

GOVERNO DO ESTADO



CEARÁ

AVANÇANDO NAS MUDANÇAS

GOVERNO DO ESTADO DO CEARÁ
SECRETARIA DOS RECURSOS HÍDRICOS - SRH
PROJETO DE DESENVOLVIMENTO URBANO E GESTÃO DOS
RECURSOS HÍDRICOS PROURB / CE

AÇUDE PÚBLICO JERIMUM
TOMO 3 ESTUDO DE IMPACTO AMBIENTAL
VOLUME 1 SÍNTESE INGLÊS

AGUASOLOS

SDU

BEC

FORTALEZA- CE
OUTUBRO DE 1993



GOVERNO DO ESTADO DO CEARÁ
SECRETARIA DO DESENVOLVIMENTO URBANO E MEIO AMBIENTE - SDU
PROJETO DE DESENVOLVIMENTO URBANO
PRO-URB / CE

AÇUDE PÚBLICO JERIMUM
TOMO 3: ESTUDO DE IMPACTO AMBIENTAL
VOLUME 1 - SÍNTESE
INGLÊS



59/03/01
ex.2

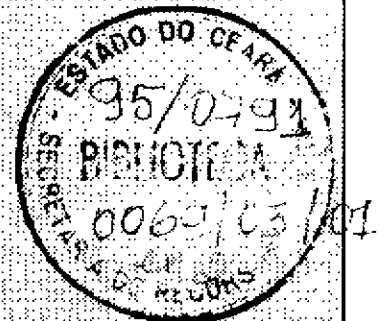
00632 - Prep (X) Scan (X) Index ()
do N° 0002/03/01
me 1
A4 18 Qtd. A3 _____
A2 _____ Qtd. A1 _____
A0 _____ Outros _____

SRH - SECRETARIA DE RECURSOS HÍDRICOS

JERIMUM PUBLIC RESERVOIR

SUMMARY OF THE ENVIRONMENTAL IMPACT STUDY

September/93



000003

CONTENTS

- PRESENTATION	01
- POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK	01
- PROJECT DESCRIPTION AND MULTIPLE PURPOSES OF THE RESERVOIR	02
- BASELINE DATA	04
- ENVIRONMENTAL IMPACT	06
- PROJECT ALTERNATIVES	08
- MITIGATION PLANS	08
- ENVIRONMENTAL MANAGEMENT, MONITORING AND TRAINING	09
- CONCLUSIONS AND RECOMENDATIONS	10

PRESENTATION

The summary of the Environmental Impact Study here presented, analyses the physical, biological and social impacts likely to result from the construction of the Jerimum Public Reservoir, in Caxitoré River, which is part of the Curu River Hydrographic Basin, State of Ceará, Brazil. It also identifies the mitigation measures of the negative impacts. The construction of the Jerimum Public Reservoir is an implementation of the State Water Resources Agency and was foreseen into the Ceará State Urban Development Project (PROURB/CE) as a political commitment of the State Government with the semi-arid hinterland cities of Ceará State.

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The dam constructions and subsequent reservoir formations are particularly necessary for most of the cities of the State of Ceará, which are essentially agricultural cities, concerning that their socio-economic situation lean upon highly unfavorable environmental conditions. The irregular distribution of the pluviometric precipitation combined with the inadequated characteristics of local soils that, even being fertile, are shallow, present low permeability, are badly drained and cover a rocky substract, result in a dull and randomic regional development. The existence of water reservoirs may minimize such problematic situation. In addition, the dam construction will create the possibility of implementing its most importante social use, the domestic water supply. However, concerning the legal requirements, the construction of dams and subsequent formation of reservoirs can not be carried through without the elaboration of an Environmental Impact Study (EIS), according to the number 001 Resolution of CONAMA - Environmental Federal Bureau, created by National Environmental Policy in 1981. The EIS should consider the positive and negative effects of the proposed project within the physical, biological and social environments, as well as the mitigation measures to prevent or compensate the negative impacts. The EIS executers must yet, present a simplified environmental report, to be made available, if necessary, to the affected population through a Public Assemble.

