IV. DESCRIPTION OF THE REGIONAL ENVIRONMENTAL SYSTEM AND INDICATION OF TENDENCIES OF THE REGION'S DEVELOPMENT AND DETERIORATION

IV.1 Delimitation of the research area

For the delimitation of the research area the following project's characteristics will be considered:

- **Dimensions**

The project comprises three municipalities of the State of Veracruz: San Juan Texhuacán, Mixtla de Altamirano and Zongolica.

The total surface of the lands obtained for the project is 24.38 Ha., while the permanent affectation surface due to the construction of the works and the reservoir amounts 4.89 Ha, corresponding to 20.06% the project's total surface.

TABLE IV.1 PROJECT'S PERMANENT SURFACE

NAME	SURFACE (Ha)
Reservoir	2.36
Dam wall	0.12
Tunnel (portal)	0.77
Conduction Tube	1.08
Transmission line (20 towers of 64m^2 each)	0.13
Power House and Substation	0.34
Access to the power house	0.09
TOTAL	**4.89**

The forestall land use change (Gallery Forest, Oak-Pine Forest and Pine Forest Renewal) will be carried out in a surface equal to 4.29 Ha and in Coffee with shadow trees in a surface of 10.54 Ha, therefore, the forestall land use change is required in a total surface of 14.83 Ha.

TABLE IV.2 DISTRIBUTION OF THE TOTAL SURFACE BY KIND OF LAND

VEGETATION	Volume (m3 VTA)	Surface (Ha)
Gallery Forest	197.839	1.39
Oak-Pine Forest	122.683	2.6
Pine Forest (Renewal)	---	0.3
Coffee with shadow trees	457.481	10.54
Subtotal for the land use change	**778.002**	**14.83**
Agriculture	1.092	4.1
Pasture ground	---	1.43
Water corps and surfaces without vegetation	---	4.02
TOTAL	**779.094**	**24.38**

- **Space distribution of the project's works and activities, including the associated and/or provisional ones**

The land space distribution will take into account the right of way, for the construction (civil work and electro-mechanic work) that allows the impounding, conduction, utilization and discharge of water for the generation of electric power with self-supply purposes.

The project is restricted to the central southwest zone of the State of Veracruz, in the denominated Sierra Negra of Zongolica that is part of the natural region of t Grandes Montañas. The UTM coordinates that delimit the zone are located between X (710750 – 714700 W); AND (2059780 – 2063480 N) and between the elevations 1,370 masl in the tail of the Apatlahuaya river reservoir and 580 masl in the discharge zone of the Power House vent to the Zongolica river.

The "Ad Hoc" methodology to define the research area, is in direct relationship with the affected water course (100 meters before its utilization and 100 meters after the confluence point between the natural water course and the one coming from the hydroelectric plant), the project's outline area, the nearby populations involved and the communication road systems used, which result that the project area is of 22.85 Ha.

Kind of works and activities to be developed.

1. Construction of a dam with an approximate capacity of two hundred thousand cubic meters that will flood a surface of only 2.36 hectares.

2. Construction of a conduction tunnel 2,790 m long and "Portal" section with a surface of 9 m^2 with a transversal section of 3.0 m width and 3.0 m height that will cross a hill in straight line.

3. Construction of a steel pipeline with a 1.22 m diameter and 2, 340 m long that will descend by the side of a ravine up to the power house of the hydroelectric generation central.

4. Construction of the power house and substation that will receive the power generated.

5. Installation of the transmission line of a length circuit of 4.3 Km. with which the link to the other substation will be made.

- **Location**

The project includes three municipalities of the State of Veracruz: San Juan Texhuacán, Mixtla de Altamirano and Zongolica: Part of the reservoir in the municipality of Mixtla; another part of the reservoir, the dam wall, tunnel intake work, tunnel and oscillation ditch in Texhuacán and pressure tube, power house, transmission line and substation in the municipality of Zongolica.

San Juan Texhuacán is located in the mountain central zone of the State of Veracruz, on the geographic coordinates 18º 37' of North Latitude and 97º 02' of West Longitude. Limits at the north with Los Reyes, to the south with Mixtla de Altamirano, to the east with Zongolica and to the west with Astacinga and Tlaquilpa.

Mixtla de Altamirano is located in the central zone of the State of Veracruz, in the spurs of the Zongolica Sierra, in the coordinates 18° 36' North Latitude and 97° 00' West Longitude. Limits to the north with San Juan Texhuacán, to the south with Tehuipango, to the east Zongolica and to the west with Astacinga. Its approximate distance south from the State Capital city, by highway is of 247 Km.

Zongolica is located in the central zone of the State of Veracruz, in the coordinates 18° 40' North Latitude and 97° 00' West Longitude. Limits to the north with Tequila and Omealca, to the south with the State of Puebla, to the east with Tezonapa, and to the west with Mixtla de Altamirano and Los Reyes. It has a surface of 347.33 Km2, figure that represents 0.48% of the whole State.

The communication road system useful for the access include the paved highway that goes from Zongolica to Texhuacán; the paved road to Mixtla de Altamirano; the deviation through an earthwork road capable of being transited in vehicle to the community of Palulca and Aticpac; pedestrian earthwork road that goes parallel to the tunnel outline zone, walking up the community of Equimititla and from there to Ocotitla where the tunnel's exit portal is located as well as the beginning of the pressure tube. It is also possible to have access to this last zone in vehicle taking in Zongolica the paved road that goes to the Las Quintas hill and from there the deviation through an earthwork road of 3.4 km up to the tunnel exit and that arrives to the community of Ocotitla. Access to the power house is through a paved road located north from Zongolica and that goes to Xonamanca and in the community Nepopualco; From Zongolica through a paved road, deviation to the community of El Zacatal on an earthwork road located between the community of San Jerónimo and Puente Porres on the margins of the Zongolica river. (Geotécnica.SC, 2008)

The project is located within the following coordinates UTM (Table IV.3)

TABLE IV.3 PROJECT'S GEO-REFERENCED DELIMITATION

VERTEX	NORTH LATITUDE	WEST LONGITUDE
Water Impounding Work Polygon.		
1	711046.80304	2060121.53633
2	711027.35102	2060141.76643
3	710969.77307	2060154.21571
4	710902.85815	2060109.86513
5	710879.51574	2060070.18302
6	710830.49667	2059959.69560
7	710788.48032	2059906.78613
8	710748.79822	2059830.53424
9	710678.77098	2059730.16186
10	710577.62051	2059604.11282
11	710538.71649	2059578.43617
12	710425.89482	2059572.98961
13	710485.02894	2059542.64447
14	710531.71377	2059533.30750
15	710583.84516	2059541.08831
16	710753.46670	2059727.82762
17	710814.93506	2059843.76161
18	710858.50756	2059909.12037
19	710921.53208	2059974.47913
20	710923.08824	2060015.71739
21	710951.87722	2060049.17485
22	710978.33196	2060065.51454
23	711012.56750	2060057.73374
Water conduction work vertexes.		
1	714529.56811	2063292.57765
2	714416.26856	2063302.93738
3	714294.87987	2062961.03392
4	714016.78594	2062973.88123
5	713906.83088	2062932.38853
6	713772.15781	2062847.41105
7	713749.73652	2062805.61118
8	713520.49802	2062682.16744
9	713474.11493	2062644.07962
10	713290.03933	2062537.26796
11	713228.62721	2062492.03191
12	713143.97503	2062424.06816
13	713076.67464	2062389.46556
14	713044.87300	2062314.89638
15	712950.29305	2062240.77909
16	712910.80521	2062186.35414
17	712851.54112	2062089.26940
Transmission Line Vertexes		
Initial Point	711615.70775	2066193.61968
PI-1	711648.78073	2066193.61968
PI-2	712074.59539	2065796.74388
PI-3	712285.43566	2065474.28230
PI-4	712731.92093	2064924.44395
PI-5	713037.84602	2064721.87193
PI-6	713711.70805	2064296.05727
PI-7	714149.92508	2063948.79095

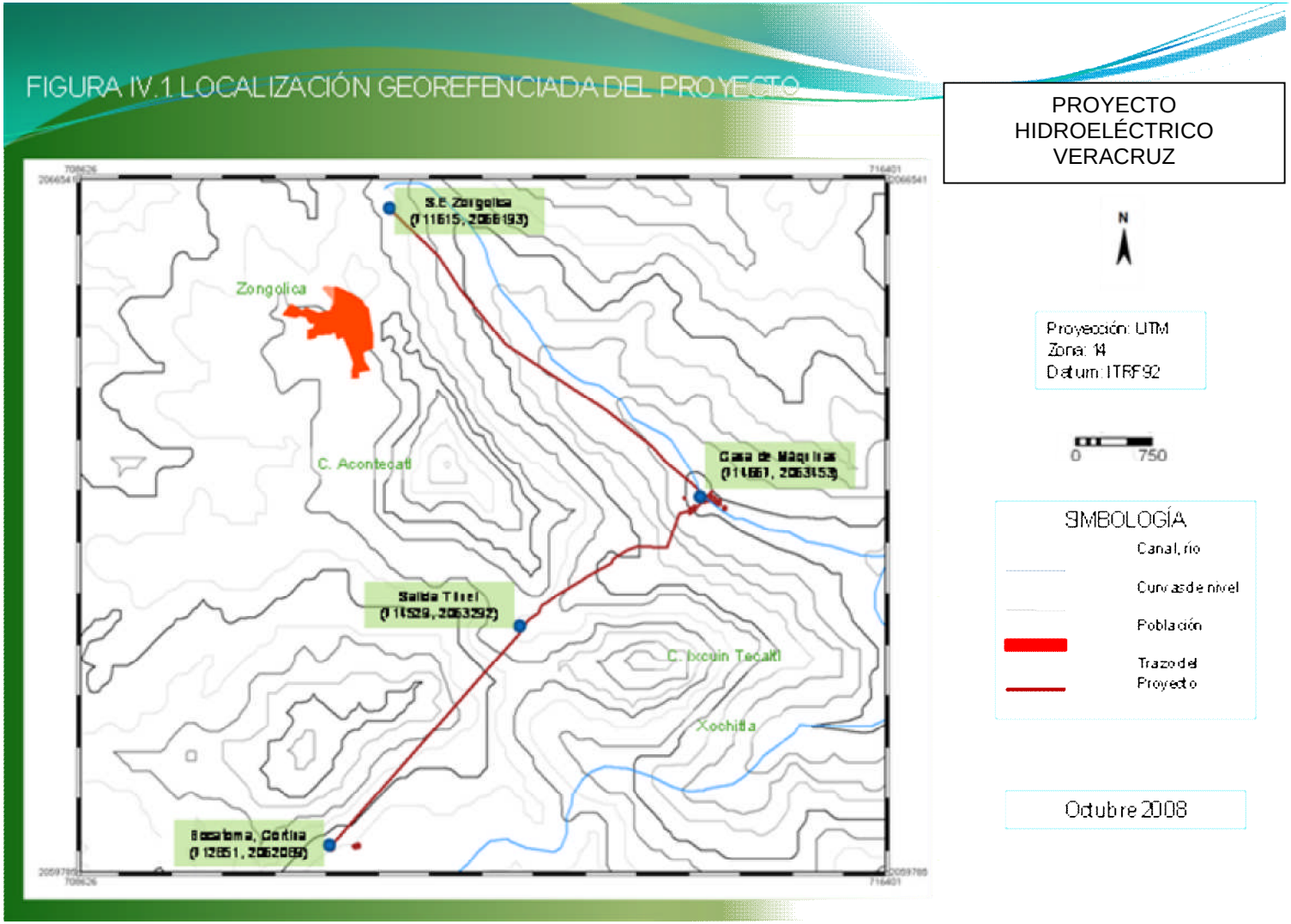
VERTEX	NORTH LATITUDE	WEST LONGITUDE
PI-8	714294.61938	2063787.56016
PI-9	714559.20324	2063568.45165
Final Point	714667.99655	2063453.80993
power house - substation polygon.		
1	714530.56874	2063366.61800
2	714559.86418	2063347.78522
3	714655.19063	2063328.02242
4	714714.01402	2063309.88715
5	714721.22163	2063309.42214
6	714832.59081	2063294.77442
7	714756.32966	2063479.61472
8	714584.50956	2063428.92895

