Avoid Fish Being Imprisoned", "Project to Rescue Ichthyofauna during River Diversion and Reservoir Filling" and "Fish Migration Project".

2.2. 10 Suppression of species from the genus Tabebuia

The EIA reported the presence of the species Tabebuia caralba, Ipê amarelo, in the development area. Law number 9743, dated December 15, 1988, governing preservation and prohibiting felling the Ipê amarelo, states in article 2, sole paragraph that "Total or partial suppression of the species shall only be permitted with prior authorization from the federal government, when necessary to execute works, plans, activities or projects of public utility or social interest. Sole paragraph: In the event of suppression established in this article, those responsible shall be required to immediately replant the same number of trees as those felled."

Therefore, authorisation to fell the species is issued by the State Forestry Institute (Instituto Estadual de Florestas - IEF.) However, note that the IEF requires presentation of a Technical Project for Flora Reconstitution (Projeto Técnico de Reconstituição de Flora – PTRF) among documents required to support the vegetation deforestation process affected by the development, in order to obtain the Authorisation for Forestry Exploration (Autorização para Exploração Florestal – APEF). Among other issues, this project describes the local flora which will be affected based on a qualitative and quantitative inventory in addition to indicating mitigating and compensatory measures.

As stated above, in the legislation transcribed, independent of the impact from construction of any project, total or partial suppression of these species may be permitted provided that the activity or project is a public utility or of social interest, such as hydroelectric power station (Minas Gerais Forestry Law number 14,300 9/02, article 13, paragraph 3, as well as federal legislation, Decree Law number 3365, dated 21/6/1941, which expressly acknowledges public utility of projects related to electricity production).

Furthermore, as observed in Law 9743, upon authorising such suppression, the party responsible is obliged to replant the number of trees felled. Therefore, the developer takes responsibility for planting at least twice the number of Tabebuia sp. cut down.

Note the small size of the development and the fact that in this region, the species is associated with pasture locations which are isolated and widely spaced and therefore under no circumstances do these trees represent specific forest units. Therefore, the impact on these populations is considered negative, direct, local, medium-term, reversible, important, low magnitude of little significance, not identifying impacts for the AE and AI.
In order to minimise the effects of this impact of the "Flora Reconstitution Project" will be implemented.

2.3 SOCIOECONOMIC ENVIRONMENT

The description of the impact on the socioeconomic environment is based on a survey carried out on 12 to 16 March 2007. This study focused on gathering fresh information regarding the municipal region of Monte Alegre de Minas, updating information on properties located in the low flow section (which will undergo a new type of interference based on changes to the water channel route) and detailed surveys on new properties affected by the reservoir and power station.

Note that the observations made do not include changes to preventive and mitigating measures indicated previously, because any interference from the new Piedade SHS project in terms of properties affected can also be mitigated/monitored by the “Land and Improvement Negotiation and Socioeconomic Issue Monitoring Projects”.

We must also point out that these actions should include the new properties and inhabitants affected by the project (21 properties are affected altogether, following alterations to the Piedade SHS design), as highlighted in the following items.

2.3.1 Interference with archaeological sites

Construction of Piedade SHS may interfere with, or destroyed, the appearance and/or burial of archaeological sites located within the works area.

Therefore, possible interference involving archaeological sites is a negative, direct but local impact. These effects will endure for a long time. Destruction of a site makes it impossible to recover information about its inhabitants, causing important, average magnitude and significant impact.

However, impact on archaeological sites in the ADA should be avoided by implementing the "Archaeological Research Project" in the period between obtaining the Provisional Licence and the Construction License.

2.3.2 Job creation

At the peak of the construction works, around 100 workers will be hired. Construction on sites similar to the Piedade SHS mainly use unskilled labor which, in general terms, can be recruited from the local region. But in recent SHS construction works, in municipal regions with similar socioeconomic profiles to Monte Alegre de Minas, the local job markets were capable of offering more than 70% of the personnel needed. Therefore, Monte Alegre de Minas and neighbouring areas are expected to provide a significant proportion of the jobs created. Note that the predominance of crop and cattle farming activities in the region result in seasonal working patterns, concentrated during the planting and harvesting phases, and employment of these people can usually be reconciled in the period between harvests.
The impact of this can be positive, with direct and indirect benefits, because of the salaries which are paid. The scope of this impact will be local over a medium-term period, and is therefore reversible. However, these results are considered important, significant and of low magnitude.

Specifically regarding the developers proposal to preferentially hire local workers, we must point out that directives for this proposition are contained in the "Project to Use Local labor".

2.3.3 Population influx indirectly attracted by the construction works

Although not measurable, there may be an influx of people in the area covered by the project based on expected job opportunities. In this case, in flowing demand will affect the city of Monte Alegre de Minas, where the works are located.

However, given the small size of the project and the low volume of jobs created, 150 at the peak construction period, there will be little pressure on the city. We can add to this the experience from other smaller projects of similar type, where we found that this phenomenon was of little relevance. Additionally, we should note that a commitment from the developer to prioritise local labor to build the hydroelectric plant and the promotional campaign forecast in the "Social Communication Project", during all phases of personnel recruitment, will contribute to minimise the effects of this process.

The impact is therefore considered negative, indirect, local and medium term. It is also classified as low magnitude and reversible, and is insignificant based on the expectation that it will attract few people.

Therefore, despite being negative, indirect, local and medium term, this impact may be mitigated by the aforementioned Projects. We can therefore conclude that this impact is not important but is reversible, low magnitude and insignificant.

2.3.4 Increased AI tertiary sector

During development construction, there is a possibility of a small increase in the tertiary sector in the city of Monte Alegre de Minas. This means that the income available to workers residing there or in the immediate surroundings may result in an increased demand for a consumer goods and services.

This impact is local, positive, indirect, medium-term, important, low magnitude however reversible and not for a significant.

2.3.5 Increased vehicle traffic on works access routes

When work starts on the Piedade SHS, they will inevitably be an increase in light and heavy vehicle traffic accessing the development region.
As the worksite for Piedade SHS is forecast to be built on the left-hand bank, access will mainly be along the main, unpaved highway which connects the city to rural properties.

This access does not currently have much vehicle activity. However, vehicle traffic will increase when work begins.

Therefore, this impact can be considered negative, direct, local and low magnitude, of little significance, however it is important, short term and reversible, and can be minimised based on the measures in "Safety and Warning Project" and "Road Infrastructure Construction Project".

2. 3. 6 Introduction and reappearance of endemic diseases

The municipal region of Monte Alegre de Minas is considered an endemic area for Chagas Disease, Malaria and Leishmaniasis.

Project development could contribute to the introduction of new endemic diseases and the reappearance of others, especially endemic diseases and STDs because of the possibility of hiring infected people and the presence of a majority of male workers during construction.

This impact is negative, medium-term, indirect, regional, important, medium magnitude and therefore moderate, however reversible.

We should note that the effect of this impact can be minimized based on the "Health Program" and "Social Communication Project".

2.3. 7 Increased municipal tax revenues

During the construction period, there will probably be an increase in service tax and ICMS revenues in Monte Alegre de Minas because of the works and greater income availability from the jobs created and possible expansion of consumer goods and services. This situation will have a positive effect on municipal government, increasing public funding and thereby the capacity to invest in infrastructure and services.

This impact is local, positive, direct and indirect, medium-term, important, low magnitude, moderate and reversible.

2.3.8 Structure construction interference

According to the new Basic Design for the Piedade SHS, the new reservoir will affect 21 properties and the water channel and other structures will affect 11.
In general terms, this impact is considered negative, direct, important, long-term and irreversible, high magnitude and therefore significant.

The "Socioeconomic Issue Monitoring Project" and the "Land and Improvement Negotiation Project" will help minimise the effects of this impact locally.

2.3.9 Interference in the daily life of the rule population

During the works there may be interference in the daily life of farmers/inhabitants on rural properties in the ADA, from the construction and traffic at the worksite. In addition there will be people from other regions on site, with different values and habits which could result in modifications to lifestyle and local security.

This impact is classified as negative, direct, important and significant, medium magnitude however reversible, local and medium term.

We should add that these processes can be accompanied and minimised, as required, based on the "Socioeconomic Issue Monitoring Project".

2.3.10 Increased noise levels

Increased noise levels from detonations and especially from equipment required to build Piedade SHS such as stone crushes, trucks, concrete machines and others may bother inhabitants of properties close to the worksite which makes this impact negative and direct, but reversible, local and short-term, minimised by the measures in "Safety and Warning Project" and renders this significant, unimportant and medium magnitude.

2.3.11 Flooding of land to form the reservoir

The following table contains the areas affected by the reservoir.

<table>
<thead>
<tr>
<th>Property number</th>
<th>Owner</th>
<th>Total area (ha)</th>
<th>Area of Interest (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>01MD</td>
<td>Juvenil M. Guimarães e Fernando</td>
<td>80.0</td>
<td>(2)</td>
</tr>
<tr>
<td>02MD</td>
<td>Antônio Ferreira Diniz</td>
<td>145.0</td>
<td>33.94</td>
</tr>
<tr>
<td>03MD</td>
<td>Francisco Ferreira Faria</td>
<td>140.0</td>
<td>18.30</td>
</tr>
<tr>
<td>04 MD</td>
<td>Gerson Faria Diniz</td>
<td>(2)</td>
<td>(2)</td>
</tr>
<tr>
<td>05MD</td>
<td>Francisco Carlos Vieira</td>
<td>242.0 (3)</td>
<td>Not Affected</td>
</tr>
<tr>
<td>06MD</td>
<td>Robson Pereira Guimarães</td>
<td>85.0</td>
<td>Not Affected</td>
</tr>
<tr>
<td>07 MD</td>
<td>Roosevelt Guimarães Diniz (Espólio)</td>
<td>35.0</td>
<td>Not Affected</td>
</tr>
<tr>
<td>08 MD</td>
<td>Leri Pareira Diniz</td>
<td>72.60 (3)</td>
<td>Not Affected</td>
</tr>
<tr>
<td>09MD</td>
<td>Dalgiza Teodora dos Reis (Dil Vilela)</td>
<td>72.60 (3)</td>
<td>Not Affected</td>
</tr>
<tr>
<td>10 MD</td>
<td>Dógenes Coelho Nogueira</td>
<td>99.22 (3)</td>
<td>Not Affected</td>
</tr>
<tr>
<td>11 MD</td>
<td>Valda Pereira de Faria</td>
<td>(2)</td>
<td>Not Affected</td>
</tr>
<tr>
<td>12 MD</td>
<td>Leonardo Ferreira de Faria</td>
<td>62.92 (3)</td>
<td>Not Affected</td>
</tr>
<tr>
<td>13 MD</td>
<td>Vanderlan Pereira de Faria</td>
<td>95.0</td>
<td>Not Affected</td>
</tr>
</tbody>
</table>

CONTINUED . . .
We can see that of the 21 properties affected, only 8 affected by the reservoir will have more than 5% of their total area flooded, with 2 properties affected will see around 10% of their total area flooded.

The predominant use of these flooded areas was, at the time the surveys were conducted, pasture, crop farming and vegetation formations (alluvial forest, brushwood and seasonal forest). Main activities are crop and cattle farming.

Note that independence of the affect of each establishment, this impact is considered negative, direct, local, irreversible, long-term, important and significant because the land subject to flooding is that with greatest production potential. However, this impact can be mitigated by deploying the "Land and Improvement Negotiation Project" and accompanied by the "Socioeconomic Issue Monitoring Project".

2.3.12 Changes to the local landscape

The lake that will be created will alter the local landscape which may result in changes to the value attributed to properties in the surrounding area, potentially creating new opportunities for economic activities, especially those related with recreation and leisure, if the river water quality allows them.

Therefore, from this standpoint, this impact is positive, direct, local, long-term, irreversible, unimportant, low magnitude effect of little significance. This impact will be provided by the "Environmental Conservation and Use of the Area Surrounding the Artificial Reservoir Plan”.

2.3.13 APP usage restrictions

CONAMA resolution number 302, dated March 20, 2002, requires mandatory maintenance of an Area of Permanent Preservation in the area surrounding artificial reservoirs, for which the developer is responsible for implementing and maintaining.
In terms of the Piedade SHS, we recommended creating an APP of 30 m, from the maximum normal N.A., which would result in restrictions on use of this section of land for owners of properties located in the future project reservoir area.

