Particular Method Environmental Impact Report of the Cerro de Oro Hydroelectric Project

I. GENERAL INFORMATION OF THE PROJECT, THE PETITIONER AND THE PARTY RESPONSIBLE FOR THE ENVIRONMENTAL IMPACT STUDY

I.1 Project

See location map.

I.1.1 Project Name

Cerro de Oro Hydroelectric Project

I.1.2 Project Location

The area of the project is located in the federal zone that includes the curtain of the Miguel de la Madrid Hurtado (Cerro de Oro) dam, which is located between Cerro de Oro and Cerro Santa Ursula in the region of Paso Canoa, within the Municipality of Tuxtepec. Its geographic coordinates are 17º 59' 50" North Latitude and 96º 15' 19" West Longitude. The transmission line will begin in the area of the hydroelectric central and will end interconnecting with the Benito Juárez electric substation of the CFE[1] located in the town of Sebastopol with coordinates 18º 02' 00" North Latitude and 96º 10' 08" West Longitude. Its trajectory will be within the regions of Santa Ursula and San Rafael, also located in the Municipality of Tuxtepec. All of the foregoing are located in the State of Oaxaca. (See topographic map with site location)

I.1.3 Useful life span of the project

The estimated useful life of the project is estimated to be 50 years. However, it will depend on the concession authorizations and revalidations the *Comisión Nacional del Agua* ("CNA") (National Water Commission) may grant for the project.

In accordance with the foregoing, approximately 24 months are estimated to apply for and obtain the loans and authorizations necessary to carry out the work, 36 months for the site preparation and construction and 50 years for the operation and maintenance stage of the project, considering the CNA grants the concession for such period.

The total project time is 55 years, but such period may vary based on the revalidations requested from the relevant authorities.

[1] Translator's Note: Abbreviation of Comisón Federal de Electricidad - Federal Electricty Commission

I.1.4 Presentation of Legal Documentation

To comply with the applicable legislation, this study is conducted in order to carry out the necessary filings before the National Water Commission, to obtain the permits and concessions relating to the construction and use of surface water, as well as land use in the federal zone managed by such authority, after obtaining the relevant authorization from SEMARNAT[2].

With regard to the land where the layout of the transmission line will be located, the filings and agreements with the owners of the land are currently being prepared to obtain the rights of way that the authority requires for this kind of projects.

I.2 Petitioner

I.2.1 Name

Electricidad de Oriente, S. de R. L. de C. V.

I.2.2 Petitioner's Federal Taxpayers' Registration Code

EOR060911Q36

I.2.3 Name and position of legal representative

Camhaji Samra Salomón
Jinich Ripstein Carlos

A copy of the company's charter is attached.

I.2.4 Address of petitioner or petitioner's legal representative to receive notices and service of process

Bosque de Ciruelos 190 - 303 A,
Col. Bosques de Las Lomas, C.P. 11700,
Delegación Miguel Hidalgo
Distrito Federal
Tel.: (01 5) 55 96 89 24
Fax: (01 5) 52 51 60 65

[2] Translator's Note: Abbreviation of the *Secretaría del Medio Ambiente y Recursos Naturales* – Ministry of the Environment and Natural Resources.

Email: scamhaji@asergen.com.mx

1.3 Party responsible for preparing the environmental impact study

I.3.1 Name

Pérez Coria Samuel Genaro

I.3.2 Federal Taxpayers' Registration Code or CURP

PECS 601019 BB4

I.3.3 Name of the technical manager of the study

Architect Samuel Genaro Pérez Coria

Federal Taxpayers' Registration Code PECS 601019 BB4

CURP:PECS601019HDFFRRM05

Professional License Number:

License Nº 1671353

I.3.4 Address of the technical manager of the study

Calle Durango Nº 133
Col.: Valle Ceylán, C.P. 54150
Tlalnepantla, Estado de México
Tel.: (015) 53 88 73 73
Fax.: (015) 53 91 09 14
Email: amchar1@hotmail.com

II. PROJECT DESCRIPTION

II.1 General Project Information

Construction and Operation of a Hydroelectric Central equipped with a turbine-generator complex with a design power of 10.8 MW; one electric substation that will serve to raise to 115 KV the voltage coming from the central, as well as 10.5 km double-circuit sub-transmission line that will interconnect with the power transmission and distribution network of CFE.

II.1.1 Nature of the Project

The Miguel Alemán (Temascal) dam located in the State of Oaxaca was built as regulation work of the Tonto River due to the periodic rises that considerably affected the lower part of the Papaloapan River. This allowed a reduction of the flooding problems in the region and using the resource for electric power generation. However, the problems in the area were not controlled in full, since there is another river, the Santo Domingo River, which converges with the Tonto River and which represents a continuous risk of flooding and overflowing, as occurred in the years 1958 and 1969, since it is one of the principal tributaries of the Papaloapan.

Considering the foregoing, the Federal Government issued a decree in 1972 approving the recommendation of the construction of the Cerro de Oro dam, which would allow controlling the outflow of the Santo Domingo River and complementing the volume of the Miguel Alemán dam for hydroelectric generation through the interconnection of both dams. For this reason, the Cerro de Oro dam was not afforded an intake structure.

The Cerro de Oro dam currently discharges an outflow of between 30 and 45 m^3/s due to its control structure, which discharges the flow of water in the Santo Domingo. This outflow can increase during the rainy season and may even at a certain time, discharge up to 6,000 m^3/s through its excess spillway.

Because the outflow discharged through such control structure is constant and the area where the curtain is located has adequate conditions to install infrastructure, it provides a good alternative for hydroelectric generation. Consequently, the use of the resource has been considered for such purpose, to allow utilizing such water flow for the benefit of the activities of the energy sector.

This way, with the installation of a hydroelectric central in the site, the outflow would be exploited, with a possibility of obtaining a force of up to 14.8 MW, depending on the charge conditions and outflow in the dam.

Another advantage would be that surfaces assigned to infrastructure in the dam, which form part of the federal zone managed by the National Water Commission, would be used

in the construction. This way, any possible effects considering the current land use, would relate to the installation of the transmission line, which, as may be observed throughout this study, will occur mainly in previously affected areas, agricultural land and existing urban areas.

The project is viewed as a sound alternative for energy use under the self-supply system that will have minor effects on natural conditions, as experimented in other hydroelectric projects, because it will use a dam that is already established and areas already affected, and the impacts generated would be basically caused by the construction activities. Such impacts may be satisfactorily mitigated with the prevention and mitigation measures referred in the study. Additionally, the region will be considerably and directly benefited by increasing the capacity of energy flow in the sub-transmission and distribution infrastructure, since this would complement the actions contemplated by the Federal Government through the Electrical Sector Projects and Investment Program (ESPIP).

The general purpose of the project is the generation of electric energy under a self-supply scheme through the construction, equipping and operation of a hydroelectric central with a design potency of 10.8 MW for an approximate annual production of 83.75 GWH, one electrical substation to raise the output voltage of the central to 115 KV, and the installation of a 115 KV, double circuit sub-transmission line approximately 10.5 kilometers long, which will originate in the electrical substation of the project and interconnect to CFE's Benito Juárez electrical substation located in the town of Sebastopol. Such point is located at coordinates 18°02'00" NL and 96°10'08" WL.

The land use currently assigned to the area intended for the installation of the hydroelectric central and substation is that of hydraulic infrastructure, as it is part of the protection area of the federal zone in the Cerro de Oro dam. With regard to the transmission line, the layout mainly crosses agricultural and livestock lands, industrial zones and human settlements.

II.1.2 Site Selection

Because the Cerro de Oro dam is already built, using as the basis of the technical and economic criteria areas close to hydraulic infrastructure that allow the installation of hydroelectric equipment and the water outflow of the dam that is normally discharged as excess into the resource supply and control structure to other users downstream of the dam, was considered.

The Cerro de Oro dam has a constant discharge due to its control structure into the Santo Domingo River and for purposes of hydroelectric generation it is a good exploitation alternative, since this flow of water would be used continuously as the discharge has come about to date. The difference however would be that the conduction would be through a tunnel that would reach the hydroelectric central and the water would be subsequently discharged into the old riverbed of the La Sal stream, which is located in the right margin of the curtain. The water discharge, after leaving the engine building would follow the course of the stream until joining the Santo Domingo River once more, approximately 2 km downstream of the dam curtain (see plots 1 and 2 of the works).

This would represent an important and direct benefit to the region since a fixed generated voltage considerably contributes to the stabilization of the voltage in the region. This is

beneficial for the operation of electrical equipment and appliances in homes and workshops. In addition, the municipalities that decide to join as consumer partners could have power supply for public lighting with considerable savings over their current consumption with CFE.

Another consideration for the selection was the use of sites close to the curtain, since the land has already been affected with the construction of the Cerro de Oro dam. This would minimize the effects on the area by using small areas of land assigned to the construction and operation of infrastructure and that have services such as access roads, electric power, water and passenger transportation services. In addition, with regard to the transmission line, the project seeks to have existing access ways to eliminate the opening of roads and a layout as short as possible over agricultural lands, rights of way, industrial zones and other areas to avoid forest vegetation as much as possible and minimize any impacts.

As can be seen, the concentration of the infrastructure will allow the minimization of impacts with the consequent reduction of construction costs. Therefore, the alternative for the development of the project is considered favorable for environmental conservation.

II.1.3 Physical location of the project and location plans

The hydroelectric central and its substation will be located immediately downstream of the embankment formed by the curtain of the Miguel de la Madrid Hurtado “Cerro de Oro” dam, in the right section that joins this structure with the Santa Ursula mountain. The discharge will be located in the riverbed of the La Sal stream, which originates next to the curtain of the dam and which is located in the region of Paso Canoa, within the municipality of Tuxtepec, State of Oaxaca. The coordinates of the project are 17º 59’ 50” North Latitude and 96º 15’ 19” West Longitude (see Topographic map).

The boundaries of the area of the project are as follows:

To the north is part of the bank of the curtain and the access road that communicates with the Los Reyes region.

To the south is the embankment of the Santa Ursula mountain and the old access to the materials bank used to build the curtain.

To the East is the channel of the La Sal stream, the access road to the region of Los Reyes and part of what was the old materials bank for the construction of the curtain.

To the West are the embankment of the curtain and the reservoir of the Cerro de Oro dam.

The transmission line will begin next to the structures that will integrate the electrical substation and will end at an interconnection point with the Benito Juárez substation, located in the town of Sebastopol, corresponding to the power distribution grid of the Federal Electricity Commission.

The coordinates of the trajectory of the transmission line are as follows:

Reference point	North Latitude Coordinates	West Longitude Coordinates
Cerro de Oro H.C.	17º 59' 50"	96º 15' 19"
P. I. 1	18º 01' 16"	96º11' 49"
P. I. 2	18º 01' 40"	96º 11' 03"
Interconnection point S.E. B. Juarez	18º 02' 00"	96º 10' 08"

The exhibits contain a location plan with coordinates, topographic map and project drawings 1, 2 and 3 with the location of the project.

II.1.4 Required Investment

The estimated investment for the project is $29,614,000 US Dollars, which converted into Mexican pesos at the exchange rate of $10.8450 published in the Official Gazette of the Federation on June 6 2007, would total $321,163,830.00. The items contemplated in such amount are as follows:

Item	Amount Million Dollars
Civil Work	9.062
Electrical Equipment and Systems	8.633
Transmission Line and breakers	2.900
Development costs	2.810
Financial costs	4.114
Out-of-pocket and other expenses	1.895
Training	0.200

The period to recover the principal may vary depending on the financial and credit conditions the project is subject to, as well as on power production during the operation period. Therefore, the recovery period is estimated to be approximately 6 years.

To cover the activities relating to the impact prevention and mitigation measures, approximately 2% of the cost of the work is considered in the out-of-pocket and other

expenses item. In order to ensure full compliance both with the measures contemplated in this study and with the conditions the competent authority imposes from time to time, this amount will be a condition for the participating companies within the cost of the construction contracts.

II.1.5 Dimensions of the project

The surface required for the project includes the areas that will be occupied by both the permanent and temporary work as detailed below:

Hydroelectric central and Substation

Item	Surface in m^2	Percentage
Total surface of H.C. and E.S.	6,072	100
Trench for pressure pipeline	255	4.20
Engine building (include outlet channel)	2,432	40.05
Substation	1200	19.76
Access to the central	325	5.35
*Camps and service areas	510	8.40
*Workshops	500	8.24
*Offices	250	4.12
Warehouses	600	9.88

*Temporary occupation surfaces

Transmission Line

Item	Surface in m^2	Percentage
Total Layout Surface	262,552	100
Foundation of towers (22)	1,408	0.54
Right of way (25mx10.5 km)	261,144	99.46

For the line, surfaces for workshops, warehouses and offices will not be used since specific properties will be leased.

Sum of group of surfaces

Item	Surface in m^2	% of the total project	Surface m^2 Temporary Use	Surface m^2 Permanent Use
Hydroelectric Central and Substation	6,072	2.26	1,260	4,812
Transmission line	262,552	97.74	*261,144	1,408
PROJECT TOTAL	**268,624**	**100.00**	**262,404**	**6,220**
			97.68%	**2.32%**

* The use of the land in the right of way of the line will not have any restriction, except for constructions that could affect the operation and safety of the line, for which it is being considered as a temporary use surface.

The surfaces that will be affected as per type of vegetation community are as follows:

Hydroelectric central and substation

Surface type	Surface in m^2	Percentage of the total surface of the project
Without vegetation	575.00	0.21
*Trees	2,550.00	0.95
No trees (herbaceous vegetation and grass)	2,947.00	1.10

*The area is represented by secondary vegetation, since previously during the construction of the Cerro de Oro dam, the land was cleared for use for camps and warehouses.

Transmission line

Surface type	Surface in m^2	Percentage of the total surface of the project
No vegetation	28,991.66	10.79
*Trees	85,347.90	31.77
** No trees (herbaceous vegetation and grass)	148,212.50	55.17

*Surfaces with trees: Medium jungle mainly of secondary vegetation (12,425 m^2) and agricultural-forest plantations (71,591.65m^2)
**Surfaces without trees: includes rural, agricultural and livestock areas.

On the surfaces with trees along the transmission line layout indicated above and in accordance with the instructions of the authority to contemplate the application for change of use of forest land, the area where the project is located is catalogued as production zone with the classification of woodlands or for use preferably as low-productivity woodland, and the intention to affect a surface of 8-53-47 hectares, of which, 1-24-25 hectares correspond to natural woodland vegetation and 7-15-91 hectares to agricultural-woodland single-crop plantations.

II.1.6 Current land use and/or bodies of water in the project site and its surroundings.

The current common or regular land use of the area contemplated for the installation of the hydroelectric central and the electric substation is for hydraulic infrastructure, corresponding to the federal zone of the Miguel de la Madrid Hurtado (Cerro de Oro) dam. Located downstream of the dam curtain are the control structure and part of the old riverbed of the Santo Domingo River in the left margin and right margin, the Santa Ursula hill, the old access road to the materials bank and the La Sal stream. This is a section of the protection area of the hydraulic facilities of the dam managed by the National Water Commission. It contains grass, herbaceous vegetation and spots of secondary vegetation. In the boundaries, the land use is for agricultural and livestock purposes. Mainly rangelands and grasslands, corn and sugar cane crops integrate the land and as the elevation of the Santa Ursula mountain increases, it becomes woodland with a certain degree of degradation due to livestock activities (vegetation).

With regard to the use of the bodies of water, the reservoir of the Cerro de Oro dam is used to store the resource as avenue control work and as communicating reservoir with the Miguel Alemán (Temascal) dam for the exploitation of the resource in the generation of electric power. Other purposes for which the dam has been used are the extraction of fishing products and nautical sports.

In the layout of the transmission line, the current use in most of the land is agricultural, livestock and rural, and in certain points, it has a urban use, as is the case of the regions of Santa Ursula, San Rafael and Sebastopol.

Downstream from the dam, the Santo Domingo River, from the dam curtain until it joins Río Tonto is basically used for the supply and discharge of wastewater from the industrial areas located along this tract and for agricultural use in the areas around the river. The La Sal stream receives the run-offs produced during the rainy season as part of the filtrations that occur in the dam. The main activities in the industrial zones of the area pertain to the manufacturing of cellulose for paper, beer and sugar mills, while in the properties dedicated to agriculture there are sugar, corn, banana and rubber plantations where the fruit is exploited and latex is extracted.

Considering for the case at hand the information on biological interest zones with respect to Priority Terrestrial Areas managed by CONABIO, the project is located at approximately 40 kilometers from the Western end of the PLR 124 “Wetlands of Papaloapan”. The project is located at an approximate distance of 25 kilometers from the Eastern end of the PLR130 “Sierras del Norte de Oaxaca-Mixe”.

With regard to the priority hydrological regions managed by the CONABIO, the area of the project is located at a distance of 6 kilometers south of the polygon that conforms the PHR 78 “Miguel Alemán-Cerro de Oro dam” and 16 kilometers from the northwest boundary of the polygon that conforms the PHR 79 “Wetlands of the Papaloapan, San Vicente and San Juan”.

Additionally, with respect to the Important Areas for Bird Conservation managed by CONABIO, the project is located within the AIPB SE-47 “Cerro de Oro”.

II.1.7 Urbanization of the area and description of required services

The project location has available electricity supply that provides energy to the gates equipment in the control structure of the Cerro de Oro dam and to the region of Los Reyes. It has two access roads, one on each side of the Santo Domingo River that provide access from the dam to the town Tuxtepec. Additionally, the roads go through the regions of Paso Canoa, Los Reyes, Santa Ursula, San Rafael, Piedra Quemada, Sebastopol, Benito Juárez and Camelias.

The services that need to be temporarily implemented for the construction stage will be the following:

Potable Water

Potable water will be supplied through large bottles acquired in the town of Tuxtepec and transported to the project site for consumption in each work front. Water will be supplied on a weekly basis, depending on the stock of bottles available in the project.

Additionally, the regions of Santa Ursula and Paso Canoas have the service available, which is provided through the well and spring. (See potable water services plan)

Electric Power

Considering the capacity of the electric power line that reaches the site, a derivation will be placed towards the camp and office area in order to have such service available. If necessary, a transformer will be placed to improve the supply and avoid overcharges that could cause problems in the equipment breakers. Additionally, there will be independent generators that will be used in certain equipment during the construction work. (See electricity services plan)

Communication services

Although nearby towns have telephone services that can be used to satisfy the project’s requirement, cellular telephony reception will be checked in the area to be able to have the service in the project. If the use thereof is not feasible, the service will be provided through satellite reception equipment, which will satisfy the requirement for both the construction and operation stages. (See telephony services plan)

Drainage

The towns of Santa Ursula and Paso Canoa have drainage services. However, sanitary services will be required for the project workers. This requirement is intended to be satisfied through the installation of septic tanks with adequate treatment and capacity. These facilities will have periodic maintenance and stabilization of waste to avoid any

pollution problem. The installation of sanitary modules has not been considered since there are no companies in the region that offer the service close to the project site, rendering the regular transportation of personnel and equipment for the continuous maintenance of such modules impossible. (See drainage services plan)

Supply and transportation of construction materials

The transportation of construction materials and supplies to the site will be required. Such service will be supplied by carrier companies or organizations in the area, as well as by the suppliers of the construction materials themselves.

Collection and disposal of domestic solid waste

Collection and disposal of the waste generated in the site will be necessary. For such purpose, containers will be installed on site and will be subsequently carried to a waste disposal location at least once a week to avoid accumulation thereof in the construction, camp and office areas. The location of the disposal site of the Municipality of Tuxtepec has been determined and it is located in the *colonia* Obrera, specifically in the Tuxtepec industrial site. For such purpose, the necessary filings will be made with the *Dirección de Servicios Básicos* (Basic Services Office) which is the municipal authority in charge of such matters, and the applicable duties will be paid to meet such need. (See waste disposal services and infrastructure map)

II.2 Specific characteristics of the project

The project consists of the installation of a hydroelectric central with a design potency of 10.8MW, an electric substation, which will serve to raise the output voltage of the hydroelectric central to 115 KV and a double circuit electric transmission line approximately 10.5 kilometers long and a 25 meter right of way, which will allow transferring the power to the national distribution grid operated by the Federal Electricity Commission.

II.2.1 General Work Schedule

The exhibits section in chapter VIII presents the scheduled programs and diagrams setting forth the activities during the different stages of the project.

II.2.2 Preparation of the Site

Clearing

To prepare the areas to make the excavations for the installation of the engine building and the pressure pipeline, it will be necessary to eliminate the vegetation and soil layer

that currently cover these surfaces. For such purpose, the material will be eliminated using light equipment and hand tools. The material will be removed and transported to the site intended for muck dumping in order to make the land surface visible to mark the layout of the excavations with lime. After making such marking and once the polygonal sections of the property are defined, the rock material will be extracted.

The anticipated volume of vegetation that will be eliminated will be around $40m^3$ considering the excess obtained when piling and carrying the material. The material will be composed mainly of grass, herbaceous plants and shrubs.

The layer of vegetable soil, mainly clay, that will be eliminated is thin in the majority of the sections, since the site, as explained before, is a section next to the dam curtain where work has been previously carried out and where limestone with minimum ground thickness is present. Considering an average thickness of 10 cm that forms the soil layer and a surface that will be permanently affected of about $4,812m^2$, an approximate volume of $481.2m^3$ of such material will be obtained, which will be transferred to the muck disposal site to be conformed when appropriate and used as a cover of the rock material at the edge of the discharge channel and to generate new vegetation in the short term.

For the transmission line layout activities, first, the axis of the line layout and the area assigned for the right of way will be marked. Second, the sites next to the work area that due to their characteristics may be affected, whether due to their inclination or the type of work to be conducted, will be inspected. In accordance with this, the trees to be removed will be cut in sections, to avoid trunks from falling and affecting surfaces outside the designated right of way.

Clearing will be carried out as necessary, considering an attack by sections, starting from the center of the layout and finishing at the ends. The directional teardown will be made towards the axis of the right of way, without affecting any surface beyond the strip assigned. Additionally, branches will be cut and the resulting product will be deposited preferably within the area of the right of way so that it serves as protection for the ground and integrates as organic matter back into the soil. This activity will be carried out depending on the requirements and conditions indicated by the authorities and the owners of the land for the management and/or use of the resulting material.

Excavations, packing and/or leveling:

As explained above, the material that results from the clearing will be used in the muck disposal site located immediately downstream of the dam curtain, so that once the rock excavation work concludes, the material is conformed and it is possible to obtain new vegetation growth on site in the short term.

It will be necessary to excavate the sites where the pressure pipes, the engine building and its outlet channel will be located, as well in the tunnel and its intake structure. Basically, rock material will be attacked. It will be extracted gradually and will serve to form and level the platform where the substation will be located. The excavation will be carried out mainly using a backhoe drill with special attachments for perforation, which will allow opening the trench for the pressure pipeline, as well as explosives, pneumatic perforators and front loaders used to make the tunnel.

The stabilization of the embankments where the excavation will be carried out will depend on the fragmentation of the material during the work. In the sites where stabilization is required, rods will be driven in the walls of the embankment and in the places where excess fractured material is found, the respective anchor and steel mesh will be placed. To consolidate the material, a layer of shotcrete will be applied to the steel mesh.

The sections at the top of the embankments both at the tunnel exit and in the borders of the land where the pressure pipes and the engine building itself will be located, will have channels to diverge rain water. Such water will be channeled towards the riverbed of La Sal stream, to avoid puddles from forming and erosion problems in the walls of the embankments until the pipes are lined or covered.

To level the land where the substation will be located, the material resulting from the abovementioned excavations will be used. This way, the material will not have to be moved outside the land and it will not be necessary to open or use materials banks. This will considerably eliminate and reduce impacts that could be caused by the exploitation of surfaces and the use of long-distance transportation to carry materials. In accordance with the foregoing the procedure to level the land will consist first of the fragmentation and extraction of the material at the excavation site. After sufficient volume is obtained, the material will be transported using either a front loader or a dump truck to the muck-dumping site. Once at the site, the material will be arranged and leveled using machinery and will be formed layer by layer with the aid of motograder and a rolling packer.

The volume of the material that will be obtained from the excavations in the works that integrate the tunnel, its intake structure, the trench of the pressure pipeline, the engine building and its outlet channel is calculated at approximately 66,000 m^3, and it will be mostly composed of clay and limestone rock material.

The work to be performed for the La Sal stream will consist mainly of removing sediment from currently slow flowing water areas and the excavation of two sections of the tract to rectify and reach the level of embankment desired for the project. This will be made using a backhoe drill and the resulting material will be deposited in the lower margins of the stream to avoid the movement of cargo vehicles to sites outside the work area and to offer a uniform profile of the channel. The length anticipated to be rectified in the riverbed of the stream in the first section will be about 200 meters, will have an embankment of 1:1 and an average depth of 1.0 meter; for the second stage, rectification will be required in an approximate length of 700 meters, an embankment of 1:1 and average depth of 2.5 meters. The width considered in the sections to be rectified will be between 10 and 12 meters, for which tentatively, a volume of material equivalent to 16,901 m^3 will be obtained. Such material will be composed mainly of clay soil, pebbles and fractured limestone rock. The resulting material, as indicated above, will be deposited in layers and flattened to obtain a low-height bank or levee, which will produce vegetation re-growth in the short-term.

II.2.3 Description of the project's temporary activities and work

Camps

To avoid installing camps on site, the possibility of leasing homes in the towns of Paso Canoa, Los Reyes, Santa Ursula, Benito Juárez or Tuxtepec as a last resort, will be explored, since the majority of the personnel hired will be from nearby towns and lodging will be required exclusively for out-of-town personnel. Therefore, temporary camps will not be set up. However, if no adequate lodging is found or if personnel transportation is inconvenient, it will be necessary to install modules. For such purpose, the installation of trailers or motor homes and multipanel® modules that can be easily assembled at the beginning, and disassembled upon the conclusion of the work, has been considered. Three motor homes in a surface of 10 x 10m each as well as a 210 m^2 surface for three multipanel modules are being considered. These surfaces include the space corresponding to vehicle access and parking. (See work scheme 1)

Workshops

3 workshops are intended to be set up for the preparation of materials and supplies that will be used during the construction of the engine building and substation. A workshop for metallic and boiler works will be required, using an approximate surface of 250 m^2 mainly to handle the piping sections. Additionally, 2 workshops of approximately 12.5 x 10 m will be required to carry out electrical and mechanical equipment repairs and general services. The structures to be installed will be simple, preferably using canvas or simple roofing attached to poles buried in the ground forming rectangles. The floor will be prepared with compacted clay or concrete surfaces to prevent spills of pollutants into the ground. Workshops will be established only during the construction stage, since upon conclusion thereof, they will be removed and the surfaces will be clear again.

Warehouses

The temporary storage of materials will be necessary to carry out civil and electro-mechanic work. For such purpose, the use of a 600 m^2 surface has been contemplated. Approximately four containers, such as those used for railroad shipping will be placed on such surface, and will serve as temporary warehouses. Additionally, a warehouse with tin roof and perimetral mesh fencing will be set up to store supplies, equipment and other constantly used materials. This action seeks to diminish the impact to the ground, since no special preparations will be made to place the containers. They will only be placed on the ground and kept there until the conclusion of the project. The containers will be removed from the site upon conclusion of the work to leave the surface clear. It is important to point out that such containers offer another advantage because since they are sealed inside, any contamination to the ground in the site will be prevented. In case of any accidental spill of liquid or solid substances, they will remain inside the container.

Moreover, a surface of 10m^2 on site is planned to be used to build a warehouse using metallic frames and tin, to keep used oils and solid materials such as burlap and rags used in the maintenance of the construction machinery and equipment, until such are sent for recycling or disposal to authorized companies. In accordance with applicable legislation, the floor will be prepared to make it waterproof and a tank will be integrated to collect accidental spills. Additionally, a curb or ditch will be installed around the base of the

warehouse to avoid any leaks of pollutants outside the warehouse and any filtration of rainwater inside the warehouse. The ventilation of the warehouse will be at the top of the walls and the necessary fire control materials and equipment, such as extinguishers and sand container will be installed. The possibility of having and using this waste warehouse not only during the construction stage but also during the operation stage will be analyzed, since the pertinent improvements and adaptations will be carried out.

Offices

As part of the temporary installations, an area of 250 m^2 is planned to be used for office space. As for camps, trailers or motor homes are intended to be used. If necessary, 3 multipanel® modules will be installed with the necessary area for personnel access and vehicle parking.

Surfaces for the repair and maintenance of machinery and equipment

Within the areas intended for workshops, an area will be assigned for the activities of machinery maintenance, consisting of preventive work, such as oil changes and minor repairs. The surface where the units to be repaired will be located will be prepared as follows: first a layer of compacted clay will be applied and a plastic canvas covering will be placed upon it; second, a new coat of clay will be applied which will be compacted until it reaches an approximate thickness of 10 cm. A small gutter around the area will be made to dispose of the water that could leak inside during rainstorms, and a canvas larger than the prepared surface will be placed as a cover or roof to prevent rain from humidifying the site and dragging any possible spills that may occur. Depending on the concentration of pollutants that the compacted clay layer may have, it will be removed and changed for a new one. The removed clay will be gathered in bins or similar containers for cooling and transportation or final disposal by authorized companies. It is important to point out that for major machinery and equipment repairs, the units will be sent to the town of Tuxtepec located 20 km from the project.

II.2.4 Construction Stage

The contention work (curtain and control structures of the dam) is already built and operating. It pertains to the infrastructure of the Miguel de la Madrid Hurtado (Cerro de Oro) dam and its characteristics are set forth below to provide the specifications and information of such work.

Dam curtain (built and operating)

The dam curtain is made of designed materials, with a maximum height of 70 m from the surface to the crown, the average length over the axis of the crest is 1,670 m and the width at the basis is 400 m, which reduces gradually until it measures only 10 m at the crest. The distribution of the materials used in the construction of the curtain was as follows: clay in waterproof core, sand gravel in filters, muck rock in backings and rock in faces. It should be pointed out that for the preparation of the dam core, a trench up to 4.0 msnm that would allow obtaining a maximum degree of waterproofing was excavated.

Control Structure (built and operating)

The control structure will be composed of a Creager type spillway structure with a design outflow of 25,983m^3/s per second, where nine radial gates, which discharge into three tunnels having a diameter of 12 m and a length of 450 m, are located. The discharge of such tunnels is through a rectangular canal approximately 150 m in length, which is located over the left margin of the old riverbed of the Santo Domingo River.

Capacities

The dam reservoir has a NAME capacity of 5290 million cubic meters with an elevation of 72.80msnm, its NAMO elevation is 67.70msnm and a capacity of 2500 million cubic meters and the NAMINO elevation is 55 msnm with a capacity of 1000 million cubic meters. The height of the curtain considering the bottom of the riverbed (20.0msnm) is 55.6 m.

The construction work required for the Cerro de Oro Hydro Electric Project and its characteristics are described below:

Hydroelectric central (see work plan 1**)**

Intake structure

It will consist of a flaring, reinforced concrete structure 1.70 m long with an interior section of 3.50 m wide x 4.00 m high and 1.00 m of perimetral flare at the entry; the axis of the water intake will be elevated at 47.00 m.

In addition, a 4.00 m long concrete section will be built at the front of the water intake and metallic screens will be installed to protect the hydraulic turbine from obstructions that prevent proper functioning.

Conduction tunnel

The conduction tunnel will be approximately 290 meters long. Contact injections will be applied to the tunnel to achieve a better consolidation of the material and its waterproofing. It will have 3 segments; the first two will be lined with reinforced concrete and the last one with metallic piping in packed concrete.

Segment N° 1 will have a rectangular section with concrete lining of 3.50 m x 4.00 m interior [dimension]. It will begin immediately after the intake structure and end on the back end of a porthole, where the protection gate will be located.

The porthole will be located 25.00 m away from the water intake and will have an excavation section of 5.50 m x 2.80 m and concrete lining to form the span of the gate and host the ventilation ducts, the fixed parts and their guides. At the end of the Segment, a

5.70 m. long transition will be made, to pass from the rectangular section to the portal section of Segment N° 2.

Segment N° 2 will have a portal excavation section, concrete lining with interior dimensions of 4.00 m x 4.00 m and a length of 195.00 m with a slope of 0.0277 to the inferior gallery of the curtain and of 0.052 to the exit portal of the tunnel.

Segment N° 3 will initiate by a transition from the portal section to an armored circular section 5.70 m long and will have the same 0.052 slope of this Section. The armored section will be 35.00 m long and will have a 3.70 m interior diameter as of the tunnel exit portal; this pipeline will lie in a 4.00 m x 4.00 m portal section and will be packed with simple concrete.

Pressure Pipeline

The section of the exterior pressure pipeline that will be 40 m long, is delimited by Segment Nº 3 (exit portal) and the Engine building. This section will be placed in a ditch that will be excavated for such purpose, placing the metallic pipeline, which will have two vertical elbows and two holders and the inclined section of the pipeline will be concrete lined. The entrance to the Engine Building will present a reduction to connect to the butterfly valve that will be installed before the entrance to the turbine.

Engine Building (see work plan 2)

The project contemplates a building of reinforced concrete with metallic rods in the ceiling and beam – track of the travelling crane, set at Elev. 16.00 m and with the roof at Elev. 49.25 m. The main body of this building will be 15.00 m wide and 25.00 m long.

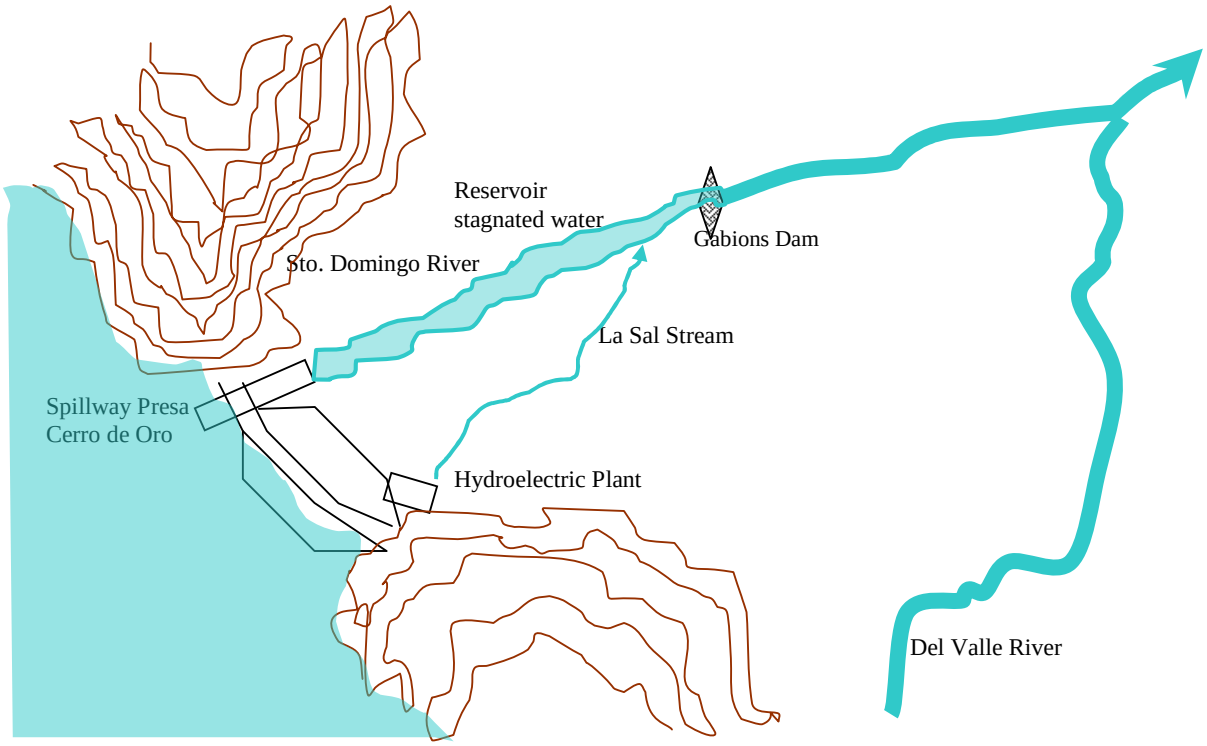
The dimensions of the engine building will be reviewed and defined by the Contractor in charge of the electro-mechanic equipment and civil work, since they are subject to the particular dimensions of each manufacturer and the criteria of the Contractor for the location of the equipment inside the engine building

Outlet channel

To return the water to the La Sal stream, a 55.30 m long and 16.00 m high concrete-lined tank has been contemplated at the outlet of the aspiration tube of the turbine, which will allow discharging the turbined water at Elev. 26.00 m through a control section. Immediately after such tank, a 17.00 m wide and 50 m long, open surface excavated channel was projected (see work plan 3).