- **Geomorphoedaphologic features.**

The Sierra Negra of Zongolica is in the central south west zone of the state of Veracruz and forms part of the Grandes Montañas natural region. It is in the mountain system of the Sierra Madre Oriental. Limits to the north with the estate of Puebla, in the part called Sierra Negra, and with the Tehuacán Valley.

Its slopes are elevated in the Sierra Mazateca, in the state of Oaxaca, and by the east descend to the Sotavento Plains, in the state of Veracruz.

In the basin where the Proyecto Hidroeléctrico Veracruz is located, the basins involved in the Project are: "Papaloapan" and "Jamapa". Within the basin the following geo-forms are characteristic: laying slopes with plateaus, plain, hills, canyon, valley, tuffs and plateaus.

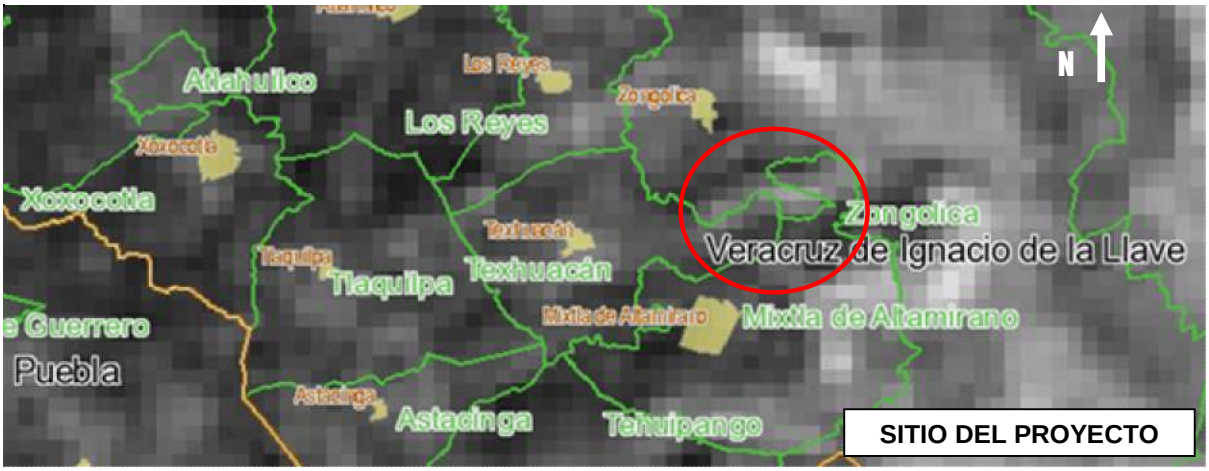


Source: INEGI, digital data 2005

- **Politic – administrative limits**

The municipality of Zongolica is contiguous to the North with: Naranjal, Coetzala and Omealca; to the East with Tezonapa; to the South with Puebla and Tehuipango; to the West with Mixtla de Altamirano, Texhuacán, Los Reyes and Tequila.

DIAGRAM IV.1. GEOGRAPHICAL INFLUENCE ZONE



Source: Sistema Nacional de Información Estadística y Geográfica INEGI 2008

- **Types of vegetation**

Table IV.4 shows the classification of the different areas used to apply an environmental policy and the vegetation included.

TABLE IV.4 KIND OF VEGETATION TO BE AFFECTED BY THE PROJECT

VEGETATION	Volume (m^3 VTA)	Surface (Ha)
Gallery Forest	197.839	1.39
Oak-Pine Forest	122.683	2.6
Pine Forest (Renewal)	---	0.3
Coffee with shadow trees	457.481	10.54
Subtotal for land use change	**778.002**	**14.83**
Agriculture	1.092	4.1
Pasture ground	---	1.43
Water corps and surfaces without vegetation	---	4.02
TOTAL	**779.094**	**24.38**

- **Productive regions.**

In accordance with the agriculture potential use map of the National System of Statistic and Geographic Information (*Sistema Nacional de Información Estadística y Geográfica*) the region subject to the research is not fit for agriculture.

TABLE IV.5 AFFECTATIONS TO PRODUCTIVE ACTIVITIES

CLASSIFICATION	SURFACE (Ha)
Coffee with shadow trees	10.54
Agriculture	4.1
Pasture grounds	1.43
TOTAL	**16.07**

IV.2 Characterization and analysis of the regional environmental system

The characterization of the physical, biotic, social and economic environment will be carried out considering a period comprising from the time when the project is initiated with a 20 years retrospective.

IV.2.1 Abiotic Environment

- **Climate**

The state of Veracruz is located in the inter-tropical strip, but it has a great diversity of warm, semi-warm, mild, cold and semi-dry climates, because its territory possesses several altitude differences (mountainous), which range from the sea level to the maximum height in the country: 5,700 masl that correspond to the Pico de Orizaba volcano. The medium temperature is of 27.6 °C; the average maximum temperature is 31.5 °C; the maximum extreme temperature is of 32.1 °C; the average minimum temperature is 24.5 °C; the minimum extreme temperature is of 22.4 °C (SMN, CNA, 2008)

Two relevant meteorological phenomenons currently have a repercussion on the climates present in the state:

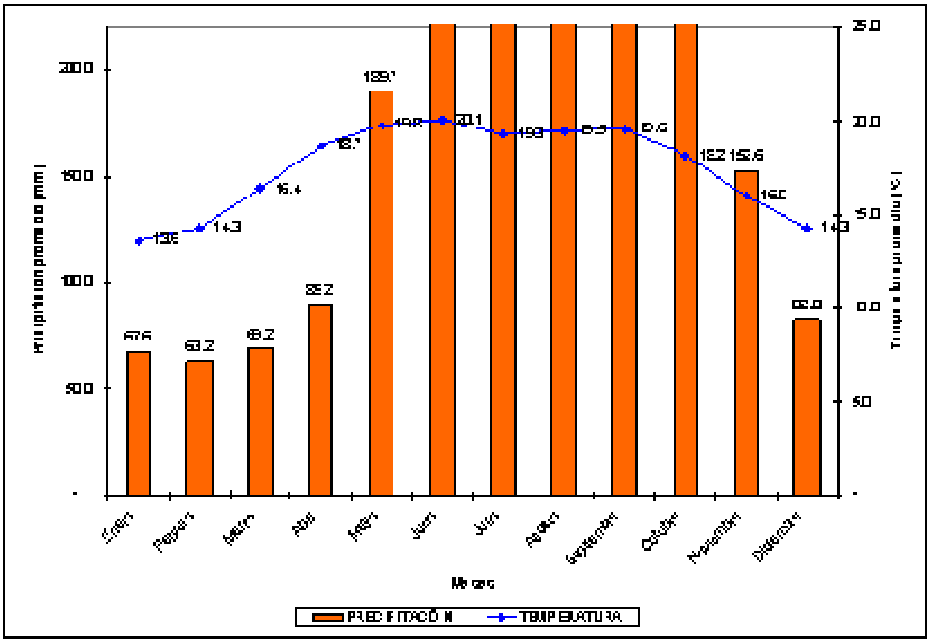
- The cyclones, that are present mainly in the autumn, even though there are some of them in summer. Their presence after the rainy season, in summer, causes that the rainy season is extended, causing eventual flooding, because the rivers overflow.
- The cold fronts or "north winds ", as are commonly known, that are frequent in Winter and some times are extended until spring. There are cold air masses, coming from polar regions that when in contact with the Gulf warm masses elevate them, forming clouds that precipitate in tempestuous manner.

In the meteorological stations nearest to the research area, of Zongolica and Tehuipango, the following climates are reported in accordance with the modifications to the climate classification system of Köppen by E. García (1988):

- Meteorological station of Zongolica at 1,294 masl presents climate Cbm (f) i´; mild humid and sub-humid, semi-cold, percentage of the Winter precipitation in respect to the total major annual of 18 days, temperature march with little oscillation.

- Meteorological station of Tehuipango at 2,820 masl presents climate type Cbm (f) ig; mild humid and sub-humid semi-cold; percentage of the Winter precipitation in respect to the total major annual of 18 days, temperature march isothermal and ganges type.

DIAGRAM IV.2. CLIMOGRAM ZONGOLICA METEOROLOGICAL STATION



In general, the zones located at an altitude of between 1,600 and 2,800 masl possess mild climates, and differ in the humidity degree and in the intensity and in the rain regime based their horizontal distance to the sierras, the influence of which is very important.

Monthly, annual and extreme average temperature.

The annual medium temperature of the municipalities of the Mountain region (Sistema Nacional de Información Estadística y Geográfica INEGI 2008) is of 20 to 22 ºC.