Still concerning the National Environmental Policy, some of the attributions of the Brazilian Environmental and Natural Resources Institute - IBAMA, are the stablishment of environmental quality standards and land uses distribution, the requirement of environmental assessments for the liberation of deforestation licenses or for other potencially pollutant activities, and the creation of environmental protection areas, among others. The third article of the 044/85 Resolution of CONAMA, defines as environmental protection areas, the lands and forests along the water courses, around the reservoirs and near the rivers' sources. Beeing that so, in the region of the Jerimum Public Reservoir, the areas to be legally considered under protection are: the lands along Caxitoré and Mandacaru rivers for a 50 meters wide strip, those along the regions' streams for a 30 meters wide strip, and the lands arond the reservoir for a 100 meters wide strip. Other laws concerning environmental issues are (i) Law nº 5197 deliberates about wildlife protection; (ii) Law nº 7802 deliberates about the use of agriculture chemical residuals; (iii) Law nº 3824 deliberates about deforestation of reservoirs sites. In this case , the projects' mentor, Water Resources State Agency will be responsible for the

PRESENTATION

The summary of the Environmental Impact Study here presented, analyses the physical, biological and social impacts likely to result from the construction of the Jerimum Public Reservoir, in Caxitoré River, which is part of the Curu River Hydrographic Basin, State of Ceará, Brazil. It also identifies the mitigation measures of the negative impacts. The construction of the Jerimum Public Reservoir is an implementation of the State Water Resources Agency and was foreseen into the Ceará State Urban Development Project (PROURB/CE) as a political commitment of the State Government with the semi-arid hinterland cities of Ceará State.

POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

The dam constructions and subsequent reservoir formations are particularly necessary for most of the cities of the State of Ceará, which are essentially agricultural cities, concerning that their socio-economic situation lean upon highly unfavorable environmental conditions. The irregular distribution of the pluviometric precipitation combined with the inadequated characteristics of local soils that, even being fertile, are shallow, present low permeability, are badly drainaged and cover a rocky substract, result in a dull and randomic regional development. The existence of water reservoirs may minimize such problematic situation. In addition, the dam construction will create the possibility of implementing its most importante social use, the domestic water supply. However, concerning the legal requirements, the construction of dams and subsequent formation of reservoirs can not be carried through without the elaboration of an Environmental Impact Study (EIS), according to the number 001 Resolution of CONAMA - Enviromental Federal Bureau, created by National Environmental Policy in 1981. The EIS should consider the positive and negative effects of the proposed project within the physical, biological and social environments, as well as the mitigation measures to prevent or compensate the negative impacts. The EIS executers must yet, present a simplified environmental report, to be made available, if necessary, to the affected population through a Public Assemble.

Still concerning the National Environmental Policy, some of the attributions of the Brazilian Environmental and Natural Resources Institute - IBAMA, are the stablishment of environmental quality standards and land uses distribution, the requirement of environmental assessments for the liberation of deforestation licenses or for other potencially pollutant activities, and the creation of environmental protection areas, among others. The third article of the 044/85 Resolution of CONAMA, defines as environmental protection areas, the lands and forests along the water courses, around the reservoirs and near the rivers' sources. Beeing that so, in the region of the Jerimum Public Reservoir, the areas to be legally considered under protection are: the lands along Caxitoré and Mandacaru rivers for a 50 meters wide strip, those along the regions' streams for a 30 meters wide strip, and the lands arond the reservoir for a 100 meters wide strip. Other laws concerning environmental issues are (i) Law nº 5197 deliberates about wildlife protection; (ii) Law nº 7802 deliberates about the use of agriculture chemical residuals; (iii) Law nº 3824 deliberates about deforestation of reservoirs sites. In this case , the projects' mentor, Water Resources State Agency will be responsible for the

000006

Deforestation Decree, once with the possession of the license allowing that agency for this activity, liberated by IBAMA.

In the State of Ceará, the Environmental State Agency in charge is SEMACE. It's attributions are to require, to analyse and to give the approval of the EIS, frequently elaborated by consultant private agencies. It also is responsible by writing the Operative Guidelines for the elaboration of the EIS which requires a detailed characterization of the projects' steps and from the area of implementation concerning the most significant impacts and possibilities of its mitigation. In case of the none approval of the EIS by SEMACE, the project will not be carried through. The State Law nº 11.996, (07/ 24/1992), deliberates about Water Resources State Policy and created the Councils and the State Committees for Water Resources Environmental Issues, which is composed by federal, state, districtal levels representative, as well as NGOs and peoples' representatives. The State Plan of Water Resources Uses brings some articulation mechanisms to reach the necessary integration and compatibilization of actions between the several government levels, including the district level, for the decision making as well as for the implementing of many activities made necessary for the project's feasibility. The Water Resources State Agency has its own attributions in the environmental sector like the supervision of documents which deal with environmental issues, including the EIS and the simplified report of the EIS, the promotion of meetings between the affected community, the local NGOs, and the State agency, the coordination of activities required by the mitigation plans and the environmental fiscalization work made necessary into the just created protection areas.