Additionally, the integration of the flow of water of the La Sal stream to the Santo Domingo River will be carried out through gabions wall at the riverbed of the Santo Domingo River immediately after the place where the two rivers meet. The purpose of this work will be to distribute the discharge from the stream and to maintain a constant water level in the area between the dam discharge structure and the junction of the La Sal stream and the Santo Domingo River, thus preserving the environmental conditions. The dam in the section of the Santo Domingo River will be built on three levels that will result in a maximum height of

2 m and width of 84 m. Such height in the gabions wall will prevent water from entering the riverbed of the stream, returning the water to the engine building in case a discharge in the spillway of the dam occurs.



In the construction, due to the water level that could exist in the stream mainly during the rainy season, a small cofferdam will be placed at the end of the discharge channel. It will be made with the same material resulting from the excavation of the channel and when the construction work concludes, it will be removed to be used as part of the levee of the channeling.

Access road

Although the road to the site already exists, it will be necessary to make the respective and definitive derivation to the engine building and substation to avoid interrupting transit towards the dam curtain during the operation stage. This work will consist of developing the access road that reaches the town of Reyes, adapting a curve that will surround the substation and reach the site where the engine building will be installed. The access will preferably be a treated unpaved road, without applying an asphalt cover to allow humidity absorption into the ground. The access road will be 5 m wide and 50 m long and will have its respective gutter and sewer for the control and deviation of leaks.

Electro-mechanic Equipment

A “Francis” type turbine with the following characteristics will be installed:

Design Power	10.8 MW	Design Outflow	40.00 m^3/s
Minimum Power	8.6 MW	Minimum Outflow	37.30 m^3/s
Maximum Power	14.8 MW	Maximum Outflow	50.00 m^3/s

Runner

Francis type (cast in a single stainless steel piece, as well as mobile blades and discharge ring as per standard ASTM-A743CA6NM)

Admission Valve

A butterfly valve will be installed. Such valve will allow the regulation of the input flow into the turbine and will serve to provide maintenance to the turbine generator group and avoid the pieces from the turbine distributor from wearing out, as well as filtrations in the blades when the turbine is not operating. It will have a sliding joint, bypass, aeration valve, hydraulic servomotors, closing counterweight and electric switchboards for its operation.

Generator

The generator will be tri-phasic, with a vertical axis operated by the turbine, with nominal velocity of 200rpm, a nominal tension of 13 .8KV a 60 Hz and nominal power of 15,331KVA.

Power transformer

There will be a three-phase 16MVA transformer, insulation in oil, with two windings for outdoor set up with nominal frequency of 60 Hz; nominal tension in the high-tension winding H 115,000 V and in the low tension winding X 13,800 V.; star connection in the high-tension winding and delta connection in the low tension winding.

Control System

The central will have a control system that will allow local start-up from both the back-up switchboard and automatic logical programmable unit controller, or otherwise, remote start-up from the monitoring room in an automatic fashion.

The system will be composed of two automated controls based on PLC. The first one will handle the generation unit and the second the auxiliary services of the central and the substation. It will have a manual back-up switchboard with wired logic and its respective control station with CPU and support peripherals. The system will include the programming equipment and failures and events recorder.

Emergency plant

This plant will be composed of a diesel motor connected to an alternator with indirect excitation and automatic tension regulator of 25kVA, 60Hz, 480 V 3 phases and will serve to ensure the electric supply for the services pertaining to the plant and the auxiliary services.

Electric Substation

It will be located on a platform built partly with material from the excavation, covering an approximate surface of 700 m^2, next to one side of the engine building.

A conventional type substation will be built to elevate the voltage coming from the hydroelectric central from 13.8KV to 115 KV, which will be directed towards the transmission line of the project. The control thereof will be handled from the hydroelectric central.

The elements that make up the equipment of the substation will be represented by the following:

Power Breakers

It will have 2 structural installation type and outdoor class power breakers, nominal current of 1250 Amp. and frequency of 60 Hz. The breakers will be tri-polar and have SF6 Sulfur Hexafluoride gas based extinguisher for a 115,000V system

Disconnecting Blades

It will have ring type disconnecting blades with vertical opening and outdoor installation, 3 of which will be without blades and grounding mechanisms, one with blades and grounding mechanism and 4 tri-polar with and without blades and grounding mechanisms; nominal current and tension will be 123 KV and 1250 Amp respectively.

Inductive potential and current transformers

6 winding type current transformers will be required. Such transformers shall have the following characteristics: outdoor service and 115 KV system nominal tension, transformation ratio 200: 5/5/5/5/A, installation on support column.

In addition, four inductive and capacitive potential transformers will be required. Such transformers shall have the following characteristics: outdoor service 115 KV system nominal tension, transformation ratio 600/1000:1, installation on support column, star connection and 200VA of total simultaneous charge in secondary windings.

Zinc Oxide Surge Arresters

Six Zinc Oxide station type surge arresters will be installed, having a designation tension of 96 KV, for a 115 KV system and outdoor service, for a nominal tension of 96KV rcm, with a protection level of maneuver transitory over-tension in wave breaker of 3000 Amp 182-189 KV Crest and protection level front of impulse wave 230-307 KV Crest.

Ground System

The substation will have the necessary elements for the supplementation of the foundation structure through the grounding system, which will be composed of a series of electrodes or cooperweld rods buried at the necessary depth to eliminate the resistivity of the ground installation. Additionally, a grid or net of buried conductors will be installed, to make the ground connection of the parts of the installation or equipment through compression connectors that may be welded. The cable that will form the exterior perimeter of the net will be placed in a way that encloses the entire area of the equipment of the substation. The net will be made of cables placed parallel and perpendicularly, with adequate spacing with respect to the restistivity of the land forming a mesh. The cables that will form the net will be placed along the lines of the structures or equipment, to facilitate the connection thereof. At each crossing the net conductors will be rigidly united and in the proper points, they will be connected to ground electrodes with a minimum length of 2.40 m, vertically fastened with their respective registries, considering the vertexes of the net.

The substation will have a chain link fencing supported by 2.00 m high galvanized tubes in the entire perimeter, with an entrance for personnel and a minimum distance from the equipment of 4.00 m.

Transmission line

The line will be 10.5 kilometers long and will have a 25-meter right of way, double circuit and one conductor per phase. It will begin at the project substation and interconnect with the Benito Juárez substation in the town of Sebastopol. It will be supported by approximately 22 towers and will have a transmission capacity of 115,000 V. The area used by the foundations in each of the towers will be around 64m^2 considering the concrete cubes that constitute the base of the structure. The line will have the following features:

Aluminum conductor with steel core Type 695 KCM, ACSR.
Galvanized steel guard cable type 7#8 AAS.
U70 BS, U70 BL type tempered glass insulators.
Single suspension chains 115 KV, Aluminum alloy steel.
Single anchoring chains 115 KV, Aluminum alloy steel
Support structures (towers) Types TAS2P, TAR2P30
Insulated foundation footings
Ground system with 5/8 rods and Nº 2 cooperweld cable
Extra-galvanized steel to form structures in towers

The cathode protection contemplated, depending on the ground resistivity of the area, will be carried out through the installation of aluminum anodes and copperweld rods applying

Cadwell welds in the unions of the structures to be protected. The anode and cathode cabling will have a black polyethylene, high molecular weight type HMWPE double lining.

The vegetation treatment depending on the project stage, will consider the following:

For the construction stage in the forest areas, the arborous and shrub-like vegetation will be eliminated where the foundation structures of the towers will be placed. The trees that due to their development characteristics, surpass the security height within the right of way will also be eliminated, considering for such purpose the lower section of the arch formed by the cables already installed. The elimination of the vegetation is intended to be carried out from the axis of the right of way to the edges and from the intermediate point of the section towards the ends, so that the direction of the teardown occurs only within the intended area, and to prevent any impact to the vegetation in nearby surfaces. The foregoing is contemplated since there is no intent to use the vegetation and the cutting and chopping of the material obtained may take place on site, without transferring it outside the work area, which provides additional protection to the site's soil.

For the operation stage, the vegetation growth will be checked mainly in the risk areas and the necessary trimmings and pruning in the right of way will be carried out. This, like in the construction stage, will consider the elimination of particular trees that could affect the operation of the line when they grow, but the development of herbaceous vegetation will be allowed. Considering the humidity and quick development of vegetation such as climbers and creeping plants at the project site, such plants will be cut in the area where the towers are located and in the sections of the right of way where the arch of the line reaches its lowest points with respect to the topographic elevation of the land.

Construction Process

Conduction Tunnel

The construction of the pressure conduction will begin with the necessary rock treatments and a perimetral waterproofing injections screen to the porthole of the gate. Next, the excavation will be carried out, the porthole lined with the fixed parts for the gate, and excavation of Section N ° 1 of the Tunnel will begin.

In the second stage, excavation will be conducted in the frontal rock zone that remains over the intake structure until reaching a platform, approximately at elevation 56.00 m and an enclosure will be made until an elevation of 43.00 m is reached to build the intake structure in dry conditions and install the metal screens thereof. If necessary, a cofferdam will be placed on the platform at elevation 56.00 m, which allows more time for the construction of the intake structure, depending on the water levels of the reservoir. In this stage, the concrete lining of conduction Section N° 1 and the treatments of the embankments of the water intake channel of the intake structure will also be carried out.

The third stage will consist of removing the block of rock in front of the water intake channel from the intake structure to allow the flow of water from the reservoir to the back of the porthole and installing the gate that will provide security to the rest of the work.

During the fourth stage, the conduction tunnel will be built, starting with the existing portal of the inspection gallery and continuing upstream until reaching the porthole of the gate.

The crossing of the tunnel over the inspection gallery will be carried out with the necessary precautions, without using explosives and reinforcing the area with an injection screen.

Engine building and substation

Excavation will be carried out in the trench of the pressure pipeline, starting from the lowest point of the land, using a backhoe drill with breaking hammer and supported by a front loader to extract material.

Next, the trench and entrance portal of the tunnel will be made to host the pressure pipeline and the general platform to the point where the underground part of the engine building ends. As the preparation of this section and the access thereto progresses, the excavation of the engine building will be carried out up to the basis of the foundation, as well as of counter-pressure tank thereof.

The excavation work of the canal will continue after the counter-pressure tank, as well as the parallel construction activities of a cofferdam downstream from the canal delivery, which will later serve as levee of the outlet channel.

The rods will be set up and the concrete cast of the general foundations of the engine building, drainage well and walls will be applied to allow the assembly and covering work of the elements of the elbow and vacuum tube. Thereafter, the surrounding cavities will be filled to facilitate the ensuing concrete casting work in the higher sections.

The concrete casting of the attachment and anchoring of the entrance of the pressure pipeline as well as of the terminal section of the pipe will be carried out, to proceed with the assembly of the final section of the pipe and “close” the building.

The concrete casting of the counter-pressure tank will follow, including the foundations, central and lateral walls and ramp. At this time, the aspiration elbow will be set up. With this, the concrete casting embedding of the elbow and aspiration tube will be applied, as well as the prior covering and iron works, etc.

After the definite height of the area of the discharge channel is obtained, the work for the La Sal stream will begin, where in accordance with the topographic profile, the sediment will be extracted in the parts of the riverbed where there are water stagnations. Meanwhile, the sediment removal and re-adaptation work of the section in the two tracts where the profile reaches its greatest height will begin and excavation will advance n the same riverbed of the stream to refine the embankments and give the inclination proportion that the project requires. As the excavation is carried out, the material will be deposited at the edge of the canal and prepared on site or placed in a dump truck to be transported to the edge of the riverbed where the height of the levee has the lowest points of the topographic profile.

The steel assembly work and the respective concrete casting of the carcass of the building will continue until the level of the surface is reached, while the finishing concrete work of the tank and discharge channel are being carried out.

The application of fillings against the engine building and sides of the counter-pressure tank that condition the foundation of the unit will continue. The filling and arrangement of

the material of the discharge channel will continue to form the definitive access as well as the substation. The concrete casting will follow in the footings and floor of the unit that will serve as foundation to set up the structure of the unit and crane bridge, to proceed to set up the crane bridge and the minimum components of the metallic structure of the unit.

Meanwhile, the cage assembly work for the arrangement of the gabions will be carried out, where the base of the canal will be prepared extracting the sediment and the floor will be configured for the placement and subsequent filling thereof. In accordance with the conditions of the site, construction of the gabions will be attempted without making additional preparations and to avoid the obstruction of water during the work.

Once the preparation of the civil work concludes, the set up of the electro-mechanic equipment, integrated by the spiral, pre-distributor tube valve, adjustment clamps, generator, etc., will be carried out.

After the arrangement and leveling of the material in the platform where the substation will be located is completed, the foundations and ground system for the concrete casting of the footings of the walls, oil traps, electric conduits, channeling, drainage, etc. will be prepared. Thereafter, a 20 cm layer of gravel will be applied in the entire area; afterwards the grounding system will be complemented and the transformers, ties, insulators and cabling will be installed.

Last, the interior concretes and details of the unit such as enclosures, set up aids, final cleaning and painting, exterior finishes including from the water tank for the bathrooms to the control room, surfaces in access and walk ways, wire fencing, general cleaning etc., will be completed

Transmission line

As a first step, the topographic land survey will be carried out to proceed to determine the points where the structures will be located and to verify the most protruding sections of the bar on site.

After the location is verified and the markings or signs of each structure have been installed, trenches will be opened to form the section to lay down the foundations of the supporting structures and they will be located and dimensioned in accordance with the project specifications. Thereafter, a compacted concrete layer with a minimum thickness of 10 cm will be placed in the foundations layout to level the structure.

Thereafter, the bar framework assembly will be carried out to form the core of the dice and the foundation concrete will be cast. During the casting, the cathode protection and grounding system will be installed by introducing copperweld bars in the floor and laying the copperweld wire at a depth of 50 cm between the foundation footings, which will be connected to each one of the structure foots.

After the leveling of each of the foundation structures has been reviewed and approved, the ground around each die will be filled and compacted with the material obtained from the excavation and the top body of the structure will be set up, finishing the assembly of the towers by sections on site.

Thereafter, the covering of towers will be performed, which includes placing chains, hardware, insulators and complements, as well as laying, placing and tensing the guard cable. As a final activity, the accessories and fittings to fasten the insulating chains will be set up and the laying and tensing of the conductor cable with its respective jointing, bridges and flashing in the towers that require it will be carried out.

II.2.5 Operation and maintenance stage

Pursuant to the schedules presented in chapter VIII, the activities pertaining to the operation stage mainly consist of power generation through the turbine-generator set with all that the transformation and transmission of current flow to the national distribution grid represents, as well as the periodic repair and maintenance activities of the electro mechanic equipment. Therefore, during this stage, no actions that could cause further impact to the environment will be carried out.

The activities relating to the operation and maintenance of the project will include; power generation, preventive maintenance, corrective maintenance and equipment replacement.

Power Generation

The generation of power will be governed by the operation policies both of the dam and of the energy flow emission to the distribution network. This means that the company is subject to authorization from the Federal Electricity Commission to transmit the electricity in accordance with a delivery protocol, for which the periods of entry into the system and the corresponding notices or disconnections for the entry of the flow into the network are scheduled in advance. In addition, the discharge volume and the water level of the dam are conditional on the indications of the National Water Commission based on its supply program, uses and the operation of the reservoir in the Cerro de Oro dam, for which the use of the resource in the hydro-electric plant will maintain strict management control.

It is important to point out that in the discharge outlet of the hydroelectric central, there will be a parshall flume, which will allow keeping a continuous record of turbinated water flow, as well as the registry meters the CFE requires to determine the amount of energy the central generates.

In accordance with the foregoing, normal operation of the plant is carried out as follows:

The availability of the resource is verified daily with the authorities in charge of the National Water Commission, in order to plan in accordance with their schedule the operation periods of the central. Communication is established with the National Energy Control Center (Centro *Nacional de Control de Energía* “CENACE”) of CFE to indicate the periods of entry into the distribution network and obtain the relevant disconnections. Afterwards, the electro-mechanical equipment is prepared to begin the synchronization of the central with the network and turbination begins to reach the required speed and maintain the power load for release into the system. Once the load has been reached and the equipment has been synchronized, a signal is sent through the control system to the substation breakers to make the respective connection and this way, transmit the power flow up to the interconnection with the distribution network.

As the power is generated, the water entry and discharge process will work as follows:

The water flow coming from the dam enters the conduction tunnel through the water intake and is directed to the section of the pressure pipeline, where, as its name indicates, greater water pressure is generated due to the reduction of the diameter of the pipeline with respect to the diameter of the tunnel, thus providing greater force with less water volume towards the access to the engine building. Therefore, when opening the butterfly valve, the flow enters the spiral pipeline increasing its pressure even more due to the decrease in the pipeline's diameter, with which a pressure jet circulates at this point that pushes the blades of the turbine-generator system, passing afterwards through the aspiration elbow until reaching the counter-pressure tank, where the turbulence and speed with which the water is released is broken to reach here a minimum speed regimen. Once water is discharged in the counter-pressure tank and its outlet channel, water will be released towards the La Sal stream, which will join the Santo Domingo River downstream. This outflow when it joins the river, with the help of the gabions dam, will create a pool of water and a sufficient level to maintain the environmental conditions in the area between the dam discharge structure and the place where the La Sal stream and the Santo Domingo River meet.

When movement is produced in the turbine-generator complex power generation will begin. This activity will be monitored automatically or manually through the control systems with the support of the central's personnel, which is concentrated in the control room and platform where the electro-mechanical equipment is distributed and located.

Preventive Maintenance

Preventive maintenance actions will consist of monitoring the wear and tear of journal bearings and turbine runner, cleaning of salts and scaling in blades, verification of gaps in sealing sections, operation tests in regulation, control refrigeration, lubrication, heating, filters and insulation systems.

For the water entry section, the condition of the components of the closing valve, such as seals, bearings, connectors, hydraulic actuators, flanges and joints will be checked. In the water intake and outlet plugs of the counter pressure tank the rolling surfaces will be checked to ensure they are in proper condition and the raising equipment will be cleaned and lubricated.

The generator and its complementary equipment will be constantly and instantly monitored by the control system, which will present both in the central switchboards and in the computers any failures that could occur. On the other hand and in addition to the automated testing process of the control system, a monthly independent inspection of each of the systems and equipment will be performed to ensure proper operation of the components. Major inspections will be performed during the maintenance of the mechanical equipment of the turbine and will be based on functions related with the wear and tear of journal bearings, hydraulic systems sealing, insulation tests and their respective response verifications in control systems.

For the transformers, the activities will focus in the inspection of the quantity and quality of the dielectric of each transformer, as well as the status of the pressure in the system to detect any leaks. The support structures and breaker equipment will be inspected in the

substation area to confirm proper functioning during operation. During the rainy season, the equipment grounding, lightning arrester and backup systems will be constantly verified to ensure they are in good condition and to confirm their connections are firm for correct operation of the equipment.

With regard to the transmission line, in addition to the auto-testing the control system provides, bi-annual rounds will be carried out to physically review the structures, cabling, and support. If any irregularity is found, repairs will be performed as necessary.

Technologies that will be used, especially those having a direct relationship with the emission and control of liquid, solid or gaseous waste.

In the equipment area, the plant will have a containment ditch that may hold any lubricating oil leak outside this area to avoid water pollution. In addition, there will be a stock of absorbing worms made with highly porous materials to collect liquids in case of any accidental spill. The lower floor of the engine building will have liquid reception tanks, wherein any liquid volume may be contained, in case any water spill containing oil, grease or any other pollutant occurs, to subsequently perform the necessary cleaning and/or treatment for a safe release outside the facility, with which any discharge of pollutants outside the engine building will be prevented.

As explained in the construction stage section, there will be a hazardous waste storehouse to store used lubricating oils product of the preventive maintenance and solid materials such as burlap, rags and papers regularly used in maintenance activities that become impregnated with such substances. These materials will be treated in accordance with the applicable legislation and sent to recycling and/or final disposal with companies duly authorized by SEMARNAT.

In connection with the maintenance of the transformers, the insulating oil will be subject to a physical-chemical analysis of gas chromatography and absence of polychlorinated biphenyls at the start of operations to verify the contents and quality of the oil and the pressure of Nitrogen gas will be periodically monitored to have optimum functioning of this equipment. Once the quality levels of the dielectric oil decrease, it will be extracted from the transformer tank and sent to recycling. This activity considering the manufacturers' specifications is contemplated during an approximate period of 10 years.

The control equipment of the central will also have an emergency plant with a group of gel batteries or accumulators to obtain a constant supply of backup power, which will avoid gas and pollutant emissions into the environment.

It is important to point out that as part of the security functions of the plant, the generation equipment will have an oil lubrication system that maintains a constant record of the pressure and volume of the liquid, causing a general automatic shutdown in case of deficiencies or losses thereof, which provides, in addition to security in the operation of equipment, environmental protection by preventing leaks that could pollute water and soil. In addition, the turbine break system will have an extraction fan and its respective filters to achieve its purposes, including avoiding the dispersion of dust and particulate material into the generation equipment and work environment and permitting maintenance at greater intervals between events.

General description of the type of services provided in the facilities.

The hydroelectric central will have sanitary services for the plant workers where a prefabricated septic tank will be used to dispose of sanitary residues, which will be connected through PVC piping to the drainage system of the bathroom, in order to avoid the flow of residues to the riverbed.

The project will have electric power supply for lighting, both inside and outside the engine building. The scope of the power will cover the access and area of the substation for proper surveillance and control of the facilities.

A satellite communication system will be installed to cover telephone and internet services through which the main communication activities will be carried out to control the continuous surveillance and operation activities of the systems. The installation of this communication system will only require setting up a satellite dish and the complementary equipment to decode the signal and for backups, cabling inside the engine building and any peripherals required for connection to the computer system that will be installed in the control room.

As indicated for the components of the central, there will be an emergency plant that will support the excitation systems of the central in case the external energy supply fails, as well as for the auxiliary services of the hydroelectric plant.

The central will have an appropriate fire extinguisher system, which will be integrated by CO_2 gas and chemical powder tanks, together with a group of sensors that will activate a pressure system that is interconnected with pipelines from the tanks to the equipment for immediate fire extinguishment. In addition, there will be portable extinguisher cylinders in the access points of each floor and at the exit of the control room.

Types of repairs to systems, equipment, etc;

The activities consist mainly of equipment inspection and the replacement of parts and components as necessary in each case. The waste generated during repairs will consist mainly of paper and rags or burlaps impregnated with grease, oil and solvents that will be stored in well-identified containers to subsequently send them for treatment and final disposal.

Corrective maintenance repairs will consist of the replacement of worn or fissured parts, rectification of friction and bearing surfaces, substitution of seals and operation verification. To repair the equipment, the gate or plug of the water intake of the tunnel will be closed and the entire conduction path will be inspected as a routine measure.

For maintenance activities, manual tools will be used and to move heavy equipment within the engine building, a crane will be installed from the construction of the unit for support, for which the use of heavy m achinery or additional construction will not be required. Likewise, preventive and corrective maintenance will be performed in the transmission line, using harnesses and manual tools, as well as a vehicle to transport the materials and tools to the site where the activity may be required.

During the maintenance of the transmission line, the growth of vines at the bases of the towers will be especially monitored, due to the corrosive effect the plants could have upon contact with the structure, which, in spite of being made of extra-galvanized steel and having the respective cathode protection, could suffer certain deterioration if acids are generated due to the humidity and the substances the plants release. For this reason, bi-annual rounds will be conducted along the path of the line and the corresponding pruning will be carried out around the bases using machetes, cutters, scythes, and if necessary, manual brush cutters to perform the task in less time. In the area of the engine building and the substation, the gutters and downspouts will be cleaned for a proper discharge and routing of rainwater. Wild plants will be manually pruned, trimmed, and removed in the sections close to the civil work. In this regard and due to the humidity conditions of the project site, these activities are expected to be carried out bi-annually, but will be performed as often as necessary.

Chapter VIII presents the Gantt diagrams with the activities schedule for the operation stage.

II.2.6 Description of the work associated with the project

Because the work site is located close to roads and areas where services are available, no associated work will be necessary, except for the interconnection of the transmission line, for which it is advisable to indicate that it will be carried out in an existing substation (E.S. Benito Juárez). The connection of the project line to the national distribution grid will be made adapting the available connections of the CFE network, for which the instructions such organization may give from time to time will be followed.

Because of the foregoing, it is deemed that such work will not cause any impact or effect.

II.2.7 Site Vacating Stage

Although the period of useful life estimated for the project is 50 years and could be considered as permanent, below are the rehabilitation and restoration measures that will be applied upon vacating the site:

Infrastructure Dismantling

As a first step, the electro-mechanical equipment will be dismantled in the hydroelectric central and all the electric and mechanical components will be removed to be able to clear the engine building. After the equipment has been removed, the handrails, stairs and metallic structures located inside the building will be dismantled to proceed to their demolition. To take the adequate measures, the relevant permit from the local authority for the transportation and final disposal of the product of the demolition will be requested in advance.

It is likely the demolition may not be carried out since the material resulting from the building would have to either be sent to another site for final disposal or used to fill the hole

where the engine building was located; however, the action has been considered in accordance with the following procedure:

The support and anchoring structure of the superior unit of the engine building will be demolished and a cofferdam at the end of the outlet channel will be enabled in order for the same structure to serve as access to the lower part of the building.

First, the inferior part of the building, where the aspiration tube and the set up section of the turbine will be demolished. The top part of the building will follow to favor the concrete falling into the interior of the walls and through the access available through the outlet channel and the demolished material will be removed to transport it to the final disposal site. It should be pointed out that the access point used during the operation of the central, as well as the levee of the outlet channel, will be used at all times, for which no new paths or roads would be opened.

Throughout the course of the demolition, the concrete blocks will be fractured and the structural profiles and bars forming the frame of the structure will be removed to gather them next to the side of the access point and send them for sale for recycling.

In the platform assigned to the substation and the foundations of the transmission towers, the electrical equipment thereof and the layer of gravel would be removed to leave the foundations and ground network open, provided the Federal government is not interested in them to maintain the power distribution infrastructure in this area.

The foundation structures will be removed to demolish them by sections and both the frame bars and the resulting copper cable will be selected to send them for sale and recycling. After the area has been vacated, the material of the platform will be distributed in the surfaces of the engine building, outlet channel and trench of the pressure pipeline, since as mentioned above, such material was originally extracted from these sites.

Land cleaning, waste disposal and surface rehabilitation

During the demolition of structures, the resulting material will be simultaneously removed and sent to the authorized disposal site to clean the site as quickly as possible. The generation of domestic or hazardous waste is not contemplated during such work, since the main activities will be demolition and extraction of materials.

As the surfaces are released, the land will be integrated using the material of the substation’s platform, extracting it from the site and arranging it in the trench where the pressure pipeline was located, in the engine building and its outlet channel, leveling the surface in the interior of the polygon and leaving a small levee around its perimeter. This way, rainwater will infiltrate towards the center and prevent the erosion of material. Last, the material that formed the levee of the outlet channel will be removed, spreading it throughout the surface of the property.

After the surfaces are integrated, a tractor with a riper, or if the material allows it, a plow to make grooves will be run over such surfaces, which will allow a more efficient water intake and the growth of vegetation in the short term.

It is advisable to set up a kind of levee before the section of the outlet channel of the dam during the vacating stage, since this will allow, at a given time, detaining any material drag that could occur during the rainy season. The above considering that the surface will not have a vegetation layer for some time.

Reforestation Activities

To supplement the surface rehabilitation activities during the vacating stage, trees of the region and species of interest are intended to be planted at the sites that do not have any vegetation.

The following are being considered among the species to be used for the reforestation activities, yet final selection will depend on availability and the production of regional nurseries.

Species	Common Name
Ceiba pentandra	Ceiba
Brosimum alicastrum	Ramón
Astronium graveolens	Jobillo, palo de cera, gateado
Manilkara zapota	Zapote, chicozapote
Protium copal	Copal
Guarea glabra	Cedrillo
Mastichodendron Capiri	Tempisque
Bursera simaruba	Cohuite, palo mulato, palo jiote
Aphananthe monoica	Coquito, palo de aguila
Hampea integerrima	Jonote, cucharo, tecolixtle
Swietenia macrophylla	Mahogany
Cedrela odorata	Red Cedar

The planting method will be in accordance with the conditions of the land; planting will be carried out in squares where the land is even and in staggered form where the land is inclined. On the other hand, the sowing will be carried out intercalating the species to yield a better distribution of the vegetable material.

It is important to point out that because it is difficult to predict with precision the characteristics of the surroundings of the location of the work during the vacating stage, below is a plan of activities and studies that shall be considered upon the termination of the useful life of the project.

Action plan to follow

- Prepare a diagnosis of the site to establish the measures that will be taken.

The items the diagnosis must consider will be:

Information relating to the physical and biological characteristics of the site.
Demographic and socio-economic information.
Historic Information.
Comparison of data on historic vs. current conditions.
Review and analysis of legislation relating to the activities to be carried out.
Analysis of problems and evaluation of tendencies of the deterioration or conservation conditions of resources existing on site.

Measures proposed for the control or restoration of the site in order of importance.

- Make a financial plan to direct the actions towards the most urgent problems in order of priority.

The plan will contemplate all the measures proposed in the diagnosis and will include in its costs:

Materials and supplies.
Labor.
Required equipment and tools.
External Consulting.
Filings and payment of duties with authorities.
Schedules and stages in which the measures will taken.

- Update and adjust as necessary, the series of preventive and remedial indications for the actions to be applied in dismantling the facilities and restoring the site.

In accordance with governing legislation, the established procedures will be reviewed from time to time and applied based on the provisions thereof. In addition, the integration of the following points will be fundamental, which must invariably be taken into account and applied.

Management and disposal of municipal waste.
Management and disposal of hazardous waste.
Personnel control during dismantling.
Resource protection.
Recovery and treatment of contaminated soil.
Machinery and equipment control and maintenance.

- Expected results and perspectives.

The intended goals of the application of the program will be presented, as well as a breakdown of the expected results considering each of the measures proposed, and they will be established as follows:

List of concepts and goals
Estimated progress schedule
Expense schedule
Details of activities and scope
Areas involved and [parties] responsible for execution

- Report of final site conditions.

The report must consider both the actions contemplated in the program and those that were gradually integrated for feedback. Such report must include the following:

List of program concepts and detailed description of the actions carried out.
Comparison of the schedule of physical-financial progress and analysis of factors that influenced the delay or early termination thereof.
Description of the conditions of the site and assessment of the alternatives taken to reach the intended goals.
Cost analysis depending on the alternatives taken.
Description of factors that will influence the preservation or deterioration of the conditions upon termination of the program.
Proposed measures and actions

- Graphic report, including a comparison of the conditions of the site prior to construction, conditions at the end of the useful life and conditions after restoration.

Historic photographs taking as a basis the initial construction period of the project, trying to integrate a five-year record until termination of the useful life.

Photographs showing the gradual recovery of the restored sites.

Drawings of the location of the restored areas making an overlay of the sites with and without the work.

II.2.8 Use of Explosives

Through the use of explosives with the controlled blasting technique, the water intake channel will be dug for the intake structure and the tunnel in the solid rock section of the slope of the curtain.

In the engine building and the outlet channel, due to the geological nature, a considerable part of the excavations will be carried out using explosives, moving the material with a caterpillar tractor, caterpillar excavators and using dump trucks.

The necessary filings will be made with the corresponding authorities in order to comply with the terms of applicable legislation.

The selection of the type of explosives to be used will be in accordance with the characteristics of the rock, the site conditions and the disposal requirements of the excavated material produced, for which dense explosives that allow a greater detonation speed and finer fragmentation of rock material will be preferred. In turn, and due to the humidity conditions in the site, such gel type explosive that has a greater resistance to water will be used. Additionally ,and due to the kind of work that will be carried out, the calculation of the charges used will be analyzed and verified in order for the explosives to release only the necessary pressure and make the blasts safely and in a controlled manner.

This way, and anticipating the work to be performed, to obtain the desired material fragmentation and reduce the vibration levels, more boreholes will be made for the blasts and reducing the ratio charge/delay will be contemplated. The delay of the blasts in this case will imply the existence of an interference in the borders of the blast, which will help control the peak frequencies to the exterior points and the derivation of the pressure force to the interior thereof, causing a greater degree of rock fracturing.

The amount of explosives to be used is calculated at approximately 0.3 to 0.6 kg per cubic meter of material. However, this estimate can vary depending on the characteristics of the rock materials and the conditions of the excavation.

II.2.9 Generation, management and disposal of solid and liquid waste and atmosphere emissions

Site preparation and construction stages

Domestic and recyclable solid waste

Domestic solid waste consisting mainly of paper, cardboard and plastic wrappers, plastic and glass bottles and aluminum cans will be generated. To concentrate such waste bins and containers with lids are planned to be installed to collect and temporarily store such waste. Waste will be collected in the different areas of the project, such as workshops, storage areas, offices and work fronts, where two containers will be placed: one to deposit recyclable or inorganic waste and another for organic waste such as food waste and biodegradable solids.

Considering the population the project may have, waste will be stored for one week, for which the bins will removed and transported to the disposal site at the end of each work week, tentatively on Saturdays. After the bins are sent away, they will be returned to the different designated areas to continue collecting waste. In connection with such waste, the corresponding filings and duty payments will be made to the municipal authority, in order to transport it each week to the town of Tuxtepec, concentrate it in the official disposal site

of the municipality and avoid storing the waste in the area of the hydroelectric central.(see map infrastructure and waste disposal services)

The recyclable waste produced will be composed mainly of paper sacks, cardboard, bottles or containers, fragments of bars, pipes, frames and other metallic materials left over from the construction activities of the civil work. Such materials, like domestic waste, will be stored in containers located on the side of the workshops and in the construction area of the civil work to avoid dispersion. The frequency of collection of such materials to send them for sale and/or recycling, will depend on the volume generated, since on one hand, it will be necessary to maintain sufficient space for the circulation of equipment and personnel, and on the other hand, the transportation of the waste must be cost-effective for the contractor that provides such service. Based on the experience in similar projects, the estimated time to collect such waste is 6 months as of the formal construction of the edifications.

Hazardous Waste

Hazardous waste generated will include used oils, filters, materials and containers impregnated with solvents, fuels and lubricants resulting from the preventive maintenance of machinery and equipment used in the construction of the project. To control such waste, a sufficient number of containers will be kept on site to store any liquids and solids generated. Liquids will be stored in containers with sealed covers and a factory drainage cap to secure their contents and minimize risks of accidental spills and during the use thereof. 10% of the container's volume will be kept free to allow the compression of any gases that could be generated inside. For solid waste, containers will be adapted with a removable lid to facilitate their use. All such containers will have a sign on the outside specifying the kind of waste that should be deposited in each one, to avoid any improper use thereof and ensure they will be used exclusively for hazardous waste.

As indicated above in the description of the temporary activities and work of the project and to ensure any maintenance waste generated does not cause any impact to the site due to soil pollution, a special surface will be prepared to store used oils and solid materials until they are sent for recycling or final disposal with authorized companies. The floor of such surface will be waterproof and have a tank to contain accidental spills. In addition, a ditch or curb will be made around the base of the warehouse to avoid any leaks of pollutants outside or rainwater filtrations inside the warehouse. The warehouse will be covered to avoid sun exposure of the containers and will have the respective materials and auxiliary equipment for fire control, such as portable extinguishers and sand container.

Such waste will be periodically sent for recycling and/or final disposal, taking into account the provisions of the applicable legislation. The temporary storage of such waste will be limited at all times to a maximum of 6 months.

The classification of the waste generated pursuant to NOM-052-SEMARNAT-1993 and the potential generation volume during the construction stage are indicated in the following table.

Waste generation- construction stage

Type of Waste	CRETIB Code	Likely Generated Volume (monthly)
USED LUBRICATING OILS. (RPNE1.1/03)	(T,I)	250 l
AUTOMOTIVE MAINTENANCE SOLIDS	(T,I)	50 kg

The volume was calculated considering during one month the preventive service of 6 machines with carter capacity of 41.6 lt each.

Atmospheric Emissions

Atmospheric emissions generated in the project will consist of dust resulting from excavations in dry material, gases and particles produced by the use of machinery and equipment with internal combustion motors. The levels of pollutants will be controlled through preventive maintenance of the machinery in accordance with manufacturers' specifications, as well as noise levels, which will be controlled as of the arrival of the machinery to the site, verifying that the respective silencers are included and monitoring that the tightness of the systems is not lost during construction. Below is a table of the estimated data of emissions generated with the equipment and machinery related with the construction.