Monthly, annual and extreme average precipitation (mm).

In respect to precipitation, in the state of Veracruz there is a total amount of precipitation of 134.1 mm; the maximum precipitation 78.7 mm and the accumulated rain from January 1 – July is of 841.0 mm (SMN, CNA, 2008)

The annual medium precipitation of the municipalities of the Mountain region (Sistema Nacional de Información Estadística y Geográfica INEGI 2008) is of 1,500 to 2,000 mm.

TABLE IV. 6 MEDIUM MONTHLY CONSUMPTIONS IN THE TELPATLÁN HYDROMETRIC STATION

VOLUMENES MENSUALES EN MILES DE m^3

AÑO	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC	ANUAL
1971	2,114	1,580	1,542	1,263	1,303	1,211	2,750	3,728	6,799	6,897	5,914	3,736	38,907
1972	3,404	2,338	1,904	1,584	1,443	1,877	9,255	20,143	10,962	8,032	4,308	3,261	68,511
1973	2,144	1,809	1,617	1,512	1,700	4,118	14,792	12,808	17,541	7,221	4,048	3,792	73,102
1974	2,829	2,107	1,877	1,640	1,463	7,170	11,710	3,818	16,614	14,425	5,786	3,735	73,175
1975	2,998	2,232	2,060	1,923	1,937	8,699	5,410	4,778	50,023	14,218	5,440	4,102	103,820
1976	3,736	2,899	2,507	2,194	2,044	8,541	23,860	9,774	18,280	13,528	10,633	7,895	105,891
1977	5,750	2,641	2,171	1,903	1,430	1,466	2,091	3,527	3,899	2,804	2,890	2,508	33,080
1978	2,330	1,586	1,447	1,166	1,047	1,976	6,482	6,205	10,667	8,788	4,056	4,275	49,995
MEDIA	3,163	2,149	1,891	1,648	1,546	4,382	9,544	8,098	16,848	9,489	5,384	4,163	68,310

Source: Estimate of the ecologic consumptions in the drifting dam of Veracruz project

Estimate of annual medium dripping in the site of the drifting dam.

As of the annual medium dripping in the Telpatlán station in the period 1971-1978, the annual medium dripping per km^2 of drained area was estimated, as shown herein below:

TABLE IV. 7 DRIPPING RECORD

YEAR	DRIPPING (hm^3/km^2)
1971	0.44
1972	0.78
1973	0.83
1974	0.83
1975	1.18
1976	1.20
1977	0.37
1978	0.57
Average	**0.77**

Source: Estimation of ecologic consumptions in the drifting dam of the Veracruz project

Dominant winds (direction and speed) in a monthly and annual basis.

In the state of Veracruz the predominant direction of the Maximum Wind is 360.0° north, with a Maximum speed of 9.0 m/s. The Direction of the Dominant Wind is 90.0° east, with an average speed of 3.0 m/s (SMN, CNA, 2008)

TABLE IV.8 MONTHLY TEMPERATURES FOR THE MUNICIPALITIES OF THE PROJECT'S AREA

MONTH	MONTHLY TEMPERATURE		
	ZONGOLICA	ORIZABA	CORDOBA
January	13,6	15,8	17,1
February	14,3	16,8	18,1
March	16,4	18,8	20,0
April	18,7	20,5	22,2
May	19,8	21,3	23,0
June	20,1	20,7	22,6
July	19,3	19,9	21,8
August	19,5	20,3	22,1
September	19,6	20,0	21,6
October	18,2	18,8	20,6
November	16,0	17,1	18,6
December	14,3	16,0	17,5
Annual Average	**17,4**	**18,8**	**20,4**

Source: Enriqueta García 1988 Modificaciones al Sistema de Clasificación Climática de KOPPEN
Annual average of records in the stations of Zongolica of 27 years, Orizaba 56 years and Córdoba of 52 years

Relative and absolute humidity.

In accordance with data obtained by the CNA (SMN, CNA, 2008), the Average of Relative Humidity 81.0%

Frequency of freezing, snowfalls and hurricanes, among other extreme climate events.

In the state of Veracruz, the following values are reported (SMN, CNA, 2008):

- Nr. of Days With Dew 7.0 day(s)
- Nr. of Days With Freezing 0.0 day(s)
- Nr. of Days With Electric Storms 9.0 day(s)
- Nr. of Days With Snowfalls 0.0 day(s)
- Nr. of Days With Hail 0.0 day(s)

TABLE IV.9 MONTHLY PRECIPITATIONS FOR THE MUNICIPALITIES OF THE PROJECT'S AREA

MONTH	MONTHLY PRECIPITATION		
	ZONGOLICA	ORIZABA	CORDOBA
January	67,6	41,8	42,6
February	63,2	33,3	36,3
March	69,2	31,3	47,7
April	89,2	48,6	50,3
May	189,7	125,3	110,8
June	455,6	371,1	345,4
July	565,3	401,7	379,5
August	442,6	343,8	351,6
September	440,3	370,7	441,4
October	265,7	193,3	211,2
November	152,6	85,6	81,3
December	82,8	44,6	50,1
Annual Average	**2.883,8**	**2.091,1**	**2.148,20**

Source: Enriqueta García 1988 Modificaciones al Sistema de Clasificación Climática de KOPPEN
Annual average of records in the stations of Zongolica of 27 years, Orizaba 59 years and Córdoba of 55 years

In accordance with the information referenced to the municipality of Mixtla de Altamirano (CIBCEC, 2003), in which a mild-dry-extreme climate is present with an annual average temperature of 15.8° C, with abundant rains in summer and at the beginning of the autumn, with lesser intensity in winter; its annual medium precipitation is of 1,420.5 mm; we can associate the existence of certain climate effects that affect the project's region, also considering physiological features and their climate conditions:

TABLE IV.10 CLIMATE EVENT AFFECTING THE REGION

Event	Frequency	More common effects
Intense winds, whirling, dust whirls	During the dry months	Partial damages in housing, interruption of the electric power and interruption of telephone communication
Hail storms	During the rainy months	Partial damages to housing and Loss of harvest
Freezing	Two or more times per year	Loss of harvest and Effects in the population's health
Forestall fires (include the ones provoked by humans)	During the dry months	Destruction of cultivated and/or forestall fields

Source: SEDESOL, (CIBCEC), 2003.

- **Solar radiation or incidence**

In the state of Veracruz, a Total Insolation of 75.4 hours/year is reported. (SMN, CNA, 2008).

- **Atmospheric Quality**

There are no data on atmospheric quality monitoring for the research zone.

- **Geology and Geo-morphology**

In general the relief of the area in which the Zongolica Sierra is located is polygenetic finding volcanic, wrinkled and complex mountains reliefs. In the mountain chain corresponding to the Zongolica and Mazateca sierras the wrinkled feature is modified by karstic processes that have engraved hills, sewers and natural bridges in the calcareous rocks. In the region preferably sedimentary limestone rocks and shale are found. (Fig. IV.4)

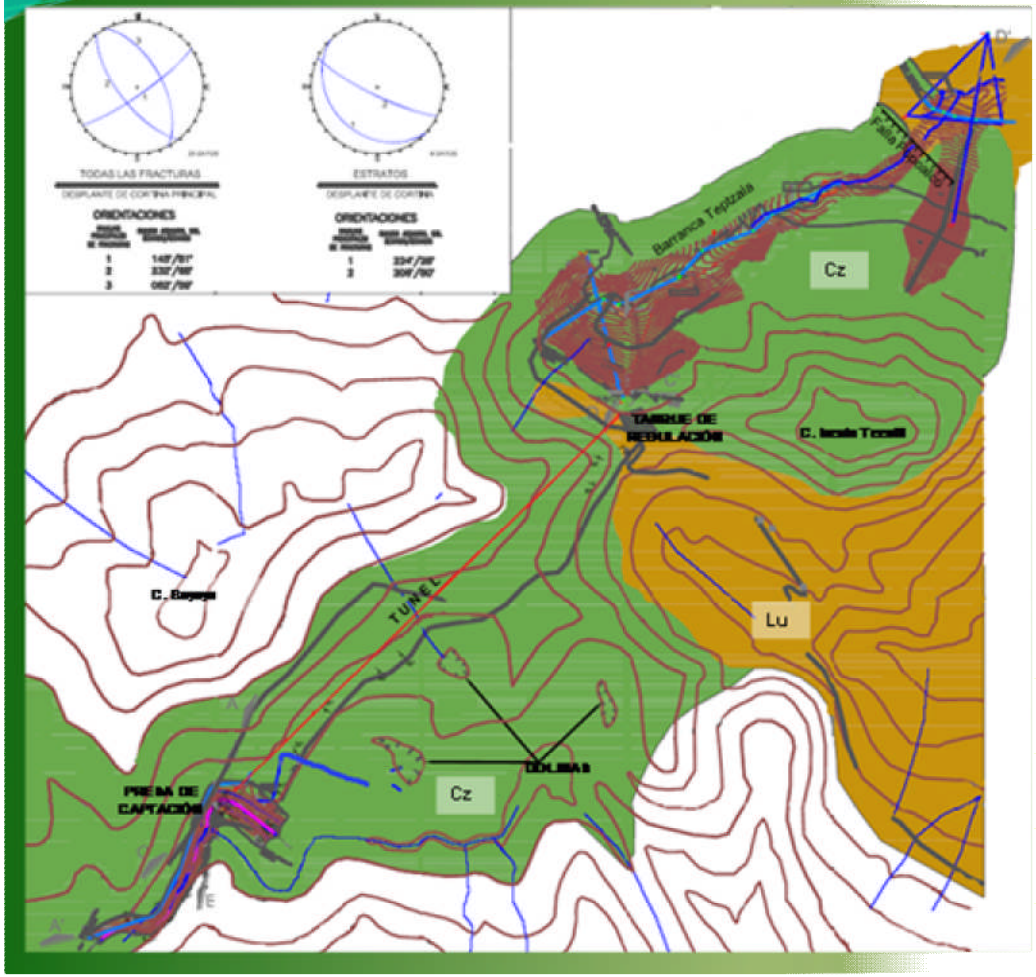
Particularly in the area of influence where the Proyecto Hidroeléctrico Veracruz is located, the hill and canyon type reliefs are found, with different presentations of slopes (Table IV.11 and Fig. IV. 5)

TABLE IV.11 PROJECT'S TRANSVERSAL SLOPES

MUNICIPALITY	MEDIUM SLOPE %	MINIMUM SLOPE %	MAXIMUM SLOPE %
San Juan Texhuacán	40	20	60
Mixtla de Altamirano	45	20	70
Zongolica	60	30	90

In the region, some geo-morphologic type events mainly associated to extreme meteorological conditions have been reported, mainly due to the increase of rains and the level of the courses and water corps. During this year (2008) the Municipality of Zongolica has suffered overflows of the Acontecatl lagoon, involving more than 85 houses within the urban area. Also the Tonto river has overflow, involving the town of Ayojapa and causing serious damages to the cultivation lands.