In the districtal level, the laws will regard the superior levels ones. The cities counties must be envolved by environmental issues as the deforestation process, the respect for the protection areas, the environmental education proceedings and, mainly, the control of the reservoir's watershed uses. Considering that the determination of land uses for a watershed basin is responsibility of the districtal agencies of the government, the cities of the influence area of the Jerimum Reservoir, as part of Curu River's watershed basin, should adequate their environmental legislation to the programe of land uses already implemented by that main watershed plan for uses. The Curu River's Watershed Plan has the following goals: take advantage on the basin's regularized discharges; emprove the regional agricultural activities; encrease the "per capita" income of the area by implementing irrigation plans; resettle approximately 500 families; regional food supplying and supplying of raw material for the local transformation industries. The State Government's goals aren't others but the socio-economic viabilization of some cities placed in the semi-arid hinterland and the promotion of rational uses for the natural resources of the area, mainly soil and water.

PROJECT DESCRIPTION AND MULTIPLE PURPOSES OF THE RESERVOIR: The Jerimum Public Reservoir is designed for water supply, irrigation and fishery activities. The dam can be located by the coordenades 3°50'08"S and 39°41'27" W. The watershed of Jerimum's reservoir is part of the main watershed basin of Curu River and is located in the west part of it. There are three cities in Jerimum's watershed, Itapajé, Irauçuba and Tejuçuoca. The access to the dam site can be made through the federal highway BR-222,

heading west to Itapajé City for about 120km from Fortaleza. 9 km after Itapajé City, one should leave the BR-222 turning left to reach a secondary road and ride on it about 20km until reaching the dam site. The project's quantitatives are summarized as follows: Site of the dam: Borders of Irauçuba and Tejuçuoca Cities, State of Ceará, Brazil; Dammed River: Caxitoré; Project Mentor: Water Resources State Agency; Expropriated Area: 421,25 ha; Population for water supplying: 51.275 inhabitants (year of 2013); Accumulation capacity: $20,5 \times 10^6 \text{ m}^3$; Reservoir area: 269,3ha; Watershed basin: 38.600ha; Mean annual precipitation: 739mm; Mean annual evapotranspiration: 2.755mm; Type of the dam: rock-fill and earth; Maximum height of the dam: 24m; Level of the top: 150,5 meters above the sea level; Spillway level: 147,0m; Maximum discharge (for 100 years risk): $252 \text{ m}^3 / \text{s}$; Regularized discharge: $0,450 \text{ m}^3 / \text{s}$; Borrowed material area: 71,47ha; Legal environmental protection area: 151,95 ha.

Off-site investments: The project includes a pipeline for water supply of the city of Itapage which will be made in cast iron with 300 mm diameter and 16,2 km length. It will be constructed along the left bank of Itapage river beginning in the power house built on the left bank of Caxitoré river. The project includes also an irrigation area downstream of the dam.

Municipal water supply: This use is the most important one in the Jerimum Project. The total water flow demand for the year of 2013 with 31.675 inhabitants to supply the city of Itapage is 65,95 l/s. The city of Irauçuba will be supplied from the Jerimum Reservoir with the discharge of 40,89 l/s for the year of 2013 presenting the population of 19.600 inhabitants. The city of Tejuçuoca will be supplied from the Tejuçuoca Reservoir (Caxitoré River) which is in phase of conclusion by the National Department of Constructions Against Droughts.

Irrigation: The irrigation area downstream the Jerimum Reservoir has the extension of 300ha, and will use 343,16 l/s. This irrigation project will be implemented by the Support Programme of Irrigated Agriculture (PROIR - Brazilian Northeastern Bank - BNB/ Constitutional Fund for Northeastern Finances - FNE), whose main purpose is to fix families in the country (To be seen in Annex 10 of EIS).

Seasonal Agriculture: Considering the perimeter extension of 10km of the reservoir and the seasonal agriculture strip 30 meters wide, plus 10ha of usefull area (including upstream of the rivers Mandacaru and Caxitoré) the total area for this use will be 40ha. This use will be managed by SRH through "Projeto Beira D'água" using a 3ha diesel kit. This programme can also be credited to PROIR - BNB/FNE. Other alternative will be Programme for the Modernization of Non Irrigated Agriculture (PROAGRI - BNB/FNE).(To be seen in Annex 10 of EIS).

Fishery Activities: This is one of the most important activities assumed by DNOCS. This use is detailed in the Fishery Plan to be presented following in this document.

000008

A lay-out scheme of multiple purposes of Jerimum Reservoir is annexed in this document.

BASELINE DATA - Characterization of the Affect Area: The hydrographic basin of the Jerimum Reservoir is part of the direct influence area of the project. The population resettlement will be undertaken inside this area. The district named Boa Vista do Caxitoré will be the nearest urban population group connected with the project. The direct influence area includes, yet, the cities of Itapajé, Irauçuba and Tejuçuoca. The indirect influence area is the Curu River hydrographic basin. Therefore, the operation of the Jerimum Reservoir has to be made within the Curu River basin management.