Machinery and equipment noise emission level

Equipment	Approx. Daily Hours of Work	Decibels emitted*	Atmospheric emissions	Fuel Type
Compressor	8	62.6-72.5 (A) 7m	N.D.	Diesel
Pneumatic Perforator	6	102-111 (A) 3m	N.A.	Compressed Air
Backhoe drill	6	84-93 (A) 3m	N.D.	Diesel
Tractor	4	87-102 (A)15m	N.D.	Diesel
Dump truck	8	88 (A) 15m	Opacity 1.99 m-1	Diesel
Pickup	5	72 (A) 15m	10ppm HC .1 CO	Gasoline
Tank truck 10,000lt	4	72 (A) 15m	Opacity 1.99 m-1	Diesel
Bulldozer	4	94 (A) 15m	N.D.	Diesel

Equipment	Approx. Daily Hours of Work	Decibels emitted*	Atmospheric emissions	Fuel Type
Mixer	8	85 (A) 15 m	Opacity 1.0 m-1	Diesel
Concrete Dosing Device	8	N.D.	N.A.	N.A.
Flatbed Truck	6	72 (A) 15m	Opacity 1.0 m-1	Diesel
Compacter	3	87-94 (A) 3m	N.D.	Gasoline
Floating crane	5	85 (A) 15 m	Opacity 1.0 m-1	Diesel
Concrete mixer 1 sack	4	110 (A) 3m	N.D.	Gasoline
Lot pulleys and sheaves	4	N.A.	N.A.	N.A.
Crane	8	80-96 (A) 3m	N.D.	Diesel

*Sources: Building-Construction Trades Dept.
dB Engineering
Atlas Copco Mexicana S.A. de C.V.
N.D. Not Determined
N.A. Not Applicable

Waste Water

The wastewater generated during this stage will originate from sanitary services, for which the installation of septic tanks has been contemplated for the control and treatment of such waste. For such purpose, the necessary sanitary services will be installed in accordance with the number of workers in the project taking into account a proportion of 1:20 to cover the needs of the work fronts. Periodic maintenance of the tanks will be performed to stabilize the waste and monitor waste control, avoiding any contamination of the soil or water bodies in the area.

Operation and maintenance stage

Domestic Solid Waste

Minimum generation of domestic waste is expected during the operation stage, since the personnel will consist of approximately 6 persons, distributed during the workweek. Therefore, a maximum of 3 kg of domestic waste is expected per week, mainly consisting of cardboard, paper and plastic wrappers and drink bottles or cans. As in the construction stage, containers with lids having sufficient capacity for temporary storage of waste will be provided to avoid any proliferation of harmful fauna. Applying the same filing procedure with the municipal authority to send the waste to the official disposal site is suggested. This will allow maintaining adequate control of the activities and ensuring compliance from the operation personnel.

Hazardous Waste

Hazardous waste, consisting of lubricating oil produced by the maintenance of the electro-mechanical equipment of the central will be generated. To manage it, the preparation of a temporary storage site is contemplated, where containers with the used oil will be stored. It is advisable to consider from the beginning of the work the preparation of hazardous waste storage, since this way, the structure will be ready when the operation stage begins. To handle such oils, initial movement using plastic containers or drums will be recommended for easy and safe handling within the plant and transportation to the warehouse. Once in the warehouse, the used oil should be transferred preferably using 200-liter containers with hermetic lids to ensure the oil does not leak in case of shifting or turn over. Transfers should be made using a manual pump to avoid spills and a large piece of paper or canvas should be placed between the containers when performing such operation as a preventive measure. Additionally, rags and other solid materials required for the maintenance tasks will be contaminated. Such materials will be treated as hazardous waste, placed in containers with lids and, like the oils, will be stored in the warehouse.

Waste will be sent for recycling and/or final disposal through companies authorized by SEMARNAT for such purposes. Such companies shall be registered as general hazardous waste generators and the relevant Annual Operation Licenses shall be submitted in order for the authority to keep control of the operations and comply with applicable legislation.

As mentioned above, there will be a temporary warehouse having a waterproof surface, containment tank to control spills and perimetral over-elevation in the floor (border), ceiling and walls covered with metallic materials, including the necessary ventilation, fire extinguisher equipment and sand, restrictive signs, indications and support equipment to handle containers.

The following table shows the types of waste and volumes that may be generated during this stage:

Operation Stage- Waste Generation

Waste	CRETIB Code	Estimated Generated Volume (six month period)
USED LUBRICATING OILS. (RPNE1.1/03)	(T,I)	300 l
ELECTRO-MECHANIC EQUIPMENT MAINTENANCE SOLIDS	(T,I)	70 kg

Atmospheric Emissions

Since power will be generated using water and both manual and electric equipment and tools will be used for the maintenance tasks, no atmospheric emissions will be produced during the operation stage. Additionally, the operation of the central itself will not emit noise to the outside due to the thickness of the concrete of the engine building and since

the dimensions of the equipment will not produce any noise-producing cavitation vibrations.

Waste Water

Sanitary wastewater will be generated in the hydroelectric central. To handle and control such waste, the installation of a prefabricated septic tank has been contemplated, which will prevent the wastewater from contaminating the ground or bodies of water in the area. Annual maintenance will be provided to the tank to stabilize the waste and strict control will be kept of its impermeability.

Additionally, and considering the operation conditions and characteristics of the hydroelectric central, there will not be any industrial wastewater discharges.

II.2.10 Infrastructure for proper waste management and disposal

There are 28 companies in the region dedicated to the treatment of contaminated soil (In situ and Ex situ), located mainly in the Coatzacoalcos area. All such companies are capable of handling the project's needs in case such services are required.

Additionally, there are 8 companies dedicated to collecting and transporting hazardous waste, which may be contracted to dispose of used lubricating oils and contaminated solids generated with the project's activities. The companies that could be hired and which are the closest are Ecoltec, S.A. de C. V. and Comercializadora y Transportadora Santa Inés, among others located in the areas of Córdoba and Orizaba, Veracruz.

There are companies in the region dedicated to oil recycling and receipt of solid waste such as the Tres Valles sugar mill, located in the Tres Valles municipality and which is relatively close to the project site (39 kilometers). Its location coordinates are: 18º 15' 30" North Latitude and 96º 10' 01" West Longitude.

The infrastructure in the region is sufficient to handle any hazardous waste that could be generated, both in the construction and operation stage of the project, for which there will be no problem in properly transporting and disposing of such waste. (see waste disposal services and information map)

In the town of Tuxtepec, there are various locations that buy and sell cardboard, paper and metals for recycling, for which the recycling and disposal of this kind of waste that could be generated in the project may be carried out through such vendors.

The municipality of Tuxtepec has an official domestic waste disposal site located in the industrial zone close to the town of Sebastopol, which covers the waste collection needs in such municipality; in accordance with the competent authorities, the selection and distribution of recyclable and biodegradable waste is performed on site. The amount of waste generated in the project would be minimal, for which the capacity of the site to offer the service will not be affected. The approximate location coordinates of the official disposal site are 18º01'32" North Latitude and 96º10'24" West Longitude.

III. RELATION WITH APPLICABLE LEGAL PROVISIONS ON ENVIRONMENTAL MATTERS AND LAND USE REGULATIONS

The construction project of the hydroelectric central Cerro de Oro is related with the planning legal and regulatory instruments and standards described and analyzed in the following sections.

III.1 Plans and Programs

All the legal and regulatory provisions that govern the political, social and productive life of our country derive from the Political Constitution of the United Mexican States, including those relating to environmental protection and providing electric power public services.

III.1.1 2007-2012 National Development Plan (NDP)

The 2007-2012 National Development Plan establishes a clear and viable strategy to advance in the transformation of Mexico on solid, realistic and in particular, responsible bases. It is structured on five principal points:

In accordance with the foregoing, the 4th central point, Environmental Sustainability relates to certain aspects considered in the guidelines of Electricidad de Oriente, S de R. L. de C. V.

The National Development Plan establishes Environmental Sustainability as one of its fundamental principles and defines such concept as the efficient and rational management of natural resources, in such a way that it is possible to improve the well-being of the current population without compromising the quality of life of future generations. One of the main challenges Mexico faces is including the environment as an element of social and economic development and competitiveness. Only this way can sustainable development be achieved.

Table 3.1.1. Relation between the principal objectives of the NDP and of Electricidad de Oriente S. de R. L. de C. V. in connection with environmental protection.

Section 4.4 Administration and justice in environmental matters	Guidelines of Electricidad de Oriente, S. de R. L. de C. V
OBJECTIVE 6 Guarantee that the administration and application of environmental law is effective, efficient expedite, transparent and fosters sustainable investment	Objectives Guarantee state of the art electric power service, within the scope of competence, in quality, quantity and price conditions
STRATEGY 6.1 Promote the development of environmental management practices that contribute to economic growth and competitiveness	Objectives
	Protect the environment, promote social development and respect the values of towns where the

Section 4.4 Administration and justice in environmental matters	Guidelines of Electricidad de Oriente, S. de R. L. de C. V
Environmental management practices are instruments that favor the efficient use of natural resources and improve the development and competitiveness of productive activities. These are generated by authorities and production agents.	hydroelectric central will be located. Be recognized by users as a company concerned about the environment and oriented towards client service.
STRATEGY 6.2 Promote private sector participation in the incorporation of eco-efficient practices in their productive activities and in the development of environmental infrastructure.	Operate with basis on national environmental, production, competitiveness and technology indicators Optimize the use of environmental, physical, and commercial infrastructure and human resources.

The connection between the Cerro de Oro project and the National Development Plan exists in the quest to maintain and/or create infrastructure and public services to provide quality electric services. Likewise, during the development of the Cerro de Oro hydroelectric central, several activities are contemplated to prevent, mitigate and/or compensate any adverse impacts to the environment and its ecosystems that could be affected thereby.

The NDP generates sector, institution, regional and special plans that specify for each sector, the objectives, goals, strategies and policies for the following years.

Programs to implement the 2007- 2012 National Development Plan

The sector programs prepared will pertain to the administrative sectors based on the provisions of articles 48 and 49 of the *Ley Orgánica de la Administración Pública* (Public Administration Organizational Law).

To achieve the purposes and awareness of national priorities, the sector, institutional, regional and special programs to be developed will contemplate energy as a central subject for national development, among others.

By virtue of the fact that the programs to implement the 2007-2012 National Development Plan are not yet available, the 2001-2007 Environmental and Natural Resources National Program is presented below.

III.1.2 Environmental and Natural Resources National Program (ENRNP) 2001-2006

The principal purpose of the ENRNP is to satisfy the change expectations of the population, building a new environmental policy in accordance with the National Development Plan.

The ENRNP has four strategic programs for environmental management:

Strategic Program 1 Stop and revert the pollution of life sustaining systems (water, air and soil).

Strategic Program 2 Stop and revert the loss of the natural capital.

Strategic Program 3 Preserve ecosystems and biodiversity.

Strategic Program 4 Promote sustainable development.

The ENRNP mentions that development must be clean, preserve the environment and rebuild ecologic systems. It also indicates that in order for quality development to exist, it is necessary to consider the interaction of social and economic sectors with the environment and natural resources, with which the implementation of the Cerro de Oro hydroelectric project is compatible.

III.1.3. Puebla Panamá Plan (PPP)

The PPP is a cooperation instrument that seeks to integrate the Mesoamerican region, coordinating efforts and actions of the seven countries of Central America and the nine states that integrate the South Southeastern region of Mexico (Puebla, Oaxaca, Veracruz, Guerrero, Tabasco, Chiapas, Campeche, Quintana Roo and Yucatán) with the perspective of promoting integral development.

This plan presents an energy initiative to promote the social and economic development of Mesoamerica. It fosters a greater and better coverage of electric power service and the integration of markets of this region in this sector to attract private sector participation, mainly in financing new generation projects that the economic development of the region demands, to reduce the cost of electricity for end users and improve the competitiveness of companies.

The relation between the PPP and the goals of Electricidad de Oriente S de R. L. de C. V, promoter of this project, is to strengthen and maintain the electric infrastructure.

III.1.4. Oaxaca State Development Plan

This plan sets forth the general goals, integral development priorities and strategies of the state, as well as the global, sector and regional policy guidelines, the projections with respect to the social and economic activities as a whole and establishes the regime of the contents of the plans and programs that will be generated within a democratic planning state system.

The goal of the State Development Plan relating to the project refers to strengthening the financial and human resources of the municipalities, so they may functionally turn into agents of change for society and in the geographic-economic and cultural realm, fulfill the expectations of common improvement of life conditions of residents.

The environmental policies of the plan seek to promote and strengthen the coordinated action among the three levels of government, as well as the participation of social organizations and academic and research institutions, to join efforts for the recovery of a healthy environment, the restoration of natural resources, biodiversity and the generation of an environmental culture parallel to sustainable development.

In this regard, the goals of Electricidad de Oriente, S de R. L. de C. V. and consequently, the activities necessary to implement the project are strictly related with such policies.

In accordance with such plan and because the state of Oaxaca has great diversity insofar as geography, climate, natural resources, culture and levels of development are concerned, a social and economic regionalization was made which classifies the municipalities of Oaxaca in eight regions, based on the abovementioned characteristics. The foregoing in order to achieve a balanced development, integrate the communities, improve their territory and use natural resources fairly and rationally to advance social and human well-being conditions in the region.

Such regions are: Cañada, Costa, Istmo, Mixteca, Papaloapan, North Sierra, South Sierra and Central Valleys. The Cerro de Oro hydroelectric central is located in the region of Papaloapan in the District of Tuxtepec

III.1.5 Urban Development Plan of the Strategic Population Center San Juan Bautista (UDPSPCSJB), Oaxaca (Plan Tuxtepec 2010)

This instrument seeks to regulate urban processes, fostering balanced development of the area. Its purposes include raising the quality of life of residents, allowing the development of economic activities with environmental protection criteria.

Such plan was published in the State Official Gazette on December 17th, 1994. On June 12th, 1999, the decree approving the amendments to the plan was published to update the uses and purposes of the land, the residential densities and roadways in the city of Tuxtepec. It is important to point out that the strategies and amendments for this plan will not become effective until 2010. In addition, the official name of UDPSPCSJB will be Plan Tuxtepec 2010 (Government of the State of Oaxaca, 1994).

In accordance with this plan, the urban development of Tuxtepec is mainly related with its condition of priority population and services center for the South Pacific regional system, with the dynamic of the production activities over industrial activities and population movements as a result of the first two factors. Therefore, in order to attend to the current conditions and development needs of this city, the plan includes several general and specific goals, among which the following relate to the purpose of the construction of the Cerro de Oro hydroelectric central:

- Consolidate the city as an industrial and commercial, financial, educational, administrative, health, supply, collection and storage services nucleus at a regional level.

- Contribute to the creation of the basic infrastructure conditions necessary to expand the industrial park to the southwest of the current urban area.

In general, terms, the Tuxtepec Urban Development Plan states the need to strengthen the industrial zone located to the southwest of such city with the necessary infrastructure, such as roads, access ways and electric power. The construction of the Cerro de Oro hydroelectric central will support such local demand.

The municipality of San Juan Bautista Tuxtepec to date does not have a municipal development plan in effect.

III.2 Ordinances

Ecologic Territorial Ordinance of the State of Oaxaca

The ecological ordinance is a planning instrument of the environmental policy that allows determining and programming the use of land and management of natural resources for each region of the country, as well as promoting the development of socio-economic activities in accordance with the natural vocation of the land.

Pursuant to the result of the consultation to the Ecology State Institute of Oaxaca, this state does not have an Ecologic Territorial Ordinance for the Papaloapan region.

Within the region where the Miguel de la Madrid Hurtado dam is located, there are no protected natural areas and the most important towns are: Tuxtepec, Paso Canoas, Santo Domingo and Sebastopol.

III.3 Management Units

Wildlife Preservation Management Units System (WPMUS)

Wildlife Preservation Management Units System WPMUS was created in 1997 to contribute towards making compatible and mutually reinforcing the preservation of the biodiversity with the needs, production and socioeconomic development of the rural sector of Mexico.

This system integrates under one common concept the sites that up to 1996 were dispersedly known as extensive and intensive breeding places for wildlife, zoos, nurseries and botanical gardens, among others and are called Wildlife Preservation Management Units, PMU's. PMUs promote alternative production plans that are compatible with the preservation of the environment, through rational, orderly and planned used of renewable natural resources existing therein, ending or reverting environmental deterioration processes.

In Oaxaca there are 37 PMU's, three of which are located in the municipality of San Juan Bautista Tuxtepec, but the project is not located on any of them. The PMUs located in the municipality are described below.

Table 3.3.1

Code	Name
SEMARNAT-UMA-EX0008-OAX	Mazín Chico
SEMARNAT-UMA-EX0010-OAX	Xuta Naxijen Niyujñan Persona (Mazateca de Cerro Tepezcuntle)
SEMARNAT-UMA-EX0014-OAX	Santa Úrsula

III.4 Protected Areas

Protected Areas in Oaxaca

Protected Natural Areas, PAN's are portions of land or water in national territory that represent the different ecosystems and its biodiversity, where the natural environment has

not been essentially altered by man and which are subject to special protection, conservation, restoration and development regimes.

Pursuant to article 46 of the Environmental Protection and Ecologic Equilibrium General Law (*Ley General del Equilibrio ecológico y la Protección al Ambiente*) PAN's are classified in Biosphere Reserves, National Parks, Natural Monuments, Natural Resources Protection Areas, Flora Protection Areas and Sanctuaries.

There are seven PAN's in Oaxaca and they are described below in the following table

Table 3.4.1

PAN Name	Surface (has)	Category	Decree	Ecosystems
Benito Juárez	2 737	National Park	30 12 37	Oak pine forest, deciduous lowland jungle
Huatulco	11 890	National Park	24 07 94	Deciduous lowland jungle, wetlands, coastal dunes shrubbery, mangroves, marine grass, coral banks
Yagul	1 076	Natural Monument	24 05 99	Sub humid deciduous jungle
Tehuacan – Cuicatlán	490 187	Biosphere Reserve	18 09 98	Tropical deciduous jungle
Chacahua Bay Beach	32	Sanctuary	29 10 86	17.4 km long sandy beach where several species of marine turtles nest and spawn
Chacahua Lagoons	13 274	National Park	09 07 37	Thorny jungle, floodable jungle, coastal dunes vegetation, halophyte, savannah, tule, palm, and mangrove vegetation sub-deciduous jungle, evergreen jungle and gallery vegetation
Escobilla Beach	30	Sanctuary	29 10 86	Sandy beach 15km long; it is the most important marine turtle nesting center of the country and the third most important one in the world

The area where the project will be built is not located on any of the Natural Protected Areas of the State of Oaxaca.

Natural Areas Conservation State System (NACSS). The government of the State of Oaxaca has created NACSS for protecting areas whose biotic and abiotic characteristics are important.

Close, yet outside the area under consideration is the area known as La Cabeza del Tigre Jungle, where there are two types of High-Altitude Deciduous Jungle and Mid-Altitude Evergreen Forest.

III.5 Priority Regions

III.5.1 Priority Land Regions PLR's

The purpose of priority land regions is to establish units from the environmental standpoint for the continental part of the land where there is a particularly rich ecosystem and a significant functional ecologic integrity, and where, additionally, there is an actual preservation opportunity.

Based on CONABIO's classification, the PLRs of the State of Oaxaca are eight: Tehuacan Cuicatlán Valley, Cerros negro-Yucaño, Triqi -Mixteca Sierras, El Tlacuache, Bajo Río Verde Chacahua Sierra Sur and Oaxaca Coast, Sierras del Norte de Oaxaca-Mixe and Soque la Sepultura jungle.

The area under consideration is not within any of the Priority Land Regions. The closest is the PLR Sierra Norte de Oaxaca-Mixe at a considerable distance of approximately 25 kilometers, followed by the PLR "Humedales del Papaloapan" located at approximately 40 kilometers.

III.5.2 Priority Hydrologic Regions PHR's

The purpose of the PHR program is to obtain a diagnosis of the principal sub-basins and aquatic systems of the country, considering the characteristics of biodiversity and the social and economic patterns of the identified areas, to establish a frame of reference that can be used by the different sectors for the development of research, preservation and sustained use and management plans. This program forms part of a series of strategies established by CONABIO, at a national level, for the awareness and preservation of biodiversity in Mexico.

In accordance with the CONABIO (2002) classification, in the state of Oaxaca there are three priority hydrological regions PHR: high and low basin of the Coatzacoalcos river, Río Verde-Laguna de Chacahua and Miguel Alemán Cerro de Oro dam. The area of the project is located 6 kilometers to the south of the polygon that integrates such PHR.

On the other hand, the project is located 16 kilometers from the northwest end of the polygon that forms the PHR “Wetlands of the Papaloapan, San Vicente and San Juan”, located in the state of Veracruz

Table 3.5.2.1 describes the characteristics of the three Priority Hydrologic Regions of Oaxaca.

III.5.3 Areas of Interest for the Preservation of Birds, AIPB’s.

For the purpose of creating a regional network of important areas for bird preservation, the AIPB’s program was created. In order to identify them in Mexican territory, in 1998 four regional coordinating offices were created (Northeast, Northwest, South and Center), which determined a total of 230 AIPB’s.

In the state of Oaxaca, there are ten AIPB’s; the area of study Cerro de Oro is located in one of them.

Table 3.5.3.1 describes the AIPB’s located in the state of Oaxaca.

III.6 Sector Information

In 1992 with the amendment to the Electric Energy Public Service Law (*Ley del Servicio Público de Energía Eléctrica*), private investment was allowed to supplement the public resources allocated to the development of the electricity sector.

Hydroelectricity has reached a significant participation in the installed generation capacity in the Mexican electricity sector.

In addition to the demand projections, the expansion studies consider the renewable energy projects, that is: hydroelectric, geothermal and wind technology. The location of the former is quite free, subject to the fuel use policies and environmental legislation and standards.

Hydroelectric projects not only have the advantage of association to renewable energy, but are also options that can be used, together with other purposes, to satisfy potable water, hydro-agricultural, avenue control, aquaculture and communication needs; in addition, these projects have an associated “fuel” the prices of which are not uncertain, although its availability may be unreliable at times.

III.6.1 Energy Sector

The proposal of the 2001-2006 National Development Plan is to change the energy sector through an effective instrument that promotes economic and social development and guarantees sustainable development. In this context, the vision of the energy sector for the

year 2025 includes the participation of private investment within an adequate and regulated legal framework that fosters efficient use of the energy, attaining energy supplies at competitive prices. With this perspective, the Ministry of Energy strengthens its mission of conducting the energy policy of the country, abiding by the constitutional framework in effect, in order to guarantee an environmentally sustainable, competitive supply.

III.6.2 Electric Industry

A central element of the National Development Plan is providing electric power service for the entire population, to incorporate it to the general dynamic of the country and offer greater productive opportunities for the population, while improving quality of life. Therefore, the purpose of the electric industry requires having sufficient supply capacity with quality standards to satisfy the energy demand in the long and short term.

III.6.2.1 Restructuring and regulatory framework of the power industry

The 2001-2006 National Development Plan indicates that the legislative and regulatory framework of the power industry needs to be amended to allow the participation of private capital to supplement state investment. In this context, and to provide certainty to the power industry, the energy policy of the current administration contemplates maintaining State governance over the control and operation of the National Transmission System, establishing an equitable policy on subsidies and applying a competitive power rates plan.

As of December 23rd, 1992, article 36 of the Electric Power Public Service Law (*Ley del Servicio Público de Energía Eléctrica*) establishes the system under which the "Cerro de Oro" Hydroelectric Project can be carried out.

Article 36. – The Ministry of Energy, Mines and State-Controlled Industry, considering the criteria and guidelines of the national energy policy and taking into account the opinion of the Federal Electricity Commission, will grant electric power self-supply, co-generation, independent production, small production or import and export permits, as applicable, in the conditions indicated for each case:

Power self-supply to satisfy the individual needs of persons or entities, provided it is not inconvenient for the country in the judgment of the Ministry of Energy, Mines and State-Controlled Industry. To grant the permit, the following will apply:

a) If there are several applicants for the purpose of self-supply from an electric central, they shall be co-owners thereof or form a company for the purpose of generating electric power to satisfy the self-supply needs of the owners. The company having the permit may not deliver electric power to third parties, whether they are individuals or companies, who were not owners of the permit-holder company upon approval of the original project, including expansion plans, except when and assignment of rights or modification of such plans is authorized; and

b) The applicant must put at the Federal Electricity Commission's disposal its power production surplus, in terms of Article 36Bis.

In addition, the Regulations of such Law, published in the Official Gazette of the Federation on May 31st, 1993, amended on July 25th, 1997, provide the following under article 72:

Article 72.- Private parties may engage in:

I. Electric power generation for any of the purposes set forth below:

a) Sale of power generated to the Commission;

b) Consumption by the private parties themselves under the systems of self-supply, co-generation or small production;

c) Use in emergencies caused by interruptions in the electric power public service, and

d) Export purposes;

III.6.2.2 Private investment participation

The current policy fosters the participation of national and international businessmen in projects conceived as part of the equipment of existing hydraulic infrastructure where the use of surpluses confer sustainability conditions upon it

Under this scheme, the participation of private investment in the sector of the "Cerro de Oro" hydroelectric project, will significantly contribute to the scope of the economic program of stable development recovery by providing basic supplies to the internal market that the productive plant requires and generating surplus available for the power market, thereby diversifying the use of water without causing negative collateral effects to the ecology.

III.6.2.3 Installed Capacity and Gross Power Generation

Gross power generation both public and private, from December 2000 to December 2001 equals approximately 156,296.3 Gigawatts hour (Gwh). This amount is 2.3 percent higher than the amount obtained the previous year during the same period. Of such volume, 145,966.3 Gwh were generated by state-controlled companies and 10 330 Gwh, by private entities. These numbers are 1.7 and 11.6 percent higher, respectively, than the previous year's figures during same period.

As of August 2001, the public and private power generation installed capacity reached 42,853.6 Mw, representing a 4.8 percent increase from the amount recorded the previous year during the same period.

III.6.2.4 Sustainability

Self-supply represents one more instrument to promote the efficient and rational use of hydraulic resources to generate power by using the available capacity surpluses existing in certain regions of the country that are already have dam infrastructures.

The Energy Regulatory Commission (*Comisión Reguladora de Energía*) granted 25 permits to private parties to generate power, 19 for self-supply, 5 for co-generation and 1 for import.

Some of the projects under this scheme are: Energía y Agua Pura de Cozumel thermoelectric central of 30 MW, Energía de Veracruz I –II projects of 651 and 279 MW,

respectively, Termoeléctrica del Golfo, first molten bed facility in Mexico with 250MW capacity, etc.

The use of this potential implies participation in the utilization of several national goods such as: water, dams, reservoirs, canals, riverbeds etc. In accordance with the sustainability scheme, with the “Cerro de Oro” Hydroelectric Project much of the existing hydraulic infrastructure will have multiple uses, without causing damages to the environment or ecosystem, serious damages to the ecosystem, serious ecological imbalance or cumulative environmental impacts. Any residual, relevant, significant, or synergic environmental impacts that could be caused during the construction of the hydroelectric central, will be mitigated through the mitigation measures and restoration programs presented herein.

III.6.3 Electric Sector Projects and Investment Program. (ESPIP)

The Electric Sector Projects and Investment Program (ESPIP) is the result of coordinated studies within the framework of the comprehensive planning of the electric system of the country.

The selection of the system components, scheduling and definition of installation sites are important activities in the decision-making process with technical, financial, environmental and social implications at a national level.

The electric system planning is carried out taking advantage, in the short and long term, of the improved investment and power production options to satisfy the future power demand at a minimum global cost and with proper reliability and quality. For such purpose, the investment, operation and unsupplied energy costs are considered, as well as the federal provisions on energy, financial, environmental and social matters.

The preparation of the ESPIP is a dynamic activity, since the modifications of amounts and scope of the projects that impose new circumstances are being continuously incorporated. The ESPIP is integrally reviewed each year, and in such review, the macroeconomic scenarios of the country prepared each year by the sector coordinator, the Ministry of Energy, are used as a basis.

III.6.3.1 Self-Supply Program.

During the period from 2005 to 2014, it is estimated that self-supplied consumption will increase 22% and reach 25TWh in 2014. This amount will represent 6.7% of national consumption such year. Remote self-supply used by the electric network would reach 12 TWh in the same year.

If the self-supply projects planned are carried out, their installed capacity would represent 8.6% of the total capacity.

III.6.4 Sector Programs:

Since the 2007 – 2012 Energy Sector Program has not been developed, the following program will be used as reference:

2001 –2006 Energy Sector Program

The fundamental purpose of the 2001–2006 Energy Sector Program is to contribute to guarantee the viability of the energy sector in the long term, maintaining sovereignty over such sector and making better use of energy resources for current and future generations of Mexico.

The Program is the product of citizen opinions and proposals gathered during the national consultation, which helped prepare the 2001–2006 National Development Plan (NDP), expert opinions given during the National Energy Sector and the contributions of the sector organizations and entities, specified in the exhibits.

The Program has a very close relationship with the purposes and strategies of the 2001 – 2006 National Development Plan. The structure of the Program is based on ten strategic objectives, fully supported in the NDP, which facilitate the understanding thereof and allows easy identification of the goals and how such can be measured.

The 2001-2006 National Development Plan establishes that the energy sector must have a modern and transparent regulation that guarantees quality service and competitive prices, secures resources to allow public companies of the sector to fulfill their objectives, foster competition and investment and promote the participation of Mexican companies in energy infrastructure projects. Additionally, one of the objectives for 2006 is having top energy companies with sufficient supply capacity, quality standards and competitive prices.

The specific purposes of this program closely relate to the purposes of “Cerro de Oro” Hydroelectric Project for the following reasons:

[The project will] contribute to establishing an electric market in which private generators will sell their generation capacity and public and private buyers will satisfy their short and long term energy needs under conditions of competition, regardless of the type of technology (hydroelectric, natural gas, carbon, wind, etc.), allowing private generators to become established without requiring government guarantees for their operations.

[The project] falls within the legal framework in effect that allows new marketing schemes for the private and social sectors;

Strengthening the regulatory body technically, administratively and legally;

Maintain long term certainty with respect to the public service tariffs, in order to motivate the development of auto-consumption projects, and

Contribute to fostering the development of hydroelectric, geothermoelectric, wind-powered and solar-powered projects, among others, both inside and outside the sector.

III.7 Regulatory Instruments

Due to its nature and construction, operation and maintenance characteristics, the "Cerro de Oro" Hydroelectric Project will be entirely governed by the:

Environmental Protection and Ecological Equilibrium General Law (*Ley General del Equilibrio Ecológico y la Protección al Ambiente).*

as it regulates the provisions of the Political Constitution of Mexico, in connection with the preservation and restoration of ecological equilibrium and environmental protection. The provisions of such law are part of public policy.

The following articles are applicable:

"ARTICLE 28. – The environmental impact assessment is the procedure through which the Ministry establishes the conditions applicable to the development of projects and activities that could cause ecological imbalance or surpass the limits and conditions established in applicable provisions to protect the environment and preserve and restore the ecosystems, in order to avoid or reduce to a minimum the negative effects on the environment. For such purposes, in the cases determined by the Regulations issued for such effect, the parties that intend to carry out one of the following projects or activities will require prior environmental impact authorization from the Ministry":

"...II.- Petroleum, petrochemical, chemical, steel, paper, sugar, cement and electricity industries";

"ARTICLE 32. – If an urban development or ecological order partial program or plan of the territory includes any projects or activities mentioned under article 28 of this Law, the competent authorities of the States, the Federal District or Municipalities may present such plans or programs to the Ministry, to obtain its authorization for environmental impact purposes in connection with the set of projects or activities that are intended to be carried out in a given area, in terms of article 31 of this Law."

"ARTICLE 88. For the sustainable use of water and aquatic ecosystems, the following criteria, among others, are considered:

IV. The preservation and sustainable use of water and the aquatic ecosystems is the responsibility of the users and of the parties that carry out work or activities that affect such resources."

Ecologic Equilibrium Law (*Ley del Equilibrio Ecológico)* of the State of Oaxaca

The “Cerro de Oro” project relates to:

TITLE THREE: Sustainable use of natural elements.

CHAPTER I: Sustainable use of water and aquatic ecosystems.

ARTICLE 69.- For the sustainable use of water and aquatic ecosystems, the following criteria are considered:

I.- Both the State and society are responsible for the protection of the aquatic ecosystems and equilibrium of the natural elements that participate in the hydrologic cycle;

II.- The sustainable use of natural resources included in aquatic ecosystems must not affect the ecologic equilibrium thereof;

III.- To maintain the integrity and equilibrium of the natural elements that intervene in the hydrologic cycle, the protection of soils, forest and jungle areas, as well as the maintenance of the basic flows of water currents and the recharge capacity of aquifers must be considered;

IV.- The preservation and sustainable use of water, as well as of the aquatic ecosystems is the responsibility of the users and of the parties that carry out work or activities affecting such resources.

ARTICLE 70.- The criteria for sustainable use of water and the aquatic ecosystems will be considered in:

I.- The preparation and integration of the state hydraulic program;

II.- The granting of concessions, permits and in general, all kinds of authorizations to use natural resources or carry out activities affecting or that may affect the hydrologic cycle;

III.- The establishment of regulated reserve or protection zones;

IV.- The suspension or revocation of permits, authorizations, concessions or assignments granted in accordance with the National Waters Law (*Ley de Aguas Nacionales*), in the case of projects or activities that damage national hydraulic resources or affect ecological equilibrium;

VII.- The policies and programs for the protection of endemic or threatened aquatic species or species in danger of extinction or subject to special protection;

National Waters Law *(Ley de Aguas Nacionales)*

The National Waters Law is a regulatory law of article 27 of the Political Constitution of Mexico in connection with national waters, it applies generally throughout national territory, and its provisions are public policy.

The following articles are applicable

"ARTICLE 7" The following are hereby declared matters of public use:

"...III. The use of national waters to generate electric power destined for public services."

"ARTICLE 20. Individuals or entities may exploit, use and utilize national waters through a concession granted by the Federal Executive through the "National Water Commission, in accordance with the rules and conditions of the National Waters Law and the regulations thereof."

"ARTICLE 24. The term of the concession or award to exploit, use and utilize national waters will not be less than five or more than fifty years.

Such concessions or awards in terms of article 22, may be extended for a term equal to the original term if the holders thereof did not incur in the causes for termination provided under this law and request such extension within five years prior to the termination of the concession or award.

While the applications for an extension of a concession or award are pending, the original titles will remain in effect"

"ARTICLE 26. – Concessions or awards for the use of national waters will be suspended in the following cases, independently of the penalties that may be applied:

I.- The concessionaire or awardee fails to make the payments required under law for the exploitation, use or utilization of the water or for the supply services thereof, until such payments are covered in full;

II.- The concessionaire or awardee does not allow the inspection, measurement or verification of the resources and hydraulic infrastructure under concession or awarded, until such situation is resolved; and

III.- The concessionaire or awardee fails to comply with the terms of the concession or award title for proven causes attributable to such party, until such situation is resolved.

In any case, the concessionaire or awardee will have a term of 15 days to resolve the relevant situation before the suspension is applied."

"ARTICLE 27.- The concession or award for the exploitation, use or utilization of national waters may only terminate due to:

I.- Expiration of the term established in the title, except if extended in terms of article 24, or waiver by the holder;

II.- Revocation for non-compliance in the following cases:

a) Disposing of volumes of water greater than authorized, when the beneficiary's right was previously suspended for the same reason;

b) Failing to pay the duties or taxes established under tax laws for the exploitation, use or utilization of national waters or for the supply services thereof, when the beneficiary's right was previously suspended for the same reason;

c) Failing to perform the work and projects authorized for the use of water and quality control thereof, in the terms and conditions set forth under this law and its regulations;

d) Transferring the rights under the title in violation of the provisions of this law; or

e) Violating the provisions of the law with respect to the exploitation, use or utilization of national waters or the preservation and quality control thereof, when for the same reason, the violator was previously subject to the application of a penalty through final resolution, in accordance with sections II and III of article 120.

III.- Termination declared by "The Commission", when national waters are not exploited, used or utilized for three consecutive years;

IV.- Revocation of the concession or award for a reason of public utility or interest though payment of an indemnification, the amount of which will be determined by experts in the terms provided for concessions under the National Assets General Law (Ley *General de Bienes Nacionales*); or

V.- Judicial Resolution."

"ARTICLE 28.- Concessionaires or awardees will have the following rights:

I.- Exploit, use or utilize national waters and the assets mentioned under article 113 in terms of this law and the relevant title;

II.- Carry out at their own expense, the works necessary to exercise the right to exploit, use or utilize t water, in terms of this law and its regulations;

III.- Obtain the declaration of the legal easements over the land that may be necessary in order to use the water or discharge it, such as drain and aqueduct easements and others established under applicable legislation or that may be agreed upon;

IV.- Transfer the rights of the titles they may have, subject to the provisions of this law;

V.- Waive concessions or awards and the rights arising thereunder;

VI.- Request administrative corrections or duplicates of their titles;

VII.-Obtain an extension of the titles for an equal term, as provided under article 24; and

VIII.- Any others granted under this law and its regulations."