FIGURA IV.4. GEOLOGIA LOCAL GENERAL



PROYECTO HIDROELÉCTRICO VERACRUZ

N

Proyección: UTM
Zona: 14
Datum: ITRF92

SIMBOLOGÍA

- Canal,río
- Curvas de nivel
- Contacto Geológico
- Fallas
- Lu — Lutitas
- Cz — Calizas

Octubre 2008

FIGURA IV.5. MODELO DIGITAL DEL TERRENO DENTRO DEL AREA DE INFLUENCIA DEL PROYECTO

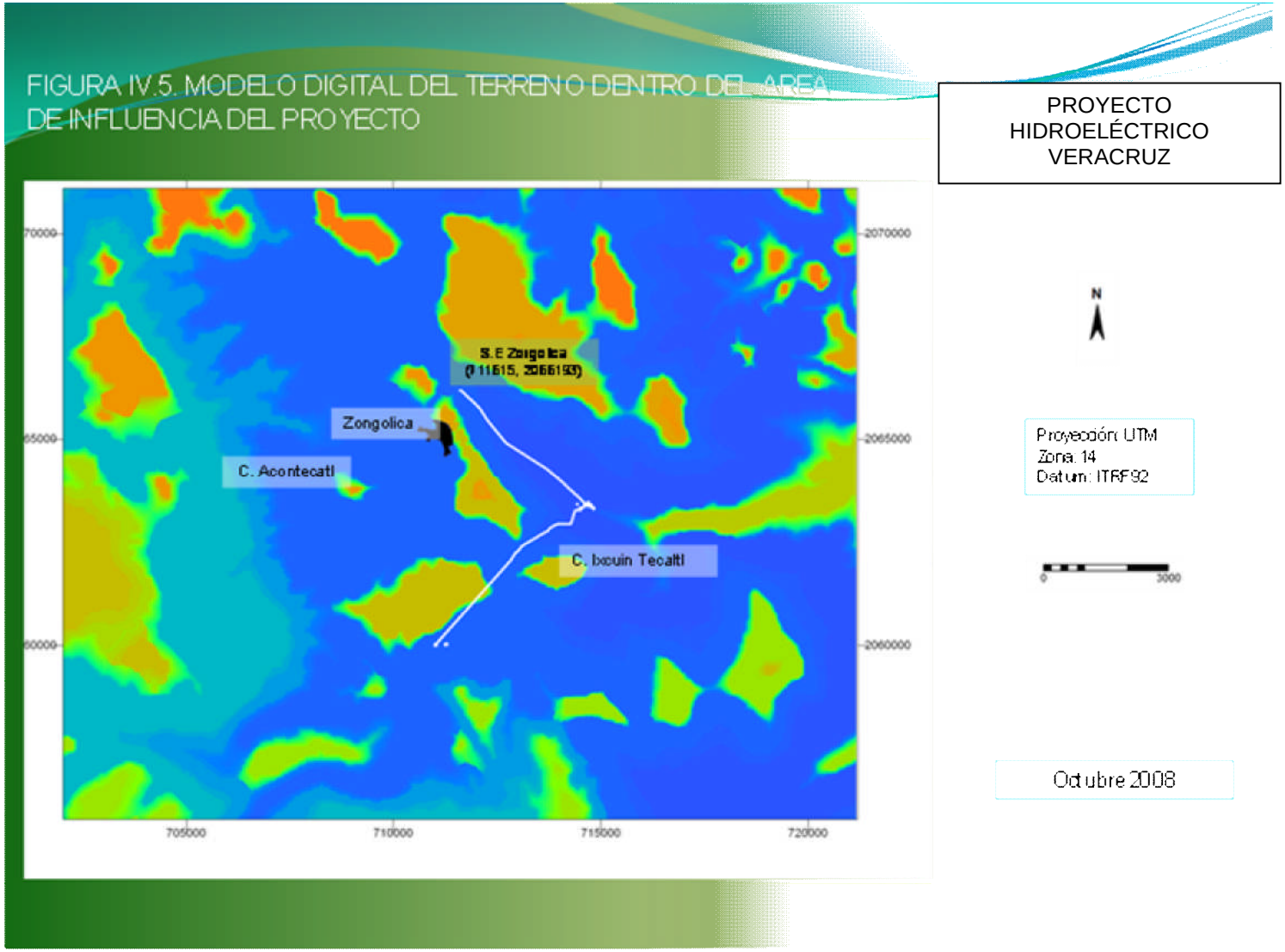


TABLE IV.12 GEO-MORPHOLOGIC EVENTS IN THE REGION

EVENT	FREQUENCY	MORE COMMON EFFECTS
Land slides or avalanches	During rain months	Interruption of highway communication

Source: SEDESOL, (CIBCEC), 2003.

In the zone of the Proyecto Hidroeléctrico Veracruz, the company that carried out the geotechnical research performed the geophysical exploration (Geotecnia S.C, 2008), that allowed it to establish the compactness characteristics of the different underground materials, thicknesses and contrasts of propagation speeds of longitudinal waves, changes in the composition of the underground materials and the possible contact between the coverage material and the rock, using the Vertical Electrical Sounding (SEV) method (Sondeo Eléctrico Vertical).

Therefore they took four project's crucial points as: the oscillation ditch and the Tunnel's Exit Portal; Dam Wall and Conduction Tunnel's Entrance Portal; Pressure Tube; Power House and Substation.

The tests performed consisted in Seismic Refraction and Vertical Electrical Soundings, producing the results shown in tables IV.13 to IV.20

For the first test (seismic refraction) they effectuated seismic refraction lying in marginal points, generating a train of seismic waves through the use of metal plates that were submitted to hammering synchronized with seismographs and geophones. The detail of the principles and methodology of this technique is attached in the Annexes section.

TABLE IV.13 SEISMIC REFRACTION IN THE OSCILLATION DITCH AND TUNNEL EXIT PORTAL

GEOSEISMIC UNIT	SPEED (Vp) (m/s)	THICKNESS (m)	ASSOCIATED MATERIAL
I	150 – 300	0.1 – 4.6	Residual soil
II	1865	3.2 – 18.5	Fractured and altered limestone
III	4800 - 5400	Undetermined	Healthy limestone

(Geotecnia S.C, 2008)

TABLE IV.14 SEISMIC REFRACTION IN DAM WALL AND CONDUCTION TUNNEL ENTRANCE PORTAL

GEOSEISMIC UNIT	SPEED (Vp) (m/s)	THICKNESS (m)	ASSOCIATED MATERIAL
I	180 – 450	0.3 – 1.1	Residual soil less compact
II	1200 - 1450	2.6 – 12.0	Altered and fractured Sedimentary volcano deposit
III	2500 - 4500	Undetermined	Sedimentary volcano deposit compact
IV	1550	5.5 – 13.0	Very fractured limestone
V	4500	Undetermined	Healthy limestone

(Geotecnia S.C, 2008)

TABLE IV.15 SEISMIC REFRACTION IN PRESSURE TUBE

GEOSEISMIC UNIT	SPEED (Vp) (m/s)	THICKNESS (m)	ASSOCIATED MATERIAL
I	170 – 405	0.1 – 3.5	Residual soil less compact
II	785-1116	3.8 – 16.4	Deposit de talus and fractured limestone deposit
III	1225 - 2500	2.1 – Undefined	Fractured limestone
IV	3500 - 5000	Undetermined	Healthy limestone

(Geotecnia S.C, 2008)

TABLE IV.16 SEISMIC REFRACTION IN POWER HOUSE AND SUBSTATION

GEOSEISMIC UNIT	SPEED (Vp) (m/s)	THICKNESS (m)	ASSOCIATED MATERIAL
I	325 – 400	0.1 –2.4	Residual soil less compact
II	1350 - 1550	0.6 – 6.8	Fractured and altered Shale
III	2980 – 3500	Undetermined	Healthy Shale

(Geotecnia S.C, 2008)

For the second test they used the Vertical Electrical Sounding(SEV) method Schlumberger Electrodics Variety arrangement, to identify the stratigraphy based on the environment resistivity values.

TABLE IV.17 VERTICAL ELECTRICAL SOUNDING IN OSCILLATION DITCH AND TUNNEL EXIT PORTAL

GEO-ELECTRIC UNIT	RESISTIVITY (ohm/m)	THICKNESS (m)	ASSOCIATED MATERIAL
U1a	2055 – 2326	1.8 – 2.0	residual soil very loosen
U1b	177 - 561	0.5 – 1.4	Residual soil
U2a	230 - 952	7.7 – 19.9	Fractured limestone
U2b	94	6.9	Fractured limestone with inter-stratiphied shale
U3	558 - 3312	Undetermined	Healthy limestone

(Geotecnia S.C, 2008)

TABLE IV.18 VERTICAL ELECTRICAL SOUNDING IN DAM WALL AND CONDUCTION TUNNEL ENTRANCE PORTAL

GEO-ELECTRIC UNIT	RESISTIVITY (ohm/m)	THICKNESS (m)	ASSOCIATED MATERIAL
U1	185	0.4	Residual soil less compact
U2	20 - 59	2.1 – 8.1	Fractured and altered Sedimentary volcano deposit
U3	215 - 505	Undetermined	Little fractured and healthy Sedimentary volcano deposit

(Geotecnia S.C, 2008)

TABLE IV.19 VERTICAL ELECTRICAL SOUNDING IN PRESSURE TUBE

GEO-ELECTRIC UNIT	RESISTIVITY (ohm/m)	THICKNESS (m)	ASSOCIATED MATERIAL
U1	26 – 255	1.6 – 6.5	residual soil less compact
U2a	47 – 165	13.3 – Undetermined	Talus deposit
U2b	240 - 2066	Undetermined	Fractured limestone

TABLE IV.20 VERTICAL ELECTRICAL SOUNDING IN POWER HOUSE AND SUBSTATION

GEO-ELECTRIC UNIT	RESISTIVITY (ohm/m)	THICKNESS (m)	ASSOCIATED MATERIAL
U1	147-166	1.1-1.9	residual clay rich soil less compact
U2	12 - 64	4 – 20.3	Fractured and altered Shale
U3	133 - 563	Undetermined	Healthy Shale

(Geotecnia S.C, 2008)

Important conclusions derived from the research (Geotecnia S.C, 2008):

1. The indirect exploration in the zone of the oscillation ditch and the conduction tunnel exit portal allowed to clearly differentiating the lateral border of volcanoclastic material with the limestone and the fault talus zone of the natural slope allowing relocating these works to the northwest in the zone of better geo-mechanical quality limestone.