Therefore, from a socioeconomic standpoint, this has a negative, direct, irreversible, long-term, local, important, significant and average magnitude impact as possible usage found will be able to continue. Furthermore, any difficulties can be overcome by introducing the "Land and Improvement Negotiation Project" and the "Environmental Conservation and Use of the Area Surrounding the Artificial Reservoir Plan".

2. 3. 14 Loss of temporary jobs

Conclusion of the works means that labor will be demobilized, inverting the job opportunities generated during development construction.

This impact can be considered negative, direct, regional, long-term, irreversible, important, low magnitude and of little significance given the small number of workers who will be hired throughout development construction.

2.3.15 Creation of permanent jobs

Plant operation will require 10 full-time jobs which will benefit the local population.

This impact is local, positive, direct, long-term, important, low magnitude however reversible and not of significance.

2. 3. 16 Increased electricity supply

Piedade SHS will have a nominal output of 16 MW, which will be incorporated into the Interconnected Electricity System.

Therefore, this impact may be considered positive, direct, regional, reversible, long-term, important, low magnitude and moderate.

2. 3. 17 Revenue creation for city taxes

The Piedade SHS operation will provide tax revenues mainly represented by ICMS, with a positive effect on municipal tax revenues.

This impact can be considered positive, indirect, local, long-term, reversible, important, low magnitude of little significance based on the size of the municipal region of Monte Alegre de Minas.
2.3.18 Risk of accidents among the population

The lake which will be created following construction of Piedade SHS can be seen as a leisure alternative by the regional population, however, on the other hand, it may present a risk of accidents such as drowning.

Given the potential risks, this impact can be considered negative, direct, local and long-term, however reversible, unimportant, low magnitude and insignificant when adopting the preventive measures included in the "Social Communication Project” and the "Safety and Warning Project”.

2.3.19 Possibility of cattle crossing the river in the low flow section

With the flow reduction on the Piedade River in the section between the dam and the power station (low flow section) which currently represents a physical barrier to cattle crossing, it may temporarily stop playing this role. During the rainy season, the river flow in this section increases significantly.

This impact, if it occurs, can be considered negative, direct, local and long-term, however reversible, unimportant, low magnitude and of little significance. The impact can be mitigated by installing fences along sections as required, on the banks of the river in the low flow section.
3 ENVIRONMENTAL ACTION PROPOSAL

Based on the identified impacts, we propose adopting a set of measures to mitigate, offset, potential eyes and/or monitor the impact which will be created by Piedade SHS during its various phases. They mainly aimed to establish an integration between the development and the environmental systems in which it is located, as well as local and regional socioeconomic characteristics currently in place.

All of the proposed measures are presented as environmental Programs, Projects and Plans in table 3.1.

<table>
<thead>
<tr>
<th>Program</th>
<th>Project</th>
<th>Execution Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Works Quality Control Program</td>
<td>Sanitation Infrastructure Project for the Work Site</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Road Infrastructure Implementation Project</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Safety and Warning Project</td>
<td>Construction</td>
</tr>
<tr>
<td>Recovery Program for Areas Affected</td>
<td>Projects to Removed and Stored Stripped Soil</td>
<td>Construction</td>
</tr>
<tr>
<td>by the Works</td>
<td>Degraded Area Recovery Plan</td>
<td>Construction, Filling and Operation</td>
</tr>
<tr>
<td></td>
<td>Monitoring and Control Project for Erosion Surrounding the Reservoir</td>
<td>Construction, Filling and Operation</td>
</tr>
<tr>
<td></td>
<td>Projects to Remove Vegetation Affected by the Development</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Projects to Recover, Rehabilitate and Revergetate Springs and Watercourses</td>
<td>Construction</td>
</tr>
<tr>
<td>Forestry Program</td>
<td>Projects to Rescue Flora, Germoplasm and Relocate Epiphytes</td>
<td>Construction</td>
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<td></td>
<td>Flora Reconstitution Project</td>
<td>Construction, Operation</td>
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<tr>
<td>Fauna Conservation Program</td>
<td>Martin Monitoring Project</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Mutum-de-Penacho Monitoring Project</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Projects to Rescue Fauna during Deforestation and Filling the Reservoir</td>
<td>Construction, Filling</td>
</tr>
<tr>
<td>Ichthyofauna Program</td>
<td>Project to Monitor Ichthyofauna Prior to Dam Construction</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Projects to Monitor Ichthyofauna following Dam Construction</td>
<td>Construction, Filling</td>
</tr>
<tr>
<td></td>
<td>Projects to Evaluate Intervention Requirements in the Low Flow Section to Avoid Fish Imprisonment</td>
<td>Construction, Filling</td>
</tr>
<tr>
<td></td>
<td>Projects to Rescue Ichthyofauna during River Diversion and Filling the Reservoir</td>
<td>Construction, Filling</td>
</tr>
<tr>
<td></td>
<td>Fish Transport Mechanism Project</td>
<td>Operation</td>
</tr>
<tr>
<td>Socio-Environmental Program</td>
<td>Social Communication Project</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Environmental Education Project</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Project to Take Advantage of Local labor</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Land and Improvement Negotiation Project</td>
<td>Construction</td>
</tr>
<tr>
<td></td>
<td>Socioeconomic Issue Monitoring Project</td>
<td>Construction, Filling and Operation</td>
</tr>
<tr>
<td>Water Quality Program</td>
<td>Limnologic And Water Quality Monitoring Project</td>
<td>Construction, Operation</td>
</tr>
<tr>
<td></td>
<td>Macrophyte Control and Monitoring Program</td>
<td>Operation</td>
</tr>
<tr>
<td>Natural Heritage Registration Program</td>
<td>Project to Monitor Water Flowing into and Out Of the Reservoir</td>
<td>Construction</td>
</tr>
<tr>
<td>Hydrometric Monitoring Program</td>
<td>Reservoir Siling Monitoring Project</td>
<td>Operation</td>
</tr>
<tr>
<td></td>
<td>Groundwater Monitoring Project</td>
<td>Operation</td>
</tr>
<tr>
<td>Weather Monitoring Program</td>
<td></td>
<td>Operation</td>
</tr>
<tr>
<td>Archaeological Research Program</td>
<td></td>
<td>Construction</td>
</tr>
<tr>
<td>Farmer Technical Assistance and Support Program</td>
<td></td>
<td>Operation</td>
</tr>
<tr>
<td>Artificial Reservoir Surrounding Area Usage and Environmental Conservation Plan</td>
<td></td>
<td>Operation</td>
</tr>
</tbody>
</table>

Table 3.1

Environmental actions proposed for a PIEDADE SHS.
Note that most of the proposed Projects integrate with one another and also to optimise the activities and resources available they have been grouped into 12 Programs. Because of these measures, in some cases, a Program may generate benefits for other Programs by creating interrelations, either during execution or in relevant activities.

We should also mention that when the development reaches the Executive Phase, all of the Projects, Plans and Programs will be detailed in a PCA - Environmental Control Plan.

3.1 Construction quality control program

3. 1. 1 Sanitation Infrastructure Project for the Work Site

3.1.1.1 Introduction

As the activities involved in deploying and operating the worksite during the Piedade SHS Construction Phase will cause alterations to the environment, this project aims to indicate measures that can be implemented to minimise them and monitor the efficiency of these activities.

3.1.1.2 Justifications

Implementation of this project is justified by the need to adapt worksite premises to the environment in which they are located, reducing the risk of water contamination and providing workers with suitable basic sanitation conditions.

3.1.1.3 Objectives

The measures to be adopted mainly aim to:

- Provide suitable water supplies for human and industrial consumption;
- Correctly dispose of domestic waste and other solid waste from administrative and operational activities;
- Provide a suitable sanitation sewage system;
- Provide proper treatment for effluent containing solids in suspension, oils and greases; and
- Adequately direct rainfall, avoiding solids being carried into the watercourses.

3.1.1.4 Target Group

Development construction employees.

3.1.1.5 Planned actions

The measures will be implemented at the beginning of the works, while mobilizing and implementing the worksite, involving the following actions:

- Implementing a system to provide water and collecting treat effluent (for example septic tanks/filters/sinks);
deployment of collection, treatment and disposal systems for domestic waste and other solid residues;

- Implementation of collection systems (oil and fat separation boxes) suitable treatment and disposal of lubricant oil used by site equipment, especially in workshops and supply and lubrication areas;
- Implement rain water drainage systems around the worksite.

### 3.1.1.6 Party responsible for implementation

The developer will be responsible for this project.

### 3.1.1.7 Physical Timetable

This project will be implemented in the Construction phase, installing the recommended equipment alongside construction of the various worksite units (administrative, workshop and others).

### 3.1.2 Road Infrastructure Construction Project

#### 3.1.2.1 Introduction

In order to ensure constant and safe vehicle and equipment traffic to and from the site, improvements and adaptations will be made to the municipal road (made of dirt) which connects the city of Monte Alegre de Minas to the bridge over the River Piedade and to the secondary dirt roads which will be used to access the development.

In order to improve the access roads, measures must be taken such as adapting the carriageway, coverings, drainage and signage systems and construction of new section to substitute those damaged by the development. Note that whenever possible, these activities should avoid groups of trees which may be in the way, avoiding abusive felling and burying water springs.

In order to prevent accidents, signs and warnings must be placed on the access routes (to reduce speed, protect vehicle traffic, people and animals on the roads etc), among other preventive measures considered prudent, as specified below in the "Safety and Warning Project".

#### 3.1.2.2 Justifications

This project is justified by the need to adopt measures on access routes which will be used to access the Piedade SHS construction location and on local roads, in the ADA, which will be affected by creation of the reservoir, in order to guarantee traffic continuity and the safety of users and nearby inhabitants.

#### 3.1.2.3 Target group

Construction employees and the population using the access routes in general.
3.1.2.4 Planned actions
The following actions have been forecast:

- Define the access routes used by vehicles travelling to the development in order to avoid impact on other, local routes;
- Adaptation/improvements to the work access routes guaranteeing that traffic is not interrupted;
- Control the traffic destined for the works, minimising trouble and the risk of accidents to the population within the ADA;
- Re-establish the connecting routes affected by development structures.

3.1.2.5 Party responsible for implementation
The developer will be responsible for this project.

3.1.2.6 Physical Timetable
This project will be implemented during the Construction Phase.

3. 1.3 Safety and Warning Project

3. 1.3. 1. Introduction/Justifications
Piedade SHS construction may increase the risk of personal accidents in traffic areas and on the worksite as well as at the reservoir and in the low flow section. Therefore, this project aims to establish security and warning measures which must be taken during construction, reservoir filling and plant operation.

3.1.3.2 Target group
The target group for the Security and Warning Program at Piedade SHS is:

- Rural property owners in the ADA and AE;
- Construction employees; and
- Public authorities in Monte Alegre de Minas.

3.1.3.3 Planned actions
The following actions have been forecast:

- Signage along development access roads and service roads providing speed limits, educational messages (including protecting the environment) and indicating the existence of inhabited areas. Speed bumps may be placed in locations with greater pedestrian traffic;
- Signage in areas of risk where explosives are stored and detonations are possible;
- Audible warnings (using sirens), warning people that detonation activities are commencing;
Set up warnings when filling the reservoir while flooding the accumulation basin;
- Inspect the reservoir area during flooding;
- Provide signage around the banks of the reservoir warning of the risk of accidents;
- Provide signage for safety areas in a low flow sections and the reservoir;
- Publish information on risks to personal safety during the construction, reservoir filling and project operation phases that in addition to preventive measures.

3.1.3.4 Party responsible for implementation
The developer will be responsible for this project.

3.1.3.5 Physical Timetable
This project will be carried out in two different stages: One when building the development (Construction Phase) and one during Reservoir Filling, both of which are temporary; and another comprising the Operational Phase, on a permanent basis.

3.2 Recovery Program for Areas Affected by the Works
This program basically aims to provide suitable treatment and conservation for the soil to support native vegetation and livestock production, in the long term, and recover areas that will be degraded by development works.

3.2.1 Project to Remove and Store Stripped Soil

3.2.1.1 Introduction/Justifications
Normally, an area is stripped when it is cleared to create new areas for work and for accommodation, opening and relocating highways and access to and construction of different units. The surface soil (organic soil) is normally removed, containing microorganisms, organic material, nutrients and propagules, which are very important to drive recovery processes in degraded areas.