"ARTICLE 29.- Concessionaires or awardees will have the following obligations:

I.- Carry out the projects and work for the exploitation, use or utilization of waters in the terms and conditions provided under this law and its regulations and verify the execution thereof to prevent negative effects to third parties or to the hydraulic development of the supply sources or basin;

II.- Make the required payments in accordance with the applicable tax legislation in effect and other applicable legal provisions;

III.- Abide by the general provisions and standards on hydraulic safety, ecologic equilibrium and environmental protection;

IV.- Operate, maintain and preserve the works that may be necessary for the stability and safety of dams, control of avenues and others required for hydraulic safety under applicable legislation;

V.- Allow "The Commission's" personnel to inspect the hydraulic work used to exploit, use or utilize national waters, including the perforation and lighting of underground water and allow the reading and verification of the operation of the meters and other activities required to verify compliance with the terms of this law;

VI.- Provide the information and documentation that "The Commission" requires to verify compliance with the conditions provided under this law and in the concession, award or permit titles referred hereunder;

VII.- Comply with the requirements of efficient water use and reuse water in terms of the official standards and the specific conditions issued for such purposes; and

VIII.- Comply with the other obligations established under this law and its regulations."

"ARTICLE 79.- The Federal Executive will determine if the hydraulic works corresponding to the hydraulic system must be carried out by the *Commission* or the Federal Electricity Commission.

The Commission may use or grant concessions with respect to the infrastructure it is responsible for, to generate the required electric power and it may also dispose of any surplus in terms of the applicable laws and pursuant to the field.

*Regulations of the Environmental Protection and Ecologic Equilibrium General Law (*Ley General del Equilibrio Ecológico y la Protección al Ambiente) *on Environmental Impact Evaluation.*

The "Cerro de Oro" Hydroelectric Project relates to the following articles of such Regulations:

"ARTICLE 5°.- The parties that intend to carry out any of the following works or activities, will require prior authorization from the Ministry in connection with environmental impact:

...K) ELECTRICITY INDUSTRY:

I. Construction of nuclear-electric, hydro-electrics, carbo-electric, geo-thermoelectric, wind-electric or thermoelectric, conventional, combined cycle or turbo-gas unit plants, except for generation plants with a capacity under or equal to half a MW, used for backup in homes, offices and residential units;

II. Construction of electric power or distribution stations o substations;

III Electric transmission and sub transmission works, and

IV. Electric power self-supply or cogeneration plants over 3 MW."

*Official Mexican Standards (*Normas Oficiales Mexicanas- NOMs*), Mexican Standards, Reference Standards and regulatory agreements applicable to the "Cerro de Oro" Hydroelectric Project.*

AIR

NOM-041-SEMARNAT-1996.- Establishes the maximum permitted limits of emissions of polluting gases from the exhaust pipes of circulating automotive vehicles that use gas as fuel.

NOM-042-SEMARNAT-1993.- Establishes the maximum permitted level of unburned hydrocarbons, carbon monoxide and nitrogen oxides for new automobiles, as well as evaporated hydrocarbons.

NOM-044-SEMARNAT-1993.- Establishes the maximum permitted level of hydrocarbons, carbon monoxide and nitrogen oxides, suspended particles, and smoke opacity of diesel motors.

NOM-050-SEMARNAT-1993.- Establishes the maximum permitted levels of emissions of polluting gases from the exhaust pipes of circulating automotive vehicles that use liquefied petroleum gas, natural gas and other fuels for fuel.

NOISE

NOM-080-SEMARNAT-1994. - Establishes the maximum permitted limits of noise emissions from the exhaust pipes of circulating automotive vehicles, motorcycles and motorized tricycles and the measuring method.

NOM-081-SEMARNAT-1994. - Establishes the maximum permitted limits of noise emissions from fixed sources and the measuring method.

ENVIRONMENTAL IMPACT IN ELECTRIC FACILITIES

NOM-113-SEMARNAT-1998. - Establishes the environmental protection specifications for the planning, design, construction, operation and maintenance of power or distribution electric substations intended to be located in urban, suburban, rural, agricultural and livestock, industrial, urban equipment, services and tourist areas.

NOM-114-SEMARNAT-1998. - Establishes the environmental protection specifications for the planning, design, construction, operation and maintenance of the electrical transmission and sub transmission lines intended to be located in urban, suburban, rural, agricultural and livestock, industrial, urban equipment, services and tourist areas.

ENVIRONMENTAL HEALTH

NOM-012-SSAI-1993. – Sanitary requirements that public and private water supply systems for human use and consumption must meet.

NOM-048-SSAI-1993. -Establishes the standardized method to evaluate health risks as a consequence of environmental agents.

NOM-056-SSAI-1993. - Establishes the sanitary requirements of the personal protection equipment.

LABOR HEALTH, SAFETY AND ENVIRONMENT

NOM-001-STPS-1993. – Relative to safety and health conditions in the buildings, spaces, facilities and areas of work centers.

NOM-002-STPS-1993. – Relative to the safety conditions for fire protection and prevention in work centers.

NOM-004-STPS-1993. – Relative to protection systems and security devices in machinery, equipment and accessories in work centers.

NOM-011-STPS-1993. – Relative to safety and health conditions in work centers where noise is generated.

NOM-017-STPS-1993. – Relative to personal protection equipment for workers in work centers.

Table N°3.5.2.1 Description of Priority Hydrologic Regions of the State of Oaxaca

PHR	States	Main Hydraulic Resources	Biodiversity	Problems	Conservation
Río Verde – Chacahua Lagoon	Oaxaca	Lentics: Coastal Lagoons of Chacahua, Pastoría, Miagua, Manialtepec, and Espejo Lotics: River Atoyac, Ocotlán, Verde, San Francisco and effluents	Mangrove palm, savannah vegetation, low deciduous and mid sub-deciduous jungle, oak pine forests induced and cultivated grasslands. Characteristic Flora: *Melocactus delessertianus* and other phanerogams Characteristic Fauna: crustaceous mollusks and birds	Modification of surroundings, overexploitation of tributaries deforestation and tree-cutting, dams in rivers and scarcity of fresh water, Chacahua lagoon very altered due to high biological oxygen demand (BOD) and high rate of particles sedimentation due to erosion of soils overexploitation in fishing and herding	Minimum ecologic expense for coastal lagoons restriction of agricultural and livestock activities, planning and rational management of fishing in coastal lagoons, restriction of agricultural activities, infrastructure work to restore coastal lagoons.
Miguel Alemán Cerro de Oro Dam	Oaxaca	Lentics: Cerro de Oro dam (Miguel de la Madrid Hurtado) and Temascal (Miguel Alemán) Lotics: Tonto, Usila, Petlapa and Santo Domingo rivers, high incline streams.	Vegetation high evergreen jungle, sub-evergreen jungle and low deciduous jungle, pine – oak and oak–pine forests, pine forests and mountain mesophilic forests, acahuales (secondary vegetation), xerophilic shrubs, cultivated grassland and riparian vegetation	Modification of surroundings: dismount of surrounding surface due to human activities generates sediment towards the dam basins, causing the accumulation of sediment, eutrophication of the system and consequent proliferation of aquatic macrophytes and hazardous insects for humans, pollution by solid waste and domestic wastewater fertilizers and pesticides.	Important as wildlife refuge especially aquatic birds, both for native and introduced species. Planning alternatives for fishing production.
Middle and High Basin of Coatzacoalcos River	Veracruz and Oaxaca	Lentics: floodable area of the mid basin Lotics: rivers	Riparian vegetation tule and Arrowroot in floodable zones, mountain mesophylic	Dismantled zones for cultivation, fill of floodable areas, deforestation, modification of natural	It is necessary to preserve the high and mid jungle zones and control the processes of

Table N°3.5.2.1 Description of Priority Hydrologic Regions of the State of Oaxaca

PHR	States	Main Hydraulic Resources	Biodiversity	Problems	Conservation
		Coatzacoalcos, Jaltepec and Sarabia, streams and small streams	forests, pine and pine-oak forests, high evergreen and mid-sub evergreen jungles	vegetation and sedimentation of rivers, highway construction. Pollution from agrochemicals and wastewater.	sedimentation in rivers.
Wetlands of the Papaloapan, San Vicente and San Juan	Veracruz	Lentics: Alvarado, Buen País and Camaronera Lagoons Lotics: Papaloapan System: Papaloapan, San Juan Evangelista, San Vicente, San Agustín and Blanco Rivers.	Vegetation: savannah, mangrove, arrowroot, tule, palm, floodable evergreen low jungle, floodable thorny shrubs, aquatic vegetation, cultivated and natural grassland. Several aquatic communities of emerging hydrophytes, palms (water palm) and tasital palms (low floodable palms). High diversity of aquatic habitats: rivers, meanders, wetlands, lagoons and swamps. High primary and secondary production.	Modification of surroundings: construction of roads, fill of floodable areas and modification of the vegetation due to agricultural activities (sugar cane cultivation); pollution from petroleum activity and waste of sugar (San Cristóbal sugar mill) and paper industry, industrial and urban waste, violation of prohibitions and minimum restrictions. Use of land: agricultural and livestock.	It is necessary to treat tributaries of the sugar mills, monitor agricultural activities, especially with respect to desiccation of floodable areas. Information on the diversity in the area of wetlands and lotic environments is lacking.

Table N° 3.5.2.2.- AIPB's in the state of Oaxaca close to the Cerro de Oro Hydroelectric Central

Name	Land Title	Use of Land and Coverage	Threats	Description	Justification
Chimalapas	*Ejidal*[3]	Forest, Conservation, Agriculture.	Inadequate exploitation of resources, deforestation	Virgin evergreen tropical forest that contains significant parts of mountain mesophilic forest	Abundant richness and various species in danger of extinction and under special protection.
Sierra Norte	*Ejidal* and Federal	Forest, Urban Areas, Conservation	Livestock, agriculture, inadequate exploitation of resources, furtive hunting and traffic, introduction of exotic species, deforestation, urban development, industrial development, farming and livestock activities.	High mountainous system, steep, dissected by deep canyons such as those of the rivers Cajones, Soyolapan and Santo Domingo. Its altitude varies from 50msnm to the south of the district of Tuxtepec to 3700msnm in the Cempoaltépetl mountain, in the Mixe zone	There are threatened species for America, there is a very extensive and preserved mesophilic forest in the country, as well as a tropical deciduous forest, pine-oak and wet jungle, and there are at least 66 endemic species of the north.
Sierra de Miahatlán	*Ejidal*		Deforestation, agriculture, narcotics and livestock	Isolated mountains of the Sierra Madre of the South of Oaxaca	It has species considered as globally threatened
Valle de Tehuacán	*Ejidal* and Private	Urban areas and livestock	Livestock, commerce, agriculture, in some areas, resistant grass crops	Columnar cactaceous plants forest, with high diversity of cactaceous and vascular plants, almost 3000 species of vascular plants, 45	Unique bioma due to its biological characteristics and the characteristics of its avifauna sharing many species with the more humid surrounding areas and some

[3] Translator's Note: The term "Ejidal" or "Ejido" refers to a special system of common-ownership of agricultural land in Mexico

Table N° 3.5.2.2.- AIPB's in the state of Oaxaca close to the Cerro de Oro Hydroelectric Central

Name	Land Title	Use of Land and Coverage	Threats	Description	Justification
				species of the 70 species of columnar cactaceous existing in the valley. Center of endemism and diversification of cactaceous plants.	with the avifauna of more northern deserts
Tlaxiaco	*Ejidal*	Agriculture and livestock		Conifer Forests	Contains one of the populations of *Eupherusa poliocerca*
Cerro de Oro	*Ejidal*	Livestock, urban areas and agriculture	Inadequate exploitation of resources, livestock and agriculture	The area is located 18 km away from the city of Tuxtepec at the basin of the Papaloapan river at the north of Oaxaca close to the boundary with Veracruz	It is a refuge for a great diversity of birds, the majority of which are species typical of the jungle. An important part of the original avifauna is preserved, within the endemic species registered in the area, as well as threatened or endangered species
Temascal Dam	*Ejidal*, Private and Federal	Agriculture and livestock	Dismount of the surrounding surface due to human activity, causing sediment to accumulate in the dam	Located in the sierras of Zongolica de Juárez and Tuxtepec and the Gulf basin	Refuge for wildlife, especially aquatic birds
Manialtepec Lagoon	*Ejidal* and Communal	Livestock, tourism, fishing and agriculture	Introduction of exotic species. Industrial and urban development,	Intermittent type lagoon, formed by sandy barriers, in its surroundings and	

Table N° 3.5.2.2.- AIPB's in the state of Oaxaca close to the Cerro de Oro Hydroelectric Central

Name	Land Title	Use of Land and Coverage	Threats	Description	Justification
			tourism, deforestation livestock, agriculture and inadequate exploitation of resources	influence area there are mangrove and aquatic vegetation, coastal dunes, low forest, thorny shrubbery, palms and acahual (secondary vegetation)	
Chacahua-Pastoría Lagoon	*Ejidal* y federal	Agriculture, mining, livestock and tourism	Overexploitation of tributaries, cutting of trees and deforestation, in the lagoon there is high pollution due to a high biological demand of oxygen (BDO)	Coastal lagoon with mangrove and palm vegetation savannah, low deciduous jungle, pine-oak, pine, and oak forests, cultivated and induced grassland	The Chacahua Lagoon is considered a national park since 1937
Piedra Larga Mountain	*Ejidal* Private	Forest, urban areas, agriculture and livestock	Deforestation, inadequate exploitation of resources, agriculture and livestock	It is located between two mountainous systems, to the north of the knot of Zempoaltépetl and south of the Miahuatlán sierra, it is an area of mixed fauna between the eastern Sierra Madre and the southern Sierra Madre	

IV. DESCRIPTION OF THE ENVIRONMENTAL SYSTEM AND INDICATION OF THE ENVIRONMENTAL PROBLEMS DETECTED IN THE PROJECT'S AREA OF INFLUENCE

Environmental Inventory

IV.1 Delimitation of the area of study

As mentioned in Chapter III, there is no Ecological Ordinance for the area of study, for which the regionalization of Environmental Management Units will not be used.

In accordance with its dimensions of 6,072 m^2, the "Cerro de Oro" hydroelectric central will be located within the federal zone of the Miguel de la Madrid Hurtado Hydraulic Dam (map Ch. I; photo N° 2), place where the original environmental conditions have been altered and where secondary vegetation predominates.

Pursuant to the activities that will be developed during the different stages of the project and the characteristics of the natural and social environment, the project's area of influence was determined based on:

a) Project Dimensions

The total surface of the "Cerro de Oro" hydroelectric project will be 6,072 m^2 for the hydroelectric central and substation which includes the ordering of the infrastructure: engine building, maneuvering yard, electric substation, (photos N° 2, 3, 4, 5, 6, 7, 8, 9).

The transmission line (photos N° 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38) with an approximate length of 10.5 km will take up a total area of 262,562 m^2 (26-25-62 has) including the length of the tract by the width of the right of way (25m).

The group and kind of works to be carried out.

Tables N° 4.1 and 4.2 show the set of work to be developed

Table N° 4. 1 Generation Works and their actions on the altered natural environment

N°	Type of Generation Works	Actions on the Environment
1	Conduction Tunnel and intake structure	Excavation
2	Pressure pipeline	Excavation

N°	Type of Generation Works	Actions on the Environment
3	Engine building	Excavation
4	Electric substation	Formation, platform

Table N° 4. 2 Transmission Works and actions on the environment

N°	Type of transmission works	Actions on the natural environment
1	Line placement	Clearing
2	Tower installation	Excavation and foundation

Location and characteristics of the associated and temporary works and activities

In accordance with the characteristics of the works, pursuant to the master plan, the associated and temporary activities are established in Tables N° 4.3 and 4.4

Table N° 4. 3 Power Generation Work and Associated Activities

N°	Generation Work	Location	Temporary Associated Activities
1	Conduction tunnel and intake structure	Subterraneous section of the federal zone and of the dam curtain.	Formation of site control and protection cofferdam.
2	Pressure pipeline	In the federal zone, next to the dry a embankment of the curtain	Trench to hold pipeline and concrete anchorage
3	Engine building	In the federal zone, at the foot of the embankment of the downstream curtain	Reinforced concrete building, installation of workshops and camps

Table N° 4.4 Transmission Works and Associated Activities

N°	Transmission Works	Location	Temporary and Associated Activities
1	Location of Lines	From the substation of the hydroelectric central up to the connection with the Benito Juárez (Sebastopol) substation	Preparation of path to lay cabling, interconnection with existent B.Juárez E.S.
2	Installation of towers	Within the right of way of the transmission line	Clearing and Excavation of foundation trenches

Waste Disposal Sites.

There are no adequate sites in the area to properly dispose of domestic waste, for which it will be sent to the official municipal dump, after obtaining prior approval from, and paying the applicable duties to, the Basic Services Directorship of Tuxtepec, the local authority competent over the issue.

As to hazardous and recyclable waste, there are 28 companies in the area dedicated to the treatment of contaminated soil (In situ and Ex situ), mainly located in the region of Coatzacoalcos. In addition, there are 8 companies dedicated to collecting and transporting hazardous waste, all of which have the necessary capacity to satisfy any requirements of such services that may arise during the construction and operation stages of the project (see map of location of infrastructure for waste handling and disposal).

Close to the project site is the Tres Valles sugar mill, located in the municipality with the same name. It is authorized by SEMARNAT to handle solids and used lubricants and is relatively close to the project (39 kilometers), for which it satisfies the project's needs for proper disposal of any hazardous waste generated.

b) Social and Economic Factors Considered.

The entire infrastructure that integrates the "Cerro de Oro" Hydroelectric Project will be located within the municipality of Tuxtepec, State of Oaxaca, whose primary roads allow access to the federal zone. Therefore, all the activities will have a direct or indirect effect on this municipality, even the layout of the transmission line.

The closest municipalities and towns of Oaxaca closest to the project site are: Los Reyes, Santa Ursula, Paso Canoa, Camelias, Benito Juárez and Tuxtepec, all of which will have a direct interaction with the hydroelectric project.

The establishment and behavior of the population that will directly interact with the hydroelectric project, has and will have an impact on the natural resources and the environment. In this case, the population-environment relationship is extremely complex, since it implies chains or processes of multiple causality, the majority of which are based or modeled on the construction and operation of the Cerro de Oro dam. It is important to point out that although this interrelation is not always direct, it does manifest itself in various forms and through different factors (economic, territorial, cultural, etc.) that in general mark the development process and its connection with its surroundings.

c) Geomorfo-edaphologic, hydrographic and climate traits, kinds of vegetation, among others.

The project is located at the boundary of the Sub-provinces Eastern Sierras and Coastal Plain of Veracruz.

Physiographic Characteristics

The "Cerro de Oro" hydroelectric project will be located within the limits of the physiographic provinces of the coastal plain of the South Gulf and Southern Sierra Madre (physiographic figure of Oax).

Table 4.5

Province	Sub-province
South Gulf Coastal Plain	Veracruz coastal plain
Southern Sierra Madre	Easter Sierras

SOURCE: **INEGI**. Physiographic chart, 1:1 000 000.

Geology

The rocks from the *Precambric* are the oldest, dating back to approximately 600 million years, and they are located to the south of the region with an west-southeast direction. They are principally metamorphic and cover 25.5% of the state surface. Rocks from the *Paleozoic* (375 million years) cover 11.6%, have a metamorphic origin and are intrusive igneous. The largest cartographic units are in the north and east end, next to the state of Chiapas. The *Mesozoic* Era period with largest coverage is the Cretacic (135 million years) with 14.3%, represented by sedimentary and metamorphic type rocks, extended throughout the state, concentrated especially in the middle zone towards the north. Other lithologic units cover 7.3% pertain to the Mesozoic Era and are located to the south, center and northeast of the state. Rocks from the Triassic-Jurassic (200 million years) are located to the north and northeast, are sedimentary and cover 3.9%. In the Jurassic Period (180 million years), the rocks are generally sedimentary, they cover 0.9%, and are mainly located to the west, close to the Guerrero state line, another unit is located in the opposite end of the state, adjacent to the southern part of the state of Veracruz-Llave. The Tertiary period covers 25.0% of the state territory, composed of extrusive igneous rocks and sedimentary rock, dating back to 63 million years. They are distributed in the central and northern part of the state, some lithologic units border the states of Puebla and Guerrero, other units located to the north border the state of Veracruz-Llave. The soils of the Quaternary (3 million years approximately), are located to the south, southeast, parallel to the coastline and other important units are located in the center of the state and to the north, bordering the state of Veracruz-Llave.(geology figure Oax.)

Table 4.6

Era	Period	Rock or soil	Percentage of State Surface
Cenozoic	Quaternary	Soil	11.08
	Tertiary	Igneous extrusive	12.02
		Sedimentary	12.98
Mesozoic	ND	Igneous intrusive	6.30
	ND	Metamorphic	1.09
	Cretacic	Sedimentary	13.48
		Metamorphic	0.73
	Jurassic	Sedimentary	0.85

Era	**Period**	**Rock or soil**	**Percentage of State Surface**
	Triassic-Jurassic	Sedimentary	3.89
Paleozoic	Paleozoic	Igneous intrusive	5.02
		Metamorphic	6.54
Precambric	Precambric	Metamorphic	25.49
Other			0.53
Cenozoic	Quaternary	Soil	11.08

Source: **INEGI**. Geological Chart, 1:1 000 000

Soils

The soil towards the mountainous zone is composed of the Superior Cenozoic (Tertiary Period) and the rest (majority) of the Pleistocene or recent (Quaternary Period). [It is] formed mainly of sedimentations and alluvions from rivers over a calcareouos base. A large portion of the land has a blackish color, is rich in natural fertilizers and has a thick fertile layer. It is located mainly close to rivers and streams. The deposits and drifting of the Pleistocene, of a continental type, commonly called "red earth", are accumulations of up to 60 meters thick, having a gentle slope, formed by clays and sands with abundant quarter gravel and high acidity. (edaphology figure Oax.).

The soil units and percentage of surface reported for the region where the Cerro de Oro hydroelectric project will be located are:

Chromic Luvisol plus Pelic Vertisol **Lc+Vp/3** Fine texture, (clays) rocky physical phase, no chemical phase.

Eutric Cambisol + haplic feozem + Regosol **Be+Hh+Re/2** Medium texture (silts), gravelly physical phase, no chemical phase.

Luvic feozem + Ortic Luvisol **Hi+Lo/2** Medium texture (silts) rocky physical phase, lithic chemical phase

Hydrography

Oaxaca is a state with a large territorial extension. It has eight Hydrologic Regions. One of such regions is the Balsas [river] region, located to the northeast of the state with the *Tlapaneco river basin* and *Atoyac river basin*, where the Yosocuta Dam is located. The Costa Chica-Río Verde region located to the east-southeast of the state includes the *Atoyac river basin* – with the current of the same name, being the most representative for this basin and the bodies of water Miniyua and Corralero lagoons-, and additionally, as part of this region *La Arena* river and others and *Ometepec or Grande* river. Also in Oaxaca is the Oaxaca Coastal region to the south of the state with the basins of the *Astata*, *Copalita* and *R. Colotepec* rivers and others, with the bodies of water Pastoría and Chacahua lagoons. The Tehuantepec region is located to the center-east of the state and has two basins, one, the *Tehuantepec river*, whose current having the same name, serves as tributary together with the current of the Tequisistlán river for the Benito Juárez Dam – the second most important one in the state. In the Superior and Inferior L. basin, there are bodies of water having the same name, which receive the flows from the superficial

currents Los Perros and Espíritu Santo, in the case of the Oriental L., it receives the flow from the Ostuta River. The Chiapas Coastal Region is located in a small area to the southeast of the state along the border with Chiapas and with which Oaxaca shares the body of water called Mar Muerto. The Papaloapan region, which is the largest in Oaxaca, with a single basin having the same name, has the greater number of currents, including the river Salado-Grande, Cajonos and Puxmetacan-Trinidad. Additionally, there are the Miguel Alemán and Miguel de la Madrid dams, all to the north of the state. The Coatzacoalcos region is present as a single basin with the same name to the northeast of the state. Last, the Grijalva-Usumacinta region has the basin *Grijalva-Tuxtla Gutiérrez* River to the east-northeast of the state and it is the smallest hydrologic representation in the state.

The geographic area of the Papaloapan River is divided into twelve hydrological basins. The project is located in the Santo Domingo River Hydrological Basin, which lies from the junction of the Salado and Grande rivers to the junction thereof with the Papaloapan River. It has a drained area of 2,611.0 square kilometers and is surrounded by the following hydrological basins: to the North by the hydrological basin Tonto River, to the South by the hydrological basins Grande River and Valle Nacional River, to the East by the hydrological basins Papaloapan River and Valle Nacional River and to the West by the hydrological basins Salado River and Grande River. (basins chart Oax.)

Bodies of Water:

The bodies of water located within the same area are the Miguel Alemán dam, also known as Temascal and the Miguel de la Madrid Hurtado dam; additionally, the junction of the La Sal stream and Del Valle (Valle Nacional) River is located at a distance of 2 and 8 kilometers respectively, downstream from the dam curtain.

Climate

Oaxaca has a wide variety of climates. There are warm, semi-warm, temperate, semi-cold, semi-dry and dry climates (see climate chart Oax).

The rainy season in Tuxtepec begins between May and June. During the season, it rains almost every day. The rainiest month generally is July, although it has sometimes been September.

Warm climates in total occur in slightly over 50% of the total surface of the state, in the areas with less altitude (sea level to 1 000 m); they are characterized by annual average temperatures that go from 22º to 28ºC and the average temperature in the coldest month is 18ºC or more. Within such climate, the warm **sub-humid climate with summer rain** predominates. It includes the entire coastal zone, from the state line with the state of Guerrero until the border with Chiapas, in addition to other smaller areas located discontinuously in the north. In such land, the highest average annual temperatures reported are between 26º to 28ºC and total annual rainfall varies from 800 to 2 000 mm. The **warm humid climate with abundant summer rain** is mainly distributed in a section that goes from the north to the east, territory where the towns of Tuxtepec, Loma Bonita, Santiago Choapam and Chimalapa, among several others, are established. Here, total annual rainfall goes from 1 500 to 3 000 mm. The **warm humid climate with year-round**

rain is located in the lower eastern slope of the Prieto Volcano and Humo Grande mountains in the form of a strip with a northwest-southeast orientation. This area reports the highest rates of total annual rainfall in the state: 2 500 to over 4 500 mm. This is due to several factors, but mainly to the fact that these slopes are exposed to the humid winds of the Gulf of Mexico and their orientation and altitude encourage the rise of winds, the cooling thereof, the condensation of the water vapor they contain and precipitation.

Almost 20% of the state is under the influence of semi-warm climates, which have annual average temperatures of 18º to 22ºC, or above 18ºC, and cover areas with an altitude from 1,000 to 2,000 m. The **semi-warm sub-humid climate with summer rain** prevails, distributed in the northern zone of the strip of the sub-humid warm climate with summer rain, and interrupted in the center of such strip by the **semi-warm humid climate with abundant summer rain**. It is also located to the northwest, east and west, among other areas. Its total annual precipitation ranges from 800 to 1,000 mm, but there are some parts where it reaches more than 2,500 mm, as occurs in the west. The **semi-warm humid climate with year-round rain** is located along the western part of the humid warm climate with year-round rain, and similarly, its total annual rainfall ranges from 2,500 to over 4,500 mm.

Temperate climates and sub-humid climates with summer rain in a larger proportion and abundant summer rain in more limited areas cover approximately 19% of the surface of the state. They occur at altitudes between 2 000 to 3 000 m, annual average temperature varies between 12º and 18ºC and the average temperature in the coldest month ranges from -3º to 18ºC. The **temperate sub-humid climate with summer rain** is located towards the center and northwest, but also towards the south. Total annual precipitation therein ranges from 600 and 1 500 mm. **Temperate humid climate with abundant summer rain** is only distributed in the high eastern slopes of the Prieto Volcano and Humo Grande mountains and in the north slope of the Zempoaltepetl mountain, places where total annual precipitation ranges from 1 000 and 2 500 mm.

In the center, south and north-northwest are the areas with semi-dry climate, which represent almost 10% of state territory. The dry climate regions are located within such areas, which do not even cover 1%. **Semi-dry semi-warm** climate, whose average annual temperatures range from 18º to 22ºC, occurs in the area where the capital of the state is located (Oaxaca de Juárez), in the towns of Ejutla and Miahuatlán and in the areas surrounding the valleys of the San Antonio, Salado, Juquila and Calapa Rivers. Here, total annual precipitation is low, ranging from 600 to 800 mm, although it is less in some parts. **Very warm and warm semi-dry climate** occurs in the area of Yautepec and part of the Tequisistlán river valley. Precipitation in this region is similar to that of the previous climate, but annual average temperature is over 22ºC. The **semi-dry temperate climate** areas are located in the surroundings of the high course of the Juquila and San Antonio Rivers, where average annual temperature ranges between 12º and 18ºC and total annual precipitation is less than 600 mm.

Very warm and warm dry climate covers the area surrounding the towns of Cuicatlán and Santa María Zoquitlán, where average annual temperature is over 22ºC and total annual precipitation ranges between 300 to 500 mm, for which these are the driest areas of the state.

Last, in places with an altitude of over 3 000 m a, such as the Nube mount, the climate is **semi-cold sub-humid with summer rain**, since average annual temperature is less than

12ºC and total annual precipitation ranges from 1 000 to 1 200 mm. This region barely represents 0.19% of the state's surface. (see figures Isohyets and Isotherm Oax.)

Meteorological Stations

Table 4.7

Code	Station	North Latitude		West Longitude		msnm
		Degrees	Minutes	Degrees	Minutes	
20-084	Papaloapan, San Juan Tuxtepec	18	09	96	05	22

SOURCE: SMN, Unidad de Servicio Metereológico Nacional (National Meteorological Service Unit)

Climate Types

Table N° 4.8

Type or Sub-type	Percentage of state surface
Warm humid with year-round rain	4.34
Warm humid with abundant rain in the summer	13.05
Warm sub-humid with summer rain	32.99
Semi-warm humid with year-round rain	1.59
Semi-warm humid with abundant summer rain	2.19
Semi-warm sub-humid with summer rain	16.39
Temperate humid with abundant summer rain	3.93
Temperate sub-humid with summer rain	14.81
Semi-cold sub-humid with summer rain	0.19
Very warm and warm semi-dry	3.12
Semi-dry semi-warm	5.66
Semi-dry temperate	0.97
Very warm and warm dry	0.77

SOURCE: **INEGI**. Climate Chart, 1:1 000 000.

d) **Type, characteristics, distribution, uniformity and continuity of environmental units (ecosystems**).

Tuxtepec is located to the north of the state, at geographic coordinates 18º 00' 16" North Latitude and 96º 15' 52" West Longitude, in the region of the Papaloapan River, at an altitude of 20 meters above sea level. Its borders are: to the north, the state of Veracruz and San Miguel Soyaltepec, to the south, the municipalities of Santiago Jocotepec and Loma Bonita, to the west, the municipalities of Santa María Jacatepec, San Lucas Ojitlán

and San José Chiltepec and to the east, the municipality of Loma Bonita. Its average distance from Mexico City is 500 km to the southeast.

Territorial Extension: The Municipality of Tuxtepec has a surface area of 933.90 km², and represents 0.979 percent of the state's surface.

"Environmental units" define the homogenous zones of natural ecosystems and identify the possibilities and problems for development. The delimitation and structure thereof are basically conceived with basis on physical, humidity, temperature, precipitation, physiognomic characterization of the vegetation, soils and physiographic parameters.

The area of the hydroelectric central and transmission line project, presents a high degree of impact caused by the presence of the hydraulic infrastructure of the Cerro de Oro dam and anthropic activities such as agriculture, livestock farming, industries and population centers, which directly affect the ecosystem. It is necessary to remember that there is no Ecological Ordinance of the Territory, for which environmental units are not identified.(see figure Vegetation Oax.)

Composition of the ecosystem reported for the area of study:

Flora: Sub-Evergreen Mid Jungle or Evergreen Tropical Forest Arborous Strata: *Astronium graveolens, Stemmadenia donnellsmithii*, *Dendropanax arboreus* (Palo de Agua), *Scheelea liebmanii.* (Royal Coyol), *Bixa orellana* (Axiote) *Bursera simaruba* (Mulato) *Protium copal* (Copalillo) *Pachyra acuatica* (Apompo) *Terminalia amazonia* (Sombrerete) *Alchornea latifolia* (Palo de huevo) *Acosmium panamense* (Guayacan) among others. Shrub Strata: *Acacia angustissima*, (White Huajillo) *Acacia cornigera*, (Cornezuelo) *Caesalpinia pulcherrima* (Espuela de caballero) *Leucaena leucocephala* (Guaje) *Piscidia piscipula* (Habi). Herbaceous strata: *Oncidium* sp. (May flower) *Vanilla fragans* (Vanilla) *Bouvardia terniflora* (Trompetilla) *Zamia paucijuga* (Palm).

Fauna: Mammals: *Didelphys marsupiales* (Common Possum), *Philander opossum* (Four-eye Possum), *Dasypus novemicinctus* (Nine-ban Armadillo), *Pteronotus personatus* (Parnell mustache bat), *Glossophaga soricina* (Pallas bat), *Uroderma bilobatum* (Dark camping bat), *Artibeus jamaicensis* (Jamaica fruit bat), *Artibeus lituratus* (Giant fruit bat), *Sciurus aureogaster* (Gray squirrel), Orthogeomys hispidus (Gopher), *Agouti paca* (Tepescuintle), *Sylvilagus brasiliensis* (Tropical rabbit), *Sylvilagus floridanus* (Serrano rabbit), Canis latrans (Coyote). Amphibians: *Bufo marinus* (Toad), *Bufo valiiceps* (Toad), *Hyla* sp. (Little Frog), *Rana berlandieri* (Frog). Reptiles: *Hemydactilus frenatus* (common Gecko), *Iguana iguana* (Green Iguana), Sceloporus variabilis (*Roño*), *Cnemidophorus* sp (Cuije), *Boa constrictor* (Mazacuata), *Oxybelis aeneus* (Bejuquillo), *Micrurus diastema* (Coral snake), *Botrhops asper* (Deaf serpent), *Kinosternon leucostomum* (Casquito). Birds: *Dendrocygna autumnalis* (White wing Pijije), *Casmerodius albus* (White heron), *Coragyps atratus* (Common Buzzard), *Chondrohierax uncitatus* (Hook beak sparrowhawk), *Buteo mangirostris* (Walking eaglet), *Buteogallus urubitinga* (Major black eaglet), *Falco sparverius* (American Kestrel), Columbina inca (Black tail turtledove). Fish: *Astyanax fasciatus* (Little Sardine), *Heterandria bimaculata* (Guatopoque manchado), *Megalops atlanticus* (Tarpod), *Poecilia* sp. (Guppy), *Xiphophorus helleri* (Spade Tail).

Natural resources

The forest surface that cannot be used for wood production is represented by shrubbery and species typical of the mid sub-evergreen jungle. The municipality also has iron, barite and silver deposits.

In the area of the project, these groups are not represented as the surfaces have been already affected by the construction of the Miguel de la Madrid dam.

With regard to water, pursuant to the data of the National Water Commission for administrative region No 10, where the project is located, the availability of resource is shown in the following table.

Table 4.9

Administrative Region	Name	Total average natural availability (hm3)	Average natural availability per capita 2004 (m3/inhab/year)	Total surface average natural leaking (hm3)	Total average recharge of aquifers (hm3)
X (10)	Central Gulf	102,544	10,574	98,930	3,614

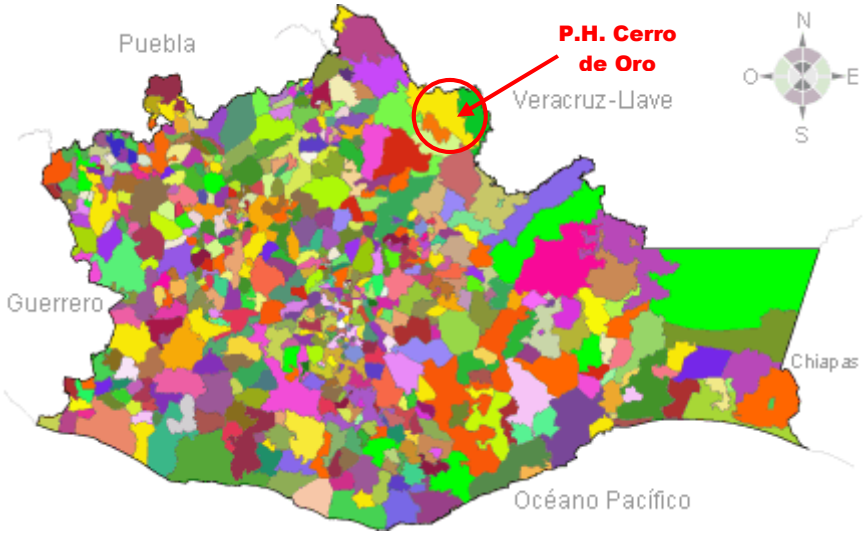
Source: National Water Commission.- Statistic Information.- Average Natural Availability of water by administrative region, 2004

In the specific case of the basin of the Santo Domingo River, the availability volume upon exit is 7,904.33 million cubic meters based on data from the National Water Commission.