2. In the Tepetzala ravine that will receive the pressure tube the results from the indirect exploration have allowed to have a better idea of the soil thickness and their compactness and of the location of the contact with the altered rock and of this with the healthy rock, which will be useful to define the probable foundation of holdups and stools.

3. In the power house and substation site the same information on soil thickness and compactness and of altered rock thickness was obtained, that will serve as supplement to define the excavation and talus geometry procedures and to adjust, if necessary, the depths of the location and foundation of the structures.

- **Edaphology**

Regionally, the predominant lands in the zone involving the municipalities of San Juan Texhuacán, Mixtla de Altamirano and Zongolica, in accordance with the Carta de Suelos, scale 1:1,000,000, edited by the INEGI, in the area of influence where the Proyecto Hidroeléctrico Veracruz is located, are:

TABLE IV. 21 EDAPHOLOGY IN THE WATER IMPOUNDING SITE

CODE	PRIMARY SOIL		SECONDARY SOIL		TERTIARY SOIL		TEXTURE	PHASE	
	Nom - Sue	Nom-Sub	Nom-Sue	Nom-Sub	Nom-Sue	Nom-Sub		PHYSICAL	CHEMICAL
Ao+Hh+Bc/2/P	Acrisol	ortic	Feozem	haplic	Cambisol	chromic	Medium	Stony	

TABLE IV.22 EDAPHOLOGY IN THE WATER CONDUCTION SITE

CODE	PRIMARY SOIL		SECONDARY SOIL		TERTIARY SOIL		TEXTURE	PHASE	
	Nom - Sue	Nom-Sub	Nom-Sue	Nom-Sub	Nom-Sue	Nom-Sub		PHYSICAL	CHEMICAL
Ao+Hh+Bc/2/P	Acrisol	Ortic	Feozem	haplic	Cambisol	chromic	Medium	Stony	

TABLE IV.23 EDAPHOLOGY IN THE TRANSMISSION LINE SITE

CODE	PRIMARY SOIL		SECONDARY SOIL		TERTIARY SOIL		TEXTURE	PHASE	
	Nom - Sue	Nom-Sub	Nom-Sue	Nom-Sub	Nom-Sue	Nom-Sub		PHYSICAL	CHEMICAL
Ao+Hh+Bc/2/P	Acrisol	ortic	Feozem	Haplic	Cambisol	chromic	Medium	Stony	

TABLE IV.24 EDAPHOLOGY IN THE POWER HOUSE– SUBSTATION SITE

CODE	PRIMARY SOIL		SECONDARY SOIL		TERTIARY SOIL		TEXTURE	PHASE	
	Nom - Sue	Nom-Sub	Nom-Sue	Nom-Sub	Nom-Sue	Nom-Sub		PHYSICAL	CHEMICAL
Ao+Hh+Bc/2/P	Acrisol	ortic	Feozem	Haplic	Cambisol	chromic	Medium	Stony	

Analyzing the data provided by the Orizaba Edaphologic Map (Carta Edafológica Orizaba) 1:250 000 (INEGI, 1999), the research area predominantly presents Acrisol and Luvisol soil types, with a small portion of Feozem in part SW (Table IV.25; Fig. IV.6)

A brief description of the predominant soils in the research area is included herein below (USDA, 2003):

Acrisol (A)

This soils are formed from limestone, shale and sandstones, they occupy an extension of 10 778.13 km^2 at a state level. The horizon A that they present has a thickness between 8 and 12 cm. Their color is drab, with clay rich crumb or clay texture, and the particles that constitute them are structured in form of angular and sub-angular blocks of medium to bulky size. It is rich in organic matter and moderate in its nutrients content. Underlying to the foregoing there is the horizon B clayey, which has clay texture, color drab red or reddish yellow, pH strongly acid (of 4.2 to 4.4) and low amounts of calcium, magnesium and potassium. The limitations to the use of these soils are the strong acidity and the poorness of nutrients, aspects susceptible of being corrected with the application of lime and fertilizers; in addition to the foregoing, in the environs of Zongolica abundant superficial stony features are present. It is common to find the associated to Feozems, Vertisol, Cambisol, Andosol and Nitosol, in areas that sustain rain forests –medium sub-evergreen and high evergreen-, mountain Mesophyll Forest and seasonal agriculture.

Luvisol (L)

Luvisols were formed in sierras, hillocks and plains from shale, limestone sandstones and basic igneous rocks. In them the horizon A ochric is of reddish drab or dark gray color, very thin and with a content of organic matter, contributed by the medium and high rain forest s. Their texture varies from sandy crumb to clayish, and the pH from moderately acid to lightly alkaline. Their particles forma a structure of sub-angular blocks of fine to bulky size. The

horizon B clayey has clay texture, drab reddish color and medium acid pH. Its ability to retain and assign them to the plants is moderate, the saturation with calcium and magnesium that it presents goes from medium to high, potassium is found in low amounts. These soils cover 058.70 km^2 of the state surface. There are currently used for the seasonal agriculture and for the cultivation of pastures. In general they are deep, but also susceptible to erosion.

Cambisol (B)

Cambisol occupy about 4328.52 km^2 of the state territory of Veracruz. They are located in different geo-forms such as hillocks of soft slopes, sierras of laying slopes and some floodable plain zones, in particular where mild, semi-warm and warm, humid and sub-humid climates predominate, that provide a diverse range of vegetal associations. These soils were formed from limestone, conglomerates, igneous rocks and alluvion. There are constituted by a horizon A ochric of drab yellowish, drab reddish or dark gray color, with sandy crumb to clay rich crumb texture, which lays on a horizon B cambic the color of which is pale drab, dark drab reddish or very dark gray, while its texture varies from sandy crumb to clayish to clayish-sandy. The Cambisol dystric (Bd) is a Cambisol with poor or very poor nutrients underground.

Regosol (R)

The Regosol type soils are constituted in the initial stage of the formation of other soils. However, in the development phase that they show, they have characteristics that allow identifying them as a unit. They are very similar to the material from which they derive (limestone, shale, sandstones and alluvion deposits). The horizon A that integrates them lays on the rock, or in a mineral layer or horizon C that has small significant variations in respect to the first one; the most remarkable one is the clear tonality. They are of drab, grayish or yellowish color; of sandy and clayish texture in the ones originated from shale and limestone. The ability of cationic exchange is low to medium and the saturation of bases high, with amounts from medium to high of calcium, from low to moderate of magnesium and low of potassium. Their fertility is medium and as the particles are weathered of greater size, several minerals are available for the plants. They are limited by rock. They are associated with Rendzina, Feozem, Vertisol, Cambisol and Luvisol. In these soils medium and high rain forests are developed, or seasonal agriculture and cultivation of pastures are carried out. The Regosol dystric (Rd) is a Regosol with poor or very poor nutrients underground.

Rendzina (E)

The Rendzinas are thin soils, lower than 50 cm deep. They are constituted by a horizon A mollic that lays on the rock, they have sandy crumb, clay rich crumb or clayish texture; granulate, crumby or in sub-angular blocks structure, fine to bulky size, that allow a fast infiltration. Their pH varies between light acidity and alkaline degrees, and the absorption ability moderate to very high, with exchangeable cations of calcium and magnesium in high and low amounts of potassium. Their location in respect to the climate is diverse, they can be located in mild areas and in semi-warm and warm areas; on sierras and hillocks where pine and oak forests grow, as well as low deciduous rain forest and high evergreen, communities providers of a great volume of organic matter that with the weathered parental material forms a complex of calcium-humus, of a dark color (black, dark gray or dark drab). Notwithstanding their low thickness and high permeability, in some zones agriculture activities are carried out on them, because their fertility is high.

TABLE IV.25 EDAPHOLOGY IN THE RESEARCH AREA

EDAPHOLOGICAL FORMULA	PREDOMINANT SOIL UNIT	SECONDARY SOIL SUBUNITS	PHYSICAL PHASE	TEXTURE
Ah+Bd+Rd/2	Acrisol humic	Cambisol dystric Regosol dystric		Medium
Lc+E+I/3	Luvisol chromic		Coarse Litic	Fine
Hh+E+I/2	Feozem haplic	Redzina Litosol		Medium

Source: INEGI, 1993

In the research zone, the land use recorded for year 2003, shows an occupation divided into uncultivated mount and agricultural type (table IV.26). In particular, in Zongolica the land is distributed in 60% agricultural, 10% housing, 2% public offices, 1% in public spaces, and 27% in hills. In Mixtla de Altamirano, the land is used 75% in the agriculture, 10% in commerce, 10% in housing, 5% in commerce, 5% in offices and public spaces and 5% is uncultivated and unproductive.

TABLE IV.26 LAND USE IN THE RESEARCH ZONE

LAND USE	KIND OF OWNERSHIP	APPROXIMATE SURFACE (HECTARES)
Forests or rain forests without utilization	Private	10-00-00
Seasonal agriculture lands	Common	50-00-00
Irrigation agriculture lands	Private	130-00-00
Inhabited area	Private	20-00-00
Mount	Private	150-00-00

Source: SEDESOL, (CIBCEC), 2003.