Therefore, deployment of the “Project to Remove and Store Stripped Soil” aims to create a strategy to remove and store stripped soil when opening up new work areas for the Piedade SHS development.

3.2.1.2 Objectives
Removal and storage of the surface soil in areas affected by the works generally aims to help the rehabilitation processes which will be implemented at a later stage in degraded areas.
3.2.1.3 Planned Actions

Removed and store the surface layer of the soil (approximately 40 cm) in all affected areas, such as: worksites, quarries, highways, leased areas, waste areas, dam construction, the water channel, substation and power station. Material should be stored in areas close to the affected areas in order to facilitate replacement. Removal and storage of the strip soil will be carried out by the same machines clearing the areas.

3.1.1.4 Party responsible for implementation

The developer will be responsible for this project.

3.1.1.5 Physical Timetable

Material storage and removal will take place during the construction phase, while clearing and stripping the affected areas when the works begin.

3.2.2 Degraded Area Recovery Plan

3.2.2.1 Introduction

The development will cause changes to the soil, the landscape and vegetation when creating the work site, building the dam and the power station, in the leased areas and waste areas, when relocating the highways affected by the reservoir and opening up new access routes. However, these alterations can be reversed, by implementing the “Degraded Area Recovery Plan”.

3.2.2.2 Justifications

According to current environmental legislation, every development causing environmental degradation must rehabilitate the affected area in order to minimize and control any impact is caused. In addition to the legal factor there are also ethical and soil conservation issues.

3.2.2.3 Objectives

The main objective of this project is to rehabilitate areas degraded by the development in order to protect the soil, control erosion processes and regenerate vegetation.

3.2.2.4 Planned actions

The following actions will be carried out when implementing the Project:

- Topographic recomposition and regularisation of the land;
- When possible, replacement of organic soil;
- Soil fertility adjustment;
- Deployment of drainage control devices; and
- Revegetation.
3.2.2.5 **Party responsible for implementation**

The developer will be responsible for this project.

3.2.2.6 **Physical Timetable**

The recovery work will begin during the Construction Phase, and will extend throughout the others (Filling and Operation). They will be conducted soon after the conclusion of each work or service at the beginning of the rainy season (September to October) and may continue through to the end of February. The preliminary services, which involve engineering works, will preferably be carried out during periods of little rain.

3.2.3 **Monitoring and Control Project for Erosion Surrounding the Reservoir**

3.2.3.1 **Introduction/Justifications**

Based on the geoenvironmental conditions locally and the project characteristics, a monitoring plan will be required for erosion processes in the area surrounding the reservoir. This is justified because when the reservoir is created, some sections of riparian forest will be destroyed on the banks of the river. The absence of vegetation, alongside soil susceptible to erosion, may trigger a process that increases sedimentation in the reservoir.

3.2.3.2 **Objectives**

Monitor the banks adjacent to the reservoir and the embankments and earthworks which will be created (opening and widening highways) in order to obtain information to prevent and reverse erosion processes, aiming to control drainage degradation and reservoir silting.

3.2.3.3 **Target group**

The developer and rural property owners in the Surrounding Area (AE).

3.2.3.4 **Planned Actions**

The following actions will be carried out when implementing the Project:

- Make contact with local owners to get their permission and/or create partnerships to carry out the project;
- Influence the “Degraded Area Recovery Plan” in order to control and minimise any areas of erosion that are found;
- Accompany erosion on slopes close to the reservoir and embankments and earthworks on the service routes in the long term.

3.2.3.5 **Party responsible for implementation**

The developer will be responsible for this project.
3.2.3.6 Physical Timetable
The project will be carried out during the Construction and Operation Phases in order to survey and oversee possible focus point of erosions on slopes close to the reservoir and embankments and earthworks on SHS access routes.

3.3 Forestry program
This Program basically focuses on the vegetation which will be affected by the development as well as vegetation remaining within the AE. Note that the Projects involved in this Program are interlinked and interdependent in terms of the relevant activities and results they will produce.

3. 3. 1 Project to Remove Vegetation Affected by the Development

3.1.1.1 Introduction
Removal of vegetation affected by the development in areas used for dam construction, building structures, worksites and administrative areas and waste disposal sites, among others, is very important so that various environmental aspects they represent can be preserved.

We should point out that the the loss of areas which are deemed Areas of Permanent Preservation, when the lake is filled, is inherent to this type of project.

3.3.1.2 Justifications
Removal of forest vegetation in the accumulation basin when filling the reservoir, and in other areas required by the development, aims to comply with:

- Legal obligations;
- Socioeconomic usage of timber;
- The need to force fauna to look for new shelter and sources of food;
- The need to maintain reservoir water quality;
- Provide safety in relation to multiple future types of reservoir usage;
- The need to maintain acceptable aesthetic standards.

3.3.1.3 Objectives
Deforestation will remove timber present in the areas used for the infrastructure required for the development and the reservoir, because this amaterial decomposes slowly (after flooding). Deforestation will also allow the gradual migration of fauna away from the area which will be flooded. By limiting tree felling to the flooding area, this will reduce the deforested area to strictly required levels, in order to avoid abusive felling.
3.3.1.4 Planned actions

The following actions have been forecast:

- Initially, obtaining a deforestation licence from relevant agencies;
- Deforestation (subject to preparing a specific project) of the affected areas restricted to the flooded area; in order to preserve the remaining vegetation, as far as possible, we suggest adopting the NA - maximum normal reservoir level, as the maximum limit for vegetation removal;
- Deforestation must be slow (in order to allow wildlife to migration) and move towards remaining areas of forest surrounding the reservoir especially when these areas of forest are connected;
- Deforestation must be carried out from downstream to upstream and from lower to higher ground;
- The timber must be removed;
- All employees involved in deforestation activities must be trained in advance in order to take due care, avoiding abusive felling and accidents involving wildlife.

3.3.1.5 Technical Team

Deforestation activities must be planned and co-ordinated by a forestry engineer, carried out by employees or outsourced to specialised deforestation companies.

3.3.1.6 Party responsible for implementation

The developer will be responsible for this project.

3.3.1.7 Physical Timetable

Deforestation activities, when required, will be carried out before building the structures required by the development and flooding the reservoir, i.e. during the Construction Phase.

3.3.2 Project to Recover, Rehabilitate and Revegetate Springs and Watercourses

3.3.2.1 Introduction/Justification

When the Piedade SHS reservoir is created, riparian forest will need to be removed. The “Flora Reconstitution Project” will define the areas where recovery of these environments will be encouraged around the reservoir and the creation of corridors interlinking forest fragments in the APP (Area of Permanent Preservation). However, because of the current usage and occupation of this land, which is basically used for livestock and farming, the region has already been substantially degraded compared with the forest reserves previously located on these sites.
CONAMA resolutions 302 and 303, both from March 2002, must be taken into account when developing this project.

3.3.2.2 Objectives

The aim is to preserve and rehabilitate some of the springs and water sources in the adjacent areas and direct drainage channels leading to the future Piedade SHS reservoir. This will recover water sources for terrestrial and aquatic fauna, revert fauna habitats, providing an increased genetic pool for the flora and fauna and contain sediments and pollutants carried by water courses while protecting against erosion.

3.3.2.3 Planned actions

The following actions have been forecast:

- Define locations where intervention is required;
- Select the species to form forest stands;
- Select and describe the methodology which will be used to create the stands;

3.3.2.4 Technical Team

The technical team will include a technician specialised in agrarian sciences and unskilled labor.

3.3.2.5 Party responsible for implementation

The developer will be responsible for implementing this project.

3.3.2.6 Timetable

Please note that the timetable for these activities will follow the same timetable for the activities in the “Flora Reconstitution Project” as most of these activities are equivalent. Additionally, please note that the timetable is dependent on other activities required to build and operate Piedade SHS as well as the time required to carry out these activities.

We should further note that the recovery/rehabilitation work for springs and drainage areas should begin when starting the “Flora Reconstitution Project” so that the operations are carried out in parallel, providing operational gains and improved efficiency and quality.
3.3.3 *Project to Rescue Flora, Germoplasm and Relocate Epiphytes*

3.3.3.1 *Introduction*

The revegetation or mixed planting of native species in anthropized areas mainly aims to create a forest as close as possible to the original one. Issues of species diversity and natural regeneration have been constantly dealt with in revegetation models. However, local adaptation of plants used for revegetation is not often considered when implementing these models. We therefore need to collect local flora and germoplasm to support the ecological succession processes.

The species of epiphytes present in the area which will be deforested must be relocated to areas with vegetation providing phytophysiological characteristics desirable for survival and continuity.

3.3.3.2 *Justifications*

The use of secondary ecological succession when creating mixed forests is an attempt to use artificial regeneration as a model which attempts to copy natural succession processes. The nature of the material used may influence the behaviour of the individual plants, which may in turn influence behaviour in population dynamics as a whole. Therefore, the purpose of revegetation processes is to recreate vegetation communities, collect germoplasm locally or in remaining vegetation areas close by in order to produce a genetic integrity and adaptability as close as possible to what was originally encountered.

For species of plants belonging to the Bromeliacea, Orquidaceae, Cactaceas, Aráceas and other families, collection will take place independent of the phenological stage and plant development.

3.3.3.3 *Objectives*

The main aim is to collect flora and germoplasm at affected locations, mainly in the reservoir accumulation basin. However, areas adjacent to the development may also be selected for seed collection. Individual epiphyte species will be collected in affected areas and relocated to adjacent areas with suitable characteristics.

3.3.3.4 *Planned Actions*

The following actions will be included in the “*Project to Rescue Flora, Germoplasm and Relocate Epiphytes*”:

- Define the areas for material collection: Areas for collection and rescue are mainly those which will undergo deforestation and areas of relevant interest;
- Collect of propagation material: The collection itself must be possible based on the type of material to be collected. This means that we will require various types of collection equipment, transport and storage for the material;
Epiphyte relocation: Individuals for relocation will be removed and located in compliance with recommendations to be issued.

3.3.3.5 Technical Team

The activities must be planned and co-ordinated by a technician with botanical knowledge and will be carried out by employees.

3.3.3.6 Party responsible for implementation

The developer will be responsible for this project.

3.3.3.7 Physical Timetable

Collection of propagation material, mainly seeds, will be carried out during the main species reproduction period during the hydroelectric project construction, prior to reservoir basin deforestation activities.

Epiphyte collection will be carried out prior to deforestation and relocation will be carried out immediately in areas of forest adjacent to the development. If immediate relocation is not possible, the collected material will be temporarily stored in a specific area.

3.3.4 Flora reconstitution project

3.3.4.1 Introduction/Justification

Riparian vegetation is fundamental for the correct ecological operation of adjacent aquatic and terrestrial bodies of water. They retain sediments carried towards watercourses, avoid silting and water contamination from pesticide on fertiliser residues; they help protect the banks against landslides and erosion and are a source of food, reproductive habitat and refuge for relevant fauna.

Alongside the "Project to Recover, Rehabilitate and Revegetate Springs and Watercourses" the Flora Reconstitution Project will rehabilitate vegetation corridors thereby supporting the genetic flow of local flora and fauna populations.

3.3.4.2 Objectives

This work aims to drive natural regeneration of riparian forest in the Area of Permanent Preservation (APP) around the future lake at Piedade SHS and standardize the procedures required to reach the proposed objective in other areas, not only those adjacent to the reservoir, for example areas which have been degraded by the development and require planting of tree species. In parallel it will help the genetic flow of local flora and fauna.
3.3.4.3 Planned Actions

The following actions will be included in the Flora Reconstitution Project:

- Define locations where intervention is required;
- Define the methodology used for recovery;
- Choose the preferred tree species;
- Quantify the areas targeted for reconstitution;
- Prepare the area around the reservoir to facilitate inspection work;
- Define the final destination for the propagation and epiphyte material.

3.3.4.4 Technical Team

The work being carried out to reforest riparian forest must be carried out under the general coordination and supervision of a Forestry Engineer or Agricultural Engineer.

3.3.4.5 Party responsible for implementation

The developer will be responsible for this project.