Social Environment: According to the demographic sense of 1991, the populations of the cities are: Itapajé, 20.082; Irauçuba 9.534 and Tejuçuoca 8.645 inhabitants. The demographic densities are below 20 inhabitants per square kilometer. 40% of that population are economically active, 40% have unofficial jobs (pay no taxes) and 20% depend on one or the two of those groups. 60% of the whole population work on agriculture activities. Although the agricultural activities represent the main potentiality of the regional lands, the natural pastures represent the most intensive use of those lands. **Population of the Impoundment Area:** The water will reach, totally or partially, 27 properties. 9 families of owners and 27 families of farm workers, not owners of the lands, live in the area. 11 of those 27 families will be resettled. Only 3 of the 11 families will live in the rural dwelling nucleus project, to be undertaken by the State Water Resources Agency (SRH). This project will have all necessary basic infrastructure. **Basic Infrastructure:** Sanitation: Irauçuba city has 684 water connections supplying 2.970 persons. Itapajé has 2.405 connections supplying 12.025 persons and Tejuçuoca has 196 connections supplying 980 persons; Electric energy: Irauçuba city has 1.193 electric energy consumers, Itapajé has 4.378 and Tejuçuoca, 444. (Source: Ceará's State Electricity Company, 1990); Communication services: Irauçuba city has 1 post office and 200 telephone lines within which 99 are domestic lines. Itapajé has 1 post office and 600 telephone lines within which 350 are domestic lines. Tejuçuoca has got only 1 post office and none installed telephone lines; Transport Infra-structure Features: Irauçuba has 556 km of none paving roads and 18 km of paving roads; Itapajé can count with the State Road CE-141 and the Federal Road BR-222 which connects it with other three cities of Ceará State, Frecheirinha, Tianguá and Sobral. It has 542 km of none paving roads; Housing: None of the three cities have problems concerning housing features; Actual Land Distribution: Most of the properties in the area are considered medium sized ones. Irauçuba has 1,862 properties in 111,130ha; Itapajé and Tejuçuoca count with 3,962 properties in 92,593ha. The impoundment area has the following land distribution: 7,41% of the properties occupy 0,17% of the impoundment area; 33,33% of the properties occupy 5,13% of the area; 44,44% of the properties occupy 18% of the area; and 14,81 of the properties occupy 76,69% of the impoundment area.

Physical Environment: The geological unit that characterizes the area is called Northeastern Complex and it is composed mostly by "gnalsses". According to the project, there will not be any difficulty concerning the substratum, in terms of the dam construction. The projects' area geomorphologic unit is called "Sertaneja Surface" and is formed by "sedimental hills". The regional soils present low permeability, shallowness and high

susceibility to erosion process, although they present high levels of decompositionable minerals which makes them reasonably fertile. The vegetation covering of the area is mostly composed with opened bush-sized "caatinga" forests. For intensive agriculture uses, the soils need some conservation technics. The most importante climatologic component of the area is the bad distribution of the rainfall during the year. The area can be dry for about nine month, in a one year period.

Biologic Environment: The vegetation covering of the projects' area is mostly composed with opened bush-sized "caatinga" forests. The species considered more resistant to the environmental adversities of the area are: *Mimosa acutistipula* (jurema preta); *Jatropha mollissima* (pinhão); *Solanum sp* (jurubeba); *Cereus gounelli* (xique-xique); *Pilosocereus sp* (facheiro); *Cereus Jamacaru* (mandacarú); *Croton sp* (marmeleiro), *Copernicia prunifera* (carnaúba); *Licania rigida* (oiticica); *Ipomea pes-caprae* (salsa); *Cyperus sp.* (tiririca); among others. The wildlife is composed mainly by birds: *Rallideos* (frango-d'água); *Jacamnideos* (jaçanã); *Psitacideos* (papacu); *Picideos* (pica-pau); *Alcedinideos* (martim-pescador); *Tyrannideos* (vovô, lavandeira); *Fumarideos* (crispim); *Icterideos* (papa-arroz); *Fringilideos* (gola, papa-capim); *Thravpideos* (vem-vem). Some of the reptiles of the area are *Prynops sp.* (cágado); *Helicops sp.* (cobra d'água); *Waglerophis sp.* (cobra).