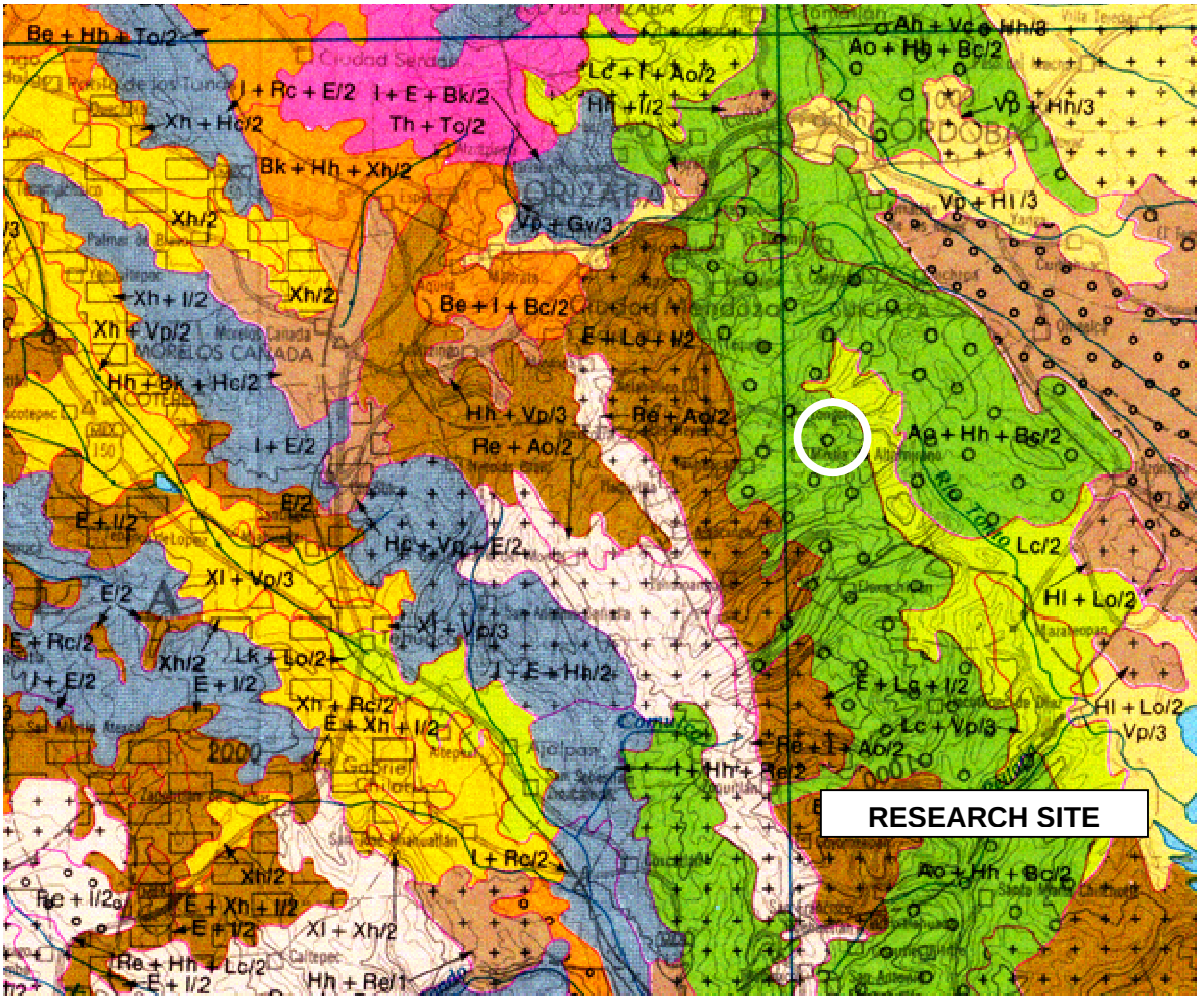
The land transformation has been evident in the period 2001 – 2003 (table IV.27) from uncultivated to agricultural. From the project's total area of 22.85 Ha, the forestall land use change (Gallery Forest, Oak-Pine Forest and Pine Forest Renewal) will be carried out in a surface equal to 4.29 Ha and in Coffee with shadow trees in a surface of 10.54 Ha, therefore, the forestall land use change is required in a total surface of 14.83 Ha.

TABLE IV.27 LAND USE CHANGE IN THE RESEARCH ZONE

CURRENT LAND USE	FORMER LAND USE	CHANGE REASON
Inhabited area	Forests or rain forests without utilization	Urban growth
Seasonal agriculture lands	Forests or rain forests without utilization	Deforestation

Source: SEDESOL, (CIBCEC), 2003.

DIAGRAM IV.3. EDAPHOLOGIC MAP



Source: INEGI Carta edafológica Serie 1 escala 1:1,000,000

- **Superficial and underground hydrology**

This region encompasses a great part of the central-south portion of Veracruz, the currents that integrate it have a radial and parallel disposition, controlled by some elevations of the

Sierra Madre Oriental and the Neo-Volcanic Axis (*Eje Neovolcánico*) (Cofre del Perote and Pico de Orizaba).

The basins present in the region correspond to the basins of the "Papaloapan" rivers with 26.93 % of the surface of the basin and "Jamapa" and others with 14.18 % of the surface. In addition to the Atoyac, Jamapa, Actopan, Hueyapan and San Juan rivers.

The Proyecto Hidroeléctrico Veracruz, belongs to the Papaloapan hydrological basin (Fig. IV.7), as affluent of the Axalticpac river and then to the Tonto river until arriving to the sandbar of Alvarado. The local drainage network includes the Apatlahuaya rivers that will supply the hydroelectric plant, the Zongolica river where the turbine water will be discharged and the Moyotepec, Coyolapa and Altotonga rivers, all of them tributary of the Tonto river, important affluent of the Papaloapan river regulated by the Miguel Alemán dam before its discharge into the Papaloapan.

TABLE IV.28 WATER CORPS ON PAPALOAPAN AND JAMAPA RIVERS

LOCATION	
Papaloapan River	**Jamapa River and Others**
Canseco Dam	Insurgente José Evaristo Molina Dam (Throwers)
Tuxpango Dam	Mandinga Lake
Alvarado Lake	-
Catemaco Lake	-
María Lisamba Lake	-
Pajarillos Lake	-
Sontecomapan Lake	-

The Papaloapan river basin is geographically located between the 16°55' and 19°03' north latitude, and the 94°40' and 97°48' west longitude (CONAGUA, 2005). It has an approximate area of 46 517 km^2, distributed by percents in the estates of Oaxaca (51%), Veracruz (37%) and Puebla (12%). From the 46 517 km^2 that constitute the basin, approximately 45% corresponds to plain and undulating lands of the coastal plain and the rest (55%) are constituted by the mountain zone and fissures of the sierras, except for the small la Cañada and la Mixteca valleys, that only represent 1% of the total surface (S.A.R.H., 1976).

The Papaloapan river fluvial system is most important one in the country because of its caudal, after the Grijalva-Usumacinta system. Its annual medium dripping is of approximately 47 000 million cubic meters. It pours its waters into the Gulf of Mexico through the Laguna de Alvarado.

Among its main affluent rivers are:

The Blanco river is born in the Zongolica Sierra in the foothills of the Pico de Orizaba and flows directly into the Alvarado lagoon. On its margins the first industrial zone of the basin was developed and two very important cities are located there, which are Córdoba and Orizaba.

The Tonto river is born in the spurs of the Mazateca sierra and if the most important affluent of its left margin. Because its basin is situated in the high precipitation zone, notwithstanding its small extension, it produces approximately 20% of the annual medium volume discharged by the Papaloapan river to the Gulf of Mexico through the Sandbar of Alvarado. Because of its river bed's characteristics it is a mature river, its waters carry the lower percentage of clog of the fluvial system, because the major part of the basin is covered by vegetation.

DIAGRAM IV.4. PAPALOAPAN RIVER BASIN

The Papaloapan river basin has abundant natural resources; lands adequate for agriculture and cattle breeding; currents that may be utilized for irrigation and for hydraulic utilizations, vast forests and exuberant rain forests. The underground has oil bearing stratum and in the mountain zone a great variety of metal and non-metal minerals exists. Within the basin works such as the Miguel Alemán Valdez dam (inaugurated in 1958) are located. This dam is located on the Tonto river, in the site denominated Temascal; Among other functions, the dam a) controls the overflows of the Tonto river; b) generates hydroelectric power; c) improves the navigation of the Papaloapan river and d) controls clogs.

Based on the basin, and taking as reference the drifting dam site, the Apatlahuaya river drains an area of 200 km^2 which is located in the superior limits of the Tonto river basin, and represents about 2.5% thereof. Some data recorded by the extinct Comisión del Río

Papaloapan in its hydrometric stations, in particular in the Telpatlán station located in the Apatlahuaya river, are shown in table IV.29 for the period 1971 to 1978. These data represented the monthly medium dripping coming from a drainage area of 88.3 km^2. The annual medium dripping was o 2.16 m^3/s, equal to a dripping of 68.31 hm^3.

TABLE IV.29 – MONTHLY MEDIUM CONSUMPTIONS IN TELPATLÁN HYDROMETRIC STATION

GASTOS MEDIOS MENSUALES m^3/s													
AÑO	ENE	FEB	MAR	ABR	MAY	JUN	JUL	AGO	SEP	OCT	NOV	DIC	ANUAL
1971	0.79	0.65	0.58	0.49	0.49	0.47	1.03	1.39	2.62	2.58	2.28	1.39	1.23
1972	1.27	0.97	0.71	0.61	0.54	0.72	3.46	7.52	4.23	3.00	1.66	1.22	2.16
1973	0.80	0.75	0.60	0.58	0.63	1.59	5.52	4.78	6.77	2.70	1.56	1.42	2.31
1974	1.06	0.87	0.70	0.63	0.55	2.77	4.37	1.43	6.41	5.39	2.23	1.39	2.32
1975	1.12	0.92	0.77	0.74	0.72	3.36	2.02	1.78	19.30	5.31	2.10	1.53	3.31
1976	1.39	1.20	0.94	0.85	0.76	3.30	8.91	3.65	7.05	5.05	4.10	2.95	3.35
1977	2.15	1.09	0.81	0.73	0.53	0.57	0.78	1.32	1.50	1.05	1.11	0.94	1.05
1978	0.87	0.66	0.54	0.45	0.39	0.76	2.42	2.32	4.12	3.28	1.56	1.60	1.58
MEDIA	1.18	0.89	0.71	0.64	0.58	1.69	3.56	3.02	6.50	3.54	2.08	1.55	2.16
Mínimo	0.79	0.65	0.54	0.45	0.39	0.47	0.78	1.32	1.50	1.05	1.11	0.94	0.39
Máximo	2.15	1.20	0.94	0.85	0.76	3.36	8.91	7.52	19.30	5.39	4.10	2.95	19.30

In addition to the foregoing, a reasonable estimation of the yield per km^2 of drained area for the drifting dam site is obtained, considering a) the short record period; b) the possible changes in the water uses in the period 1979-2008, and c) the deforestation observed in the basin

Annual medium dripping = 0.70 * 0.77 hm^3/km^2 * 200 km^2 = 107.8 hm^3 = 3.418 m^3/s

Minimum consumption in the drifting dam site = 3.418 m^3/s * 0.17 = 0.58 m^3/s

In order to reduce the uncertainty associated with the dripping estimation in the drifting dam site, two automatic Hydrometric stations were installed in the basin, with some interesting data. The Apatlahuaya 1 station located very close to the drifting dam is important. The drained area up to the site is of 200 km^2. The Apatlahuaya station 2 is located very close to the place were the Telpatlán station was. The drained area up to the station site is of 85 km^2. Table IV.30 shows the date recorded in the Apatlahuaya 1 station, from September 2007 to August 2008.