3.3.4.6 Timetable

The timetable for rebuilding riparian vegetation depends on other activities required to implement and operate the SHS, as well as the “Project to Recover, Rehabilitate and Revegetate Springs and Watercourses” and the “Project to Rescue Flora, Germoplasm and Relocate Epiphytes.”

We should also note that the work to create forests stands in areas close to deforested areas should begin after the deforestation so that these activities do not occur simultaneously, which would negatively affect the efficiency and quality of both.

3.4 Fauna conservation program

This Program encompasses the Projects which will be implemented in order to study, conserve and handle terrestrial fauna.

3. 4. 1 PROJECTO TO MONITOR MARTINS (CYPSSELOIDES SENEX AND STREPTOPROCNE ZONARIS)

3.4.1. 1. Introduction/Justification

The martins were registered in shelters at waterfalls in the development area and at the “Roosevelt” waterfall on the Piedade River, also noting the nesting process of Cypseloides senex at the “Roosevelt” waterfall.

Waterfall in the development area will be subject to reduced flow because of its location downstream from the dam. The “Roosevelt” waterfall will also suffer from reduced flow, because it is also located in the
low flow section, therefore having a major effect on the locations where the martins were registered.

These species collectively gather on walls next waterfalls or in dark and damp capes next waterfalls in the forest; they stand upright. Their nests are made of moss and small stones firmly stuck together with mud and saliva and lined with fragments of vegetation and they are generally located in damp locations such as stone walls and escarpments around waterfalls and in wet and dark caves. *Cypseloides* builds its solid “throne” around waterfalls and also on walls which are fully exposed to daylight, which is not common for an Apodidade. Both types like being sprayed with drops of water (SICK, 1997).

### 3.4.1.2 Objectives

This Program intends to evaluate the effects that may be caused on populations of martin’s present in the Piedade SHS ADA following changes that will be made to their habitats.

### 3.4.1.3 Planned Actions

The first phase of this project will be carried out to monitor the populations of martins at waterfalls under natural conditions.

The second phase will be started after the dam has been built in order to verify changes to martin population dynamics based on the reduced water flow at waterfalls and whether any nearby location will be chosen as a new nesting place.

### 3.4.1.4 Party responsible for implementation

This program will be carried out by the developer.

### 3.4.1.5 Physical Timetable

Altogether, five on-site campaigns will be carried out. The first campaign will be conducted before work begins. The campaigns will be conducted quarterly.

### 3.4.2 PROJECTO TO MONITOR THE MUTUM-DE-PENACHO (CRAX FASCIOLATA)

#### 3.4.2.1 Introduction

The mutum-de-penacho, a bird classified as vulnerable according to the Biodiversitas foundation, was registered in the area surrounding two farms in the ADA. At these locations, the birds visit the orchards and feed alongside domesticated birds. These orchards are connected to riparian forests and rivers running into the Piedade River, located in the ADA. The riparian forests form corridors which are used by fauna to travel and are surrounded by areas of pasture.
Influence from the development works will fragment these forests and affected areas used by the mutum.

3.4.2.2 Objectives

This program aims to diagnose the survival conditions for the species before works begin and any effects during works and after the have ended.

3.4.2.3 Planned Actions

The concentration of mutum-de-penacho under natural conditions will be monitored. Information and education procedures aimed at site workers will mainly address issues related to capturing and hunting these species, in order to restrict this type of activity.

3.4.2.4 Party responsible for implementation

This program will be carried out by the developer.

3.4.2.5 Physical Timetable

Five on-site campaigns will be carried out during the works. The first campaign will be conducted before work begins and will last for seven days, two of which will be used travelling to and from the area. A period of one day will be spent in contact with local owners and defining observation points. The other campaigns will be carried out bimonthly and will last for six days, two for travelling to and from the site and four for surveys.

3.4.3 Project to Rescue Fauna during Deforestation and Filling the Reservoir

3.4.3.1 Introduction

As the flood basin will be deforested first and then flooded, we suggest appropriate monitoring of deforestation and reservoir filling activities.

In light of this, wildlife (including active nests, in other words those with eggs and chicks) may remain in areas which are deforested and/or flooded. Others, especially snakes, may move towards areas occupied by rural properties located within the AE and may represent snake related risks.

Therefore, during deforestation and flooding, actions must be defined to protect, rescue or avoid the death of wildlife, optimising their dispersion into local natural environments.
3.4.3.2 Objectives

The Project to Monitor and Rescue Fauna at the Piedade SHS has the following goals:

- Accompany, help, rescue and/or relocate wildlife (as well as active and inactive wildlife nests) which are at risk, while clearing areas in the development and reservoir flooding area;
- Generate basic data on the biology of the species so that conservation and handling methods can be established safely and efficiently.

3.4.3.3 Methodology

The following actions have been planned:

- Select and train teams of professionals and assistants involved in these activities;
- Acquire the material and equipment required to carry out these activities;
- Define the destination of any fauna which is captured: This fauna may be relocated to preselected areas (forest fragments in the AI and AE);
- Construction of an Animal Triage Centre capable of identifying, registering, maintaining and providing clinical services for live fauna;
- Teach local inhabitants on procedures to capture, contain and store animals which are found dead and prevention of predatory fauna slaughter, as the chances of local inhabitants coming across fauna will increase;
- Accompany deforestation activities in the flood basin, capturing wildlife which has been hurt or are unable to migrate alone out of the deforested area (relocating it to adjacent locations);
- During flooding, the flooded areas will be travelled by boat, collecting nests and animals which may be trapped or hurt. Animals which have been hurt and are unable to move outside the flooding area on their own will be taking to the Triage Centre where they will receive suitable treatment;
- Request a specific environmental licence from IBAMA/Belo Horizonte (MG).

3.4.3.4 Team

The size of the team takes into account the number of professionals needed to work in shifts.

The team will include a biologist, a veterinarian and two technical assistants, with experience, as well as four other assistance and worksite employees (to capture and treat the animals and also to maintain the TC).

A full-time team of employees will undergo specific training in the period before deforestation, during which they will be shown techniques and strategies to be adopted so they can carry out these activities. The use of safety equipment will be mandatory in the TC and in the field.
with gloves, leg protectors, pants, boots etc. There will also be regular contact between the teams in the field and the office, via radio, to resolve any problems that may arise and take decisions.

3.4.3.5 Party responsible for implementation

This project will be carried out by the developer.

3.4.3.6 Physical Timetable

The project will be carried out while deforestation is ongoing prior to construction and reservoir filling.

3.5 Icthyofauna program

This item includes environmental projects which will be implemented at the Piedade SHS, in order to study, conserve and handle icthyofauna.

3. 5. 1 Project to monitor icthyofauna prior to dam construction

3.5.1.1 Introduction

Various aspects of fish biology on the Piedade River are unknown. Therefore, increasing basic knowledge of the structure of fish communities is an important program for regional fish handling and conservation.

3.5.1.2 Justifications

The availability of detailed knowledge of icthyofauna communities is important as guidance for icthyofauna conservation activities. Furthermore, changes in fish communities caused by the development can only be adequately understood if the basic standards are defined prior to any alterations caused by the dam, in order to conduct future comparisons.

3.5.1.3 Objectives

Study of the icthyofauna community in the Piedade SHS Sphere of Influence will include the following goals:

- Increase knowledge of the local icthyofauna composition;
- Estimate the numerical and biomass abundance;
- Define preferred habitats for the species.

3.5.1.4 Target Groups

This project will study the icthyofauna community in the Piedade River along the section where the Piedade SHS will be built.
3.5.1.5 Methodology

This project will cover at least a period of no less than one year (a complete hydrological cycle) before the works are concluded.

Five locations within the development sphere of influence will be sampled quarterly in addition to streams and other rivers in the region. Capture methods will be standardized (quantitative sampling) enabling statistical comparisons throughout the survey.

The fish captured will be packed in labelled plastic bags, separated by season, type of environment, fishing method and mesh. The fish will be stabilised in 10% formalin. After this procedure, all of the fish will be packed in suitable recipients.

In the laboratory, the samples will be washed and conserved in a solution of 70ºGL ethyl alcohol. Samples captured in the stationary nets will be identified, labelled and subsequently weighed and measured. Larvae and young fish will be separated, counted and identified to the lowest possible taxonomic category.

The relative abundance of species will be estimated from the catch per unit effort (CPUE) based on data obtained from the stationary nets. Similarity analyses will be carried out using the Sorensen index.

3.5.1.6 Party responsible for implementation

The developer will be responsible for implementing this project. The project will be led by a biologist who has experience with ichthyofauna.

3.5.1.7 Physical Timetable

This project will be carried out in the development planning and construction phases.

3.5.2 Project to Monitor Icthyofauna after the Dam Has Been Created

3.5.2.1 Introduction

The Coordinating Committee for Environmental Activities in the Electrical Industry (COMASE, 1994) found several deficiencies in an analysis of water monitoring programs at Brazilian dams. Based on this analysis, the following recommendations were proposed:

- Monitoring must be carried out throughout the development Sphere of Influence on a continuous basis.
- Monitoring must be construed as an activity to evaluate the level of variation presented by a body of water in relation to a known standard or model.
If these rules are complied with, monitoring projects will be able to provide suitable guidance on conservation or handling strategies used, and evaluate their effectiveness over the medium and long term.

3.5.2.2 Justifications

Monitoring project provides suitable guidance for icthyofauna community handling conservation strategies in the area affected by the development. This project is required to provide data so that activities can be carried out to avoid losing by diversity at a local level (the region influenced by the development) and regionally (Paranaiba basin).

3.5.2.3 Objectives

The aim of this study is to accompany fish communities in the period after the Piedade SHS has been built. Data obtained from this project will be used and compared with the period prior to the dam construction, allowing us to adopt handling and conservation methods to attenuate or reverse negative impacts detected.

3.5.2.4 Target Groups

This project will study the icthyofauna community in the Piedade River along the section where the Piedade SHS will be built.

3.5.2.5 Methodology

This project will begin immediately after the reservoir has been closed and will include eight quarterly collections over the first two years. The project duration and frequency are justified because the changes brought about by the dam are continuous and directly related to the hydrological cycle. The need for continued studies will be evaluated at the end of this project.

The methodology used in this phase will be the same one used in the studies conducted prior to dam construction, described in detail in the Project to monitor icthyofauna prior to dam construction.

3.5.2.6 Party responsible for implementation

The developer will be responsible for this project. The project will be led by a biologist who has experience with icthyofauna.

3.5.2.7 Expected Outcomes

Reports will be produced at the end of each year of the studies. The reports presented annually will provide all of the information in a single volume. This procedure will avoid referencing several documents and make information access faster and more accurate.
3.5.2.8 Technical Team

- 1 biologist with experience in ichthyofauna monitoring
- Laboratory technician

3.5.2.9 Institutional Requirements

The Brazilian Institute for the Environment and Natural Renewable Resources (IBAMA), the Forestry Police and the State Forestry Institute (IEF) must be contacted in order to obtain the necessary licences.

3.5.2.10 Physical Timetable

This project will be carried out in the plant operation phase.

3.5.3 Project to Evaluate Intervention Requirements in the Low Flow Section to Avoid Fish Imprisonment

3.5.3.1 Introduction

When the flow is interrupted by part of the dam, pools may form along the low flow section imprisoning fish. It is therefore very important to detect any pools that could be created and evaluate their geometric characteristics (size – especially depth – interconnection with other pools) in terms of how far they may facilitate this type of impact.

3.5.3.2 Objectives

This program aims to evaluate the need for intervention on the low flow section to reduce the possible negative effects that may be caused among fish populations according to the repercussions on their habitats.

3.5.3.3 Methodology

When rescuing fauna after closing the floodgates to fill reservoir, the low flow section must be inspected. This will be carried out to evaluate the need for any mitigating procedures which will mainly include opening channels on the rocky riverbed to interlink any pools so that fish can naturally move around when the water level is higher.

3.5.3.4 Expected Outcomes

After on-site inspection, a final report will be produced, evaluating and proposing any mitigating measures required.
3.5.3.5 Technical Team

- 1 biologist with experience in ichthyofauna monitoring
- laboratory technician

3.5.3.6 Party responsible for implementation

The developer will be responsible for this Program.

3.5.3.7 Institutional Requirements

The Brazilian Institute for the Environment and Natural Renewable Resources (IBAMA), the Forestry Police and the State Forestry Institute (IEF) must be contacted in order to obtain the necessary licences.