000010

ENVIRONMENTAL IMPACT

The environmental impacts identified in the EIS were based in the Checklist for Addressing the Environmental Impacts of Dam and Reservoir Projects from Social Commission for Asia and Pacific, 1990, and are as follows:

CHECKLIST OF ENVIRONMENTAL PARAMETERS FOR JERIMUM DAM CONSTRUCTION, WATER SUPPLY AND IRRIGATION

ACTIONS AFFECTING ENVIRONMENTAL RESOURCES AND VALUES	DAMAGES TO ENVIRONMENTAL	NATURE OF THE ENVIRONMENTAL IMPACT	RECOMMENDED FEASIBLE PROTECTION MEASURES
a - Social problems i - Population resettlement ii - Payment to the landlords iii - Employment places offer	<ul style="list-style-type: none"> - Families have to be resettled in a new place - Owners have to be paid according to the Brazilian Constitution (1988) - Construction and operation of the reservoir 	<p>LS,ST,B,Rm,IP,DI,Is</p> <p>LS,ST,B,Rm,IP,DI,Is</p> <p>Re, LT, SB, Is</p>	<p>Resettlement planning</p> <p>Payment in time according to the law</p>
b - Problems related with technical alternative selection iv - Earth movements	<ul style="list-style-type: none"> - Erosion risks - Non utilized material disposition - Not renewable natural resources (earth and rock for dam construction) - Risks connected to the employees insurance - Risks connected to the employees sanitary conditions - A esthetic hazards (noise, vibration, etc) 	<p>LS,ST,A,IP,DI,Im</p> <p>LS,LT,A,R,Rm,II,Is</p> <p>LS,LT,A,I,DI,Im</p> <p>LS,ST,A,Rm,IP,DI,Is</p> <p>LS,ST,A,R,Rm,IA,II,Is</p> <p>LS,ST,A,I,IP,II,Is</p>	<p>Use the minimum of opened erosion area and the minimum possible time; plant temporary crops or covering with disposable materials for stabilization; build drainage channels, levels, or absorption areas; observe insurance standard methods; control sanitary conditions in the work area; getting awaring the population about every kind of hazards.</p>
c - Rational reservoir deforestation	<ul style="list-style-type: none"> - New places of employment are produced - Wood for construction and energy are produced - Erosion is increased - Loss of forest resources 	<p>LS,ST,B,DI</p> <p>LS,ST,SA,I,Rm,IP,DI,Is</p> <p>LS,ST,A,DI,Is</p> <p>LS,ST,SB,Rm,IP,DI,Is</p>	<p>Rational deforestation plan for reservoir area</p>
d - Reservoir filling v - Land submersion vi - River channel submersion vii - Lake formation	<ul style="list-style-type: none"> - Loss of native areas and natural habitats of the local vegetation and wild life - Loss of wood - formation of habitats which favor life and breeding of disease vectors - Increase of ground water around the reservoir - Rittle micro-climate modification - Formation of habitats for flighes and aquatic birds - Oportunity for water uses and transportation - Reservoir silting 	<p>LS,ST,A,R,Rm,IA,DI,Is</p> <p>LS,ST,A,I,Rm,IP,DI,Is</p> <p>LS,ST,A,Rm,IA,II,Is</p> <p>LS,ST,B,Rm,Is</p> <p>LS,ST,B,I,IA,II,Is</p> <p>LS,ST,B,Rm,II,Is</p> <p>LS,ST,B,I,Rm,II,Is</p> <p>LS,LT,A,I,Rm,DI,Is</p>	<p>Wild life escape planning Program of planting native species</p> <p>Control the regional sanitary conditions Promote sanitary education of the population</p> <p>Use the possibility of drill wells</p> <p>Erosion control</p>

000011

CHECKLIST OF ENVIRONMENTAL PARAMETERS FOR JERIMUM DAM CONSTRUCTION, WATER SUPPLY AND IRRIGATION

ACTIONS AFFECTING ENVIRONMENTAL RESOURCES AND VALUES	DAMAGES TO ENVIRONMENTAL	NATURE OF THE ENVIRONMENTAL IMPACT	RECOMMENDED FEASIBLE PROTECTION MEASURES
viii - Downstream changes in the river channel and near bank areas	<ul style="list-style-type: none"> - River become perennial - Flood peak reduction - Dilution increasing - Possibility of irrigated lands - Wild life - Modification of the process erosion-deposition of sediment - Ground water recharge increasing - Continuous flow during the year 	LS,Re,LT,SB,Is LS,LT,B,Is LS,LT,B,Is LS,LT,SB,Is LS,LT,B,Is LS,LT,A,I,Is LS,LT,B,DI,Is Re,LT,SB,Is	Environmental Protection Law State Water Resources Plan
ix - The Jerimum reservoir itself	<ul style="list-style-type: none"> - Fixing the man in the hinterland - Water supply - Sanitary control necessity - Land ownership modification - Land price modification - Multiple use conflict - Water tax collection problem - Recreational possibilities - New roads - New agri-industries - More employment places - Better agriculture - Fishery implementation 	Re,Na,SB,DI,Is LS,LT,SB,Is LS,LT,A,Rm,DI,Is LS,LT,B,Rm,DI,Is LS,LT,B,Rm,II,Is LS,LT,A,Rm,Is LS,LT,A,Rm,Is LS,ST,A,Rm,Is LS,LT,B,Rm,Is LS,ST,B,Rm,Is LS,ST,B,Rm,Is Na,Re,LT,SB,DI,Is Re,SB,DI,Is	Water supply treatment Sewage system Accomplishing the goals of the State Water Resources Plan Accomplishing the goals of the Environmental Protection Laws
a - Irrigation problems x - Flow regularization	<ul style="list-style-type: none"> - Possibility of irrigation 	LS,Re,Na,LT,SB,Is	
xi- Water logging xii- Utilization of chemicals xiii- Utilization of water from channel as drinking or cooking water	<ul style="list-style-type: none"> - Soil and water salination - Water contamination - Disease risk 	LS,SA,Rm,DI,Is Re,SA,Rm,DI,Is LS,A,Rm,II,Is	Drainage Control chemical utilization Prohibition of the use of irrigation waters as human water supply
f - Water supply pipeline xiv - Regularization of the water supply system xv- Pipeline strips area for operation and maintenance	<ul style="list-style-type: none"> - Public health improvement - Expropriation problems 	Re,SB,DI,Is LS,A,Rm,DI,Is	Legal actions