Socio-systems

The territorial division of the State of Oaxaca recognizes 570 municipalities, 729 municipal agencies, 1,526 municipal police agencies and 726 rural centers, that is, 3,551 communities with political-administrative acknowledgment and a population range in which at least 525 municipalities have less than 15,000 residents, which is the legal minimum to form a municipality. This is due to historic reasons related with the defense of the people, their municipal and territorial categories, the changes and the confusion of the legislation.

The municipal institution is the stage where the local administrative and political dynamics of indigenous communities develop. Although the municipality has respected the articulation space with the colonial order and subsequently, with the national State, in Oaxaca, it is also a result of the tenacious territorial defense of indigenous peoples and the repetition of individual forms of local government. For such reason, it has 570 municipalities (23 percent of the total municipalities in the country), the largest percentage of communal tenancy of land and the largest concentration of indigenous people in Mexico.



Source: INEGI.- Information by state.- Municipal division, Oaxaca

IV.2.Characterization and analysis of the environmental system

The environmental system for the area of the Cerro de Oro hydroelectric project, it was determined that pursuant to the surface covered by the infrastructure of the central, the transmission line, the surfaces the project will affect without being permanently occupied and/or the environmental factors that without having a direct relationship with the construction, operation and maintenance thereof, will not have a negative effect on the ecosystems and the life of the residents. [sic][4]

For the development of this section, the elements of the physical, biotical, social, economic and cultural elements, as well as the different land uses existing in the area of the Cerro de Oro hydroelectric project were thoroughly analyzed, considering the seasonal variability of environmental components in order to reflect their behavior and tendencies.

[4] Translator's Note: Incomplete sentence in original version. It was not possible to determine the meaning to translate it properly.

IV.2.1. Abiotic Aspects

A) Climate

- Type of climate

The area of study is located in the Municipality of Tuxtepec, which registers *Af(m)* Humid warm climate with summer rain. The rainiest season in such climate is the summer and part of the fall, which is when tropical cyclones affect Mexico, are more frequent and the amount of rain considerably increases in the areas with this kind of climate.

- Climate Phenomenon (cold fronts, tropical storms and hurricanes, and other extreme events).

The Gulf of Mexico has very important geographic regions. For instance, its continental platform is very broad compared with the Mexican Pacific Ocean. The waters of the basin of the Gulf in general are warmer, since they are in the inter-tropical area, have the warm circulation called Gulf Current or Jet Stream and the dynamics of the Lazo current, among others. In the winter, cold polar air masses invade its waters and consequently, generate the phenomena of such basin known as "*nortes*" (cold fronts). At times, the winter systems interact with the trajectories of the tropical cyclones that actually pertain to the summer and part of the fall; in this situation, conditions commonly become adverse and highly risky for the population established in the coastal zone. This situation depends on how close the systems are to the coastline. "Cyclones occur especially in the tropics because the principal cause thereof is climatic" (Ortiz, 1984, p. 41).

Tropical cyclone season in the basin corresponding to the state of Veracruz, begins on June 1st and ends November 30th, that is, it covers the end of spring, the summer and part of the fall of the northern hemisphere, although cyclone systems can sometimes occur prior to the season and seldom after it.

The distribution of the coastal plain of Veracruz in general does not represent an obstacle for tropical cyclones to pass through. By contrast, the Easter Sierra Madre is an important barrier that counteracts the force of tropical cyclones when they hit state territory.

The trajectory that describes the marine phenomenon of a tropical cyclone, together with the powerful force it produces, currently makes it difficult to predict its behavior in real time, in spite of existing technological and scientific advances.

Diverse tropical cyclones that have affected the state of Veracruz in the past and their trajectories, especially from their place of origin until their culmination point were also diverse. Many tropical cyclones that have hit the territory of Veracruz and which originate in the tropical North Atlantic and the Caribbean Sea, previously affected other continental regions in their course, including the Yucatan Peninsula, and subsequently entered into the Gulf of Mexico, moving towards the Veracruz coast. By contrast, tropical cyclones that originate in the Gulf of Mexico, if they move towards the eastern coast of Mexico, are very likely to hit the state.

The tropical cyclones that have affected the surroundings of Veracruz during the period from 1930 to 2005 totaled 43, of which 13.95 percent were developed as tropical depressions, 30.23 percent were tropical storms and 55.81 percent were hurricanes.

45.83 percent of the cyclone phenomena were category 1; 25 percent reached category 2 due to the intensity of their winds; 20.83 percent were category 3 and those that reached categories 4 and 5 represented only 4.16 percent each.

The tropical cyclones formed in the waters of the North Atlantic represented 20.93%, in the Caribbean Sea 23.25 percent and in the basin of the Gulf of Mexico 55.81 percent. With regard to the place of impact, 65.11 percent entered into land from the northern part of the Veracruz coastline, 11.62 percent through the central part, 16.27 percent arrived from the central-south and 6.97 percent entered from the south only.

The state of Veracruz had the most tropical cyclones during September, with a total of 39.53 percent, 34.88 percent in August, 11.62 percent in July, yet in June and October only 6.97 percent respectively, reach the shore.

For 48 years, tropical cyclones did not enter the State of Veracruz. Tropical depressions increased in the 1990's, although in 1961 there were 2 consecutive tropical cyclones in the months of June and July. The years in which the greatest impacts to the state occurred were 1931, 1933, 1955 and 2005*. (Scripta Nova.-Vol. 10 No 218.-2006)*

- Average monthly, annual and extreme precipitation

The precipitation data is indicated in the following tables:

Table N° 4.10

Monthly average precipitation in mm													
Location Tuxtepec concept	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	40 years	37.4	37.0	36.4	39.4	98.0	385.8	497.3	412.1	429.8	220.9	84.3	59.3
Driest Year	53	15.8	15.0	23.5	32.5	66.5	272.3	301.3	168.2	211.1	37.1	81.0	1.2
Rainiest Year	81	111.3	70.9	34.8	58.3	102.4	1193.2	607.8	841.1	439.3	206	52.8	185.7

Source: *Proyecto Manejo Sustentable de laderas* (Sustainable Slope Management Project) COLPOS PMSL.

Table N° 4.11

Precipitation Total (millimeters)													
Location	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tuxtepec	61-90	36.1	33.2	26.3	22.5	91.8	339.3	410.0	380.0	386.6	188.3	73.1	47.7

Source: *SMN Registro Normales Climatológicas* (Climate Normals Registry) 1961-1990

Table N° 4.12

Historic Maximum Monthly Precipitation (millimeters)													
Location	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tuxtepec	51-98	111.3	127.4	84.1	126.8	324.5	1193.2	962.2	1209.9	732	448	172.4	185.7
	Year of Maximum	81	97	98	62	56	81	58	69	69	58	55	81

Source: *Proyecto Manejo Sustentable de laderas COLPOS PMSL*.

Table N° 4.13

Historic Minimum Monthly Precipitation (millimeters)													
Location	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tuxtepec	51-98	8.7	0.1	0.1	0.1	0.1	106.6	227.2	123.6	211.1	48.2	18.7	1.2
	Year of Minimum	70	62	73	58	98	98	75	74	53	63	74	53

Source: *Proyecto Manejo Sustentable de laderas COLPOS PMSL*.

- Average monthly, annual and extreme temperatures.

Pursuant to the data of the National Meteorological Service dependent of the CNA for the "Tuxtepec" location, the registered temperatures are reported in the following tables. It should be pointed out that the information provided herein corresponds to the site closest to the area of the project.

Table N° 4.14

Monthly Average Temperatures (historic)													
Location Tuxtepec concept	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average	20 years	20.8	22.1	24.3	26.3	27.9	27.7	26.2	26.2	26.0	24.5	21.7	21.1
Year of Minimum		76	70	70	71	70	73	74	71	75	74	70	73
Year of Maximum		74	62	76	64	80	62	66	62	64	62	73	77

Source: *SMN Registro Normales Climatológicas 1961-1990*

Table N° 4.15

Average Maximum Temperature °C													
Location	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tuxtepec	61-90	25.0	26.2	29.9	32.6	33.8	32.2	30.4	30.5	30.1	28.7	27.0	25.8

Source: *SMN Registro Normales Climatológicas 1961-1990*

Table N° 4.16

Monthly Average Temperature °C													
Location	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tuxtepec	61-90	20.5	21.2	24.2	26.5	27.9	27.2	25.9	26.0	25.8	24.6	22.7	21.4

Source: *SMN Registro Normales Climatológicas 1961-1990*

Table N° 4.17

Average Minimum Temperature °C													
Location	Period	Months											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tuxtepec	61-90	15.9	16.2	18.4	20.5	22.1	22.3	21.4	21.5	21.6	20.4	18.4	17.0

Source: *SMN Registro Normales Climatológicas 1961-1990*

- Monthly and annual dominant winds (direction and speed).

During the dry season in the region, the wind hits in the form of whirlwinds. Winds in Tuxtepec are always moderate and the dominant direction is towards the Southwest.

B) Geology and geo-morphology

- Lithological characteristics of the area.

a) Sedimentary Rocks

The predominant sedimentary rocks are limestone of the Cretacic and some intercalated slates. They are marine originally and are made up of some animal and vegetable remains (coelenterates, gastropods, rudites, foraminifers, pelecypods, algae, etc.) Correa et al, 1974.

In general, limestone constitutes a significant part of the South Sierra Madre. In Oaxaca, it is also found in the northeast and southeast of the state.

b) Metamorphic Rocks

Metamorphic rocks, which are the oldest, some from the Precambric, are represented by gneiss y esquists, as well as by slate and phylites. These kinds of rocks are found mainly in the South Sierra Madre.

The lithological relationship set forth below is based on the field observations that are supplementary to the previous studies, therefore the descriptions differ in the presentation method from those usually included in the estratigraphic column.

The area of study is located on the right margin of the Santo Domingo River. In the region, very pleated marine sedimentary rocks from the Superior Creatic are present, which form mountainous chains with a northwest-southeast direction, with altitudes up to 350msnm. Tertiary marine deposits cover the rocks of the Cretacious and integrate knolls not more than 80m high and the plain located downstream from the curtain of the Miguel de la Madrid Hurtado dam.

Description of Materials

In the area of study and its surroundings, as mentioned before, there are marine sedimentary rocks grouped into five formations, three Cretacic and two Tertiary. Recent continental deposits complete the estratigraphic column. The first three units belong to the Superior Cretacic and are in ascending estratigraphic order: Guzmantla limestone g(z), Atoyac limestone ay(z) and Méndez lutite m(lu). These are covered with angular discordance by lutites and arsenics of the Chicontepec Formation of the Pliocene, which are restricted in the area of the reservoir. Through another similar discordance, the conglomeratic and sandy facie of the Formation Concepción Superior of the Miocene (Formation Red Soil) tc(cg) cover all the previous sequence with the product of a transgression. The resistant continental units are alluvions, residual soils and embankment deposits.

Superior Cretacic

Guzmantla Formation (Ksgz).- Fine textured compact limestone, towards the base it appears in 40 to 50cm thick layers, includes strata with scarce flint presence, with carsticity characteristics. It has a beige color and contains sporadic clay-like intercalations. Forms part of some folding located inside the dam's reservoir and along its margins.

Atoyac Formation (Ksay).- Granular texture compact limestone, beige color, at times with clayish laminations, its stratification is regularly from 20 to 50 cm, exists outside the area of the reservoir of the Miguel de la Madrid dam and forms part of the plain.

Méndez Formation (Ksm).- Gray color lutite with ochre and yellowish tones. At weathering, it appears as fractures and lumps. These surfacings are located on the left margin of the Miguel de la Madrid dam.

Tertiary

Chicontepec Formation (Tchi) Intercalation of lutite and arsenic, having a gray-greenish color. Towards the base, lutite predominates in strata from 5 to 10 cm. towards the top mainly arsenic in strata up to 5m, surfaces within the reservoir.

Tierra Colorada Formation (Ttc).- Conglomerate of metamorphic, igneous and sedimentary pebbles, stone and gravel packed in a matrix of sand, silt and clay with red-color characteristics.

Quaternary

Alluvion (Qal).- Heterogeneous mix of clay and sand.

Vegetable Soil (Qsv).- Composed of sandy black silt.

- Most important geomorphologic characteristics (description in general terms).

Regional

Coastal Plain of the Southern Gulf: This province includes the coastal regions of the states of Veracruz and Tabasco where deep alluvial soils abound, since this is the area where many of the principal rivers of Mexico, such as the Grijalva-Usumacinta system, the Coatzacoalcos and the Papaloapan flow into the Gulf of Mexico. In Veracruz the land slopes down to the coast forming hills, but to the south of this state and in Tabasco it gradually becomes more even. To the east of Tabasco, there is a large floodable zone with abundant permanent swamps until close to the Términos Lagoon. This lagoon is semi-isolated from the sea by a great bar. One important physiographic discontinuity, the volcanic sierra of the Tuxtlas, interrupts this province over the coast. Here, aside from numerous small volcanic formations, rise the San Martín volcano at 1,658 meters and the Vigía de Santiago volcano, with 800 m/s.n.m. Catemaco Lake having 9 to 10 km in diameter, is the largest volcanic caldera of the country. A sub-province of the coastal plain of Veracruz, almost all of it is located within this state's territories and it is the one with the largest extension, with 27,001.17 square km, representing 37.29% of the total surface of the state. Generally, this province is divided into three main regions: the knolls systems of the west, the actual alluvial coastal plain and the knoll systems of the south and southeast.

South Sierra Madre: This province borders to the north with the province of the *Eje Neovolcánico* (Neo-Volcanic Axis), to the east with the Southern Gulf Coastal Plan, the Chiapas Sierras and the Central-American Coastal Plain of the Pacific, and to the south with the Pacific Ocean. It covers part of the states of Jalisco, Colima, Michoacán, Mexico,

Morelos, Puebla, Oaxaca, Veracruz and the entire state of Guerrero. It is considered as the most complete and less known of the country and owes most of its particular traits to its relationship with the Cocos plate. It is one of the mobile plates that integrate the terrestrial outside cortex or lithosphere. It emerges to the surface of the bottom of the Pacific Ocean to the southwest and west of the coasts, towards which it slowly drifts two or three centimeters per year to find, along the length thereof, the site called "of subduction " where it shifts once again towards the interior of the Earth. This is the cause of the strong seismicity present in this province, in particular on the coasts of Guerrero and Oaxaca, with the Acapulco trench being one of the most active zones. This relationship has surely determined that one of principal structural axes of the province –depression of the Balsas river, coastal mountain ranges, coastline, etc.- has a strict east-west orientation, condition which has important precedents in the province of the *Eje Neovolcánico* (Neo-Volcanic Axis) and which contrasts with the predominant northwest-southeast structural orientation of the north of the country. The sub-province of the Eastern Sierras Orientales spans from the region of Orizaba, Veracruz, to Salina Cruz, Oaxaca, and extends in the south between such port and the port Pochutla. The northern part, known as Zongolica sierra, is less abrupt than the rest of the sub-province. In it, the calcareous rocks of the Cretacic dominate, which make it similar to the Eastern Sierra Madre.

Local

The geomorphology existing around the area of study where the Cerro de Oro hydroelectric central will be built, consists of a series of low elevation knolls of soft and rounded contours that barely stand out from the low floodable lands pertaining to the coastal plains. In addition, there are calcareous sierras located on both margins of the curtain of the Miguel de la Madrid Hurtado dam and within the reservoir, they have a northwest- southeast orientation and constitute the foothills of the Eastern Sierra Madre.

- Presence of faults and fractures

Regional Structural Geology

In the area of study and its surroundings, there are a series of structures catalogued as anticlinoria and siclinoriums. These structures are quite closed, some of them are: symmetrical, parallels, in knee and inverted, within which we can list the following: María Isabel Anticlinoria and Camelia Roja Anticline. These structures were folded during the Laramide Orogeny where NE.SW oriented compressed forces acted, which originated NW-SE orientation structures, movement to the SW and NE and dips that oscillate at the interval of 10-85°.

No fractures or faults are reported for the area of study.

- Susceptibility of the area to: earthquake, slides, collapses, floods, other earth or rock movements and possible volcanic activity.

The area of the Miguel de la Madrid Hurtado hydroelectric dam is located in a region of medium seismic activity, that is, in the eastern end of the volcanic belt, and the places with the highest seismic activity are the coasts of the Pacific, including the Baja California

peninsula, the states of Sinaloa, Jalisco Michoacán, Guerrero, Oaxaca and part of the south of Chiapas.(López Ramos E. 1993).

In accordance with the division of zones for the Mexican Republic, the project is located practically in the division of the seismic areas B and C, which are catalogued as intermediate, since earthquakes are not reported often or the zones are affected by high accelerations that do not surpass 70% of the acceleration of the soil.

During the year 2002, an earthquake of 5.0 degrees on the Richter scale was recorded in the Tuxtepec area, which occurred in this area where the Cocos plate becomes sub-horizontal, at a depth of 120 km. Through a case study, it was determined that the source shows a normal fault focal mechanism over a NW-SE oriented fault plane, which coincides with the orientation of the tension axis of other events reported for the region.

Figure: Division of seismic zones of Mexico

Source: *Servicio Sismológico Nacional (National Seismologic Service)-I.G. UNAM*

- Movements and landslides

Due to the fact that the land where the Cerro de Oro hydroelectric central will be located is almost level, there are no movements or landslides.

- Potential Volcanic Activity

The closest volcanoes to the Cerro de Oro hydroelectric project are the San Martín volcano to the southeast and the Citlaltépetl volcano to the west. Both are at a distance of 177km, for which they do not represent any danger to the area.

C) Soils

- Soil types in the project site and area of influence

The soils of the Tuxtepec region date back to the Cenozoic, Mesozoic Paleozoic and Precambric periods; most of the land Tuxtepec covers is alluvion land and therefore, is very fertile. In many cases, the soil is up to 10 m deep.

In the area intended to locate the project there is a large amount of limestone that forms the Santa Ursula and Oro mountains, for which a considerable reduction in the thickness of the soil layer can be found, of up to 10 cm in depth.

In the project area, the kinds of soil existing in the plain or valley parts are those identified as Chromic Luvisol + Pellic Vertisol (**Lc+Vp/3**) with fine texture, composed of clays of rocky physical phase and without chemical phase. For the high sections such as the Santa Ursula and Cerro de Oro mountains, fine textured Luvic Feozem + Ortic Luvisol **(Hi+Lo/2)**

composed basically of silts is present; its physical phase is rocky and its chemical phase is lithic.

The distribution of soils present in the area of the Cerro de Oro hydroelectric project, including the transmission line is summarized in the following table:

Distribution of soils Table

Soil type	Location
LP+Lc+HI/3 [Plintic *Luvisol + chromic luvisol + luvic feozem /fine]*	TL and hydroelectric infrastructure area
Lo+LK+Vp/3 [Ortic *Luvisol + Calcic Luvisol + pellic Vertisol/fine*]	TL and hydroelectric infrastructure area
HI+E+I/3[Luvic *Feozem +Rendzine+Litosol/fine*]	Hydroelectric infrastructure area
Hh+Lc+Re/2 [Haplic *Feozem +Chromic Luvisol +Eutric Regosol /medium*]	Hydroelectric infrastructure area
Hi +Lo/2 [Luvic *Feozem + Ortic Luvisol*]	TL and hydroelectric infrastructure area
Lc+Vp/3 [Chromic *Luvisol +Pellic Vertisol*]	Hydroelectric infrastructure area

The predominant soil unit Luvisol (L) has the following characteristics: high susceptibility to erosion, fertile, clayish, slightly acid, red to yellowish tones although it also presents grayish and brownish tones that are not completely dark.

D) Superficial and underground hydrology

The area of the project is located in the basin of the Papaloapan before the union of the Santo Domingo River with the Río Tonto River, both of which form the Papaloapan.

The basin of the Papaloapan River includes hydrologic region No. 28. It is located in the basin of the Gulf of Mexico, approximately in the middle part of the arch that forms the Mexican coast. The total area of the hydrologic basin is calculated at 46,517 km². The Santo Domingo River pertains to this hydrologic region and the area of the basin to the site of the dam is 5,350 Km^2.

The hydrographic system of the Papaloapan is the second most important in the country because of its flow, after the Grijalva-Usumacinta system. Its waters flow into the Laguna de Alvarado at an average 47,000 million cubic meters per year, with fluctuations between 25,000 and 67,000 million cubic meters. The average value is equal to 112% of the annual outpoured volume at a national level.

- Nearby Reservoirs and Bodies of Water.

Dams

The Miguel de la Madrid Hurtado “Cerro de Oro” Dam is located at the basin of the Santo Domingo River and the Miguel Alemán “Temascal” dam is located on the Tonto River.

Rivers and Streams

Downstream from the curtain of the dam, two rivers join the riverbed of the Santo Domingo River on its right margin. The first one, the La Sal stream, which has a lesser outflow, enters at an approximate distance of 2 km. The second one, Río del Valle (Valle Nacional) river, which has a greater outflow, also enters through the right margin of the Santo Domingo river, at a distance of 8 km with respect to the location of the dam.

- Main uses or activities.

In accordance with the data of the National Water Commission, the use of water in the basin is distributed as follows: agricultural 59%, industrial 11%, agro-industrial 15%, public urban 14% and other uses represent 1%, of a total volume of 1,036 million cubic meters/year (Mm^3/year). There is a high non-deplenishing demand (17,973 Mm^3) for the generation of electric energy, which mainly includes the Temascal hydroelectric facility in the dam having the same name, as well as other smaller hydroelectric, such as Tuxpango and Canseco.

All the bodies of water close to the project are used in agricultural and livestock activities, alternating different activities such as sugar cane, corn, sesame, coffee, peanut and some fruit crops, particularly plantain bananas, rubber and cocoanut, along with livestock. With regard to the Miguel de la Madrid dam, in addition to outflow control and communicating basin with the Miguel Alemán dam for the generation of electric energy, the reservoir is being used for fishing and to a lesser extent, for nautical sport activities.

- Subterraneous Hydrology

There is no available underground hydrology information for the area where the Cerro de Oro hydroelectric will be built.

With regard to the measurement of the characteristic of the aquifer, readings of the underground water level are regularly carried out, however, study updates and uses census are not conducted frequently. With respect to the measurement of the piesometric levels in the Coast of Veracruz aquifer, until 1999 there was at least one reading per year, however, in accordance with the publication of the Determination of Water Availability in the Coast of Veracruz Aquifer, the pilot wells do not have leveled curbs, which prevent determining precisely the flow network. (Source: *Diagnóstico del sector agua en Veracruz.- Proyecto del Programa Hidráulico Estatal*)

IV.2.2 Biotic Aspects

A) Land Vegetation

Mid Sub-evergreen Jungle or Evergreen Tropical Forest

With respect to the floristic composition, it is important to point out that the evergreen tropical forest in general and especially in low latitudes, is not rich in pteridofites and briofites. Conifers seldom occur in this type of vegetation and seldom is the biomass integrated by dicotiledoneous, represented by many numerous families. Of the latter, it is interesting to note that the Compositae, the vastest group of the phanerogamas are frequently completely absent from evergreen tropical forest climax or exist in a very scarce proportion (Rzedowski 1972). The groups that are almost always well represented are: Rubiaceae, Orchidaceae and Leguminosae.

The evergreen tropical forest in México presents a great number of different communities, the *Lonchocarpus* aff. *sericeus* forests is described by Sousa (1964) as having floodable soils with pseudogley, of Tuxtepec, Oaxaca, in addition to the dominant species, the following high trees are present: *Scheelea liebmannii, Rodbinsonella mirandae, Brosimum alicastrum, Spondias bombin.*

The following lists includes genres also found in the secondary derived vegetation of the evergreen tropical forests of Mexico: *Acacia, Adelia, Albizzia, Bauhinia, Bixa, Calliandra, Chrysophyllum, Cnidoscolus, Combretum, Crotalaria, Desmodium, Didymopanax, Eugenia, Inga, Lantana, Mimosa, Myriocarpa, Paullinia, Piper, Siparuna, Tabebuina, Tabarnaemontana, Tetrororchidium, Vitex.*

In the area of study, this kind of vegetation is found mainly in conditions of high disturbance, due mainly to the infrastructure of the Miguel de la Madrid Hurtado dam and the agricultural, livestock, industrial and urban development activities

It is worth mentioning that in the area where the engine building and electric substation will be built, the National Water Commission removes arborous and shrub-like vegetation to maintain the areas that could be vulnerable for the dam curtain free and clear of vegetation.

- Types of vegetation and distribution in the area of the project and its surroundings.

As mentioned above, [in] the area where the work is planned to be developed, the vegetation presents a high degree of disturbance, for which the conditions of the project area and its surroundings are described below. (See drawing land use and vegetation)

Since vegetation is one of the most important aspects of the landscape of the natural region, its physiognomic and structural characteristics are the result of the conjugated action, in space and time, of various ecological factors. Among these factors, the most important climatic elements are temperature, precipitation, relative humidity, etc., which, in turn, are influenced by latitude, altitude, relief and substratum.

It should be pointed out that in the site there are scarce types of flora and fauna. However, towards the areas surrounding the project and its area of influence, we can observe that the type of vegetation is mainly represented by an evergreen tropical forest.

Table N° 4. 18 lists the vegetation types reported for the Tuxtepec Region by diverse researchers. Such table evidences the absence of species in the zone where the hydroelectric central will be built, as well as the few species present in the site selected for the layout of the transmission line.

Table N° 4.18

Scientific Name/ Common Name	Biologic Form	Reported for the Tuxtepec Region:	Located within the federal zone of the Miguel de la Madrid Hurtado dam	Located in part of the transmission line
ACANTHACEAE *Thumbergia alata* Ojo de pájaro	Grass	Aguilar	Absent	Absent
AMARANTHACEAE *Gomphrena globosa* Sempreviva	Grass SV	Sousa	Absent	Absent
ANACARDIACEAE *Astronium graveolens* Gateado	Tree SMP	Campos	Absent	Present
Spondias mombin Jobo	Tree SV	Campos	Absent	Absent
ANONACEAE *Annona muricata* Guanábana	Tree	Sousa.	Absent	Absent
Malmea depressa Nazareno prieto	Tree SV	Sousa	Absent	Absent
Rollinia jimenezii Anonilla	Tree	Sousa	Absent	Absent
Xylopia frutescens Malagueta	Tree	Sousa	Absent	Absent
APOCYNACEAE *Stemmadenia donnellsmithii* Cojón de toro	Shrub SV	Campos	Absent	Present
Thevetia ahouai Huevo de perro	Shrub SV	Campos	Absent	Present
T. coronaria	Shrub SV	Campos	Absent	Absent
T. peruviana Venenillo	Shrub SV	Campos	Absent	Present
AQUIFOLIACEAE *Ilex condensata* Escobillo prieto	Tree	J. Jiménez	Absent	Absent
ARACEAE *Anthurium schlechtendalii* Malanga	Epiphyte Grass HEJ	Sousa	Absent	Absent
ARECACEAE (PALMAE) *Bactris balanoidea* Chiquiyul	Shrub HEJ	Sousa	Absent	Absent
Chamaedorea tepejilote Tepejilote	Grass HEJ	N Diego	Absent	Present

Table N° 4.18

Scientific Name/ Common Name	Biologic Form	Reported for the Tuxtepec Region:	Located within the federal zone of the Miguel de la Madrid Hurtado dam	Located in part of the transmission line
Ch. oblongata Palm	Grass HEJ	J. Jiménez	Absent	Absent
Desmoncus chinantlensis Palm	Shrub HEJ	Sousa	Absent	Present
Scheelea liebmanii Coyol real	Tree SV	Sousa	Absent	Present
ARISTOLOCHIACEAE *Aristolochia maxima* Guaco	Grass HEJ	Sousa	Absent	Absent
ASCLEPIADACEAE *Asclepios curassavica* Leche de sapo	Shrub SV	Sousa	Absent	Present
ASTERACEAE (COMPOSITAE) *Eupatorium odoratum* Crucetillo oloroso	Shrub SV	J. Jiménez	Absent	Absent
Eupatorium sp. Crucetillo	Shrub SV	J. Jiménez	Absent	Present
Montanoa grandifolia Acahual	Shrub SV	J.Jiménez	Present	Present
Tagetes erecta Flor de muerto	Grass	J. Jiménez	Absent	Present
T. lucida Pericón	Grass SV	J. Jiménez	Present	Present
Vernonia deppeana Xiquite	Shrub SV	J. Jiménez	Absent	Absent
BEGONIACEAE *Begonia sp.* Begonia	Grass HEJ	J. Jiménez	Absent	Present
BIGNONIACEAE *Crescentia cujete* Jícaro	Tree Pastizal	J. Jiménez	Absent	Present
Parmentiera aculeata Guchilote	Tree Pastizal	J. Jiménez	Absent	Present
BIXACEAE *Bixa orellana* Axiote	Tree SV	J. Jiménez	Absent	Present
BOMBACACEAE *Ceiba pentandra* Pochota	Tree SV	J. Jiménez	Absent	Present
Pachyra acuatica Apompo	Tree SV	J. Jiménez	Absent	Absent
BORAGINACEAE *Cordia alliodora* Sichicuwater	Tree SMP	Sousa	Absent	Absent
C. stellifera	Tree SV	Sousa	Absent	Absent
Heliotropium angiospermum Alacrancillo	Grass SV	Sousa	Absent	Absent
BROMELIACEAE *Aechmea bracteata*	Grass SV	J. Jiménez	Present	Present
Aechmea sp. Pita	Grass HEJ	J. Jiménez	Absent	Present
BURSERACEAE *Bursera subminiliformis*	Tree	Sousa.	Absent	Present

Table N° 4.18

Scientific Name/ Common Name	Biologic Form	Reported for the Tuxtepec Region:	Located within the federal zone of the Miguel de la Madrid Hurtado dam	Located in part of the transmission line
Bursera simaruba Chacá, palo mulato	Tree SV	Sousa	Absent	Absent
CANNACEAE *Canna indica* Chilalaga	Grass SV	J. Jiménez	Present	Present
COCHLOSPERMACEAE *Cochlospermum vitifolium* Pongolote	Shrub SV	J. Jiménez	Absent	Absent
CYPERACEAE *Cyperus diffusus* Reed	Grass SV	Sousa	Present	Present
DILLENIACEAE *Curatella americana* Bejuco tachicón	Tree SV	Sousa	Absent	Absent
DIOSCOREACEAE *Dioscorea composita* Barbasco	Tree HEJ	J. Jiménez	Absent	Absent
ELEOCARPACEAE *Muntigia calabura* Capulín manso	Shrub SV	Sousa	Absent	Present
EUPHORBIACEAE *Acalipha alopecuroides* El gatito	Grass SV	Sousa	Absent	Absent
A. wilkesiana	Grass HEJ	Sousa	Absent	Absent
Alchornea latifolia Palo de huevo	Tree HEJ, MSEJ	J. Jiménez	Absent	Present
Cnidoscolus acinitifolius Mala mujer	Shrub SV	Sousa	Absent	Absent
Croton draco Sangredo	Tree SV	Sousa	Absent	Absent
Croton aff. *Glabellus* Lecherillo	Shrub SV	Sousa	Absent	Absent
C. reflexifolius Huesillo prieto	Shrub SV	J. Jiménez	Absent	Absent
Euphorbia millii	Shrub	J. Jiménez	Absent	Absent
GRAMINEAE *Digitaria horizontales* Grass	Grass	J. Jiménez	Present	Present
Lasiacis grisebahii Grass	Grass HEJ	J. Jiménez	Absent	Absent
L. ruscifolia Grass	Grass SV	J. Jiménez	Absent	Absent
LAURACEAE *Nectandra sp.*	Tree HEJ	Sousa	Absent	Present
LEGUMINOSAE *Mimosa eurycarpa* Uña de gato	Shrub	Standley.	Absent	Absent
Acacia angustissima Huajillo blanco	Shrub SV	Sousa	Absent	Present
A. cornigera Cornezuelo	Shrub SV	Sousa	Absent	Present
Acosmium panamense Guayacan	Tree HEJ MSEJ	Sousa	Absent	Present

Table N° 4.18

Scientific Name/ Common Name	Biologic Form	Reported for the Tuxtepec Region:	Located within the federal zone of the Miguel de la Madrid Hurtado dam	Located in part of the transmission line
Bauhinia divaricada Pata de cabra	Shrub SV	Sousa	Absent	Present
Caesalpinia pulcherrima Espuela de caballero	Shrub SV	Sousa	Absent	Present
Calliandra houstoniana Timbrillo rojo	Shrub SV	Standley	Absent	Absent
Cassia flexuosa	Shrub SV	Sousa	Absent	Absent
C. grandis Caña fistula (cane)	Tree	N Diego	Absent	Present
Cojoba arborea Caña masa (cane)	Tree HEJ MSEJ	J. Jiménez	Absent	Present
Chamaecrista nictitans	Grass SV	J. Jiménez	Present	Present
Enterolobium cyclocarpun Anacaste	Tree SV, SMP	Sousa	Absent	Present
Eritrina folkersii Cochoquelita	Tree	Sousa	Absent	Present
Hymenaea courbaril Guapinol	Tree Crops	Sousa	Absent	Absent
Inga vera Jinicuile	Tree Riverbank	Sousa	Absent	Present
Gliricidia sepium Cocuite	Tree Crops	Sousa	Absent	Absent
Leucaena leucocephala Guaje	Shrub SV	Sousa	Absent	Present
L. glabrata Guaje	Shrub SV	Sousa	Absent	Absent
Lonchocarpus hondurensis Palo de Agua	Tree HEJ	J. Jiménez	Absent	Present
Lonchocarpus sp Purple Rose	Tree HEJ	J. Jiménez	Absent	Present
Mimosa albida Dormilona grande	Grass SV	Sousa	Present	Present
M. pudica Dormilona	Grass SV	Sousa	Absent	Present
M. pigra Zarza (prickly bush) lagunera	Shrub SV	Sousa	Absent	Present
M. vellociana Uña de gato	Grass SV	Sousa	Present	Present
Pithecellobium dulce Múchite	Shrub SV	Sousa	Absent	Present
P. recordii Cocoite de montaña	Tree	Sousa	Absent	Absent
Pithecellobium sp	Shrub SV	Ramírez Alcocer.	Absent	Absent
Platymiscium yucatanum Chagane	Tree HEJ	M. Martinez	Absent	Absent
MALVACEAE *Malvaviscos arboreus* Tulipancillo	Shrub	Reko	Absent	Absent
Robinsonella mirandae Majahuca blanca	Tree HEJ MSEJ	Sousa	Absent	Absent

Table N° 4.18

Scientific Name/ Common Name	Biologic Form	Reported for the Tuxtepec Region:	Located within the federal zone of the Miguel de la Madrid Hurtado dam	Located in part of the transmission line
MALPIGHIACEAE *Byrsonima crassifolia* Nanche	Tree Cultivos	Sousa	Absent	Present
MELASTOMACEAE *Conostegia sp.*	Shrub V S	Carmargo Ricalde	Absent	Present
Leandra sp.	Shrub SV	Camargo Ricalde	Absent	Present
Miconia argentea Hoja de lata	Tree/Shrub. SV	Aguilar	Absent	Present
M. fulvostellata Ojo de pájaro	Shrub SV	Aguilar	Absent	Present
MELIACEAE *Cederla odorata* Cedar	Tree HEJ	Campos	Absent	Absent
Swietenia macrophylla Mahogany	Tree HEJ	Campos	Absent	Absent
Trichilia havanensis Tinajilla	Tree SV	Campos	Absent	Present
MORACEAE *Brosimum alicastrum* Ojite	Tree HEJ, MSEJ	Camargo Ricalde	Absent	Present
Ficus tecolutensis Amate	Tree	Reko	Absent	Absent
Trophis recemosa Leche María	Tree SMP SV	Vera	Absent	Absent
MUSACEAE *Musa cavendishii* Platanillo	SV	Aguilar	Absent	Absent
M. acuminata Guinea Banana	Introducida y/o cultivada SV	Mejía y Dávila	Absent	Present
ORCHIDACEAE *Oncidium* sp. Flor de mayo	Grass HEJ SV	Villar y Velasco	Absent	Present
Vanilla fragans Vanilla	Grass HEJ	Villar y Velasco	Absent	Absent
PIPERACEAE *Piper auritum* Omequelite	Shrub SV	Aguilar	Present	Present
RUBIACEA *Bouvardia ternifolia* Trompetilla	Grass SV	González Ortega	Absent	Present
Sickingia rhodoclada Nazarene	Tree HEJ	Sousa	Absent	Present
SAPOTACEAE *Manilkara sapota* Gum	Tree HEJ	Rzedowski	Absent	Present
SAPINDACEAE *Cupania dentata* Agua al ojo blanco	Tree MSEJ, HEJ, SV	Agilar	Absent	Present
ULMACEAE *Aphanante monoica* Rosadillo	Tree HEJ, MSEJ	Sousa	Absent	Present

Table N° 4.18

Scientific Name/ Common Name	Biologic Form	Reported for the Tuxtepec Region:	Located within the federal zone of the Miguel de la Madrid Hurtado dam	Located in part of the transmission line
Trema micrantha Capulín	Tree SV	Sousa	Absent	Present

SV=Secondary Vegetation ; MSEJ= Mid sub-evergreen jungle; HEJ= Selva Alta Perenifolia

As can be seen there is no primary vegetation in the area where the Cerro de Oro Hydroelectric central will be built and the existing vegetation is mainly secondary. This is because the primary vegetation was torn down to construct the dam, therefore, the infrastructure of the Miguel de la Madrid Hurtado dam is currently on the site (photos 40, 41, 42).