3.5.3.8 Physical Timetable

This program will be implemented during ichthyofauna rescue activities, issuing a final report one month after the fieldwork has been concluded.

3.5.43 Projects to Rescue Fauna during Deforestation and Filling the Reservoir

3.5.4.1 Introduction

When building the dams, two actions will very likely imprison fish by quickly modifying the natural flow of the water on a variable section of the river. These activities are diverting the river in order to build the dam and closing the floodgates to fill the reservoir. These events may result in the death of fish in the affected section, requiring rescue activities.

During reservoir filling and when creating cofferdams, the water level along a specific section of the river will fall substantially. These conditions are adverse for fish, requiring intervention to avoid mass death.

3.5.4.2 Objectives

Accompany diversion of the Piedade River in order to build the Piedade SHS dam and the reservoir filling process.

3.5.4.3 Target Groups

This project will study the ichthyofauna community in the Piedade River along the section where the Piedade SHS will be built.

3.5.4.4 Methodology

The current methodology involves collecting imprisoned fish in the exposed areas on the river bed. Live fish which are captured will be released directly into the river.
when there is a satisfactory water level. Any dead fish will be preserved for future study and as evidence of local fauna. When diverting the river, these actions will be carried out along the entire section sealed off. When the flood gates are closed, rescue work will involve the section immediately downstream of the dam in any area considered critical.

3.5.4.5 Technical Team

Two biologists with ichthyofauna experience and on-site assistants.

3.5.4.6 Party responsible for implementation

The developer will be responsible for this project.

3.5.4.7 Institutional Requirements

The Brazilian Institute for the Environment and Natural Renewable Resources (IBAMA), the Forestry Police and the State Forestry Institute (IEF) must be contacted in order to obtain the necessary licences.

3.5.4.8 Physical Timetable

This project will be carried out in the development construction and reservoir filling phases.

3.5.5 Fish transport mechanism project

Recent legislation (Minas Gerais, 1997) has made it mandatory to build fish transportation mechanisms on all dams built in Minas Gerais from the same year. According to this law, this article does not apply when, based on the project characteristics, this measure is considered inefficient. Therefore, the environmental impact studies for dams must include an evaluation of the need to implement such mechanisms.

Reproduction is one of the most important biological aspects of a species, on which its success depends. Dams have substantially changed the recruitment of migratory fish species because they interrupt their migratory routes. Strategies used to eliminate dam obstacles in fish migration routes include the construction of transportation mechanisms. Fish transportation mechanisms include stairs and elevators (Clay, 1995). Although in some cases these transportation mechanisms are not fully effective, they have been the most popular and widely recommended methods currently in use.

So far, no information has justified deployment of a mechanism to transfer fish from the Piedade SHS dam area. Such a mechanism is therefore likely to be unnecessary. However, the final analysis of this issue will be presented at the end of the first fish monitoring phase, as stated previously in this PCA.
3.6 Social and environmental program

This Program includes projects to control socioeconomic and environmental aspects around the Piedade SHS.

3.6.1 Social communication project

3.6.1.1 Introduction/Justification

Construction of the Piedade SHS will result in changes to everyday life in the region because of the civil engineering works and changes to the landscape when the power station comes on line.

Communication is a tool used to create a connection between the developer and the various groups connected with construction of the SHS, providing them with information and promoting dialogue.

3.6.1.2 Objectives

The object hereof is:

- To provide information (on the Piedade SHS project during its various phases, linked with health care, the environment, labor, etc) to site workers and populations in the ADAE and AI.

3.6.1.3 Target Group

- Municipal Government
- AI, AE and ADA populations;
- Site workers.

3.6.1.4 Planned activities

Activities planned for these goals include:

- Distributing information leaflets;
- Holding meetings with the target groups;
- Talks;
- Producing posters and other visual material.

3.6.1.5 Party responsible for implementation

The developer will be responsible for this project.

3.6.1.6 Timetable

The Project will be implemented throughout the development construction period.
3.6.2 Environmental education project

3.6.2.1 Introduction/Justification

Environmental Education includes processes during which individuals and societies build social values, knowledge, skills, attitudes and competences to preserve the environment.

3.6.2.2 Project Group

The people covered by this Environmental Education Project include:

- Rural property owners in the ADA;
- AI population;
- Site workers.

3.6.2.3 Objectives

- Create conservation and environmental preservation awareness among the target group;
- Reduce the pressure from hunting, chasing and collecting wildlife and flora.

3.6.2.4 Planned activities

Environmental Education Project activities include:

- Use tools from the Social Communication Project throughout site construction in order to promote the environmental characteristics in the region;
- Holds talks with people living in the ADA and AI and site workers on the region’s environmental characteristics, the development characteristics and environmental projects which will be carried out;
- Carry out activities to increase formal education, reinforcing municipal environmental education directives.

3.6.2.5 Party responsible for implementation

This project will be carried out by the developer.

3.6.2.6 Timetable

The project will be carried out while the development is in progress.

3.6.3 Project to Take Advantage of Local labor

3.6.3.1 Introduction/Justification

Work to build hydroelectric power stations requires mobilizing a group of workers which, during a specific period during the development construction phase, generates a relative boost to the job market in the project AI and ADA.
the scope of which is directly associated with the volume of workers to be hired and the size of the city where the development is located.

The Piedade SHS construction timetable forecasts 18 months of construction work, from the developer commencing works on civil engineering projects up to the power station coming online, involving around 166 workers, at most, during the peak construction phase.

Table 3.2 estimates maximum labor levels forecast for development construction throughout the 18 month period.

<table>
<thead>
<tr>
<th>Type of Labor</th>
<th>Months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>01</td>
</tr>
<tr>
<td>Direct Labor</td>
<td>50</td>
</tr>
<tr>
<td>Indirect - Support Labor</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
</tr>
</tbody>
</table>

Labor demand is relatively small, an estimated 166 workers will be directly employed during the peak work period (month 10) of which around 85% are expected to be hired regionally. The other 15% are more experienced (not necessarily more specialized) and will be brought in from outside. In table 3.3 below, we have forecast the number of professionals directly employed during the peak construction period.

<p>| Number of professionals and their function |
| Direct employees doing peak construction period |
| DIRECT JOBS | ESTIMATE |
| University Graduate | 3 |
| Supervisors | 16 |
| - Concrete |
| - Assembly |
| - Earthworks |
| - Administration |
| Official workers | 72 |
| - Builders |
| - Carpenters |
| - Riggers |
| - Welders |
| - Electricians |
| - Mechanics |
| - Surveyors |
| - Administrative |
| DIRECT JOBS | ESTIMATE |
| Assistants | 75 |
| - Civil Works |
| - Electrical and Mechanical Works |
| - Workshops |
| - Security |
| - Cleaning |</p>
<table>
<thead>
<tr>
<th>General Services</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total During Peak Construction</td>
<td>166</td>
</tr>
</tbody>
</table>
In terms of the number of indirect jobs, these are estimated at around 30% of total direct jobs during the peak construction period, mainly in the healthcare areas (doctor and/or nurse), trade (sales, leasing, food and/or hotel accommodation) and services (repairs, home help and/or teaching) in the development region.

The adoption of a Project to Take Advantage of Local Labor seeks to involve part of the labor available within the AI municipal region (Monte Alegre de Minas) during SHS construction works, in order to maintain the positive effects of job creation within the region and avoid any negative interferences, especially social and cultural shocks between the local population and people arriving from other regions.

This is justified by the fact that most of the workers will be hired, as shown in the table above, will be unskilled, boosting recruitment within the region itself.

We should note that the greater the development of the service and construction industries in the region, the greater the possibility of actually contracting local labor.

After the works are concluded, the temporary jobs will no longer exist. Of course, it is impossible to completely avoid the effects of demobilization, even with gradual demobilization, however, in light of the small number of workers forecast for the development, this impact is expected to be small.

Additionally, social communication and institutional activities will provide guidance and direction so that this process has as little impact as possible.

3.6.3.2 Objectives
The aim of this Project is to establish directives to mobilize and demobilize labor employed while building the Piedade SHS in order to maximise the effective job creation in municipal region of Monte Alegre de Minas, and to minimise the negative effects of demobilization when the civil engineering works are concluded.

This project therefore aims to:
- Prepare a public and private organisations providing labor to prepare themselves for the possible increase in labor supply/demand when hiring;
- Establish a link between the developer and the ADA and AI communities in order to integrate them with the development by contracting local labor;
- Provide support to local organisations in the job market in order to coordinate joint professional training activities;
Support and promote social and economic development in the ADA and AI in terms of professional qualifications;
Support the development’s integration and inclusion within the social and economic dynamics of the municipal region.

3. 6.3.3 Operationalization

The basic directives guiding deployment of the Project to Take Advantage of Local labor are based on the principle that in order to maximise the positive effects of job creation, with maximum absorption of local labor, there must be a partnership with the AI City Hall and ADA leaderships.

In fact, the approach adopted in this type of situation is to create partnerships and involve the community around the development. This involves adopting a posture, when building the development, where the developer becomes an active agent, appropriately interacting with the community, resulting in a mutual relationship in which both parties take on responsibilities.

Therefore, in general terms, there are great expectations in the community and local government in terms of development activities, in order to recruit the largest possible number of local workers.

This project will be put into effect in the following stages:
1) Advertise Places: The developer will use local indications media to advertise jobs, by speciality.
2) Registration: The developer will register at work is interested in working at the Piedade works. This can be carried out by providing available labor record books at the Monte Alegre de Minas City Hall. The records will include general information in order to identify the candidate, especially their address.
3) Conduct the recruitment and selection process: When carrying out recruitment and selection, one of the criteria for choosing candidates must be “resident in the development area” in other words, in a municipal region of Monte Alegre de Minas, which will boost the candidate’s chances of selection and hiring.
4) Labor training: If required, the developer will carry out quick training courses for some of the staff hired. Training will be carried out for up to a week on site, involving groups of between 15 and 20 students. Course hours will vary according to the needs of each group and function.
5) Labor demobilization: Demobilization of most of the labor will happen when the civil engineering works have been concluded therefore this will be after the aforementioned “peak” period. The demobilization process is not completely disconnected from the hiring process. Within this context, the first issue that must be addressed is the temporary nature of the job created, which must be
emphasized from the very beginning, when jobs are advertised, up to conclusion of the hiring process. Therefore, in any activity involving recruitment this characteristic must be highlighted. Notes that the developer will responsible for informing the relevant City Hall, in advance, of the actual timetable for hiring and subsequently the timetable for demobilization.

3.6.3.4 Target group

The target group for this project to recruit local labor is:

- ADA community: Population living within the ADA and surrounding area;
- AI community: Urban population of Monte Alegre de Minas.

3.6.3.5 Party responsible for implementation

The developer is solely responsible for this program and it must be implemented by subcontractors involved in the works. Job advertising and prior registration can be carried out with support from local City Halls.

3.6.3.6 Human Resources Involved

In order to carry out this project, human resources professionals from the developer and subcontractors will be used.

3.6.3.7 Physical timetable

The project will begin 30 days after the LI is granted, extending throughout the works period during which there will be periods when employees are hired and laid off.

3. 6.4 Project to negotiate land and improvements

3.6.4.1 Initial Considerations

The land and improvement negotiation process is used to acquire land and improvements located on them on rural properties which will be completely or partially affected by the hydroelectric power plant construction.

An appropriate process is highly favourable for the development as it creates a good relationship between the developer and directly affected population.

According to a specific decision taken by Eletrobrás, the developer is entitled to lease any land of interest instead of purchasing it, provided it is not occupied by permanent structures or flooded when forming the reservoir. Although the legislation entitles the developer to acquire any assets of interest by expropriation, every effort should be made
to conduct a process based on amicable negotiation, outside the courts, in order to develop the best possible relationship between the developer and those affected.

3.6.4.2 Target group

The people targeted by the negotiation process:
- Owners of the affected land;
- People granted permission to live on land which will be affected by the development;
- Permanent jobs on properties affected which will be lost because of the development;
- Partners (title partners, third parties, etc) who will lose working relationships are directly affected properties.