LS - Local and Specific
 Re - Regional
 Na - National
 GI - Global
 ST - Short Term
 LT - Long Term
 SB - Significant and Beneficial
 SA - Significant and Adverse

B - Beneficial
 A - Adverse
 O - None Impact
 R/I - Naturally reversible/unreversible
 Rm - Restorable by mitigation or management
 IA/IP - Accidental Impact/Planned Impact
 DI/II - Direct Impact/Indirect Impact
 Iu/Is - Unique Impact/Sinergic or cumulative Impact

PROJECT ALTERNATIVES: Four location alternatives were studied: a) at Mandacaru river; b) at Caxitoré river; c) at the confluence of the two rivers; d) 1.200 meters below the confluence, (at Caxitoré river). The following table summarizes each studied alternative, and demonstrates that the best option is location c because it presents a lower cost along with a higher regularized volume. The definition of the crest level (150,5) was done considering the existence of an upstream reservoir. The choice of the cross section is connected with the availability of construction material. The earth and rockfill type was chosen concerning the lower costs and good effectiveness, as well as the favorable landscape component it brings for the region. The hydrological and geological studies were responsible for the choice of the spillway level (147) and its width (80m). The non construction alternative will result in the maintenance of the intermittence of Caxitoré River, which presents no flow at all during drought periods that can reach 9 month in a year.

Alternative	Annual Inflow Volume (hm ³)	Regularized Volume (hm ³)	Costs (US\$/m ³ regularizado)
a	15,5	5,9	0,22
b	17,3	4,2	0,38
c	33,4	9,6	0,22
d	35,0	8,6	0,28

MITIGATION PLANS

Resettlement Plan: The State Water Resources Agency promoted a meeting with the affected population and the local NGO for the decision making about the payment of the lost material in the impoundment area, the construction of the houses, the infrastructure to be installed in the area to be occupied by the resettled families, and other resettlement issues, as well as the sharing of responsibilities upon the environmental measures to be undertaken in the area. In this process the State Agency indicated a representative to answer to any resettlement questioning. The documentation of this first meeting is included in the EIS. Once over the negotiations and the decision making process, the State Agency will start the delivery of the construction material. The State Agency will, also, develop an educational plan on sanitation issues and will install sanitation equipment in the houses sited around the lake. The resettlement process can be done in 8 month and should be concluded before the reservoir filling.

Racional Deforestation of the Jerimums' Reservoir Impoundment Area: All lands below the level 147m, which means, 269.3ha, will be impounded. This area should be deforested before the filling of the reservoir. The implementing agency must deforest only the strictly necessary area. The agency should allow the population to take advantage on the existent timber of the area. The detailed deforestation process is included in the EIS. This process should last 7 month, the most. Only the last two month of the deforestation process

can coincide with the with the reservoir filling process. Considering the efficiency of the mechanic method, detailed in EIS, it will take 45 days, 6 hours a day of work to conclude the stump take-off. Considering the manual method, 30 men working 8 hours a day will do the stump take-off, in 45 days.

Wildlife Protection Plan: The wildlife rescue process should be undertaken before and during the deforestation process. Specifically, the rescue operations should start 1 month before the beginning of the deforestation process and from this point on, the two processes can continue parallelly. If properly equipped with the rescue material, 10 men, working 8 hours, can prepare 5ha in one day. For each 8 hours of work it will be needed a 12 hours range of no interventions in the prepared area, so that the animals can be rescued. The wildlife protection plan can, therefore, be concluded in 54 working days.

Fishery Plan: The fishery plan can be started as soon as the lake is totally filled. According to the plan description indicated in EIS, it will take four years to reach its most productive stage. The State Water Resources Agency will be responsible for the installation of the fishery infrastructure in the surroundings of the lake. The State Agency should stimulate the population to create an institution which would obtain funds for the formation of a small fishery industry, regulate and control the activities in the reservoir surroundings for the protection of fish population, promote training courses for fishermen and educational programmes stimulating proper uses for the reservoir.