The medium annual dripping in the record period of the Apatlahuaya 1 station is of 2.445 m^3/s, this represents 71.5% of the annual medium dripping estimated for the drifting dam site.

The calculation of the volume discharges with ecologic purposes based on the Flow – Average duration curve, was as follows:

- For input consumptions, Q, to the drifting dam lower than 8 m^3/s, an ecologic consumption q_e = 0.1 * Q m^3/s is discharged
- For input consumptions, Q, to the drifting dam greater than 8 m^3/s, an ecologic consumption q_e = Q – 7 m^3/s is discharged.

TABLE IV.30 - DAILY AVERAGE CONSUMPTIONS IN THE APATLAHUAYA 1 HYDROMETRIC STATION AUGUST 2007- JULY 2008

ESTACION HIDROMETRICA ATLAPAHUAYA 1
Gastos Aforados en el periodo Septiembre 2007 - Agosto 2008
m^3/s

Día	2007				2008							
	Sep	Oct	Nov	Dic	Ene	Feb	Mar	Abr	May	Jun	Jul	Ago
1	23.993	3.223	1.574	3.419	1.349	1.149	0.923	0.746	0.682	0.701	5.116	7.374
2	16.346	3.223	1.529	2.909	2.093	1.109	0.924	0.727	0.692	0.746	2.178	6.230
3	10.891	3.223	1.518	2.524	2.506	1.132	0.898	0.710	0.684	0.713	1.604	5.558
4	7.732	3.047	1.504	6.965	2.560	1.111	0.891	0.709	0.684	0.718	1.453	4.827
5	4.636	2.768	1.468	8.104	2.221	1.099	0.891	0.693	0.673	0.888	2.181	4.616
6	4.111	2.563	1.449	5.716	1.959	1.080	0.880	0.674	0.665	0.797	5.195	4.785
7	5.101	2.400	1.469	4.392	1.798	1.070	0.892	0.682	0.656	0.804	8.536	5.249
8	8.900	3.307	1.407	3.664	1.700	1.076	0.892	0.672	0.599	1.143	9.042	4.804
9	8.270	2.660	1.393	3.213	1.634	1.069	0.893	0.666	0.699	1.166	24.472	4.286
10	6.292	2.739	1.376	2.812	1.593	1.043	0.887	0.715	0.655	1.383	21.151	3.954
11	5.149	3.067	1.396	2.574	1.570	1.051	0.882	0.738	0.612	1.090	11.233	3.678
12	4.470	2.893	1.349	2.412	1.520	1.032	0.876	0.735	0.617	1.055	7.644	3.783
13	3.827	2.491	1.309	2.273	1.491	1.033	0.870	0.746	0.766	1.321	6.382	3.391
14	3.448	2.327	1.294	2.174	1.460	1.042	0.864	0.753	0.955	1.632	6.009	3.112
15	3.388	2.196	1.321	2.077	1.433	1.032	0.860	0.745	0.802	1.193	5.039	2.963
16	3.457	2.096	1.445	2.034	1.408	1.012	0.856	0.740	0.764	1.040	4.194	2.849
17	3.213	2.010	1.335	1.920	1.386	1.010	0.853	0.707	0.764	0.965	3.626	2.672
18	2.905	1.954	1.294	1.872	1.363	0.994	0.848	0.708	0.816	0.937	3.179	2.525
19	2.675	1.887	1.266	1.819	1.308	1.000	0.841	0.694	0.816	0.909	2.979	2.423
20	2.450	1.877	1.245	1.763	1.295	0.990	0.832	0.687	0.782	0.882	18.148	2.328
21	2.340	1.801	1.221	1.704	1.285	0.981	0.824	0.684	0.772	0.858	20.933	2.257
22	2.263	1.739	1.205	1.675	1.275	0.987	0.816	0.698	0.756	0.844	10.819	2.194
23	2.148	2.214	1.205	1.641	1.251	0.992	0.812	0.679	0.751	0.837	8.113	2.126
24	2.037	2.134	1.208	1.565	1.222	0.958	0.813	0.690	0.742	0.832	6.614	2.051
25	1.953	1.943	1.167	1.544	1.191	0.936	0.801	0.678	0.741	0.813	5.822	1.984
26	1.838	1.846	1.195	1.514	1.168	0.936	0.785	0.684	0.740	0.814	14.972	1.948
27	1.836	1.783	1.383	1.485	1.180	0.924	0.792	0.689	0.716	0.826	10.037	1.923
28	2.163	1.701	7.753	1.451	1.177	0.931	0.805	0.703	0.737	0.881	7.956	1.910
29	2.163	1.671	5.462	1.405	1.164	0.941	0.810	0.715	0.751	0.896	6.805	1.954
30	2.163	1.619	4.118	1.379	1.154		0.807	0.709	0.699	1.096	6.373	1.914
31		1.609		1.356	1.131		0.792		0.702		11.714	1.816
Promedio	5.072	2.322	1.825	2.624	1.512	1.025	0.852	0.706	0.724	0.960	8.368	3.335

Gasto Medio Anual = 2.445 m^3/s

Escurrimiento Anual = 77.120 km^3

TABLE IV.31- FLOW – DURATION CURVE ESTIMATED FORT HE DRIFTING DAM SITE

Gasto Q	Función de probabilidad Acumulada	Función de probabilidad Acumulada
m^3/s	<=	>=
0.482254707	0.000342231	99.96577687
0.498066337	0.000684463	99.93155373
0.509134477	0.001026694	99.8973306
0.51071564	0.001368925	99.86310746
0.51071564	0.001711157	99.82888433
0.51071564	0.002053388	99.79466119
0.51071564	0.002395619	99.76043806

- For two consecutive consumption it was proceeded as indicated herein below to calculate the volume:

$$V_k = 0.1\frac{\frac{Q_{i+1}+Q_i}{2}}{100}(P_r\{Q >= Q_{i+1}\} - P_r\{Q >= Q_i\})(365)(\frac{86400}{1000000})$$ hm^3, for consumptions lower than 8 m^3/s.

$$V_k = \frac{\frac{Q_{i+1}+Q_i}{2} - 7}{100}(P_r\{Q >= Q_{i+1}\} - P_r\{Q >= Q_i\})(365)(\frac{86400}{1000000})$$ hm^3, for consumptions greater than 8 m^3/s.

Where:

Q_i :	Consumption with order number i, in m^3/s
Q_{i+1} :	Consumption with order number i+1, in m^3/s
$Pr\{Q>=Q_i\}$:	Probability that consumption Q is greater or equal to Q_i in %
$Pr\{Q>=Q_{i+1}\}$:	Idem for Q_{i+1}
365:	Number of days in the year
86400:	Number of seconds in one day
0.1:	10% of the daily medium consumption

Assigning a probability equal to the difference of the accumulated probabilities that both Q values are exceeded, it was concluded:

- For consumptions lower than 8 m^3/s the annual volume discharged was estimated in: 6.574 hm^3

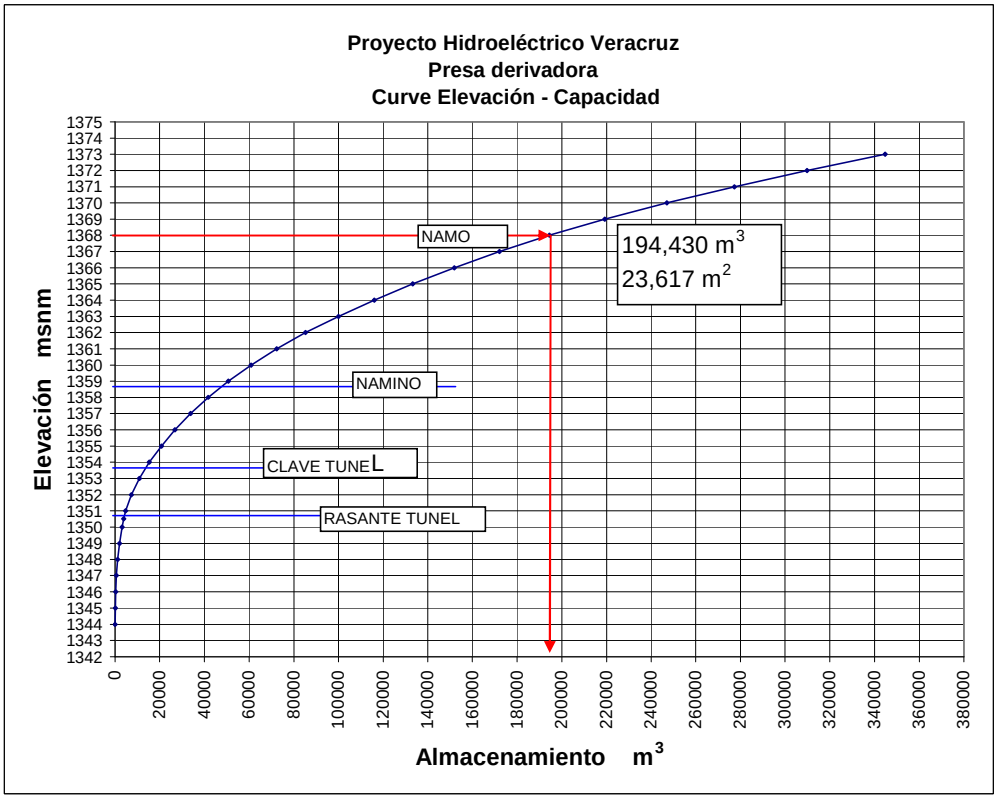
- For consumptions lower than 8 m^3/s the annual volume discharged was estimated in: 24.634 hm^3

- The total annual ecologic volume discharged in the dam results of: 31.208 hm^3

The annual medium dripping estimated in the site of the drifting dam the Veracruz project is of 107.37 hm^3, therefore the ecologic volume discharged in the drifting dam represents 29% of such annual medium volume. The dam has an approximately capacity of 200,000 m^3, with a hydrodynamic pattern shown in the illustration IV.5.