3.6.4.3 Property Negotiation

Negotiation process will involve the following activities:

3.6.4.4 Topographical Survey and Baseline Projection

Topographical survey in baseline projection for the project must be carried out, establishing the limits of the AI, comprising the reservoir area, Area of Permanent Preservation (APP) and areas where other project structures will be built (power station, dam, water channel, etc). Ideally, the reservoir and APP will have different boundaries enabling clear identification of the areas affected by each of them on site.

This activity has been concluded, defining the land which will be affected by the dam, water channel, water intake and power station.

3.6.4.5 Registration

Properties must be registered, providing:
- Drawing with a planimetric survey of the area affected;
- Location and reef description of improvements;
- Definition of total surface area affected by each element of the project (reservoir, down, Power Station, APP, etc) and improvements within this area (house, corral, warehouse, silos, plantations, etc).

A registration file must be drawn up for each property containing this information.

Note that for categories involving the people affected, other than owners, registration information must provide a general description of the area affected including at least:
- Name;
- Related property (name, number and name of owner);
3.6.4.6 Evaluation Report

An evaluation report will be issued for each property based on the information registered, which will be used as the basis for negotiations carried out between the developer and the target group.

The evaluation report will be prepared by a specialised technician at Agrimensura e Topografia Ltda. The report must take into consideration relevant ABNT Standards such as, for example, those relating to “Rural Property Valuations”.

Its main objective is to establish parameters and criteria to measure the values for negotiating naked land, improvements, crops, forests and other structures on rural properties affected.

3.6.4.7 Negotiations

3.6.4.7.1 Rural Landowners

On the developer’s site, the negotiation must be conducted by professionals specifically hired for this purpose, who will develop a constant dialogue with the ADA owners based on visits and meetings in order to measure their expectations.

Within the transfer process involving ownership of assets the following negotiation methods must be offered:

- Partial or total acquisition of property (cash payment for the purchase) when the property is partially affected and the remaining portion is economically viable, or totally affected or even partially affected but the remaining portion is economically unviable;
- Exchanging the land and improvements for another rural property of interest to the owner;
- Negotiating only the affected area, relocating any improvements on the affected area to the remaining area (when the remaining area is still economically viable);
- Rural resettlement;
- Leasing, which includes assigning the asset for a specific period of time subject to the payment of rent.

Total or Partial Acquisition of the Entire Property

When the owner opts to sell all part of the land, the following must be considered when establishing the price:

- The price of the naked land, subject to the type and quality of the soil, as well as access to basic infrastructure (water and electricity) if compromised;
- Indemnity for buildings, taking into account actual investment required to
rebuild them at standards at least equivalent to the original;

- Indemnity for permanent crops, based on the estimated value of affected production, including the period and investment required to replace them over an area similar to the existing crops. In order to define indemnity for affected production, we must survey the market value of products affected during a retroactive period of no less than five years. This allows us to identify any price variations on the market. We suggest that indemnity values be equivalent (subject to appropriate monetary restatement) to market values, during the period analysed for each of the products involved;

- Indemnity for other crops, pasture (native and planted), forests (native and planted) in line with updated market values;

- Consider prices paid on the local market for land in the area, respecting individual differences between the properties.

Furthermore, cash indemnity (land purchases) must be sufficient to reorganise the lives of the families in a manner at least equivalent to current conditions, noting that, after receiving indemnity, the owner will use the amount due as he or she sees fit, with no interference from the developer.

Negotiations may include acquisition of remaining areas, taking into account the agricultural productivity of the land on a case-by-case basis. Productivity analysis must be carried out by specialised third-party agronomists, and based primarily on the concept of “liability” for the producer. In this case, we must also consider:

- The size of the remaining area;
- The quality of the land;
- The availability of basic infrastructure (highways, water, etc);
- The type of economic activity carried out by the farmers;
- Techniques used by farmers;
- If a water source for either animals or humans is lost, the companies responsible for replacing it;
- Finally, the owner’s opinion on the method of negotiation.

Joint analysis of the technical issues and the opinion of the owners/inhabitants of the ADA will define the economic feasibility of the remaining areas and the choice of negotiation method. However, the opinion of the farmer/inhabitant must have a greater weight in the negotiations, and he is entitled to involve an evaluator representing the community from the ADA.

**Exchanging Land and Improvements**

When opting to exchange, the following must be considered:

The new land must be similar condition to the previous land allowing the family to continue farming;

- The areas exchanged must be technically evaluated taking into account the equivalence
in size, land quality according to the usage capacity system, the availability of water sources and basic infrastructure and equivalent proximity to urban centres;

- The negotiation may include reuse of materials from improvements which will be demolished, as was their transportation to the new land;
- The developer will be responsible for moving the family and their assets;
- When exchanging improvements, the new constructions and installations must be the standard at least equivalent to the current ones;
- The owner’s preference for land close to relatives and neighbours may be taken into account, provided it is similar to the current property.

Negotiating Only the Affected Area and Relocating Improvements
The owner may choose to retain the remaining portion of land. In this case, we must consider:

- Relocation of improvements, within the rural property, may be carried out by the company, depending on the negotiations, or by the owner, subject to payment for such improvements;
- The developer responsible for relocating improvements must ensure that their standard is at least equivalent to the current improvements;
- The negotiation may include reuse of materials from improvements which will be demolished;
- This relocation must be evaluated subject to verifying the feasibility of the farmer remaining on what is left of the land; if the improvements are found to be affected because of their proximity or even flooding from the reservoir, reconstruction or relocation of these improvements will take place in locations to be decided by the farmer and which ensure continued social reproduction. When defining new locations we must also take into account human safety, health/sanitary quality, animal drinking water and other aspects.

Rural Resettlement
Resettlement, when applicable, must comply with the following directives:

- The resettlement land must be in similar condition to the previous land allowing the family to continue farming;
- Resettlement area will be subject to a technical evaluation taking into account the equivalence in size, land quality according to the usage capacity system, the availability of water sources and basic infrastructure and equivalent proximity to urban centres, compared with the original land;
- The negotiation may include reuse of materials from improvements which will be demolished, as was their transportation to the new land;
- The developer will be responsible for moving the family and their assets;
• On the resettlement, the new constructions and installations must be of a standard at least equivalent to the current ones;
  • The owner’s preference for land close to relatives and neighbours may be taken into account, provided it is similar to the current property.

**Leasing**

This involves a lease for a specific period of time subject to monetary compensation of land used temporarily by the development.

3.6.4.7.2 *Rural Farmers Who Are Not Owners*

In addition to the land owners, we must also include full-time workers, inhabitants and partners in the negotiation process who will see their income source and/or housing affected, according to the following basic directives:

• Indemnity for improvements and crops, when they belong to the worker, adopting the same criteria used for rural landowners, not requiring legal registration of ownership for proof of assets;
• Feasibility of relocating the improvements, adopting the criteria used for rural landowners, in agreement with the owner of the land subject to agreement between the parties;
• Negotiation with the non-landowning farmer at the same time as the landowner;
• Option for the rural recycling program, in order to provide a permanent structure in terms of land, housing and work;
• Negotiation for urban properties to relocate farmers whose sources of production and/or jobs have been affected because of the development and have no interest in remaining on their land.

The entire negotiation process must be properly documented. We suggest making formal invitations to meetings with the people involved and that these meetings be registered in minutes and with photographs.

**3. 6.5 Socioeconomic Issue Monitoring Project**

**3. 6.5.1 Justification**

The potential transformational effects of hydroelectric projects may lead to structural changes in the space in which they are located, having a negative or positive effect on local quality of life during and after their execution.

Based on the dynamics of the process, we need to develop actions that monitor the main socioeconomic aspects in the region, required to evaluate possible transformations within the area and to propose corrective actions of any adverse effects. This is because it is only by properly understanding socioeconomic and environmental issues which represent the reality in the area affected will we be able to create conditions in order to evaluate any interference which will be caused by building a development.
Monitoring is therefore capable of informing the developer and the public authorities involved in action planning, so that they can make changes during and after the development has been built, adapting and implementing measures required throughout the process.

### 3.6.5.2 Objectives

This project aims to reveal possible transformations that could arise from Piedade SHS implementation/operation in the area studied, in advance, either at an urban or rural level.

### 3.6.5.3 Goals

The fact that the impact of Piedade SHS will affect heterogeneous areas, namely urban and rural areas, requires different approaches based on the different indices that will be measured.

We therefore propose monitoring separated into two major blocks as follows:

- Evaluation of possible transformations in the urban area, represented by the city of Monte Alegre de Minas, whose proximity to the worksite makes it vulnerable to the effects of the development;
- Evaluate potential changes in the rural zone, which, in the reservoir area, is represented by the suppression of land, usage restrictions, land relocation, farming and the lifestyle of resident families and, downstream, in the low flow section, affects on water usage along this section.

Therefore, based on a specific characteristics of the areas to be monitored we can categorise the goals we expect to reach as well as the evaluation parameters and indicators we have selected to achieve these goals.

#### 3.6.5.3.1 Urban Area

The goal here is to determine the level of interference the development will have on current urban infrastructure by monitoring the following indicators: health, education, public safety and jobs.

These indicators are likely to suffer most interference from the development based on the characteristics identified in the socioeconomic survey of the study areas.

We have selected the parameters which will be measured for each of these indices, as well as the respective sources of information, which will be responsible for generating the data required to analyse the behaviour of the various areas targeted by this project over time.
- **Health**
  The following parameters have been selected: Number of consults, behaviour, evolution and appearance of new diseases, especially STDs and others linked to works activity.

  Sources of information: Hospital de Monte Alegre de Minas which has been selected as a benchmark and the work site health clinic.

  All health monitoring activities, as well as the tools used for this purpose, are included in the Health Project, whose results will be incorporated into periodic reports sent to FEAM.

- **Education**
  Based on the “initial and final enrolment” parameters, we will determine any increase in educational demand and consequently in local population, as was possible bottlenecks in this sector because of human and physical resources.

  Sources of information: Monte Alegre de Minas City Hall, responsible for education; state in the unusable teaching institutions in the city, through their legal representatives.

- **Public Safety**
  Public safety related issues involved parameters which will monitor statistics on cases registered and referrals. Based on these variables, we can evaluate the level of crime in the area and the ability of the current infrastructure to deal with it.

  Sources of information: Monte Alegre de Minas Military Police responsible for security in the project area.

- **Employment**
  The direct effects on the job market, based on the dynamic nature of the third sector in development construction, are difficult to measure and of little relevance because traders know that increased demand is temporary and therefore avoid hiring. The most important aspect we need to follow is the number of jobs generated by the project in the region.

  Sources of information – technical reports from the developer alongside the general timetable for hiring labor.
3.6.5.3.2 Rural Area

The main goal of monitoring in the rural area is to measure changes accompanying the Piedade SHS construction process, in an attempt to record various changes caused by external factors, which are not always accepted and understood. This monitoring will evaluate selected parameters for each indicator, using the various situations in the ADA as a benchmark, alongside the specific characteristics of each one.

Therefore, based on these assumptions, we have selected the following areas for monitoring:

- Reservoir Area – defined as the group of rural properties affected by the suppression of land and improvements and restricted usage.
- Downstream Area – defined as the group of rural properties located on the low flow section and beginning of the reinstated flow section during the construction and operation phases.

We will now define the indicators and respective parameters selected for each area of interest, according to the goals we need to achieve.

3.6.5.3.3 Reservoir Area

The following indicators will be monitored in this area:

- **Level of Satisfaction**
  Based on the “perception of people affected” parameter, the objective of this indicator is to measure the level of satisfaction among the population in terms of the negotiation and adaptation to the new space, based on direct interviews with rural owners and non-landowners residing in the area.

- **Living Conditions**
  This indicator will try and measure the positive and negative effects on the living conditions of the families residing in the reservoir area, caused by the development, based on selected social and economic parameters.

  From a social standpoint, the following variables have been selected: Housing conditions, health and basic infrastructure (electricity, water supply, communication, access, etc) based on a direct survey with the population residing around reservoir.

  From an economic standpoint, issues evaluated refer to the land structure x types of exploration, level of productivity, productive use of the APP, assimilation of new production techniques x technical support and income, among others.
3.6.5.3.4 Downstream Area

Monitoring in this area will be supported by the following indicators:

- Effects Caused by the Works

This indicator seeks to measure the negative affect on water usage and properties located downstream from the dam, in the low flow section, and the power station, the beginning of the reinstated flow section, based on water usage evaluations from the Piedade River in this section.