Degraded Areas Recuperation Plans: Specific provisions must be made to eliminate or mitigate environmental damage in the impoundment area during and after construction. Some of the procedures are the responsibility of the contractor and others, basically the fiscalization work, are the responsibility of the State Water Resources Agency among with the State Environmental Agency. Provisions should be incorporated into construction related impacts. Adequate location of borrow areas should be made; air and water pollution from construction equipment, earth movement and living quarters, avoided; screening of laborers for imported water-related diseases; solid waste disposal; siting of contractor facilities and other infrastructure to minimize destruction of natural landscape, and noise pollution. Some corrective procedures like the reforestation of the area are better detailed in the EIS.

ENVIRONMENTAL MANAGEMENT, MONITORING AND TRAINING: The State Water Resources Agency is mainly responsible for the management, monitoring and training processes to be undertaken for the implementation of Jerimum Public Reservoir and its Mitigation Plans. SRH State Agency will promote a training course for environmental monitors, which characterization is as follows:

**TRAINING COURSE FOR ENVIRONMENTAL MONITORING AND EMPLEMENTATION
OF MITIGATION PLANS OF JERIMUM PUBLIC PROJEC**

NOME DO CURSO	I COURSE FOR RESERVOIR MANAGEMENT
PROMOTION OF SRH (State Water Resources Agency)	
INTERESTED POPULATION	Fishery, Forestation, Agriculture and Operative Engineers as well as technicians from Federal Technical School or Engineers from SRH.
NUMBER OF VACANCIES	20
DURATION: 200 hours, 45 days	
SCHOLARSHIP GRANT	US\$ 5,00/student/day
COSTS	. US\$ 5.000,00 for professor's payment . US\$ 1.000,00 for management, instalations, material and equipment expenses . US\$ 4.500,00 for scholarship grants . Total: US\$ 10.500,00
NATURE OF THE SELECTION	Interview with a representative of SRH

The range of implementation of the Mitigation Plans as well as its costs are shown in the following Figure.

The implementation costs of the Mitigation Plans are detailed in the EIS. A General Diagram of the undertaking is shown in Annex 7 of the EIS.

Although, this responsibility can be shared with other governmental agencies like the Electricity State Agency, the Waste Water State Agency, the Environmental State Agency, and some municipal agencies in charge in the direct influence area. The educational programmes about environmental issues should be very frequent in all the implementation process. Some of the procedures to be carried on in the watershed basin are: the farming activities should always use racional techniques, sanitary control of critical areas; observation of actual environmental laws and rules: Law nº 7.803 of 07/18/1989, about the 100m protection strip around the reservoir; 50m protection strip along the streams; adequacy of wastewater equipment installed around the lake; strict observation of upstream land use rules, concerning soil exploration, liquid and solid discharges, prohibition of forest burning for agricultural uses, observation of hunting and fishing rules, etc.

CONCLUSIONS AND RECOMENDATIONS: The implementation of Jerimum Public Reservoir in Curu River Watershed Basin was analysed under two points of view. The first one assesses the need of accumulating water for several uses in that hinterland region of Ceará State. The second one analyses the environmental impacts

likely to result from the construction of the dam and subsequent formation of the lake. Regarding the first feature, it would be enough to affirm that it is not possible to reserve water in the underground aquifers of the region because the substratum is mostly rocky, which means that there is no other way of accumulating and using the badly distributed rainfall of the area, but by forming artificial lakes. Regarding the second feature, a potential environmental impacts checklist was elaborated, strictly searching for negative impacts so that their respective mitigation measures could be indicated. Once analysed the checklist, it can be concluded that, although there are several negative impacts, they all can be minimized through mitigating measures. The Environmental Impact Study does not have any objections concerning the alternatives for site and design technologies chosen for the dam and reservoir, understanding that they will not result in such negative impacts upon the natural or social resources of the area, that justify not constructing the dam. The recommendations are related to three ranges: before the construction of the dam, during and after the filling of the reservoir:

Before the construction of the dam:

1. Promotion of meetings between the implementing agency and the affected population;
2. Develop plans to employ manpower from the expropriated areas;
3. Develop land use projects for resettlement and downstream population;
4. Development of environmental education programmes linked with preserved ecological and cultural areas;
5. The owners of the expropriated lands should be paid before the beginning of the proposed project, in market prices and in cash. The affected population have to receive from SRH at least, all that was lost with the implementation of the project.