- Uses of the vegetation in the area (species of local use and importance for local or ethnic groups and species having a commercial interest).

None of the species found during the development of this study are reported as important for ethnic groups, organizations or local groups. Ceremonial or religious uses are not reported either. The rubber tree, however, does have a wide range of uses including: adhesive, gum for chewing gum, varnishes and electric insulators produced with latex from trunk. Additionally, the wood is used in musical instruments, crafts and construction. In the area, this species is used in great surfaces as single crop, principally for the extraction of latex and sale of fruit.

Due principally to the land use of the area of the Cerro de Oro hydroelectric project and its direct and indirect area of influence, it is evident that the anthropic pressure has had a direct influence on the diversity of the natural vegetation, leaving the site where the hydroelectric central will be built without vegetable and animal representatives.

Because no vegetation exists, no species of commercial value for local residents are reported.

In accordance with the surveys performed with local residents, the uses reported in the region of Tuxtepec are listed in table N°4.19

Table N° 4.19

Scientific Name/Common Name	Biological form	Local Use	Commercial Interest for local groups
Agave sp. Maguey	Shrub	Live fence, Medicinal	None
Yucca sp.	Shrub	Live fence, ornamental	None

Table N° 4.19

Scientific Name/Common Name	Biological form	Local Use	Commercial Interest for local groups
Astronium graveolens. Gateado	Tree	Timber-yielding	Without reference
Manguifera indica Peach mango	Tree	Edible, Medicinal	The fruit
Spondias mombin Jobo	Tree	Live fence, edible	The fruit
Annona muricata Guanábana	Tree	Edible	The fruit
Malmea depressa Nazareno prieto	Tree	Medicinal	Without reference
Xylopia frutescens Malagueta	Tree	Construction timber yielding, fuel	Without reference
Stemmadenia donnellsmithii Cojón de toro	Tree/ Shrub	Medicinal, glue	None
Thevetia periviana Venenillo	Shrub	Medicinal	None
Ilex condensata Escobillo prieto	Tree	Construction, Fuel	Without reference
Dendropanax arboreus Palo de water, cucharo	Tree	Medicinal, Fuel	Production of panels
Bactris balanoidea Chiquiyul	Shrub	Fodder, crafts	Without reference
Chamaedorea tepejilote Tepejilote	Grass	Ornamental, edible	Inflorescence
Scheelea liebmanii Coyol real	Tree	Construction	Without reference
Aristolochia maxima Guaco	Grass	Medicinal, Ornamental	None
Asclepios cirassavica Leche de sapo	Shrub	Medicinal	None
Eupatorium odoratum Crucetillo oloroso	Shrub	Medicinal	Without reference
Eupatorium sp. Crucetillo	Shrub	Medicinal	None
Montanoa grandiflora Acahual	Shrub	Medicinal, ornamental	None
Tapetes erecta Flor de muerto	Grass	Medicinal, ornamental	Without reference
T. lucida Pericón	Grass	Medicinal, ornamental	None
Vernonia deppeana Xiquite	Shrub	Medicinal	None
Crescentia cujete Jícaro	Tree	Medicinal, agricultural implements	The fruit
Parmentiera aculeata Guchilote	Tree	Medicinal, edible	The fruit
Bixa orellana Axiote	Tree	Fuel, medicinal, coloring.	None
*Ceiba pentandra** Pochota	Tree	Live fence, ornamental	None
Manilkara zapota	Tree	Edible, fodder, tanning, timber production	Latex, fruits

Table N° 4.19

Scientific Name/Common Name	Biological form	Local Use	Commercial Interest for local groups
Bursera simaruba	Tree	Live fence, medicinal	None

- Presence of vegetable species under legal protection.

Threatened species or species in danger of extinction

Although studies on Oaxaca's flora and fauna consider Tuxtepec as an area with a considerable amount of endemisms and species under special protection or certain conservation status, due to the infrastructure of the Miguel de la Madrid Hurtado dam, the sites where the Cerro de Oro hydroelectric central will be built and where the transmission line will pass through, which have a mainly agricultural land use, including their area of influence, do not have any species of flora and fauna under a legal protection regimen. The foregoing, pursuant to NOM-059- SEMARNAT 2001, *environmental protection – native species of wild flora and fauna of México– risk categories and specifications for inclusion, exclusion or change – list of endangered species*, as well as under other applicable provisions, including the Convention on International Trade of Endangered Species of Wild Flora and Fauna, CITES; international conventions, etcetera.

In accordance with the list of species reported and determined for the area where the hydroelectric central and its transmission line are intended to be built, none of the species included in NOM-059- SEMARNAT 2001 exist therein. Table N° 4.20

Species of hunting interest.

There are none and none are intended to be introduced

B) Land and/or aquatic species

- Composition of the fauna communities present in the area.

By virtue of the fact that the area where the Cerro de Oro Hydroelectric Project will be built lacks the necessary physiographic conditions to establish endemisms, and that current conditions have caused the non-representation of the vegetable community (mid sub-evergreen jungle) and the predomination of secondary vegetation in lieu of the former.[sic][5]

[5] Translator's Note: Incomplete sentence in original version.

Additionally, as can be observed from the Chapter VIII Photographs, the scarce flora and fauna of the area where the hydroelectric central will be built and the layout of the transmission line will pass through are represented by extensive farming areas and some spots of mid altitude sub-evergreen jungle intermixing with a well-represented secondary vegetation. It is impossible to establish with certainty the composition of the fauna community of the area, without counting the large empty spans of the forest because of the deforestation.

Consequently, the information on the composition of the fauna communities presented herein will be based on the more studied groups in the State, since there are no records or inventories prior to the construction of the Miguel de la Madrid Hurtado dam for the federal zone. Thus, the fauna associated to the type of vegetation that prevails in the less perturbed areas is set forth in Table N°4.20

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
MAMMALS	DIDELPHIDAE *Didelphis marsupiales* Common Possum	Oaxaca	TL
	Philander opossum Tlacuache cuatro ojillos (Four-eyed Possum)	Tuxtepec	TL
	DASYPODIDAE *Dasypus novemcinctus* Armadillo de nueve bandas (Nine band Armadillo)	Oaxaca	TL
	MORMOOPIDAE *Pteronotus personatus* Murciélago bigotudo de Parnell (Parnell Bat)	Oaxaca	TL
	PHYLLOSTOMIDAE *Glossophaga soricina* Murciélago lengüeton de Pallas (Pallas Bat)	Tuxtepec	TL
	Sturnira lilium Murciélago de Charreteras menor (Charreteras Minor Bat)	Oaxaca	TL

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
	Sturnira ludovici Murciélago de Charreteras mayor (Charreteras Major Bat)	Oaxaca	TL
	Uroderma bilobatum Murciélago acampador oscuro (Dark camping bat)	Tuxtepec	TL
	Artibeus jamaicensis Jamaica Fruit Bat	Tuxtepec	TL
	Artibeus lituratus Giant Fruit Bat	Oaxaca	TL
	Carolia brevicauda Silky short tail bat	Oaxaca	TL
	Diphylla ecaudata Hairy leg Bat	Oaxaca	TL
	SCIURIDAE *Sciurus aureogaster* Gray squirrel	Oaxaca	TL
	GEOMIDAE *Orthogeomys hispidus* Gopher	Oaxaca	TL
	DASYPROCTIDAE *Dasyprocta mexicana* Zerete	Tuxtepec	TL
	AGOUTIDAE *Agouti paca* Tepescuintle	Tuxtepec	TL
	LEPORIDAE *Sylvilagus brasiliensis* Tropic Rabbit	Oaxaca	TL
	Sylvilagus floridanus Serrano Rabbit	Oaxaca	TL

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
	CANIDAE Canis latrans Coyote	Oaxaca	A
	PROCYONIDAE *Porción lotor* Raccoon	Oaxaca	A
	Nasua narica Coati	Oaxaca	A
	MUSTELIDAE *Galictis vittata* Ferret	Oaxaca	TL
	TAYASSUIDAE *Tayassu tajacu* Collar Peccari	Oaxaca	A
BIRDS	ANATIDAE *Dendrocygna autumnalis* Black –bellied whistling duck	Tuxtepec	A
	ARDEIDAE *Casmerodius albus* White heron	Oaxaca	TL
	CATHARTIDAE *Coragyps atratus* Common Buzzard	Oaxaca	TL
	ACCIPITRIDAE *Buteo mangirostris* Aguililla caminera (Eaglet)	Oaxaca	A
	Chondrohierax uncinatus Pico ganchudo (hook beak sparrowhawk)	Oaxaca	TL
	Buteogallus urubitinga Major black eaglet	Oaxaca	TL
	FALCONIDAE *Falco sparverius* American Kestrel	Oaxaca	TL
	COLUMBIDAE *Columbina inca* Black tail turtledove	Oaxaca	A

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
	Columbina minuta Smooth chest Turtledove	Oaxaca	A
	Columbina talpacoti Red Turtledove	Oaxaca	A
	PISTTACIDAE *Aratinga canicularis* Orange front parrot	Oaxaca	A
	CUCULIDAE *Crotophaga sulcitostris* Major cowbird	Oaxaca	A
	CAPRIMULGIDAE *Caprimulgus vociferus* Tapacamino cuerporruín	Oaxaca	TL
	Nyctidromus albicollis Chotacabras pauraque (Nightjar)	Oaxaca	TL
	TROCHILIDAE *Amazilia rutila* Cinnamon hummingbird	Oaxaca	A
	ALCEDINIDAE *Chloroceryle americana* Green Kingfisher	Oaxaca	A
	PICIDAE *Melanerpes aurifrons* Cheje Woodpecker	Tuxtepec	A
	FURNARIIDAE *Anabacerthia variegaticeps* Breñero cejudo	Oaxaca	TL
	TYRANNIDAE *Elaenia flavogaster* Elenia vientre amarillo	Oaxaca	TL

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
	Pyrocephalus rubinus Mosquero cardinal (cardinal)	Oaxaca	TL
	Pitangus sulphuratus Luis bienteveo	Oaxaca	A
	Megarhynchus pitangua Luis pico grueso	Oaxaca	A
	Tyrannus melancholicus Tirano tropical (tropical tyrant)	Oaxaca	A
	Pachyrampus Aglaiae *Mosquero cabezón degollado (headless flycatcher)*	Oaxaca	TL
	CORVIDAE *Cyanocorax morio* Chara papán (jay)	Oaxaca	TL
	HIRUNDINIDAE *Tachycineta bicolor* Bicolor Swallow	Oaxaca	A
	Thoryothorus maculipectus Chivirín moteado	Oaxaca	A
	TURDIDAE *Myadestes unicolor* Clarín unicolor (unicolor bugler)	Tuxtepec	TL
	Turdus grsyi Mirlo pardo (Gray blackbird)	Tuxtepec	CM, TL
	Turdus migratorius Mirlo primavera (Spring blackbird)	Oaxaca	CM, TL
	PARULIDAE *Vermivora pinus* Chipe aliazul (Blue winged warbler)	Tuxtepec	A

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
	Leptotila verreauxi Paloma suelera (Suelera Dove)	Oaxaca	TL
	Accipitridae Paloma (Dove)	Oaxaca	A
	Columbia livia Paloma común (Common Dove)	Oaxaca	A
	Cathartes aura Zopilote común (Common Buzzard)	Oaxaca	TL
	Ardeidae Paloma (Dove)	Tuxtepec	A
REPTILES	CORYTOPHANIDAE *Basiliscus vittatus* Turtle	Oaxaca	A
	EUBLEPHARIDAE *Coleonyx elegans nemoralis* Turtle	Oaxaca	A
	PHRYNOSOMATIDAE *Sceloporus gadovae* Lizard	Tuxtepec	TL
	SCINCIDAE *Eumeces brevirostris brevirostirs* Without reference	Oaxaca	A
	TEIIDAE *Ameiva undulata dextra* Without reference	Tuxtepec	A

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
	XENOSAURIDAE *Xenosaurus penai* Without reference	Tuxtepec	A
SUB-ORDER SERPENTS	COLUFLANGEE *Clelia clelia clelia* Without reference	Oaxaca	TL
	ELAPIDAE *Pelamis platurus* Without reference	Oaxaca	A
	LEPTOTYPHLOPIDAE *Leptotyphlops goudoti bakewelli* Snake	Tuxtepec	TL
	TYPHLOPIDAE *Ramphotyphlops braminus* Without reference	Oaxaca	TL
	VIPERIDAE *Crotaluas durissus ssp.* [2] Tropical Rattlesnake, Tzabacan	Oaxaca	A
AMPHIBIOUS	AMBYSTOMATIDAE *Ambystoma rivulare* Ajolote (Axolotl)	Oaxaca	A

Table N° 4.20

GROUP	*Scientific Name* / Common Name	Reported for the region, site or town	Location
	LEPTODACTYLIDAE *Eleutherodactylus augusti cactorum* Without reference	Tuxtepec	A
	RANIDAE *Rana zweifeli* Frog	Oaxaca	A

TL: Layout of the transmission line
A: Absent in the transmission line layout, particularly in the surface that the infrastructure of the Hydroelectric central will cover
(1).- Species subject to special protection under NOM – 059- SEMARNAT-2001
(2).- Species catalogued as threatened in accordance with NOM – 059- SEMARNAT-2001

The scientific and common names of the species existing where the hydroelectric central and the line will be built are indicated under Table N° 4.20. It should be pointed out that in the sampled sites during the fieldwork, no species in state of conservation pursuant to NOM–059-SEMARNAT-2001, under ban, in the hunting calendar or that are indicator species of the quality of the environment were found.

Due to the lack of fauna inventories for the area and the deterioration of the natural environment in the area where the hydroelectric central will be built and the surface through which the transmission line of the Cerro de Oro hydroelectric project will pass, this study does not report results referring to: the abundance, distribution, relative density of endangered or special relevance species.

IV.2.3 Landscape

The area of study currently does not possess a variety of natural resources, since its land use is for hydraulic infrastructure, for which the establishment of the hydroelectric central is consistent with current uses.

Visual quality of the immediate surroundings is good. From the point where the engine building and electric substation will be located it is possible to clearly see the curtain of the Miguel de la Madrid Hurtado dam, surrounded by a well-represented arborous and shrub strata, dominated, as mentioned above, by species representative of secondary vegetation, which are indicators of perturbed environments. The quality of the background is modified, that is, the visual background is represented by the dam's reservoir.

Downstream from the dam curtain, irregular human settlements were observed in high-risk areas.

IV.2.4 Socioeconomic Conditions

Due to its location and access conditions, the municipality of Tuxtepec will not be socially impacted.

The purpose is to analyze how the human communities established in the area of study of the project relate to their environment. Such analysis will provide knowledge on the demographic aspects, the habitat, the resources and environmental services. At the same time, it will be possible to identify the relevant elements that if altered by the project, would affect the distribution and abundance of the population, the use of natural resources, and the environmental services that would determine the quality of life as well as traditions and customs.

A) Demography

- Number of inhabitants by identified population nucleus.

Pursuant to the XII General Population and Housing Census 2000 conducted by INEGI, the total population of the municipality of Tuxtepec is 133,913 inhabitants, of which 64,631 are men and 69,282 are women. The total population of the municipality represents 3.89 percent, with respect to the total state population.

- Population growth rate of the municipality of San Juan Bautista Tuxtepec.

Table 4.21

Period	Municipal
1980 – 1990	6.07%
1990-1995	3.0%
1995 – 2000	0.95%

SOURCE: *Sistema Nacional de Información Municipal.- INEGI United Mexican States. XII General Population Census, 2000 tabulated from the Census Sample. Extended Questionnaire. México, 2000.*

The municipality number for Tuxtepec is 184.

The average annual population growth rate from 1980 to 1990 of the municipality of Tuxtepec with respect to the State of Oaxaca was 3.64%, and from 1990 to 1995 3.95%-. The population density reported for 1990 was 176.17 Inhab. /km^2 and for 1995, 204.28 Inhab. /km^2.

Housing

Pursuant to the information provided by the National Municipal Development Center, the typical housing in the municipality of Tuxtepec is 2 to 5 room private homes, representing 50.67% of the dwellings with asbestos and metal sheet roofs, with electric power and running water, with a good services coverage index.

Health and Social Security

- Social security system and coverage

Infrastructure of Health Sector in 2000 for the municipality of Tuxtepec.

Table 4.22

Units (clinics or hospitals)	First Level	Second Level	Third Level
	19	3	0

Table 4.23

Beds		Doctors	
Countable in census	98	General Practitioners	72
Not countable in census	74	Specialists	76
Offices	63	In another activity	39

Table 4.24

Consultations		Nurses	
General	101,916	General	126
Specialized	26,494	Specialized	22
		Others	136
Surgical Interventions	5,113	Childbirths	3,451
Active Family Planning Users	6,281	Live births	3,408

Education

- Population between 5 and 14 years attending school: 118,341; population with the minimum education level: 87.5%; illiteracy index: 0.79.

Table 4.25

Schools	Pre-school	Elementary	Middle School	High School	Training for work	Mid professional
	100	133	52	12	7	3
Students						
Total	12,813	40,774	21,535	10,799	9,330	1,976
Groups						
Existent	264	997	279	117	165	25

Poverty Index

Pursuant to the Consejo Nacional de Población (Conapo) (National Population Council).

In accordance with the data of the Consejo Estatal de Población (COESPO) (Population State Council), in 2000 the State of Oaxaca was the third state with the highest marginalization in the country, while the municipality of San Juan Bautista Tuxtepec registers an average marginalization index number 1,775 at a national level.

In some of the education, basic services and nutrition indicators, the state is behind the rest of the country, being among those with the highest relative marginalization. In some towns, municipalities and regions, these indicators are a cause for concern, since despite regional progress, marginalization still predominates in numerous municipalities, within which contrasts occur in the relative development of communities, some of which have low and others very high levels of marginalization.

Oaxaca is a state that is behind the other states of Mexico in connection with social well-being pursuant to the 1990 Population and Housing Census. The illiteracy indicators of the state are above the national level, because the percentage of illiterate persons in the state over 15 years old is 21.49%, while the national index is 12%. Additionally 45.53% of the population over 15 years of age has not completed elementary school in the state while the national indicator for such group is 29%. The foregoing means that out of every 10 residents over 15 years of age in the state, almost 8 are illiterate or did not complete elementary school.

As to services coverage in the state, 44.36% of the registered homes have drainage and electricity and 18.89% have drainage and running water. With regard to the 86.73% of the residents that have homes with kitchens in the state, 70.95% have separate kitchens and 11.83% have the kitchen in the same room as the bedroom.

In the state of Oaxaca, el 41.60% of the occupants of the registered homes still have dirt floors inside, yet nationally, such indicator is only 20%.

In accordance with such indexes, the situation becomes more acute in the priority attention regions.

Marginalization and unemployment are the principal problems of the state. In over half the territory of the State, there are high marginalization levels, corresponding to a degree of 2.079, mainly due to the geographic difficulty and isolation of the communities, which makes it difficult to provide the goods and services of the municipal seats.

Low productivity and scarcity of employment in the marginalized zones cause a strong immigration flow, chiefly to the capital of the country and the United States.

Indicators for the municipality of Tuxtepec.

Table 4.26

Over 15 years illiterate	Occupants in private households	
21.49%		
Over 15 years without having completed elementary education		
45.53%	Without drainage or toilet	18.07%
Residents in towns of less than 5 thousand.	Without electric power	12.54%
64.01%	Without running water	26.95%
Employed with income under 2 m.w.	Overcrowded	59.45%
71.93%	With dirt floor	41.60%

m.w= minimum wage

In the area of influence of the hydroelectric project, the predominant economic activities are corn, rice, pineapple, sugarcane, beans, tobacco, coffee, banana, mango, cocoanut and rubber crops. (Photos 17, 23, 29, 31) (See figure agricultural potential Oax)

In the livestock sector, meat and cattle milk production is incipient. In backyard conditions, pork farming is carried out, while poultry farming is stagnated because of the high cost of supplies and low market prices of the products.(see figure livestock potential Oax.)

Forest activity in the state of Oaxaca depends on a forest regionalization handled in the State Forest Commission. It is based on tree forest surfaces and on the total timber-yielding supplies of the different botanic genres that constitute the temperate and cold climate forests, the distribution of the authorized timber-yielding uses in connection with

the management thereof by the technical forest services suppliers and the classes of forests from a commercial standpoint.

Economic Participation

In 2000, the population for the state of Oaxaca was estimated at 3,438,765 residents of which 48.2% were men and 51.8 % women, being at the 10th national place; since a large percentage lives in rural areas, this percentage indicates the pressure of the State over farming land. The rural EAP [Economically Active Population] is 417,088 persons, representing 22.5% of rural population and 38.8% of the state's EAP.

In the agricultural and livestock sector, 22.13% of the employed population does not receive any salary, 36.78% receives less than minimum wage and 18.24 receive the equivalent to 1 to 2 minimum wages.

Women have increased their participation in agricultural and forest activities, as well in access to land tenancy, currently representing 21.03% of the potential parcel owners.

The Gross Internal Product (GIP) of the State represents 1.52% of the national GIP, however, the GIP has had a 1.03 increase factor in the last years. In connection with rural income, more than 50% derives from agricultural and forest activities; non-agricultural rural income is generated by other activities such as industry and services.

Tuxtepec's participation in the economy is reflected in the following tables:

Table 4.27

Economic participation 2000		
Population	Residents	Percentage
Over 12 years of age	87,107	65.04
Economically active	47,350	35.35
-EAP Employed	46,852	34.98
- EAP Unemployed	498	0.37
Economically inactive	49,002	36.59
Not specified	953	0.71

EAP by activity sector

Table 4.28

EAP by activity sector		
Sector	Persons	Percentage
Primary	11262	23.78
Secondary	10202	21.54

EAP by activity sector		
Tertiary	24824	52.42
Not specified	1062	2.24

Rate of economic participation of the economically active population over 12 years of age 49.0% and an occupation rate of 98.94%

Table 4.29

EAP by productive branch		
Field	Persons	Percentage
Agriculture, livestock and fishing	11262	24.03
Mining	41	0.08
Manufacturing industry	6992	14.92
Electric power and water	112	0.23
Construction	3057	6.52
Commerce	8503	18.14
Transportation and communication	1941	4.14
Financial Services	184	0.39
Government Activities	1497	3.19
Recreation and cultural services	210	0.44
Technical and professional services	575	1.22
Hotel and restaurant services	2467	5.26
Real estate services	99	0.21
Others except government	4452	9.50
Support for businesses	472	1.0
Educational Services	3027	6.46
Health and social assistance services	1397	2.98

- Presence of Ethnic Groups

Table 4.30

Indigenous population		
Percentage of indigenous population in the municipality	16.93	%
Total indigenous municipality	22,678	Residents
Over 5 years old	17,620	Residents
Under 5 years old	5,058	Residents

45.29% of the total indigenous population of the municipality speaks Chinanteco and 12.65% speaks Chinateco de Ojitlán.

Nutrition Index

Pursuant to INEGI reports, malnutrition in the state of Oaxaca is as follows: 22.03 % of the population presents low malnutrition, 5.01 % presents moderate malnutrition and the remaining 0.67% severe malnutrition.

Facilities

- Waste management and final disposal services, water supply sources, electric power, etcetera.

There is a site for waste disposal within the municipality itself.

The principal communities of the area have running potable water and electric power through a 34 kv line. The communities close to the project such as the towns of Los Reyes and Santa Ursula have telephone service, elementary school, sports courts, drainage and public lighting.

Types of predominant social organizations

In the state of Oaxaca, Tuxtepec is the second most important municipality.

The total surface of the municipality is 933.90 square kilometers, that is, 0.979% of the total surface of the State. (Source: *Enciclopedia de los Municipios de México, Oaxaca*)

In order to take maximum advantage of the production potential of the region and considering the different kinds of producers, their diverse productive capacities and the geographic areas where they are located, in the area where the project will be located, the principal activities are:

Industry

Tuxtepec has a sugar mill and a diosgemine plant. Also in Tuxtepec is El Aric, a company of coffee producers and El Trópico, a brewery, as well as different export-level banana companies.

Producers are organized in Agrarian Nuclei.

Productive Potential

With regard to productivity, 44.6% of the agricultural surface is concentrated in districts, which have a surface of 252 thousand 265 has., for which low profitability is registered, where at a state level, land used for agriculture is 38.8 % of common use land and 82.6%% of the parceled land, livestock production is 12.9 % in common use land and 4.6% in parceled land, farming and livestock industry is 29.4 % in common use land and 10.4% in parcel land, forest production is minimum, with 20.1% occurring in common use land and 1.1 %, in parceled land; the remaining 7.1 % pertains to other uses. Considering that 1 million 103 thousand 284 Has. is land used for agricultural purposes in the State, constituting 11.5% of the State's surface, of which 89 thousand 284 Has. are irrigation land and 1 million 14 mil Has. are seasonal land, traditional techniques such as slash and burn method, are common practices in the State of Oaxaca. When such techniques are used on surfaces with inclines over 15%, it causes soil degradation. The principal products of the state are corn and beans. During the 2000/2001 corn was planted on 81,527 Has. and 80,850 Has. were harvested, obtaining a production of 178,151 Tons. Beans were planted in a surface of 7,021 Has. and the entirety of such surface was harvested, yielding a production of 6,483 Tons. As for livestock, the region does not register high production indexes. (See figures Agricultural and Livestock Potential Oax)

In low-water seasons, livestock activities greatly diminish.

There are no ecologist groups for the project area.

Economic Aspect

- Land Tenancy Structure.

For the region pertaining to our area of study, land tenancy or ownership is distributed among *ejidatarios* (common owners of agricultural land) and minor landowners.

- Competition for the use of natural resources.

Pursuant to the established regional organization in the State of Oaxaca for the region to which Tuxtepec pertains, there is no data available of any kind of competition for the use of natural resources.

- Possible conflicts for the use, demand and utilization of natural resources among the different productive sectors.

No conflicts were identified for this concept.

B) Socio-cultural Factors

ANALYSIS OF THE CULTURAL SYSTEM

1). Use of natural resources in the area of influence

As mentioned before, the use of natural resources in the area of the project is represented by rubber tree plantations, which produce multiple benefits including latex and gum extraction, etc.

2) Project acceptance level

The construction project of the Cerro de Oro hydroelectric central in federal land of the Miguel de la Madrid Hurtado dam is well accepted by the residents of the surroundings of the federal zone. Such residents regard it as a great opportunity for the creation of new temporary jobs during the construction process and afterwards, during the operation stage, they consider it will be an additional energy source where new job-offering industries will be established.

3). Value attributed to the spaces or sites located within the land where the project will be located.

It should be pointed out that because the land is located within the federal zone, which is restricted for use solely for hydraulic infrastructure services, the value of the spaces or sites where the project will be located (engine building, electric substation and transmission line) is zero from the standpoint of meeting, recreation or collective use places for the residents.

4). Historic Heritage

Since the area is restricted for the use of hydraulic infrastructure, there is no element of historic heritage therein, such as historic, artistic or archeological monuments. Additionally, the areas where the transmission line will pass through are mainly farming lands and no historic, artistic or archeological monuments or single urban complexes exist therein, since most are newly created areas.

IV.2.5 Environmental Diagnostic

In accordance with the field information obtained and the record images of the construction of the dam, the area where the Cerro de Oro Hydroelectric Project will be developed had been previously impacted and lacks individuals (flora and fauna) that identify the place as a well-preserved site. On the contrary, the majority of flora pertains to the type of secondary vegetation that appears after an evergreen tropical forest has been felled. In accordance with the flora and fauna inventories made during this study's fieldwork, none of the species found are indicators that the environment is in a state of succession. This is due to the following: the areas where the engine building and the electric substation will be developed are within the federal zone handled by the National Water Commission. These surfaces are regularly cleared by the security guards of the facilities of the Miguel de la Madrid dam, for the purpose of having the areas of the dam free and clear of vegetation, to avoid the vulnerability of the dam, since the infrastructure is considered as strategic due to the connection it has with the Temascal hydroelectric central. With regard to the areas over which the transmission line will pass, the current use of land in many of such areas is for agricultural, livestock and rural purposes and some have an urban purpose, such as the towns of Santa Ursula, San Rafael and Sebastopol.

In the areas next to where the hydroelectric central will be installed and where the transmission line will pass, it is possible to observe that the secondary vegetation derived from the evergreen tropical forest currently covers surfaces that are much larger than the climax forest.

Pursuant to Rzedowski J. 1978, in general, the succession of the vegetable communities in warm and human climates appears to be extraordinarily complex and in many cases, it is difficult to find in a specific region the regularities of sequence of beings that are more or less clear in other kinds of climates. This phenomenon is particularly noticeable at the level of the arborous and shrubbery phases, which predominate in the regions with secondary vegetation, since the stages where grassy vegetation prevails last very little and are restricted to occupation by ruderalis and arvensis brush.

Sarukhán (1964) conducted an experiment of vegetation succession in the Tuxtepec Oaxaca region over a cleared area. During two years of observation, he reached a series of conclusions that can be observed in the surroundings of the area the where the construction Cerro de Oro Hydroelectric Project is intended:

1. After establishing the first species, the development of the succession is influenced by stumps and other elements capable of regeneration that were left in the land when the clearing was carried out.

2. In the young stages of the succession, representatives of three phanerogam families dominate: Leguminoseas, Compositae and Gramineae.

Additionally, Sousa (1964) conducted a general floristic study of the secondary vegetation that develops in Tuxtepec and found that such secondary vegetation contains species that can be used as indicators of the climax associations from which they derive.

Potential use of the land

The deforested areas located within the federal zone do not have a potential agricultural and/or livestock use, since they were authorized under an exceptionality criterion for the development of basic infrastructure (highways, electric transmission lines, hydraulic infrastructure, etc.) in 1998.

Due to its characteristics and dimensions, the hydroelectric project will not have an influence so significant that it will cause important changes in the local landscape. Although a decrease in the flow along two kilometers of the Santo Domingo River and a flow increase in the La Sal stream are expected, the flow of the Santo Domingo River after it joins the La Sal stream will be the same.

As mentioned above, the assigned land use of the area where the hydroelectric central will be located is for hydraulic infrastructure. The project will not change this condition; rather, it will consolidate it.

As to the current situation, the land use of the properties over where the transmission line will pass is for agricultural and livestock purposes, for which the majority of such properties lack natural vegetation.

Deterioration of the Vegetable Community

Both the construction of the hydraulic infrastructure and the agricultural and livestock activities have greatly affected the vegetable community with respect to its distribution and abundance. In accordance with the reports of Sousa 1964, the species indicated in Table N° 4.18 are characteristic of the disturbed places, whose distribution is uninterrupted in the surroundings of the federal zone.

Federal Zone

The components of the federal zone, such as the reservoir and control structure, will not suffer any modifications with the development of the “Cerro de Oro” hydroelectric project. The reservoir’s ecosystem will remain intact.

The curtain will however suffer modifications in one of its galleries, yet this will not have any repercussions in the aquatic ecosystem.

The level of the water reservoir will not have any oscillations.

It is important to point out that the intake structure will have a screen structure. This, together with the depth of the structure will prevent fish and other objects from passing, for which the icthiofauna population of the reservoir will not be affected.

During the operation of the engine building and substation, the noise produced will only be perceptible inside the building.

It should be noted that in the federal zone, the land use is authorized under the criteria of exceptionality for basic infrastructure. Therefore, the “Cerro de Oro” hydroelectric project is very compatible with the current use.

Due to the characteristics of the current natural stage and of the hydroelectric project’s operation, the vegetation of the area of influence of the engine building and substation will not be altered.

Surface waters

The flow of the Santo Domingo River will decrease considerably with the operation of the hydroelectric central along the tract between the discharge of the spillway and the junction with the La Sal stream. It should be pointed out that the riverbed will not remain without running water at any time, neither during construction nor during operation. On the contrary, the flow of the La Sal stream will increase, having once again the flows it used to have before the Miguel de la Madrid Hurtado dam was built. Currently, this stream contains considerable sediment, which is intended to be removed along the riverbed, prior to the operation of the Cerro de Oro hydroelectric central. The material extracted from sediment removal will be placed on the shoulders of the stream, for which the environmental conditions and adjacent lands will not be affected.

Right of Way of the Transmission Line.

Along the 10.5 km of the transmission line that will be built, the landscape will be modified, since the transmission towers are not a natural element of the region. However, once the line is operating, the holders of the land may continue to use it in their customary agricultural activities, which predominate in the area (photos N° 16, 17, 18, 22, 29, 30, 31)

In the sites where the towers will be developed, the change of the land use will be permanent.

Currently, in a considerable part of such properties agricultural and agro-forest activities are carried out.

Conclusions

No activities are identified that could cause environmental or other damages to the ecosystem, as a result of the environmental impacts the “Cerro de Oro” Hydroelectric Project will cause on one or several environmental elements or ecosystem processes that may trigger an ecologic imbalance.

The loss of environmental elements that affect the function or structure or that modify the evolution or succession tendencies of the ecosystem will not be propitiated.

There will not be any significant alterations of the environmental conditions that could cause the destruction, isolation or fragmentation of ecosystems.

V. IDENTIFICATION, DESCRIPTION AND EVALUATION OF ENVIRONMENTAL IMPACTS

Current Environmental Conditions

The Cerro de Oro hydroelectric central is a project that intends to take advantage of the existing hydraulic infrastructure of the Miguel de la Madrid Hurtado, whose curtain is located between the Cerro de Oro and Santa Ursula mountains in the town of Paso Canoa, within the Municipality of Tuxtepec. Its geographic coordinates are 17º 59' 50" North Latitude and 96º 15' 19" West Longitude. The central will be located at the foot of the embankment of the curtain in the federal zone. The transmission line will begin in the area of the hydroelectric central and end when it interconnects with the Benito Juárez electric substation CFE, located in the town of Sebastopol with coordinates 18º 02' 00" North Latitude and 96º 10' 08" West Longitude. Its trajectory will cover the towns of Santa Ursula and San Rafael, also located in the municipality of Tuxtepec, Oaxaca.

Currently, the land where the hydroelectric will be developed is characterized by its scarce vegetation, dominated by grasses and weeds. The shrub strata are scarcely represented by species characteristic of secondary vegetation, and trees are very reduced. In the place, it is also possible to see some transmission lines and the embankment of the dam's curtain

Fauna is also scarce. The predominating species are amphibians and reptiles. It should be pointed out that the place does not have any evidence of the establishment of a vegetable succession stage after the construction of the Miguel de la Madrid Hurtado dam. This is principally because the personnel in charge of the dam's security frequently fell and trim the vegetation in the federal zone that borders the curtain and where the hydroelectric central will be built, to maintain the vulnerable areas of the infrastructure free from vegetation.