Sources of Information: direct surveys involving resident and non-resident rural landowners.

3.6.5.4 Timetable

The project will begin during the Construction Phase and will last for one year, after obtaining the LO.

3.6.5.5 Party responsible for implementation

This project will be carried out by the developer.

3.6.6 Health project

3.6.6.1 Introduction/Justification

The Piedade SHS will be built on the Piedade River, in the municipal region of Monte Alegre de Minas. The region is located in the Minas Triangle, 76 km from Uberlandia and 69 km from Ituiutaba.

The Piedade SHS construction project is not a large-scale development. The workers, including specialised labor, will mainly be recruited from people living in the municipal region of Monte Alegre de Minas. In terms of the regional population, there will be no significant increase in the population or any major overload of the local health system. There will be a little accommodation at the work site, for people sporadically involved in special services. The works will last for a year and a half, with 166 workers directly employed during the construction phase.

The flow of workers to the works site may cause an imbalance in the local society and health system for the following reasons:

- Importing endemic diseases;
- Increased number of accidents and greater violence in the region;
- Social problems from immigration;
- An increase in prevalent infirmities following the arrival of susceptible individuals.

We therefore need to implement a public health policy and worker health policy which minimises the possibility of negative impacts.

The healthcare activities will be centred on the municipal region of Monte Alegre de Minas, in the project AI, because of the ease of access.
3.6.6.2 Objectives
This program aims to provide workers with primary health care open above that required by the Department of labor Regulations. It basically aims to reduce the demand for clinical healthcare, levels of absenteeism because of illness and accidents and avoid importing endemic diseases.

3.6.6.3 Target group
The group of people affected is basically the workers contracted for construction.

3.6.6.4 Worker Health Activities
These activities must be implemented by subcontractors and aim to comply adequately with the requirements in the Consolidated Labor Laws and Regulations from the Department of labor.

Venomous Animal accident control aims to reduce the lethality of snake and scorpion accidents by providing adequate serum treatment and health education activities.

An outpatient clinic will be built on site, prepared for preventive and curative actions including emergency treatment for medication and small surgical procedures as well as treatment for lesser injuries. It will be in a location with easy access and it will provide a fast departure route for the ambulance.

Epidemiology Oversight aims to provide early treatment and preventive measures against new diseases. There will be constant contact with the Municipal Health Department and Epidemiology Oversight Department in order to take joint action in the event of epidemics or outbreaks. The main diseases include:

3.6.6.5 Human Resources
The outpatient clinic will provide a nursing technician and a clinical technician who will also be the occupational physician, to carry out small procedures and refer patients. NR – 7 requires the presence of an operational position on site, for which the developer will be responsible for filling. The clinician (and the occupational physician) will be located at the outpatient clinic and will also be responsible for epidemiological oversight.

3.6.6.6 Party responsible for implementation
The developer will be responsible for this project.

3.6.6.7 Timetable
The Health Project will begin when activity starts on site and will continue throughout development construction.
3.7 WATER QUALITY PROGRAM

This Program encompasses two Projects which will be deployed in an integrated manner in order to study and preserve water systems.

3. 7.1 Limnologic and Water Quality Monitoring Project

3. 7.1.1 Presentation

This monitoring project will evaluate physical, chemical and biological transformations caused by the reservoir and evaluate the limnologic status and seasonal fluctuations of the reservoir. This will provide information to analyse evolutionary trends and evaluate the quality of water for the multiple possible usages of the new aquatic environment. A monitoring plan will therefore be able to systematically accompany parameters indicating the evolution of environmental and sanitary quality of the water system, in light of potential changes arising from development.

Adoption of the monitoring project will cover all phases of the development (Construction, Filling and Operation) so that changes in the limnologic dynamics can be diagnosed based on changes in the free-flowing and still water environments. This type of diagnosis will allow us to adopt control measures if any problems occur. The role of biological monitoring is very important because by accompanying the dynamics of aquatic organisms we can truly understand the impact involved.

3. 7.1.2 Justification

The process which involves the creation of the monitoring process must take into account how suitable it is as an instrument to evaluate water quality. Desirable water quality is considered quality that guarantees that none of the possible water uses are affected, in terms of local and regional requirements. The Limnologic and Water Quality Monitoring Project is justified by the need to research reliable and representative data on the Piedade River, on the section involved in the development, in order to provide information to accompany any and all changes in its characteristics following construction and operation of the Piedade SHS. The data collected will also be used if new prophylactic measures are required.

3. 7.1.3 Objectives

The main objective of this project will be to generate the data required in order to set up a method capable of maintaining the desired level of water quality, in terms of systems to minimise possible effects of development construction and operation.

3. 7.1.4 Target Groups

Because of its technical nature, this project will only involve the items studied, mainly water systems and the aquatic environment. Within the Environmental Management approach, the data generated
by this project can be released to the communities in the affected area, after it has been adapted for consumption by lay people, through “Social Communication Project” activities.

### 3.7.1.5 Planned Actions

The monitoring program will take into account the different methodologies for the three distinct phases (construction, filling and operation). The construction stage will include the entire Executive Project phase, beginning at the same time as the civil engineering works. The filling stage includes the first month after filling has been concluded. The monitoring methodology during the plant operation will be adopted from the second month after the reservoir has been filled.

We will define points, parameters and frequencies so that the monitoring objectively analyses the behaviour of water quality in the future reservoir and in the section download from the dam, taking into consideration potential modifications in anthropic activities in this area.

During the construction phase, the sampling network will be adapted, in other words one point located in the reservoir (PIE-02) will be excluded and another point upstream from the system will be included (PIE-01A). The other points will remain unchanged. The physical/chemical, bacteriological and hydrobiological parameters defined to accompany water quality on the Piedade River the same used in the diagnostics.

During the operational phase, the sampling network from the previous phases will be maintained in addition to one point on the lake of the former SHS, located on the low flow section (PIE-03A). The physical/chemical, bacteriological and hydrobiological parameters will be the same ones evaluated in the diagnostics. A thermal and oxygen profile of the reservoir and the lake of the former SHS will also be conducted, also measuring the transparency of still water systems. At PIE-03A, the following parameters will be evaluated: total acidity in CaCO₃, total alkalinity in CaCO₃, fecal coliforms, total coliforms, electrical conductivity, color, biochemical oxygen demand (DBO₅), soluble iron, total iron, total phosphate, nitrate, ammonia nitrogen, total nitrogen, orthophosphates, dissolved oxygen, pH, total dissolved solids, solids in suspension, total solids, water temperature, turbidity, phytoplankton – middle of the lake and benthic – bank.

Quarterly sampling campaigns will be carried out based on the key hydrological periods (rainy season and dry season) and in intermediate phases, during construction and operation. Point PIE-03A will be monitored every six months during the campaigns in the key seasons (rainy and dry). During the reservoir filling phase, two campaigns will be conducted, one during the week prior to fill in, which may be conducted on the day that the dam is closed, and another one month after filling. Reports will also be produced.

Monitoring of molluscs from the genus *Biomphalaria* (a potential transmitter of mansonic schistosomiasis) will be conducted during the quarterly on-site campaigns during the operational period. This procedure will be done on preventive basis, based on item 8, section d,
Article 20 of COPAM Directive 010/86, which states that the presence of potential schistosomiasis transmitters in a water system makes it unsuitable for bathing. As recreation and bathing are important uses within the many types of reservoir usage, we believe it is important to evaluate this issue on a routine basis.

Based on the monitoring results at PIE-03A, the developer will produce the studies required to evaluate maintenance, demolition or adaptation of the existing dam downstream from the forecast location of Piedade SHS, in order to avoid compromising water quality in the low flow section.

3. 7.1.6 Party responsible for implementation

The developer will be responsible for this project. The developer will contract a specialised company for this purpose and shall include qualified technical staff among its employees to conduct this work.

3. 7.1. 7 Physical Timetable

In the Construction License phase, a Environmental Control Plan – PCA will be produced which, in principle, will present a detailed overview of the first 24 months of the study. Based on this evaluation, the entire scope of the monitoring program will be redefined from time to time in order to optimise this work. Based on this optimisation, basic procedures will be developed to execute the second phase, which comprises long-term monitoring.

This project will be developed through quarterly campaigns during the construction phase, which will comprise the entire Executive Project Phase, beginning prior to the commencement of civil engineering works. The Filling phase will begin when works have been concluded and the dam is closed and includes the first two months after the future reservoir has been filled. The monitoring methodology during the plant operation will be adopted from the second month after the reservoir has been filled.

3. 7.2 Macrophyte monitoring and control project

3.7.2.1 Introduction

“Marcophytes represent vegetation that varies from single cell organisms to angiosperm” (ESTEVES, 1998). According to their ecological and morphological characteristics, the macrophyte classification can be applied to emersed aquatic macrophytes, submerged aquatic macrophytes with roots, free floating submerged aquatic macrophytes and floating aquatic macrophytes.

Aquatic macrophytes are considered one of the most productive groups of organisms and based on their metabolic activity they are capable of having a major effect on the environment. If allowed to grow out of control, they may change the ability to navigate along the water course and alter hydroelectric power station operation, obstructing water flow into the turbines, and
creating suitable conditions for the proliferation of disease transmitters and reducing dissolved oxygen in the water.

3.7.2.2 Justifications

Growth of the macrophyte population the reservoir may be caused by changes in the hydrological regime when the river changes from free-flowing to still water and water fertilisation, encouraging reproduction of populations located in the still waters.

Therefore, monitoring of macrophyte colonisation in the reservoir is required to ensure appropriate project operation and local environmental quality. The activities in this project will be carried out alongside the activities in the “Limnologic And Water Quality Monitoring Project” because both issues are very similar.

3.7.2.3 Objectives

- Identify and verify, through sampling campaigns, the main species of macrophyte at each point in order to adopt effective control methods;
- Evaluate the information obtained in order to control eutrophization;
- Reach a balance between other aquatic communities, such as phytoplankton, zooplankton and benthic communities.

3.7.2.4 Planned Actions

As a methodology, we are creating a monitoring network, specifying campaign frequency and proposing collection and identification controls that are effective enough to quantify and specify the species.

Control measures adopted at the future SHS reservoir on a preventive basis include flora recuperation in the area surrounding the reservoir and degraded areas and on a corrective basis, activities such as mechanical removal.

3.7.2.5 Technical Team

The technical team conducting this work will include a biologist specialised in aquatic plants and an assistant.

3.7.2.6 Party responsible for implementation

This project will be carried out by the developer.

3.7.2.7 Timetable

Macrophyte monitoring in the reservoir will begin during the plant operation phase, in other words, soon after the dam has been closed and the lake has been formed and will continue throughout the plant’s working life.
3.8 NATURAL HERITAGE REGISTRATION PROGRAM

3.8.1 Introduction

When conducting the new surveys based on the new engineering designs, in addition to the two waterfalls in the low flow section already identified, the field surveys identified three waterfalls which will be submerged in the area of the future reservoir, one located on the Piedade River and the other two located on the “no name” and Boa Vista streams, on the right bank of the River Piedade.

Therefore, the Environmental Control Plan includes this Natural Heritage Registration Program.

3.8.2 Justifications

The five existing waterfalls, three in the area of the future reservoir and two between the dam and Piedade SHS power station, are important in terms of natural heritage.

The waterfall known as the Erson waterfall which is about 7 m high, is located on the Piedade River and is not used for bathing because of the volume of water, the lack of an appropriate pool and many rocky outcrops nearby.

The other two waterfalls are located on the affluence on the right-hand side of the Piedade River, one on the Boa Vista and the other on the “no name” streams. They are about 5 and 6 m tall respectively and are not used for bathing because they are difficult to reach and in high-risk locations.

The first waterfall is located downstream from the forecast dam location and is around 6 m high. It is not used for bathing because of the volume of water, difficult access and the risks on site. Because of these characteristics, the river is used for leisure purposes downstream, on a sporadic basis.

The second waterfall, called Usina Velha, Piedade or Guiamarães, has a drop of around 45 m. The banks are very steep, around 30%, forming an angle of almost 90° with the side embankments. The pool is rocky with outcrops and whitewater, which makes it an extremely dangerous section for bathing. People rappel on the walls on a sporadic basis.