During and after the filling of the reservoir:

1. Sow grass on bare of reservoir banks to prevent soil erosion and afforestation of slopes with fast growing trees to rehabilitate deforestation areas;
2. Monitor water quality (upstream, reservoir, downstream);
3. Health education for local population;
4. Water quality monitoring coordinated by the State Environmental Agency - SEMACE;
5. Social assistance for resettled and the population of the rivers' surroundings.

000016

ANNEXE - LAY-OUT SCHEME OF MULTIPLE PURPOSES OF JERIMUM RESERVOIR

000017

A TÉCNICA QUE CONDUZ AO FUTURO



Projeto Curu - Paraipaba

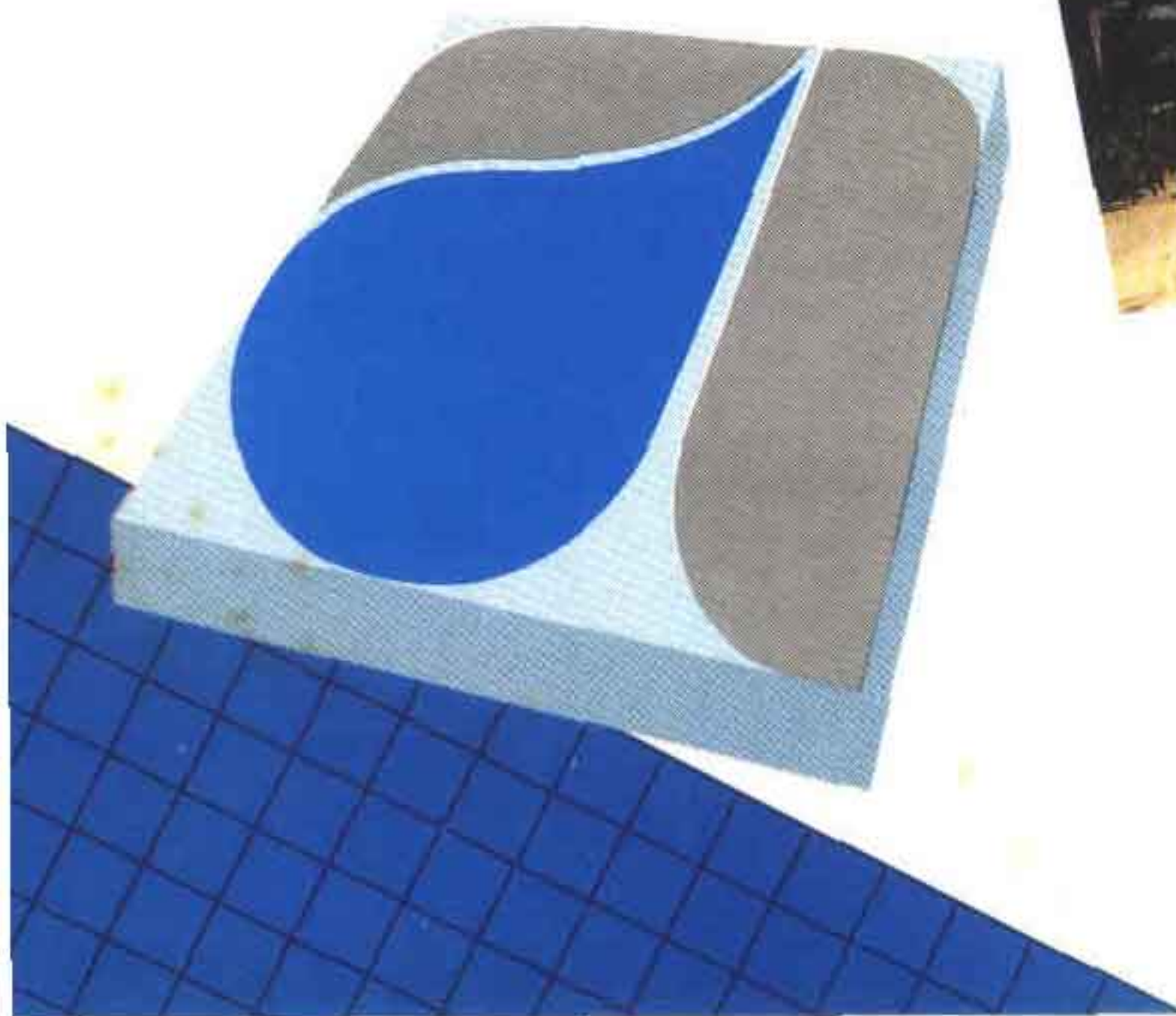


Praia de Iracema



Projeto Curu - Paraipaba

terrac



000018

Quando uma empresa acompanha a evolução de seu tempo utilizando inovadoras e avançadas técnicas para a execução de seus serviços com eficiência e responsabilidade, cumpre o seu papel perante o futuro, contribuindo, desta forma, para o progresso do homem.



FAZ PARTE DA EVOLUÇÃO