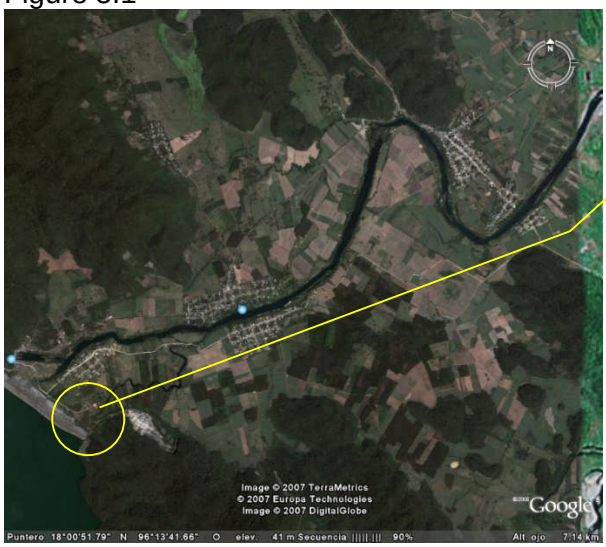
In the properties adjacent to the federal zone, downstream from the curtain, there are rubber single-crops.

Another important element of the current environment is the Santo Domingo River, which, as mentioned in Chapter II, receives the outflow of the control structure of the Miguel de la Madrid Hurtado dam.

It is important to mention that the La Sal stream constitutes an element of the superficial hydrology of the place. This stream's intake basin has been flooded by the reservoir of the Miguel de la Madrid dam and its current flow is formed by the filtrations of the dam and runoffs from the Cerro Santa Ursula.

The environmental scenario of the areas where the transmission line will pass through is mainly composed of land used for agricultural and livestock activities and farming, including rubber, sugar cane and corn crops, as well as urban and rural areas.

Figure 5.1



V.1 Methodology to Identify and Assess Environmental Impacts

The procedure followed to identify, describe, quantify and assess environmental impacts caused by the “Cerro de Oro” Hydroelectric Project is the Leopold reduced matrix method.

In such method, impacts are categorized depending on the degree of severity in related categories. The method consists of identifying in order the main activities of the project, establishing them in columns and categorizing the environmental aspect in rows. The interaction between the two forms a table that allows identifying the impacts of the project on the environment. This method makes it possible to establish a subjective value for such interactions and grade the impacts.

V.1.1 Impact Indicators

Given the environmental conditions of the site where the Cerro de Oro hydroelectric central will be developed and of the sites where the transmission line will pass, the following impact indicators were determined:

1.- Degree of alteration of the natural system.- The purpose of this indicator is to know the level of alteration existing in the natural system of vegetable layers, as a result of human intervention (construction and operation of the Miguel de la Madrid Hurtado dam).

2.- Degree of conservation of the forest system.- It is deemed as the presence of forest areas that have prevailed as a natural unit and have not been significantly affected by human activities. Additionally, with regard to the layout of the transmission line, it is based on the hypothesis that agricultural and livestock and agro-forest systems have replaced forest systems.

3.- Change of vegetable coverings of the natural system.- In accordance with investigations conducted by Sarukhán on disturbed areas of evergreen tropical forests, vegetation alone is always subject to a dynamic tending to vegetable succession. However, in the area where the hydroelectric central will be established, the disturbing action of the constant pruning by the National Water Commission interferes in this succession, causing the domination of herbaceous characteristics of the secondary vegetation.

V.1.2 Impact Indicators List

- Number of mobile sources (during the construction and operation stages of the hydroelectric central Cerro de Oro).
- River flows affected by flow decreases or increases; decrease in the case of the Santo Domingo river[6] and increase in the case of La Sal stream.
- Affected vegetable formation
- Number of endemic or protected species affected
- Reproduction areas affected by the risk of removal during clearing
- Area of occupation of vegetable and animal species; such surfaces will be reduced with the infrastructure of the hydroelectric central.
- Migration of fauna communities towards less disturbed areas.
- Soil movement volume

V.1.3. Assessment Evaluation and Criteria

V.1.3.1 Criteria

The following criteria were used for the environmental impact assessment:

- Dimension: considered as the degree of effect of each definite impact on the corresponding environmental factor.
- Sign: through this criterion, it is determined whether the impact analyzed is positive or negative, insofar as it affects the environment.
- Permanence; criterion used to assess the temporary scale in which the impact analyzed acts over the corresponding environmental factor. These may be sporadic, temporary or permanent.
- Reversibility: the possibility that the affected system can return to its original conditions when the effect ends, by itself or through the application of mitigation measures.
- Viability of adopting mitigation measures: the application of this criterion will determine through a general technical and economic assessment, the possibility of minimizing a specific impact through the application of mitigation measures.

[6] In the section between the spillway discharge and the place where it meets the La Sal Stream.

V.1.3.2 Assessment Methodology and Justification of the Methodology Chosen

The methodology applied in the development of this study, as indicated under section V.1, is the reduced Leopold matrix method, where impacts are catalogued in accordance with the degree of severity in relative categories. The method consists of placing the preponderant activities of the project in order, organized in columns. The environmental aspects will be categorized in rows. The interaction between both aspects forms a table that allows identifying the environmental impacts of the project. This method permits establishing a subjective value for such interactions and assessing the impacts.

This methodology has been selected considering that:

- The environment is altered, as evidenced by the type of vegetation present in the area.
- The site where the project will be developed is within the federal zone of the Miguel de la Madrid Hurtado dam and for such reason, generating electric power is compatible with the current land use.
- The central, during the operation and maintenance stages, will not generate air emissions and the waste generated will be domestic waste, composed of the trash generated by the personnel operating the central.

The first step in evaluating the environmental impacts is identifying such impacts. After they are identified, they are described, classified and rated in accordance with the quality thereof, as beneficial or adverse, as shown in Table 5.1

Table 5.1 Rating of Environmental Impacts

Quality of Environmental Impacts	
Impact Rating	Characteristics
Beneficial	Positively changes the environment, the ecosystem and/or has a positive effect on the population. Environmental improvement of the ecosystem.
Adverse	Negatively changes the environment, the ecosystem and/or has a negative effect on the population. Environmental deterioration of the ecosystem.

The next step consists of the determination of the degree of the impact:

Table 5.2 Degrees of Impact

Degree of Impact	
Degree	Characteristics
Significant	Cumulative,* synergic,** significant or relevant,*** and residual.****
Not significant	Micro, precise and temporary that may be mitigated.

* Cumulative: the effect on the environment that results from the increase of the impacts of particular actions caused by the interaction with others generated previously or currently occurring.

** Synergic: impact produced when the joint effect of the simultaneous presence of several actions supposes a greater environmental incidence than the sum of the individual incidences contemplated separately.

*** Significant or relevant: impact that results from the actions of man or nature, which cause alterations in the ecosystems and their natural resources or health issues, hindering the existence and development of man and other living beings, as well as the continuity of natural processes.

**** Residual: the impact that persists after applying mitigation measures.

Each one of the environmental impacts determined is assigned a rating, in accordance with the quality and degree of the impact assessed. In addition, names are established for the ratings to be assigned in accordance with the degree of the effect in case it is not significant.

The symbols established to represent the different kinds of impacts in this document is presented in Table 5.3

Table 5.3. Value assigned to Environmental Impacts

Value assigned to Environmental Impacts	
Type of Impact	Value assigned
Significant adverse impact	-2
Non significant adverse impact	-1
No impact	0
Non significant beneficial impact	+1
Significant beneficial impact	+2

In this phase of the study, the procedure proposed is developed. This way, the environmental impacts generated during the site preparation, construction, operation and maintenance of the “Cerro de Oro” hydroelectric central are determined, with reference to

the environmental factors involved, which will depend mainly on the physical-chemical, biological and socioeconomic characteristics and aspects involved. In this description, an analysis will be made through the modified and reduced Leopold matrix. The classification will maintain one element of the environment constant while the stage of the project varies, thereby obtaining the behavior of the impact in connection with time.

The determination and classification of the environmental impacts is set forth in Table 5.4. The justification and comments to the classifications assigned to each impact identified are presented after the impact matrix.

As a final phase of the process, the most significant beneficial and adverse effects are evaluated.

Table 5.4 Reduced Leopold Matrix for the “Cerro de Oro” hydroelectric central.

			SITE PREPARATION			CONSTRUCTION					OPERATION
RESOURCES	CATEGORY	TYPE	Installation of support infrastructure	Clearing, preparation and/or excavation	Fill	Intake structure	Excavated conduction tunnel	Pressure pipeline trench	Excavated engine building and discharge channel	Electro-mechanic equipment and TL	Operation and maintenance
WATER	Underground	Quality	0	0	0	0	0	0	0	0	0
		Quantity	0	0	0	0	0	0	0	0	0
	Surface	Quality	0	0	0	-1	0	0	-1	0	0
		Quantity	0	0	0	0	0	0	0	0	-2
SOIL	Subsoil	Stability	0	0	0	0	0	0	0	0	0
	Surface	Potential Use	0	-1	0	0	0	0	-1	-2	+2
AIR	Atmosphere	Quality	0	-1	-1	0	-1	-1	-1	0	0
		Noise	-1	-1	-1	-1	-1	-1	-1	0	0
		Odors	0	0	0	0	0	0	0	0	0
BIOTA		Vegetation	0	-1	0	0	0	0	0	-2	-2
		Fauna	0	-1	0	0	0	0	0	0	-2
ECOSYSTEM	Ecologic Dynamic	Energy and matter flows	-1	-1	0	0	0	-1	-1	-1	-2
		Landscape	-1	-1	-1	0	0	0	-1	-1	-2
ECONOMY	Local Economy		+1	+1	+1	+1	+1	+1	+1	+1	0
	Employment		+1	+1	+1	+1	+1	+1	+1	+1	0
	Quality of life		+1	+1	+1	+1	+1	+1	+1	+1	+2
	Agriculture		0	0	0	0	0	0	0	0	+2
HUMAN SETTLEMENTS	Population		0	0	0	0	0	0	-1	0	+2
	Infrastructure and services		0	0	0	0	0	0	0	0	+2
	Urban centers		0	0	0	0	0	0	0	0	+2

IMPACT KEY: -2, Significant Adverse; -1, Not significant Adverse; 0 Without Impact; +1, Non Significant Beneficial; +2 Significant Beneficial

The qualitative characteristics, such as duration, reversibility, need for remedial measures and importance assigned to each impact are described below.

SITE PREPARATION STAGE

In this stage, in accordance with the activities referred under chapter II of this study, the following were identified:

Underground Water

There will be no impacts in the underground water since during the infrastructure support activities, demolitions, excavations and filling, the aquifer will not be affected, as the dimensions and depth of the work are reduced.

Additionally, in connection with the transmission line, the excavations will be superficial and no filling, leveling or compacting will be carried out. No camps or support infrastructure will be installed. Consequently, no impact will be caused to underground water.

It should be pointed out that for the development of the “Cerro de Oro” hydroelectric project, the installation of wells or the extraction of underground waters is not contemplated. Consequently, no impacts are expected.

Surface water

No impacts are expected over the surface bodies of water, the Santo Domingo and La Sal stream in this stage.

Additionally, no surface water impact is expected in connection with the transmission line since its support structures will be installed outside natural drains or beds of rivers or streams.

Subsoil

No impact will be caused to the subsoil during the installation of the support infrastructure and stripping.

Surface Soil

No impacts are expected to be caused on the potential use, since the land use of the site where the hydroelectric central will be installed, between the dam’s discharge channel and the old bed of the Santo Domingo River, is authorized under the criterion of exceptionality for basic infrastructure, including hydraulic use for electric power generation and the installation of transmission lines, among others.

A non-significant, micro, specific permanent and irreversible adverse impact is expected due to the 2.50 m deep excavation for the foundation of the 22 transmission towers planned to be installed.

Air Quality

Hydroelectric central: During the demolition, excavation and filling activities, dust and particles will be generated, which will cause a temporary, reversible and preventable non-significant adverse impact.

Transmission line: During the excavation activities for the foundations, a temporary, reversible and preventable non-significant adverse impact is expected due to the emission of dust and particles.

Noise

Hydroelectric central: During the installation of the support infrastructure, demolition, excavation and filling activities, a temporary, reversible, non-significant adverse impact that can be mitigated will be generated, since noise between 90 and 150 decibels will be produced while the machinery is in operation.

Transmission line: No impact will be generated.

Odors

Hydroelectric central: No odors will be produced during this stage of the project. Therefore, no impact will be generated.

Transmission line: No environmental impact is expected, as no odors will be generated during this stage of the project.

Vegetation

Hydroelectric central: Non-significant adverse impacts are expected on this resource since with the process of clearing and stripping, the vegetation of the site will be lost. It should be pointed out that the only vegetation in the site is grass, herbaceous vegetation and some secondary vegetation shrub types (photos N° 7, 8, 9, 10, 11, 12, 13, 14)

Transmission line: In accordance with the forest zoning statement, the area where it will pass through is considered as non-forest land and has a predominantly agricultural land use. There are however spots of vegetation, which in accordance with the most representative species, pertain to evergreen tropical forest. In this regard, a non-significant temporary, reversible adverse environmental impact that can be mitigated is expected during the stripping activities.

Fauna

Hydroelectric central: A non-significant adverse impact is expected, since the fauna of the region will be displaced to less perturbed sites.

Transmission line: A non-significant, temporary, reversible adverse impact that may be mitigated will be generated due to the presence of the workers in charge of the stripping and excavation, which will cause the herpetofauna to be displaced to less perturbed sites.

Energy and Matter Flow

Hydroelectric central: A non-significant temporary adverse impact is expected due to the site preparation activities that may cause displacement of the existing fauna. With the stripping and vegetation removal, impacts are expected on the matter and energy flows.

Transmission line: When the fauna moves to less perturbed places, the energy and matter flows change, causing a non-significant adverse impact that can be mitigated and compensated.

Landscape

Hydroelectric central: The ecosystem is the group of relationships that allow the coexistence of a diversity of living beings, their energy and matter flows and the relationships among their communities. This definition does not exclude human beings and their relationships with living things in their environment. In the ecosystem, the impact on energy and matter flows in the setting is evaluated. During the site preparation stage, non-significant adverse impacts will be generated because the scarce existing vegetation will be removed, which will modify the landscape permanently, because the land use in the property (Federal Zone) where the hydroelectric will be developed is for hydraulic and energy infrastructure. Thus, it is considered that the hydroelectric central conforms to the assigned land uses.

Transmission line: A non-significant, temporary, reversible adverse impact that can be auto-mitigated is expected during the stripping activities.

Local Economy

Hydroelectric central: The impact expected for this stage of the project is beneficial, temporary and important since projects such as this one, will cause an increase in sales in the communities close to the project located in the municipality of Tuxtepec.

Transmission line: Business sales will increase by virtue of the fact that to reach the project site, it is necessary to use the access road designed for such purpose and the economic activity generated will benefit several communities. Thus, a temporary, non-significant beneficial impact will be caused.

Employment

Hydroelectric central: A non-significant, temporary impact is expected since this kind of projects causes the hiring of local labor in the municipality of Tuxtepec as workers and heads, for which income increases.

Transmission line: A non-significant temporary beneficial impact is expected over several communities by hiring local labor during this stage of the project.

Quality of life

Hydroelectric central: No impact is expected.

Transmission line: As a result of an increase in their income, an improvement in the quality of life of several communities is expected. This impact is considered as non-significant, and beneficial due to its temporality.

Agriculture

Hydroelectric central: No environmental impact is expected in connection with the agricultural and livestock activities of the region during the execution of this stage of the project.

Transmission line: Although the land that will be stripped is used for agricultural and livestock purposes, no impacts are expected because the time when such activities will be carried out coincides with the period during which no agricultural activities will be performed.

Population

Hydroelectric central: No adverse impacts are expected since the actions contemplated during this stage of the project will be carried out within the federal zone and the only disturbance caused to the population will be the increased traffic in the federal highway and the entry of the excavation equipment to the federal zone.

Transmission line: No impact is expected during this stage of the project.

Infrastructure and Services

Hydroelectric central: No impact is expected during this stage of the project.

Transmission line: No impact will be generated during this stage of the project.

Urban Centers

Hydroelectric central: No impact is expected during this stage of the project.

Transmission line: No impact will be generated during this stage of the project.

CONSTRUCTION STAGE

In this stage of the project, the machinery and equipment described in chapter 2 hereof will be used. Several impacts will be generated as a result of such activities.

Underground Water

Hydroelectric central: No impact will be generated in the quality and quantity of the underground water during this stage of the project since no deep excavations or perforations will be carried out.

Transmission line: During the assembly of the towers, no impact will be generated on the quality or quantity of this resource.

Surface water

Hydroelectric central: A non-significant adverse impact is expected due to the construction of the discharge channel.

Transmission line: No impact will be generated to this resource as a result of the installation of the towers or lines.

Subsoil

Hydroelectric Central: No impact will be generated to the subsoil during this stage of the project.

Transmission line: No impact will be generated during this stage of the project.

Superficial Soil

Hydroelectric central: No impacts are expected on the potential use since the land use of the site where the hydroelectric central will be developed is authorized under the exceptionality criterion for the installation of basic infrastructure, including use of water to generate electric power and the installation of transmission lines, among others. However, during the construction activities, material will be moved and removed, for which a non-significant adverse impact is expected.

Engine Building: Excavations will be conducted on rock and partially, on filling material. After the building is completed, hollows will be filled and the excavated embankments will be stabilized, to avoid future erosion problems.

Outlet channel: Deep excavation and with erosion possibilities in the operation stage of the project, for which the basin thereof will be lined with concrete and the embankments with shotcrete and geotextile carpet.

La Sal Stream Riverbed: Excavation will be conducted on silty material with erosion possibilities, for which the following preventive measures will be taken:
Embankments 1.5:1
Velocity not over 0.80m/s
Allow the development of native vegetation on the rims.

Transmission line: The potential land use will be affected in the tower foundation areas (isolated footings having a 64m^2 surface per tower), for which a significant cumulative, permanent, irreversible adverse impact that may be compensated is expected in each place where the footings are located.

Air Quality

Hydroelectric central: The activities carried out during this stage will cause non-significant, temporary adverse impacts due to the excavation of the conduction tunnel and the engine building.

Transmission line: During this stage, no dust or particles will be released into the environment, for which no impacts will be produced.

Access road: No impact is expected.

Noise

Hydroelectric Central: Durante this stage of the project, the noise produced will be caused mainly by the power generators and the pneumatic compressors. Such noise will be up to 105 decibels, which is above the limits established by the legal standards. This will cause a minor temporary adverse impact that can be mitigated to the personnel working in this area.

Transmission line: No impact will be generated

Odors

Hydroelectric central: No odors will be generated during this stage of the project.

Transmission line: No odors will be generated during this stage of the project.

Vegetation

Hydroelectric central: No impacts to this resource are expected during this stage, since the place where the engine building and substation will be built will be cleared during the site preparation stage and the access road to the site lacks vegetation.

Transmission line: Certain sections of the properties where the foundations of the transmission towers will be built are currently used for crops or have spots of secondary vegetation with some elements of evergreen tropical forest. Therefore, a cumulative, permanent, irreversible adverse impact that can be compensated is expected.

Due to the installation of 10.5 km of the line, it will be necessary to prune or remove the vegetation that may be growing in the relevant areas. Thus, a non-significant, temporary, reversible adverse impact that can be auto-mitigated is expected.

Fauna

Hydroelectric Central: No impact is expected

No impact to this resource is contemplated during the construction of the engine building and substation, since the current human activities on site, together with the site preparation activities will dispel the fauna.

Transmission line: No impact will be generated since the effects are very specific.

Energy and Matter Flows

Hydroelectric Central: Because during this stage of the project the movement of machinery, equipment, workers and materials is continuous, a non-significant, temporary, reversible adverse impact that may be mitigated is expected.

Transmission line: With the insertion of the transmission towers and due to the removal of the scarce existing vegetation, energy and matter flows are expected to be affected, causing a non-significant adverse impact.

Landscape

Hydroelectric Central: By virtue of the fact that during excavation and filling movement of soils will occur, a non-significant, temporary, irreversible adverse impact that may be mitigated and compensated is expected.

Transmission Line: Since the infrastructure of the transmission towers is not part of the natural landscape and during the construction thereof materials will be moved and the tower structures will be installed, a non-significant adverse impact is expected.

Local Economy

Hydroelectric Central: The concentration of workers considerably increases the sales of the businesses close to the project and the economic boost is expected to be reflected even in Tuxtepec. Thus, a non-significant, temporary beneficial impact is expected

Transmission line: The sales of the businesses that are on the way will increase, since to reach the site, it is necessary to use the access road intended for such purpose. The economic boost caused by the sale of supplies and food will benefit several communities, causing a non-significant, temporary beneficial impact.

Employment

Hydroelectric Central: The impact expected during this stage of the project is beneficial, temporary and important since local labor will be hired as field workers, chiefs, supervisors, watchmen, janitors and non-specialized machinery operators. For such reason, a non-significant, temporary beneficial impact is expected.

Transmission line: A non-significant, temporary beneficial impact is expected over several communities due to the hiring of local labor during this stage of the project.

Quality of Life

Hydroelectric Central: The quality of life of residents is expected to improve as a result of their increased income. This impact is considered non-significant and beneficial due to the temporality of the occurrence.

Transmission line: The quality of life of residents of several communities is expected to improve as a result of their increased income. This impact is considered non-significant and beneficial due to the temporality of the occurrence.

Agriculture

Hydroelectric Central: No environmental impact on the agricultural and livestock activities of the region is expected during this stage of the project.

Transmission line: Although the properties on which the towers will be built and the transmission lines placed are mainly used for agricultural purposes, no impact on the economy derived from agricultural activities will occur, since the company will pay the adequate compensation.

Population

Hydroelectric central: Since the activities carried out during this stage of the project will be performed within the federal zone, the only disturbance to the residents will be the constant passing of pick-up and dump trucks, which is considered as a non-significant, temporary, reversible and preventable adverse environmental impact.

Transmission line: No impact is expected during this stage of the project.

Infrastructure and Services

Hydroelectric central: No impact is expected during this stage of the project.

Transmission line: No impact will be generated during this stage of the project.

Urban Centers

Hydroelectric central: No impact is expected during this stage of the project.

Transmission line: No impact will be generated during this stage of the project.

OPERATION AND MAINTENANCE STAGE

During this stage, no substances and/or materials that could affect the environment are used.

Underground Water

Hydroelectric central: No impact will be generated during this stage of the project

Transmission line: No impact will be generated during this stage.

Surface water

Hydroelectric Central: During the operation activities of the hydroelectric central, a significant, preventable environmental adverse impact that may be mitigated is expected on the flow of the Santo Domingo river, since it will decrease in a section of 2 km, from the Miguel de la Madrid Hurtado dam discharge structure to its junction with the La Sal stream, since the hydroelectric will discharge water into the La Sal stream.

Hydroelectric Central: No adverse impacts are expected in connection with the quality of this resource, since the water used to generate power will be the water that currently flows out through the Miguel de la Madrid Hurtado dam discharge structure. It is important to point out that the water is not consumed or polluted and that its temperature remains unchanged, as only the potential energy is exploited.

Transmission line: No impact will be generated.

Subsoil

Hydroelectric central: No impact will be generated.

Transmission line: No impact will be generated.

Surface Soil

Central Hydroelectric: A significant beneficial impact will be produced since the operation of the plant will be congruent to the land use authorized for this federal zone.

Transmission line: No impact will be generated.

Air quality

Hydroelectric central: No impact will be generated.

Transmission line: No impact will be generated.

Noise

Hydroelectric central: The noise generated will only be perceptible inside the building.

Transmission line: No impact will be generated

Odors

Hydroelectric central: No odors will be produced during this stage of the project for which no environmental impact is expected.

Transmission line: No odors will be produced during this stage of the project for which no environmental impact is expected.

Vegetation

Hydroelectric central: A relevant or significant adverse impact is expected on the riparian vegetation during this stage of the project since the decrease in the flow of the Santo Domingo River will drastically diminish the water level. Consequently, the vegetation established at the river's edge will be severely affected in a section of 2km, causing the riparian vegetation of this section to disappear.

Transmission line: No impact will be generated during this stage.

Fauna

Hydroelectric Central: A significant adverse impact that may be mitigated is expected since the desiccation of the riparian vegetation will cause the disappearance of the habitats of land and semi aquatic species that use such places for feeding, nesting, recreation, etc. If no preventive and mitigation measures are taken, a synergic impact would be generated, causing an environmental effect greater than the sum of the individual effects contemplated separately.

Transmission line: No impact will be generated.

Energy and Matter Flows

Hydroelectric Central: A significant adverse impact that may be mitigated will be caused to the energy flows of the ecosystems of the riverbanks.

Transmission line: No impact will be generated during this stage of the project.

Landscape

Hydroelectric Central: Riverbanks will be modified when the riparian vegetation dries out and the river's flow will decrease drastically in a section of 2 km. However, this is considered as a significant adverse impact that may be mitigated.

Transmission line: A non-significant, permanent adverse impact that may be compensated is expected.

Local Economy

Hydroelectric central: No impact will be generated

Transmission line: No impact will be generated.

Employment

Hydroelectric central: No impact will be generated.

Transmission line: No impact will be generated.

Quality of Life

Hydroelectric Central: The energy flow of the hydroelectric central with its interconnection to the substation close to the towns of the municipality of Tuxtepec will benefit residents directly and indirectly because they will have a reliable energy supply from a nearby source. The continuous generation period of the hydroelectric central will reduce voltage

variations, thereby making appliances last longer. This impact is considered beneficial, significant and permanent.

Transmission line: No impact will be produced.

Agriculture

Hydroelectric central: No impact is expected.

Transmission Line: A significant beneficial impact is expected for the owners of the properties over which the transmission line will cross, since aside from receiving payment of the respective right of way duties, they may continue to use the surface intended for the right of way to plant crops.

Population

Hydroelectric central: Significant beneficial impacts will be produced on the communities and industries to which energy will be supplied, including the stabilization of the supply voltage because of the closeness to the energy source, without tension drops or interruptions.

Transmission line: No impact is expected during this stage of the project

Infrastructure and Services

Hydroelectric central: A significant beneficial impact will be produced with the power supply.

Transmission line: No impact will be generated during this stage of the project.

Urban Centers

Hydroelectric Central: A significant beneficial environmental impact is expected due to the reliable power supply that will exist, without emitting pollutants into the atmosphere.

Transmission Line: An indirect beneficial impact will be generated on the nearby urban centers, since the energy produced in the hydroelectric central will arrive to a substation close to them, providing certain supply reliability and reduced voltage variations.

Justification and Description of the Methodology

The impacts caused by the hydroelectric project will be assessed with basis on the analysis of the reduced and modified Leopold matrix by assigning a grade to the different elements of the matrix. Such assignment is an intermediate technique between the Rau methodology and the concept of scalars of the *Environmental Evaluation System* and is

based on the consideration of impacts, pursuant to the importance of their scope along the trophic chains and their effect on the environment and humans.

This way, the effect on the environment (water, air and soil), as a non-renewable resource, adds up to an amount of scalars greater than human interest (economy and human settlements); in turn, the latter has a greater scalar rating over ecology (biota and ecosystem). The rating factors will be assigned in accordance with the following grade:

Environment	10
Human interest	6
Ecology	4

Thus, in the modified Leopold matrix, there are 180 elements corresponding to 9 columns and 20 rows, of which 9 x 9 elements (81) correspond to the environmental impact. The elements of the matrix total

81 x (-2) x 10 = -1620 points

As to effects to the environment, if all the figures obtained are adverse significant, which means, the worst possible impact to the environment caused by the project, the total would be -1620. The same figure would result if all grades obtained were due to significant beneficial impacts.

In the human interest category there are 9 x 7 matrix elements that with a rating factor of 6 and for a significant adverse impact in all the elements (corresponding to the worst-case scenario) would total

63 x (-2) x 6 = -756 points

and significant beneficial impact with the same positive-sign grade.

The ecology category has 9 x 4 matrix elements and a rating factor of 4. The maximum punctuation solely for significant adverse impacts would be

36x (-2) x 4 = -288

and +288 in the best beneficial impact. If the maximum impacts are calculated by project stage, the maximum impact values would be those listed under Table 5.5

Table 5.5 Theoretical Maximum Impact Values by Project Stage

Maximum Impacts per Stage	Environment	Human Interest	Ecology
MAXIMUM BENEFICIAL IMPACT			
Site preparation stage	+540	+252	+96
Construction stage	+900	+420	+160
Operation and maintenance stage	+180	+84	+32

MAXIMUM ADVERSE IMPACT			
Site preparation stage	-540	-252	-96
Construction stage	-900	-420	-160
Operation and maintenance stage	-180	-84	-32

Table 5.6 presents the punctuation the “Cerro de Oro” hydroelectric project obtained for each stage and environmental category.

Table 5.6. Values of Actual Impacts

Actual Impact per Stage	Environment	Human Interest	Ecology
BENEFICIAL IMPACT			
Site preparation stage	0	+54	0
Construction stage	0	+90	0
Operation and maintenance stage	+20	+60	0
ADVERSE IMPACT			
Site preparation stage	-60	0	-28
Construction stage	-120	-6	-28
Operation and maintenance stage	-20	0	-32

RESULTS

Last, Table 5.7. presents the impact percentages calculated for the project with respect to the maximums obtained as per

{Impact (beneficial/adverse) / Impact (beneficial/adverse)) maximum}* 100

Table 5.7. Impacts Percentage with respect to Maximum Impacts

Stage	Environment (WATER, AIR, SOIL)		Human Interest (ECONOMY AND HUMAN SETTLEMENTS)		Ecology (BIOTA AND ECOSYSTEM)	
	Adverse	Beneficial	Adverse	Beneficial	Adverse	Beneficial
Site preparation	-11.11	0.00	0.00	21.43	-29.17	0.00
Construction	-13.33	0.00	-1.43	21.43	-17.50	0.00
Operation and Maintenance	-11.11	11.11	0.00	71.43	-100.00	0.00

Once the environmental impacts are quantified for each environmental category, several interesting points on the impact that the project will have on the environment may be determined.

V.2.4. Impact Evaluation

Environment

By analyzing Table 5.7, it is possible to conclude that during all the stages considered, the project will produce different environmental adverse impacts percentages. For the site preparation stage, the percentage obtained was -11.11%. It is deemed that this impact could be cumulative if no mitigation measures are established and implemented to avoid the interaction thereof with prior and/or ongoing impacts. For the construction stage, the result was -13.33% and -11.11% for the operation stage, since during the latter, the flow of the Santo Domingo River will be reduced. For such reason, mitigation measures will be implemented to avoid the decrease in the outflow from affecting aquatic fauna, material and energy flows and the landscape in a section of 2 km, preventing the riverbed from drying out.

Beneficial impacts are considered during the project's operation stage for the category of superficial soil with 11.11%. This considering that the surfaces the project will be occupying will be used more efficiently in accordance with the original interest pursued with the construction of the dam and by preserving certain areas with the delimitation of the properties assigned to the project.

Human Interest

Adverse impacts for the construction stage are observed, representing 1.43%. Such impacts may be mitigated by following the measures proposed and through the application of the official regulatory provisions.

In connection with the beneficial impacts produced by the "Cerro de Oro" hydroelectric project, certain percentages are high for all the project stages, being 21.43% for the site preparation stage and 21.43% for the construction stage, since during this stage a direct economic boost due to the hiring of labor is expected over the communities closest to the project, and 71.43% for the operation and maintenance stage, since the hydroelectric central will indirectly raise the quality of the power flow and advance the industrial productivity of Tuxtepec, which will improve the quality of life of the population.

Ecology

In connection with adverse impacts, -29.17 % is reported for the site preparation stage, -17.50% for the construction stage and -100% for the operation stage.

No beneficial impacts were identified during the operation stage.

Conclusion

The site where the infrastructure of the hydroelectric central will be built and where the different activities to be carried out during the preparation, construction, operation and maintenance stages is within the federal zone, which may be accessed through a road that is in good condition. Therefore, the area of direct influence of the project will cover the federal zone and the 10.5 km of the transmission line's length, including the right of way thereof.

It should be pointed out that there will be no relief, land or riparian vegetation changes, since the mitigation measures contemplated will avoid leaving the 2km of the Santo Domingo River without water. Additionally, no changes in the distribution of organisms will be generated, no pollutants will be released into the air, soil, or superficial and underground water and noise will not be generated, since the mitigation measures will reduce or eliminate such potential sources of pollution.

VI. PREVENTIVE AND MITIGATION MEASURES FOR THE ENVIRONMENTAL IMPACTS.

VI.1 Description of the mitigation or remedial measure or program of measures by environmental component

Each one of the impacts identified triggers a gradual and accelerated deterioration process that affects the environment. Some of those impacts may be avoided through preventive or remedial actions.

To guarantee the execution of such actions, they will form part of the contracts that will be entered into for the construction of the project.

Any breach of the environmental protection clauses included in the contracts will result in an economic penalty, which will be perfectly determined in each contract.

Preventive Measures	
Environment	Surface water, air, soil, atmosphere (noise), flora and fauna,
Characteristics of the impacts identified	Non-significant adverse

Project Actions
Demolition and Excavations. A large portion of the material obtained from the excavation will be used to fill the land to install the substation, another portion will be used to produce concrete and the remainder will be placed as part of the outlet channel of the hydroelectric central. Contention and rainwater drainage works are contemplated In the right of way of the transmission line: Clearing and stripping of the site. Stripping and excavation in the sites where the foundations of the transmission line will be placed.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
1	In the area where the engine building and substation will be built: Water the land continuously to keep it humid to avoid emitting particulate material into the atmosphere. *Duration* During low water season, it will be applied in the site preparation and construction stages. *Operation and Maintenance Specifications:* Using a tank, water all areas with propensity for the formation of dust storms.	
2	In the area where the engine building and substation will be developed and along the segment of transmission line All machinery and equipment using internal combustion motors must pass a preliminary inspection and system enabling before the work begins. *Duration:* During the site preparation, construction and operation stages. *Operation and Maintenance Specifications:* Regular scheduled preventive maintenance and vehicle smog check, if applicable.	Article 104 of the *Ley del Equilibrio Ecológico y protección al ambiente* (Ecologic Equilibrium and Environmental Protection Law) of the State of Oaxaca. NOM-041- SEMARNAT-1996 (referred in chapter 3) NOM-042- SEMARNAT-1993 (referred in chapter 3) NOM-044- SEMARNAT-1993 (referred in chapter 3) NOM-045- SEMARNAT-1996 (referred in chapter 3) NOM-080-SEMARNAT-1994(referred in chapter 3)
3	In the area where the engine building will be built Establishing cofferdams and trenches to avoid soil materials to reach the riverbed of the La Sal stream.	Protective cofferdams and sediment retaining trenches or any other structure that prevents the filtration of such material.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
	Duration: During the site preparation and construction stages. *Operation and Maintenance Specifications:* They will operate as dikes to avoid pollution of the stream.	
4	In the area where the towers will be installed and [along the] layout of the transmission line: The slash and burn method, using any defoliating substance, burning of material resulting from the clearing and stripping and/or the disposal thereof in riverbeds, streams, ravines or natural drains whether close to or far from the project site, are strictly prohibited. *Duration:* During the site preparation, construction and operation stages *Operation and Maintenance Specifications:* The measure does not imply the use of machinery or equipment nor any construction.	This material will be immediately disposed of in the sites that the local authority determines for such purpose, for which the construction company, prior to beginning the construction, must obtain such authorization from the municipality.
5	Along the layout of the transmission line: Vegetation will be manually removed, in a directional manner, using axes, machetes and saws if necessary, leaving 0.30 m. stumps on the ground. Vegetable remains resulting from this activity will be cut and scattered over the cleared area in order to protect the soil and reintegrate them into the soil as organic matter. *Duration:* During the site preparation stage *Operation and Maintenance Specifications:*	If possible, the products of the stripping and excavation will be preferably combined in the filling areas, allowing the organic matter to decompose and provide nutrients to the soil and seeds will added to further accelerate the re-growth of vegetation. NOM-113-SEMARNAT-1998 (referred in chapter 3) NOM-114-SEMARNAT-1998 (referred in chapter 3)

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
	The measure does not imply the use of machinery and equipment or any construction work	
6	In the area where the engine building and substation will be built: Installation and maintenance of a latrine for each 20 workers. *Duration:* During the site preparation and construction stages. *Operation and Maintenance Specifications:* Two pre-manufactured septic tanks will be installed for the discharge of the latrines, which will receive periodic maintenance. Such services will be contracted from a specialized company, which will provide the required periodic cleaning services and dispose of the waste in an adequate place authorized for such purposes.	
7	In the area where the engine building and substation will be built: Machinery operators and workers will receive ear protectors. *Duration:* During the site preparation and construction stages *Operation and Maintenance Specifications:* The measure does not imply the use of machinery or equipment or any construction work.	NOM-011-STPS-1993. (referred in chapter 3) NOM-017-STPS-1993. (referred in chapter 3)

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
8	In the area where the engine building and substation will be built. Perfectly identified bins will be installed for the disposal of garbage (domestic solids) and recyclable materials, such as cardboard, steel pieces, plastic, wood, etc. *Duration:* During the site preparation and construction stages. *Operation and Maintenance Specifications:* The bins will have hinged lids and will be emptied every week or two weeks, as required.	A collection and final disposal program indicated by the municipal authority will be implemented on site, as well as a program for the recovery, sale and/or donation of recyclable material. The applicable duties to dispose of domestic waste in the official disposal site will be paid.
9	In the area where the engine building and substation will be built It is strictly prohibited to dispose of any solid or liquid waste of any kind in the reservoir.	Addressed under one or several clauses in the contracts to be executed. Compliance with this stipulation will be monitored as part of the activities of the project supervision.