Construction of the Piedade SHS will create a reservoir covering 150 ha and a low flow section around 7 km long. This means that the three waterfalls located in the area of the future reservoir will lose all of their physical characteristics and the two waterfalls located in the low flow section will also change, especially during the dry period of the year, changing their characteristics: river water flow. Furthermore, leisure activities on the river in this section will be influenced by the power station.
This therefore requires an approach that covers two initiatives: The first, to provide a detailed record of the current characteristics of the waterfall; the second to reconcile future conditions with community leisure activities.

### 3.8.3 OBJECTIVES

- Register the current characteristics of waterfalls located in the ADA, including land morphology;
- Register locations in the ADA used by the community for leisure activities describing the locations in terms of morphology, people using them and type and frequency of usage;
- Establish a plan to take advantage of natural heritage areas in the ADA, maintaining current opportunities for users and their leisure activities and the ability to support natural heritage sites, executed during plant operation.

### 3.8.4 TARGET GROUPS

The groups targeted by this Program:
- Rural landowners in the ADA;
- Other inhabitants in the municipal region of Monte Alegre de Minas.

### 3.8.5 Planned Actions

- Conduct research among people living in the ADA and AE together with details on current leisure activities and the community interest in maintaining them;
- Topographic survey of the waterfalls, indicating local morphological conditions, producing maps and photographic and audiovisual records of the natural heritage;
- Evaluate the possibility of maintaining current usage, and the ability to sustain natural heritage and the activities which will be conducted by the developer to support this activity.
- Create alternatives for the ADA community to offset lost leisure areas that have been identified.

### 3.8.6 Party responsible for implementation

This program will be carried out by the developer.

### 3. 8. 7 Physical timetable

The deadline for implementing these measures will be the commencement of works, with actions carried out throughout development construction up to one year after the Piedade SHS comes on line.
3.9 HYDROMETRIC MONITORING PROGRAM

3.9.1 Project to Monitor Water Flowing Into and Out Of the Reservoir

3.9.1.1 Introduction/Justifications
Studies and knowledge of the hydrological regime of a watercourse require an understanding its flow variations over time. In general, in order to evaluate this flow, daily records are taken (twice a day) of the water level, calculating the ratio between the water level and the flow. This methodology can be considered an indirect process for measuring the flow and staff gauges are installed at suitable locations to regularly check the water level.

The group of devices used to obtain the water level (staff gauges), the flow measurement section and levelling references, are called a fluviometric station. Operation of a fluviometric station allows us to update the discharge curve at its location, among other activities.

The National Electrical Energy Agency – ANEEL issued Resolution number 396, dated December 4, 1998, establishing the conditions required to deploy, maintain and operate fluviometric stations associated with hydroelectric developments. During the Piedade SHS project and construction phase, staff gauges will be installed in the regions between the reservoir and the power station, in order to define the final key curve for the turbine design. After the plant comes on line, flow control will use a water sensor downstream from the power station in order to measure the spillway and turbine flows.

3.9.1.2 Objectives
The Program to Monitor and Flows Running Into and Out Of the Piedade SHS reservoir has the following goals:

- Updates the discharge curve for the development;
- Define and maintain the discharge curve for the machine intake;
- Understand the spillway and turbine flows;
- Provide a series of daily average flows;
- Provide information for other monitoring programs (for example Water Quality).

3.9.1.3 Target Groups
The National Electrical Energy Agency – ANEEL and the National Water Agency – ANA will have access to the monitoring results.

3.9.1.4 Planned Actions
The main observer activities are:
- Daily gauge readings;
At very high water levels, conduct as many readings as possible, informing the time the readings were taken:

- Inform the program coordinator of all events observed during station operation (for example: extremely high water levels).

The main hydrometrist activities are:

- Verify the conditions of the stations, regulating the gauges and making corrections as required;
- Verifying that the group of gauges complies with the minimum and maximum levels observed during the season, adapting them as required;
- Training the observer and checking his performance;
- Ensuring suitable conditions in the measurement section.

The main coordinator activities are:

- Analyse bulletins checking for data consistency, verifying the correct data has been provided and calculating average daily readings;
- Updating station logs;
- Transmitting information to ANEEL.

### 3.9.1.5 Party responsible for implementation

This project will be carried out by the developer.

### 3.9.1.6 Timetable

This project will be implemented during the Construction Phase.

### 3.9.2 Reservoir silting monitoring project

#### 3.9.2.1 Introduction/Justifications

The programs to monitor reservoir silting are required at developments that generate electrical energy, either small or large hydroelectric power stations, because they allow us to monitor any changes in the river regime and transportation of sediment into the body of water whose waters are used in the process to generate electricity. These programs also provide information to develop and quantify corrective measures.

#### 3.9.2.2 Objectives

The Reservoir Silting Monitoring Program at the Piedade SHS has the following objectives:

- Determine average solid discharges into the reservoir;
- Increase our understanding of hydrosedimentology behaviour in the Piedade River following power station construction;
- Provide information to determine the level x area x volume levels;
- Check the forecasts in the environmental feasibility survey relating to
3.9.2.3 Target Groups

FEAM, which will receive project results submitted in a final report at the end of the first year of operation and, subsequently, in a report on each campaign carried out. Additionally, the intermediate results of the campaign will be available at all times for consultation by interested parties, at the program coordination office.

3.9.2.4 Planned Actions

- Conduct bathymetric measurement campaigns in the reservoir;
- Conduct campaigns to sample sediments deposited in the lake;
- Evaluate reservoir silting, estimating lost reservoir volume based on bathymetric surveys conducted during the campaigns.

3.9.2.5 Timetable

This project will be implemented during the Operation Phase.

3. 9.3 Groundwater monitoring project

3.9.3.1 Introduction/Justifications

The Groundwater Monitoring Project aims to find out if there are any effects on the groundwater levels in the area under the influence of the development, more specifically in the area where underground water is captured.

This program, in terms of the Piedade SHS construction, is justified because it provides further knowledge on changes in groundwater levels in the project Sphere of Influence, generating basic data on the region.

3.9.3.2 Objectives

The groundwater monitoring program aims mainly to:

- Manage underground water sources;
- Accompany variations in groundwater levels at selected points following Piedade SHS construction and operation.

3.9.3.3 Target Groups

The main groups targeted by this program are IGAM, FEAM and the city halls which will have access to the reports produced for each campaign. Additionally, the intermediate results of the campaign will be available at all times for consultation by interested parties, at the program coordination office. ANA and ANEEL are also interested parties.
3.9.3.4 Planned Actions

- Define the number and location of piezometer installations;
- Monitor interference based on variations in groundwater levels in the area affected by the development.

3.9.3.5 Party responsible for implementation

The developer will be responsible for this project.

3.9.3.6 Timetable

This project will be implemented during the Operation Phase.

3.10 WEATHER MONITORING PROGRAM

3. 10. 1. Introduction/Justification

Whether processes, in other words, the joint action of meteorological parameters (temperature, humidity, rainfall) are secondary effects based on static factors (latitude, altitude and proximity or distance from the sea) and dynamic factors (intermediate and large-scale atmospheric circulation).

The local and regional climate integrated with intermediate and large scale dynamic mechanisms and other environmental factors are important as weather characteristics are modified, intensified or mitigated by them.

However, given the scale of the reservoir as well as the entire Piedade SHS development, we do not expect any climate alterations resulting from the surface area of the reservoir

3. 10.2. Objectives

- Collect and organise information on the climate in the region where Piedade SHS is located.

3. 10.3 Planned Actions

- Description of general circulation, mainly responsible for the local and regional climate regimes. Atmospheric circulation represented by anticyclone, depression and frontal systems initially explain the predominant characteristics of the climate;
- Description of time variations between various weather effects, such as: Spatial distribution of rainfall, temperature based on monthly maximums and minimums, wind speeds and relative humidity of the air;
- Monitor the following weather variables: Air temperature, wind speed and direction, and humidity, rainfall and sunlight measurement.
3.10.4 Party responsible for implementation
The developer will be responsible for this project.

3. 10. 5 Physical timetable
This project will be deployed after the reservoir has been closed, with reports presented every six months.

3.11 Archaeological survey program

3. 11. 1. Introduction/Justification
Archaeological surveys aim to ensure that the loss of archaeological sites located in the development area is offset by incorporating knowledge produced as part of national history, as decreed in IPHAN directive No. 230.

The diagnosis based on the consolidated survey in the Piedade SHS identified new archaeological sites in the ADA, and expanded the reservoir region to 220 ha.

3. 11.2 Objectives
The object here is to:
- Conduct prospective archaeological surveys with subsurface intervention, using soundings in the ADA;
- Recover archaeological sites located within the ADA.

3. 11.3 Planned activities
Activities planned for these goals include:
- Systematic coverage of the directly affected area (150 ha) and its immediate surroundings;
- Within the ADA, carry out underground soundings to define site limits and check for remains in potential archaeological locations where vegetation does not allow us to see the soil;
- Topography of sites in archaeological interventions;
- Sampling excavations and surface collection on all sites located within the survey, to obtain remains and contextualised information;
- Photographic documentation and field records and indexes for all stages of the recovery operation.
- Heritage Education Activities
- Laboratory studies.

3.11.4 Party responsible for implementation
The developer will be responsible for this project.
3.11.5 Timetable

The project will be carried out before the development restarts.

3.12 Farmer Technical Assistance and Support Program

3. 12. 1 INTRODUCTION

Complying with an LP condition for the Piedade SHS, referring to the previous project, in order to obtain the Construction and subsequently the Operating Licence, this program was drawn up to support rural farmers who decide to remain on what is left of their properties and will have to adapt their farming activities, when it is shown that they and consequently their families are unable to continue their current activities.

3. 12.2 Justification

This group was defined as they are responsible for economic production on the properties. Full-time and temporary employees or daily workers will not be directly involved in this program, however, please note that technical support activities encompasses farmers and employees, in order to maintain their income and quality of life.

3.12.3 OBJECTIVE

This program involves planning actions to support rural farmers and their partners on properties affected by the Piedade SHS development and to provide guidance on the Technical Support services which will be offered, providing services which are aligned with local realities in order to promote sustainable development and improve the quality of life of the owners, their partners and consequently their employees, identified in the previous environmental surveys and which remain on the properties which remain after negotiation of land and improvements, and who need to change the activities they carried out prior to negotiating with the developer, according to the "Land and Improvement Negotiation Project".

3. 12. 4 Planned Actions

Develop directives supported by the “Working Directives with Small Farmers and Their Organisations” adopted by EMATER-MG from 1997.

3.12.5 Target group

This program targets owners who decided to remain in what is left of their properties and will be forced to change their farming activities, when proven that they are unable to continue their current activities.

3. 12. 6 Party responsible for implementation

The developer will be responsible for this Program.
3. 12. 7 Timetable

Activities will begin 120 days after the reservoir is closed or when the local landowning situation has been completely defined, and will continue for a period of 12 months. Monthly visits will be conducted during crop periods and quarterly during the period between crops.

3.13 Artificial Reservoir Surrounding Area Usage and Environmental Conservation Plan

3. 13. 1 - Presentation

The Artificial Reservoir Surrounding Area Usage and Environmental Conservation Plan will establish directives and regulations for the multiple uses of the reservoir as well as directives, regulations and actions to govern conservation, recuperation, use and occupation of the area surrounding according to CONAMA resolution number 302, dated March 20, 2002.

3. 13.2 Objectives

The plan aims to indicate the main types of usage which can be employed on the future lake and the surrounding area, ensuring that the public can integrate with the new scenario, also defining restrictions on usage in terms of safety issues which are established, thereby creating usage zones and making improvements that have a direct influence on the body of water.

3.13.3 Target groups

The target group for this Plan comprises owners whose properties are adjacent to the reservoir and properties in the surrounding area whose area may involve a relevant participation with the reservoir, based on the geomorphology of the direct contribution basin. Additionally, it will include the population in the development sphere of influence.

3.13.4 Party responsible for implementation

The developer will be responsible for implementing this project.

Notes that some of these activities will necessarily require third party involvement, especially the authorities representing the City Hall in Monte Alegre de Minas, alongside institutions representing the community as well as higher government agencies.

3. 13. 5 Physical timetable

This plan will begin after the SHS Construction License has been granted, and will continue until the OL has been granted.