Preventive Measures to follow	
Human Interest	Population
Characteristics of the impacts identified	Without impact (social harmony between the activities of the project and area residents)

Project Actions
Introduce into the federal zone the machinery and equipment necessary for construction, such as: Tractor, front loader, large backhoe drill and bulldozer. In the transmission line's right of way. Continuous transit of pick up and flatbed trucks along dirt roads and low transit roads.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
1	In the access way to the area where the engine building and substation will be built. Give prior notice to the residents or owners or the affected places of the day or days on which movement of machinery is scheduled. *Duration:* During the site preparation and construction stages.	Addressed in one or several clauses of the contract or contracts to be executed.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
	Three-days prior to the date on which the machinery will be introduced. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	
2	In the area where the engine building and substation will be built On the day the machinery will be moved, place signs and personnel to ensure the persons of the community do not suffer any accidents and prevent cattle from crossing during maneuvers. *Duration:* During the site preparation and construction stages. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Addressed in one or several clauses of the contract or contracts to be executed.
3	In the area where the hydroelectric central will be built, including the transmission line layout. Hiring minors is strictly prohibited.	Art. N° 175 of the Federal Labor Law

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
4	Entering into or crossing the properties of the *ejidatarios* or owners without their consent for activities pertaining to the marking of the transmission line layout is strictly prohibited. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Addressed in one or several clauses of the contract or contracts to be executed, since the respective agreements will be entered into with the property owners to obtain rights of way.

Preventive Measures to follow	
Environment	Soil
Characteristics of the impacts identified	Non-significant adverse

Project Actions
In the Federal Zone Movement of materials as part of the activities pertaining to the site preparation stage. Deep excavations to reach the foundations level

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
1	In the area where the engine building will be constructed, the rock excavations and partially, in filling material, with erosion possibilities. After the building is completed, hollows will be filled and embankments stabilized. *Duration:* During all construction stages. *Operation and Maintenance Specifications:* The embankments will be stabilized preserving the inclines that allow the stable resting of materials and will be covered with shotcrete, geotextile and native vegetation.	

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
2	In the area where the outlet channel will be built. Deep excavation with possibilities of erosion. *Duration:* During the operation stage. *Operation and Maintenance Specifications:* The channel basin will be lined with concrete and the embankments with shotcrete and geotextile blankets.	Safety of the hydroelectric central.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow.
3	Riverbed of La Sal stream. The basin will be dug in silty material *Duration:* During the construction and operation stages of the project. *Operation and Maintenance Specifications:* Embankments will be formed 1.5:1 Velocity not over 0.80m/s Allow the development of native vegetation along the banks.	Safety of the hydroelectric central

Preventive Measures to follow	
Environment	Quality of surface water, Atmosphere (noise), vegetation, fauna
Characteristics of impacts identified	Non-significant adverse

Project Actions
In the Federal Zone During the construction activities, electric compressor generators and machinery will be used, which will produce noise that fluctuates between 60 and 105 decibels. Concentration of workers in the work fronts. Personnel, machinery and vehicle movement in the construction site.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or programs to follow
1	In the area where the engine building and substation will be built Provide security equipment to workers such as: ear protectors, helmets, boots, gloves, etc. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work; the	NOM-011-STPS-1993 (referred in chapter 3)

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or programs to follow
	accessories that are in bad condition will be replaced.	
2	In the area where the engine building and electric substation will be built and along the transmission line layout. Have at least two first aid kits in each work front and a permanent transportation service for emergencies in the work area. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work; expired medication will be replaced and the first aid kits will be inspected to ensure they have the necessary materials.	NOM-011-STPS-1993 (referred in chapter 3)
3	In the area where the engine building and substation will be built. Provide the machinery and equipment with noise reduction devices. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* Give periodic maintenance to noise reduction devices.	NOM-081-ECOL-194 (referred in chapter 3)

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or programs to follow
4	In the area where the engine building and substation will be built It is strictly prohibited to introduce machinery such as backhoe drills into the riverbed of the Santo Domingo river. *Duration:* During the site preparation and construction stages *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Addressed in one or several clauses of the contract or contracts to be executed.
5	In the area where the engine building and substation will be built. Washing machinery and equipment in the riverbed or in any other stream or intermittent or permanent river is strictly prohibited. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work; signs referring to the issue will be installed.	Addressed in one or several clauses of the contract or contracts to be executed.
6	In the area where the engine building and substation will be built Disposing of waste or dead animals (run over by contractors or supervisors) in nearby water bodies is strictly prohibited.	Addressed in one or several clauses of the contract or contracts to be executed.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or programs to follow
	Duration: During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work; signs referring to the issue will be installed.	
7	In the area where the engine building and electric substation will be built and along the transmission line layout. Felling vegetation for the purpose of safekeeping and/or storing machinery is strictly prohibited. *Duration:* During the site preparation and construction stages *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Addressed in one or several clauses of the contract or contracts to be executed.
8	In the area where the engine building and electric substation will be built and along the transmission line layout. To store machinery, only the sites authorized and indicated for such purpose may be used. *Duration:* During the site preparation and construction stages. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Addressed in one or several clauses of the contract or contracts to be executed.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or programs to follow
9	In the area where the engine building and electric substation will be built and along the transmission line layout Servicing or giving maintenance to vehicles in the federal zone, roads, dirt roads, maneuver areas, storage spaces and camps is strictly prohibited. Al vehicles must be sent to established auto repair shops. *Duration:* During the site preparation and construction stages. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work; signs referring to the issue will be installed.	Addressed in one or several clauses of the contract or contracts to be executed.
10	In the area where the engine building and electric substation will be built and along the transmission line layout Throwing tires or pneumatics into the rivers, streams, small ravines, to the sides of roads or in any other place is strictly prohibited. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work; signs referring to the issue will be installed.	Addressed in one or several clauses of the contract or contracts to be executed.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or programs to follow
11	In the area where the engine building, the electric substation and the transmission line will be built Hunting fauna of any kind is strictly prohibited. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work; signs referring to the issue will be installed.	Addressed in one or several clauses of the contract or contracts to be executed.
12	In the area where the engine building and substation will be built. It is prohibited for the companies in charge of maintaining septic tanks to throw any waste thereof into rivers, streams or bodies of water. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Addressed in one or several clauses of the contract or contracts to be executed.
13	In the area where the engine building and substation will be built. Any waste oil, grease, lubricant, paint or solvents, and any containers, paper, burlap, cardboard and rags impregnated with such products or any other chemical product classified as hazardous, must be deposited in leak proof containers, with lids and perfectly labeled. Such containers will be placed in protected areas until collected by companies authorized for such purpose.	*Ley General para la Prevención y Gestión Integral de los Residuos* (General Law for the Prevention and Comprehensive Management of Waste)

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or programs to follow
	Duration: During every stage of the project. *Operation and Maintenance Specifications:* The storage area enabled must have a roof and a concrete floor with a structure or trap that allows trapping any residues in case of spills. Such waste may be kept for a maximum of six months in the temporary warehouse enabled for such purpose on site.	
14	In the area where the engine building and substation will be built. Specialized companies will remove such containers with hazardous waste from the site. *Duration:* During every stage of the project. *Operation and Maintenance Specifications* A logbook to record any entrance and exit of hazardous waste will be kept. A control or record of the hazardous waste manifestos delivered to the company authorized to collect them for final disposal will be kept.	*Ley General para la Prevención y Gestión Integral de los Residuos* (General Law for the Prevention and Comprehensive Management of Waste)

Preventive Measures	
Human Interest	Population
Characteristics of the impacts identified	Non-significant, adverse

Project Actions
Due to the work in the federal zone: In the following communities: Paso Canoas, Los Reyes and Santa Ursula Continuous transit of pick up, dump and flatbed trucks. Due to the installation of the transmission line: In some communities of the municipality of Tuxtepec Continuous transit of pick up and flatbed trucks through dirt roads and low transit roads.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow
1	In the area where the engine building and electric substation will be built and along the transmission line layout. Place signs in the roads and dirt roads indicating speed limit of 20 km/hr. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Address the obligation to follow signs and instructions in one or several clauses of the contract to be executed with all companies.

Preventive Measures		
N°	Mechanism	Legislation, plans where inserted and/or program to follow
2	In the area where the engine building and electric substation will be built and along the transmission line layout Advise suppliers of materials and services of the restrictions and speed limits that will be implemented in the project's access roads. *Duration:* During every stage of the project. *Operation and Maintenance Specifications:* The measure does not imply the use of machinery and equipment or any construction work.	Give the respective warnings and instructions to drivers; advise suppliers of the [applicable] provisions when service orders or requests are placed or submitted.

Description of the mitigation measures or system.

This section describes the mitigation measures determined as a result of the analysis developed under Chapter V. It was determined that the project will not generate critical environmental impacts that may compromise the biological diversity or cause the fragmentation or imbalance of the ecosystem or synergic effects of the current conditions of the ecosystem.

Technical Summary N° 1

Impact mitigation measures to be taken during the site preparation and construction stages	
Environment	Surface water (La Sal stream)
Characteristics of Impacts Identified	Non-significant adverse
Stage of the project during which it will be executed.	Site preparation and construction
Elements to formulate the mitigation measure	By virtue of the restrictions contained in the preventive measures, surface water shall not be polluted with grease, oils or any other chemical products. The only parameters of the quality of the water expected to be changed insofar as concentration thereof are total dissolved solids and total suspended solids. However, if due to the works, the impact extends outside the cofferdam, monitoring will be necessary to detect if any of the parameters considered in the Water Quality Ecologic Criteria for the protection of aquatic life surpass the established limits, including SDT and SST, and proceed with the application of the following mitigation measures.

Mitigation Measures
Bodies of Water: In the reservoir, Santo Domingo River and La Sal stream downstream from the project area. **1. Detect the source of the pollution, determine if it is chemical (grease, oils, etc.)** **2. Isolate the site where the emission of pollutants originated** **3. Clean the land over which the rain could drag the polluting material to the body of water** **If the origin of the contamination is organic (fecal streptococcus, nitrogen increase, etc.)** **4. Determine if the source derives from the project or a local activity that may be contaminating the reservoir or river.** **5. If the source derives from any activity of the project, cancel the activity immediately and substitute the action using technologies that do not contaminate the bodies of water.** **6. Verify that the new technology does not contaminate.** **7. If the pollution originates from sources unrelated to the project activities, the competent authority must be immediately notified.**

Technical Summary N° 2

Impact Mitigation Measures to Implement during the Site Preparation, Construction, Operation and Maintenance Stages	
Environment	Surface water (Santo Domingo River)
Characteristics of the impacts identified	Adverse Significant
Stage of the project in which it will be carried out or implemented	Operation and Maintenance
Judgment elements to formulate the mitigation measure	Due to the operation of the hydroelectric central, the flow of the river will decrease considerably in a section of 2km from the Miguel de la Madrid Hurtado dam discharge structure until its junction with the La Sal stream. A gabions ditch is intended to be established immediately after the junction of the Santo Domingo river with the La Sal stream. This will avoid the riverbed from drying out by keeping it flooded and with flowing water, that is, the riverbed will have enough water without becoming stagnant.

Mitigation Measures
Body of Water: Río Santo Domingo **1. A gabions ditch is intended to be established immediately after the junction of the Santo Domingo river with the La Sal stream. This will avoid the riverbed from drying out by keeping it flooded and with flowing water to preserve aquatic life, that is, the riverbed will have enough water without becoming stagnant.**

Technical Summary N° 3

Impact Mitigation Measures to be Implemented during the Site Preparation and Construction Stages	
Environment	Surface Water (Reservoir of the Miguel de la Madrid Hurtado dam) (La Sal Stream)
Characteristics of the impacts identified	Non-significant adverse
Stage of the project in which it will be implemented or executed	Construction (Conduction tunnel, trench pressure pipeline and engine building).
Judgment elements to formulate the mitigation measure	By virtue of the restrictions contained in the preventive measures, surface water will not be polluted with grease, oils or any other chemical product. The only parameters of the quality of the water expected to be changed insofar as concentration thereof are total dissolved solids and total suspended solids. However, if due to the works, the impact extends outside the cofferdam, monitoring will be necessary to detect if any of the parameters considered in the Water Quality Ecologic Criteria for the protection of aquatic life surpasses the established limits, including SDT and SST, and proceed with the application of the following mitigation measures.

Mitigation Measures
Bodies of Water: In the reservoir and stream **1. Detect the source of the pollution, determine if it is chemical (grease, oils, etc.)** **2. Isolate the site where the emission of pollutants originated** **3. Clean the land where rain could drag the polluting material to the body of water** **4. If the origin of the contamination is organic (fecal streptococcus, nitrogen increase, etc.)** **5. Determine if the source derives from the project or a local activity that may be contaminating the reservoir or river.** **6. If the source derives from any activity of the project, cancel the activity immediately and substitute the action using technologies that do not contaminate the bodies of water.** **7. Verify that the new technology does not contaminate.** **8. If the pollution originates from sources unrelated to the project activities, the competent authority must be notified immediately.**

Technical Summary N° 4

Impact Mitigation Measures to be Implemented during the Site Preparation, Construction, Operation and Maintenance Stages	
Environment	Soil
Characteristics of the impacts identified	Non-significant adverse (in the federal zone) Adverse significant (in the transmission line layout)
Stage of the project in which it will be implemented or executed	Upon conclusion of the construction
Judgment elements to formulate the mitigation measure	During the demolition, excavation and filling activities, care must be taken to ensure that the embankments from the slopes that may be affected have an incline that allows drainage, provides stability and permits the growth of natural vegetation, respecting the natural drains of the hill.

Mitigation Measures to Apply during the Execution of the Project and upon Conclusion of the Construction.
In the federal zone **1 Respect the natural incline of the land** **2 If it does not provide stability conditions, make terraces** **3 Once the activities conclude, ensure that all existing inclines are stable.** **4 Avoid the filling or obstruction of natural drains** **5 All loose rock material must be integrated and stabilized** **6 Any pieces of steel, wood, plastics, tires and other construction waste may not be mixed, buried or covered with soil.** **7 The sites altered during construction including dismantling of warehouses, workshops, camps and offices, that must contemplate the following as a minimum[sic]:** **If there was stripping** **1 Arrange the land in accordance with its natural incline.** **2 Stabilize** **3 Plow the surface** **Transmission line (Potential Soil Use)** **4 Because most of the area where the section of the transmission line will pass through has a potential agricultural use, it is likely that the land with natural vegetation that may require clearing is used by the owners or *ejidatarios* thereof for their productive activities; thus, it is necessary to ensure they are used immediately.**

Technical Summary N° 5

Impact Mitigation Measures to be Implemented during the Site Preparation, Construction, Operation and Maintenance Stages	
Environment	Vegetation
Characteristics of the impacts identified	Adverse significant (along the transmission line layout)
Stage of the project in which it will be implemented or executed	Upon conclusion of the construction
Judgment elements to formulate the mitigation measure	Although it is expected that it will only be necessary to clear a small amount of vegetation and the properties over which the transmission line will pass have an agricultural land use in the federal zone, the application of financial resources to the programs of CONAFOR is proposed as compensation of the effects the project will cause.

Compensation Measures to Apply upon Conclusion of the Construction.
In the federal zone **Due to the dam security policies implemented by the National Water Commission in the area where the hydroelectric central will be developed, consisting of felling all vegetation close to the curtain, a payment for reforestation and maintenance activities over a surface equal to the surface used by the hydroelectric central's infrastructure is proposed as compensation, independently of the payment to the Mexican Forest Fund for the change of use of forest land.**

Technical Summary N° 6

Impact Mitigation Measures to be Implemented during the Site Preparation, Construction, Operation and Maintenance Stages	
Environment	Fauna
Characteristics of the impacts identified	Non-significant adverse
Stage of the project in which it will be implemented or executed	Prior to the site preparation activities
Judgment elements to formulate the mitigation measure	Because they are very deteriorated sites, practically all the natural fauna has been displaced to less perturbed areas; however, there are some reptiles that even if not reported within NOM-059- SEMARNAT 1994, are part of the fauna that is characteristic of the Tuxtepec area and are reported by different authors.

Mitigation measures to be applied during the project development and upon completion of construction.
Along the transmission line layout **1. Dispel fauna with noise, form groups of 5 to 10 workers** **2. Advance slowly making noise to dispel fauna.** **3. Conduct support clearing only in the places of the right of way having vegetation and where the towers will be installed, to prevent fauna from returning to the site after it is dispelled.**

Technical Summary N° 7

Impact Mitigation Measures to be Implemented during the Site Preparation, Construction, Operation and Maintenance Stages	
Ecology	Landscape
Characteristics of the impacts identified	Non-significant adverse
Stage of the project in which it will be implemented or executed	Upon completion of the construction of the project
Judgment elements to formulate the mitigation measure	This issue is frequently ignored, which causes many unattended actions or impacts to turn into serious problems.

Mitigation measures to be applied during the project development and upon completion of construction.
In the federal zone **1. Upon completion of construction, characterize the landscape** **2. Inventory the structures pertaining to the hydroelectric central** **3. Inventory all dispersed materials product of the construction, inside and outside the federal zone, as well as any remaining material along the transmission line** **4. Prepare program to collect such material** **5. Establish a term for all the companies that participated in the project to clear all materials, machinery and equipment from the site.** **6. Clean all occupied sites.**

Technical Summary N° 8

Impact Mitigation Measures to be Implemented during the Site Preparation, Construction, Operation and Maintenance Stages	
Environment	Vegetation
Characteristics of the impacts identified	Adverse significant (Bank of the Santo Domingo River section of 2Km).
Stage of the project in which it will be implemented or executed	Operation
Judgment elements to formulate the mitigation measure	Care and preservation of riparian vegetation

Compensation measures to apply upon completion of the project
1. Establish a gabions ditch immediately after the junction of the Santo Domingo river with the La Sal stream, to avoid the riverbed from drying out by keeping it flooded and with flowing water to preserve the life of the riverbank, that is, the riverbed will have enough water without it becoming stagnant.

At least one mitigation measure is associated to each environmental impact identified.

The supervision of the mitigation measures will be contracted and compliance thereof will be verified by the presentation of a monthly report, including supporting documentation and images.

VI.2 Residual Impacts

In accordance with the definition that appears in the guide used to prepare this report, residual impact is the effect that remains in the environment after applying mitigation measures.

In accordance with the application of the methodology used in this report, the only residual impacts determined are indicated in the following Table.

Environmental Component	Project Activity	Residual Impact	Cause
Flora	Opening of permanent areas due to installation of structures	Loss of vegetable layer.	Tree felling and selective paring
Landscape	Installation of the hydroelectric central and transmission line	Deterioration of visual quality in the immediate surroundings and scenery	Installation of structures

It should be pointed out that although a gabions dam will be built immediately downstream of the junction of the Santo Domingo river with the La Sal stream as a mitigation measure, the impact will persist, because there will be a change in the river system along a 2km section.

VII. ENVIRONMENTAL PROJECTIONS

VII.1 Forecast of the scenery

Taking the current environmental scenery as reference to make a future projection that visualizes a completed and operating hydroelectric central, there are the following issues:

Critical and relevant environmental impacts:

1. Environment

1.1 Surface water: there will be a greater flow in the riverbed of the La Sal stream due to the discharge of the hydroelectric central into such riverbed.

The flow of the Santo Domingo River along a 2 km. section between the Miguel de la Madrid Hurtado dam discharge structure and its junction with the La Sal stream will decrease considerably. With the dam formed by the gabions wall, the river system along 2km will change from a lotic system to a lentic system since the riverbed in this section will continue to have flowing water. From the junction of the river with the stream, the Santo Domingo river system will not suffer any impacts and consequently, there will be no modifications.

With the gabions dam as a mitigation measure, drying out the Santo Domingo along a section of 2km will be prevented.

An auto regulation mechanism and stabilization of the ecosystem are expected to occur along this 2km section.

1.2 It is important to point out that the water quality of the bodies of water (dam reservoir, flows of the Santo Domingo River and La Sal stream) will not be affected with the operation of the hydroelectric central.

1.3 Surface Soil: The current use of this resource will be modified along the layout and right of way of the transmission line. The most important impacts will be caused to the representatives of the evergreen tropical forest, which although scarce, may be observed along the line's layout.

VII.2 Environmental Supervision Program

This program will establish the environmental protection obligations assumed by Electricidad de Oriente, S de R.L. de C.V. that must be followed and fulfilled during the development of the project and operation of the hydroelectric central, taking into account the following:

1. Environmental protection legislation, regulations and standards;

2. Contents of the resolution in connection with the environmental impact assessment,

3. Contents of the resolution in connection with change of use of forest land;

4. Mitigation measures included in this environmental impact report;

5. Environmental compliance reports;

6. Contractual specifications established among Electricidad de Oriente, S de R.L. de C.V. and the contractors.

Justification:

The Environmental Monitoring Program is expected to serve as the main instrument to control the environmental protection activities carried out to avoid, minimize and mitigate any potential environmental impacts that may occur during the construction of the Cerro de Oro Hydroelectric Project and the operation of the central.

Purposes

General:

Identify the environmental protection commitments undertaken by Electricidad de Oriente S de R.L de C.V.

Observe and comply with all prevention, protection, control and mitigation measures proposed in this environmental impact report.

Observe and comply with the terms and conditions issued by the *Secretaría de Medio Ambiente y Recursos Naturales* (Ministry of the Environment and Natural Resources) included in the authorization relating to environmental impact assessment.

Specific:

Detect environmental changes tending to degrade [the environment] that were not considered in the environmental impact report.

Integrate and direct a database using a classification by variables of the anticipated and unanticipated effects detected during the different stages of the project.

Determine the existence or absence of environmental variations during the construction and operation of the hydroelectric project.

Establish mechanisms that allow the implementation of mitigation and/or compensation measures for impacts undetected in this environmental impact report.

Scope

The actions established in the program will be carried out during the construction stage of the hydroelectric project and the operation of the central. Such actions will be in

accordance with applicable laws and regulations and with the mechanisms selected to form the database (parameters, indicators and indexes).

Areas of application

Construction area of the hydroelectric central (engine building and electric substation), transmission line and access roads.

VII.3 Conclusions

Throughout the development of this study, it was possible to determine that the construction and operation of the "Cerro de Oro" hydroelectric central will not have environmental repercussions since the project will be developed over land with scarce vegetation, integrated by representatives of secondary vegetation.

Pursuant to the results obtained in this study, vegetation is (currently) one of the most affected resources. The site destined for the construction of the hydroelectric central presents evidence of continuous felling.

Once the construction concludes and the hydroelectric central begins operating, a sustainable use of the resource will be encouraged, with zero environmental cost during the operation stage.

Additionally, the area of influence determined for the hydroelectric project receives the growing pressure of the agricultural and livestock border, which has a direct influence over the vegetation, causing the establishment of spots of secondary vegetation in the best case.

The tower anchoring and transmission line laying activities will not produce cumulative and/or synergic adverse impacts, since the surface cleared will be minimum and the procedures described under section *II.2.2 Site Preparation,* used for the clearing guarantee the lowest environmental cost.

It is important to point out that the impact prevention measures play a key role in the work intended to be developed in altered sites, since such measures must be carried out before the impacts occur. That is, they must be necessarily executed before each one of the construction activities to avoid actions that cause cumulative and/or synergic impacts.

The analysis of the feasibility studies of the integral exploitation of the Miguel de la Madrid Hurtado dam and the results of the environmental impact assessment that the "Cerro de Oro" Hydroelectric Project will cause, indicate that the construction and operation of the central, instead of causing environmental or ecosystem damages, will generate sustainable management of the resource by making efficient use of the existing hydraulic infrastructure.

As a result of the implementation of the prevention and mitigation measures during the different stages of the project, no loss of any environmental element or ecosystem process is expected that could trigger an ecological imbalance or serious damage to the ecosystem. Therefore, the structure and/or functioning thereof will not be affected.

To guarantee that the prevention and mitigation measures are applied at the appropriate time, for the necessary period and to ensure that the implementation thereof does not have a negative influence or repercussion on other elements of the ecosystem, an environmental monitoring program has been developed.

This program will allow prompt detection of possible unanticipated impacts that could pose a risk for the ecosystem. This way, the project will not cause the destruction, isolation or fragmentation of ecosystems.

Last, it is important to emphasize that the “Cerro de Oro” hydroelectric central will not generate substances or materials that may pollute the water, soil, air or aquatic and land flora and fauna of the site.

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VIII. IDENTIFICATION OF THE METHODOLOGICAL INSTRUMENTS AND TECHNICAL ELEMENTS THAT SUPPORT THE INFORMATION PROVIDED ABOVE

VIII.1.1 Plans, drawings and maps

Plan PHCO-IB-01- Intake structure and pressure conduction, Hydroelectric plant Cerro de Oro.

Plan PHCO-IB-02 (Plan 1 of 2).- Engine building.- Cerro de Oro Hydroelectric Project.

Plan PHCO-IB-02 (Plan 2 of 2).- Engine building.- Cerro de Oro Hydroelectric Project.

Macrolocation map.- Location of Cerro de Oro Hydroelectric Project.

Topographic map 1:50,000 E14B89-E14D19 TUXTEPEC, VALLE NACIONAL.- Location of the hydroelectric central and transmission line layout of the Cerro de Oro Hydroelectric Project.

Infrastructure Location Map for Waste Management and Disposal.

Work Schedule .- Cerro de Oro Hydroelectric Project engine building area

Work Schedule .- Cerro de Oro Hydroelectric Project transmission line area

Location Coordinates Plan.- Cerro de Oro Hydroelectric Project.- engine building and inflexion points of the transmission line.

Plano of Complex.- Cerro de Oro Hydroelectric Project.

Services Availability Plan.- Electric Power. Cerro de Oro Hydroelectric Project Area

Services Availability Plan.- Potable Water. Cerro de Oro Hydroelectric Project Area.

Services Availability Plan. Drainage. Cerro de Oro Hydroelectric Project Area.

Use of land and vegetation Plan. Cerro de Oro Hydroelectric Project Area.

VIII.1.2 Photographs

Photograph 01. Panoramic of the location of the project in the Miguel de la Madrid Hurtado dam (Cerro de Oro).

Photograph 02. Panoramic of the area planned for the project location.

Photograph 03. Area of the engine building and of the portal of the conduction tunnel.

Photograph 04. Inspection Gallery in the right margin of the curtain.

Photograph 05. Panoramic of the site taken from the dam curtain.

Photograph 06. Photo from the road heading to the dam curtain.

Photograph 07. Photo of the area intended for the disposal of the excavation material and installation of the substation.

Photograph 08. North view towards the Cerro de Oro.

Photograph 09. Panoramic of the dry embankment in the Cerro de Oro dam curtain.

Photograph 10. Photo of the road leading into the curtain area and control structure.

Photograph 11. View of the properties close to the infrastructure of the Cerro de Oro dam.

Photograph 12. Dirt road that communicates with the site intended for the work.

Photograph 13. View of the properties close to the dam infrastructure.

Photograph 14. View towards the area of the control structure of the Miguel de la Madrid Hurtado dam (Cerro de Oro).

Photograph 15. Photo of commercial activities of the area.

Photograph 16. Close-up of the first section of the transmission line layout.

Photograph 17. Corn crops in the properties where the transmission line will be set up.

Photograph 18. Photo of dirt road that communicates the towns of Los Reyes and Santa Ursula.

Photograph 19. Town of Los Reyes, services.

Photograph 20. View of the properties over which the intended layout of the transmission line will cross.

Photograph 21. Type of crops in the area.

Photograph 22. Divisions of the properties with live fences and barbed wire.

Photograph 23. Rubber plantations in the region.

Photograph 24. Close-up of a rubber plantation in the area where the transmission line is intended to be installed.

Photograph 25. Town of Santa Ursula, services.

Photograph 26. Agricultural and livestock activities in most of the properties located in the area of the project.

Photograph 27. Rangelands, seasonal crops and fields mainly in the first kilometers of the transmission line layout

Photograph 28. Corn crops close to the transmission line layout.

Photograph 29. Sugar cane crops in the area of the transmission line layout.

Photograph 30. Layout of the transmission line as close as possible to the trajectory of the existing path.

Photograph 31. Proximity of the path to the transmission line layout to avoid opening new access roads.

Photograph 32. Communities with basic services.

Photograph 33. Town of San Rafael.

Photograph 34. Transmission lines that cross the path of the project's line.

Photograph 35. Transmission line layout that goes into industrial properties in the town of Sebastopol.

Photograph 36. Town of Sebastopol.

Photograph 37. Factories and infrastructure in the Sebastopol area.

Photograph 38. Benito Juárez Substation, interconnection point of the transmission line of the project.

Photograph 39. Centers of study in the town of Sebastopol.

Photograph 40. Archive photograph over the area intended for the development of the project, during the completion of the Cerro de Oro dam.

Photograph 41. Archive photograph over the area intended for the development of the project, during the completion of the Cerro de Oro dam.

Photograph 42. Archive photograph over the area intended for the development of the project, during the completion of the Cerro de Oro dam.

VIII.2 Other Exhibits

Figure "Physiography" State of Oaxaca, Source: INEGI, Physiographic statement scale 1:1,000,000

Figure "Geology" State of Oaxaca, Source: INEGI, Geologic Statement scale 1:1,000,000

Figure "Basins" State of Oaxaca, Source: INEGI, Surface Waters Hydrologic Statement scale 1:1,000,000

Figure "Edaphology" State of Oaxaca, Source: INEGI, Surface Waters Hydrologic Statement scale 1:1,000,000

Figure "Climates" State of Oaxaca, Source: INEGI, Climates Statement scale 1:1,000,000.

Figure "Isothermals" State of Oaxaca, Source: INEGI, National Water Commission, National Meteorological Service.

Figure "Isohyets" State of Oaxaca, Source INEGI, National Water Commission, National Meteorological Service.

Figure "Vegetation" State of Oaxaca, Source INEGI, National Water Commission, National Meteorological Service.

Figure "Agricultural Potential" State of Oaxaca, Source INEGI, Potential Use Statement, Agriculture scale 1:1,000,000

Figure "Livestock Potential" State of Oaxaca, Source INEGI, Potential Use Statement, Livestock scale 1:1,000,000

Itemized Schedule.- "General Schedule by Stages"

Itemized Schedule.-"General Construction Schedule"

Itemized Schedule.- "Site Preparation and Construction Schedule"

Itemized Schedule.-"Personnel Use Schedule, site preparation and construction stages".

Itemized Schedule.-"General Operation Schedule".

Itemized Schedule.- "Abandonment Schedule upon Conclusion of the Useful Life of the Project".

Charter of Electricidad de Oriente, S. de R.L. de C.V..- Deed No. 52064

Affidavit of the person who prepared the General Environmental Impact Report of the Cerro de Oro Hydroelectric Project.

VIII.3 Glossary

Agricultural and livestock area: Land used for agricultural production or livestock breeding, which has lost the original vegetation due to such anthropogenic activities.

Industrial, urban equipment or services area: Urban land or land close to an urban area where a series of real properties, installations, facilities, constructions and equipment are established and used to provide urban services to the population and carry out economic activities.

Maneuvers Area: Area used for pre-assembly, set-up and lining of support structures, the dimensions of which depend on the type of structure to be used.

Rural Area: Area with population centers that are frequently disperse and under 5,000 inhabitants. Generally, agricultural and livestock activities predominate in such areas.

Urban Area: Area having concentrated human settlements of over 15,000 inhabitants. These areas are the seats of public administration institutions, organized commerce and industry and have at least one of the following services: drainage, electric power and potable water network.

Beneficial or detrimental: Positive or negative.

Biodiversity: The variability of living organisms of any source, including land, marine and other aquatic ecosystems and the ecologic complexes they pertain to. It includes the diversity within each species, among species and of the ecosystems.

Maneuvers and patrol road: Fraction of land located on the central axis of the right of way along the trajectory of the electric transmission or sub-transmission line, used to transport necessary personnel, materials and equipment for the construction, supervision and maintenance of the line during its operation.

Critical Environmental Components: They will be defined in accordance with the following criteria: fragility, vulnerability, importance in the structure and functioning of the system, presence of flora, fauna and other natural resources considered in any protection category, as well as important elements from a cultural, religious or social standpoint.

Relevant Environmental Components: They will be determined on the basis of the importance they have on the equilibrium and maintenance of the system, as well as by the project-environment interactions expected.

Environmental Damage: Damage occurring on an environmental element as a consequence of an adverse environmental impact.

Damages to Ecosystems: The result of one or more environmental impacts over one or several environmental elements or ecosystem processes that trigger an environmental imbalance.

Serious Damage to the Ecosystem: Any damage that causes the loss of one or several environmental elements, that affects the structure or function or that changes the evolution or succession tendencies of the ecosystem.

Right of Way: The strip of land located along each airline, whose longitudinal axis coincides with the topographic layout of the line. Its transversal dimension varies in accordance with the type of structures, the magnitude and lateral movement of the arrow and with the operational electric tension.

Serious Ecological Unbalance: Significant alteration of the environmental conditions that contemplate cumulative, synergic and residual impacts that may cause the destruction, isolation or fragmentation of ecosystems.

Duration: The duration of the impact; for example, permanent or temporary.

Difficult regeneration species: Species vulnerable to biological extinction due to the specificity of their habitat requirements and conditions for reproduction.

Environmental Impact: Modification of the environment caused by the actions of man or nature.

Cumulative Environmental Impact: The effect on the environment that results from the increase of the impacts of specific actions caused by the interaction with others that occurred in the past or are currently occurring.

Residual Environmental Impact: An impact that persists after the application of mitigation measures.

Significant or Relevant Environmental Impact: An impact caused by the actions of man or nature, which causes alterations in the ecosystems and natural resources or in health, hindering the existence and development of mankind and other living things, as well as the continuity of natural processes.

Synergic Environmental Impact: An impact produced when the joint effect of the simultaneous presence of various actions supposes an environmental incidence greater than the sum of the individual incidences separately contemplated.

Importance: Indicates the significance of the effect of the impact on the environment. For this purpose, the following is considered:

a) The current condition of the environmental element, elements, or components that will be affected.

b) The relevance of the function or functions affected in the environmental system.

c) The environmental quality of the site, the incidence of the impact on the deterioration processes.

d) The environmental capacity expressed as the impact assimilation and regeneration or auto regulation potential of the system.

e) The degree of conformity with the land uses and/or of the current and projected natural resources.

Irreversible: Any condition the effect of which supposes the impossibility or extreme difficulty of returning through natural means to the status existing before the action that produced the impact occurred.

Transmission line: The line that conducts the electric power with tensions of 161 (one hundred and sixty-one) kV or more. For the project, although the tension of the line will be 115 KV and this pertains to the sub-transmission category, it has been labeled as “transmission” line for the consistency of the concept and purpose of the infrastructure.

Magnitude: Extension of the impact with respect to the area of influence through time, expressed in quantitative terms.

Compensation Measures: Set of actions the purpose of which is to compensate the environmental deterioration caused by the environmental impacts associated with a project and which help restore the environmental conditions that existed before the project activities were carried out.

Preventive Measures: Set of actions the petitioner must carry out to prevent foreseeable environmental deterioration effects.

Mitigation Measures: Set of actions the petitioner must carry out to mitigate the environmental impact and reestablish or compensate the environmental conditions existing prior to the disturbance caused by the development of a project, in any of its stages.

Nature of the Impact: Refers to the beneficial or adverse effect of the action on the environment.

Reversibility: Occurs when the alteration caused by impacts generated by the performance of work or activities over the natural environment can be assimilated by the settings due to the operation of ecologic succession natural processes and auto-depuration mechanisms of the environment.

Environmental System: The interaction between the ecosystem (abiotic and biotic components) and the socio-economic subsystem (including cultural aspects) of the region where the project is intended to be developed.

Total Surface: Sum of the surface by section (length of the section times the width of the right of way).

Surface by Section: The result of multiplying the length of the section times the width of the right of way.

Urgency of Application of Mitigation Measures: Quickness and importance of the remedial measures to mitigate the impact, considering as criteria whether the impact surpasses limits or the relevance of the environmental loss, mainly when it affects critical functions or structures.

Natural Vegetation: Set of arborous, shrub and herbaceous elements present in the area that will be affected by the electric infrastructure and related work.