The water uses and the kind of contamination prevailing in general in the research zone are shown in Table IV. 32.

DIAGRAM IV.5 HYDRODYNAMIC PATTER IN WATER MASSES OF THE DAM'S RECEPTACLE



The identification of the punctual or estimated sources of contaminants contributions are important to know the aquatic environmental status, that explains the aquatic biological growth dynamics (flora and fauna) and the possible potential that may be utilized from the dam or the water course by the encircling population. Table IV.33 shows the concentrations of different parameters that allow measuring the water physical-chemical quality of the Apatlahuaya river during this current year 2008.

TABLE IV.32. NATURAL WATER SOURCES IN THE ZONE

NATURAL WATER SOURCE	RECHARGE SOURCE	MAIN USES	KIND OF CONTAMINATION
River	Other superficial or underground affluent	Domestic use, animal consumption and domestic use	detergents and other chemical substances are thrown, Organic wastes such as plants and death animals are thrown and Solid wastes are thrown
Spring or water eye	Other superficial or underground affluent	Human consumption, animal consumption and domestic use	Natural processes are generated which harm the water quality and prevent its consumption

Source: SEDESOL, (CIBCEC), 2003.

TABLE IV.33. PHYSICAL-CHEMICAL CHARACTERIZATION OF THE APATLAHUAYA RIVER

PARAMETERS	RESULTS				UNITS	NOM127-SSA-94
	Apr-08	Aug-08	Sep-08	Oct-08		
Smell	Agreeable				…..	Agreeable
Taste	Agreeable				…..	Agreeable
Nitrates	3				mg/l	10
Calcium	52,48	48.53	52,57	54,26	mg/l	NA
Carbonate	14,34	0,8	0	0	mg/l	NA
Bicarbonates	130,18	171,9	154,96	136,01	mg/l	NA
Magnesium	25,56		2,91	3,1	mg/l	
Color	less 10				u-Pt-Co	20
pH	8,2	7,3	7,93	7,94	unid	6.5 - 8.5
Temperature				16	°C	
Sulfates	17,68	19,9	27,08	17,09	mg/l	400
Total hardness	141,16	137,5	141,55	146,43	mg/l	500
TDS	150	199	128	60	mg/l	1000
Chlorides	6,4	8,9	17,37	4,92	mg/l	250
Conductivity	286				mg/l	NA
Total solids	155	20	299	221	mg/l	NA
Manganese		0,01			mg/l	0,15
DBO				70	mg/l	
DQO				77,5	mg/l	

The rock units with high possibilities to store underground water susceptible of being utilized, are located west from the Veracruz port and is integrated in a major proportion by medium

consolidated conglomerates of the Tertiary. Even though, the resource has been utilized constantly, provoking an excessive utilization of aquifers.

In accordance with the hydrologic map of underground waters, scale 1:250 000, E 14-6 ORIZABA, edited by the INEGI, in the area of influence where the Proyecto Hidroeléctrico Veracruz is located, the following geo-hydrologic units are found:

Consolidated material with high possibilities.- Mainly constituted by travertine with numerous hollows in banded structure, intercalated with fine and medium grain sand; occasionally caliche of reduced thickness is in the bottom, which restricts the superficial permeability.

Consolidated material with medium possibilities.- Formed by conglomerate oligomytic the high tertiary the fragments of which are of igneous extrusive rocks, with size that varies from 1 cm to 1 m, placed in sandy matrix.

Consolidated material with low possibilities.- Constituted by igneous, sedimentary and metamorphic rocks. The first ones are intrusive and extrusive; The intrusive are granite and granodiorite, of phaneritic texture, with scarce to intense fracturing, low permeability and shallow weathering; the extrusive: andesite, dacite, basalt and gaps of intermediate and basic composition are of aphanitic and phaneritic texture, have moderate and scarce fracturing, the permeability is high in the basalt of the Quaternary and the basic volcanic gap; medium in the basalt and the Tertiary gap, and low for the andesite and the dacite.

Non-Consolidated material with high possibilities.- Constituted by continental sedimentary deposits of coarse , sandy, slimy and argil material, with intercalations of travertine and gypsum, its particle seize is of bulky and fine grain with sandy and sand-argil texture towards the coastal plain; there are inadequately cemented and their thicknesses are from 60 to 80 m and inferred up to 120 m; free aquifers have been developed therein.

Non-Consolidated material with medium possibilities.- Is constituted by alluvial and aeolian material, with presence of carbonates en el alluvial and sodium salts and potassium in the colic, its particle size varies from argil to gravel, its texture is sandy-argil; the alluvial has an approximate thickness of 40 m, high permeability; except for the Victoria town, where the texture is argil and originated low permeability. These materials form free aquifers surrounded by marine and continental carbonated rocks.

Non-Consolidated material with low possibilities.- Represented by alluvial, aeolian and lacustrian material and conglomeratic and pyroclastic deposits; its particle size is of clay, sand, cantos, ash, lapilli and bombs; wrongly compacted and cemented, with high and medium permeability, of reduced thicknesses able to store water located under a river bed.

Within the area that comprises Zongolica, in accordance with the preceding classification, it is located in a consolidated rock unit with low possibility. However, at a local level this permeability may increase in the calcareous formations, because the dissolution of carbonates in this region is very advanced. The numerous dolines found there, which in many cases consume the superficial currents and turn them into underground currents, are evidence of this phenomenon. Likewise, the high degree of dissolution presented by the carbonated formations, undoubtedly have a repercussion in the water quality, high in carbonates.

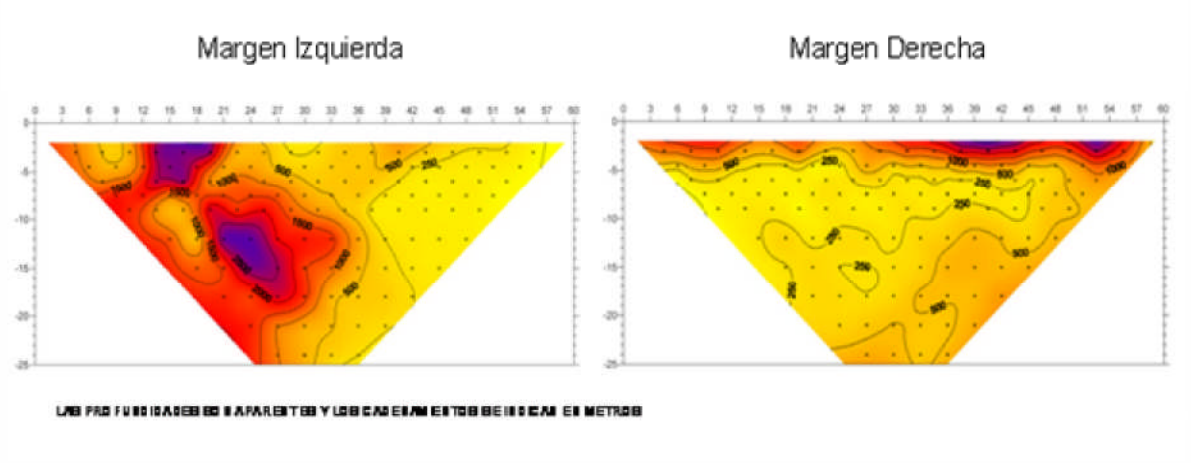
The consolidated material unit of low possibilities is constituted by igneous, sedimentary and metamorphic rocks. The first ones are intrusive and extrusive; the intrusive are granite and granodiorite of phaneritic texture with scarce to intense fracturing, low permeability and weathering shallow; the extrusive, andesite, dacite, basalt and gaps of intermediate and basic composition ser of aphanitic and phaneritic texture, they have moderate and scarce fracturing, high permeability in the basalt of the Quaternary and the basic volcanic gap, medium in the basalt and the Tertiary gap, and low for andesite and dacite.

The sedimentary rocks correspond to intercalations of limestone, shale, limonite, fine grain sandy and conglomerate in addition to the deposits previously described, outcropping of fine or medium grain sandy with intercalations of limolitic horizons are located; lastly, we have conglomerate polymictic of low compactness and medium permeability; as a whole, the units are correctly lithified with scarce fracturing and moderate fold; these factors determine the low permeability of the unit, due to the inability to transmit or store water; certain springs are observed, which manifest infiltration due to the existence of scarce transmission structures which for hydrologic purposes are despicable.

Since 1976 in several places of Veracruz the elastic or partial closed season operates for the utilization of the underground waters. For example: the zones of Alvarado, Oriental, Cuenca del Río Guayalejo, Minatitlán, Pueblo Viejo, among others.

In the zone of the Proyecto Hidroeléctrico Veracruz, geo-physics exploration researches were carried out (Geotecnia S.C, 2008) consisting in two lines of dipolar electrical testing pit with the purpose of verifying the possible existence of karstic cavities or the presence of fractures with important opening that could be detected through resistive abnormalities revealed with this method.

DIAGRAM IV.6. PROFILE OF APPARENT ISORESISTIVITY OF THE DIPOLAR ELECTRICAL TESTING PIT LINE PERFORMED IN THE RIVER



IV.2.2 Biotic Environment

- **Terrestrial and aquatic vegetation**

The state of Veracruz possess a great floristic diversity calculated in approximately 7,500 species of vascular plants (Sosa y Gómez-Pompa, 1994). Within these groups of plants we find the medicinal, ornamental, comestible, ceremonial, combustible and timber-yielding plants.

Under Rzedowski, 1978, the vegetation is represented by the mountain Mesophyll Forest, arboreal elements of the gallery forest and riparian vegetation.

The mountain Mesophyll Forest is characteristic of regions of rough reliefs, stiff slopes and hillsides, the soils are shallow or profound, yellow, red or black with abundant organic matter. The epiphytes are very well presented, among which we find: moss, ferns, lichen, orchids, bromeliads, among others. In Mexico this kind of vegetation corresponds to the altitude humid climate, and within the group of communities that live in the mountain zones it occupies more humid places that the ones typical of the *Quercus* and *Pinus* forests. The inferior altitudinal limit of this kind of vegetal is situated around 600 m, however in very few places of Mexico we find this forest in altitudes higher than 2700 m, even though its superior altitudinal limit depends more on humidity than on temperature.

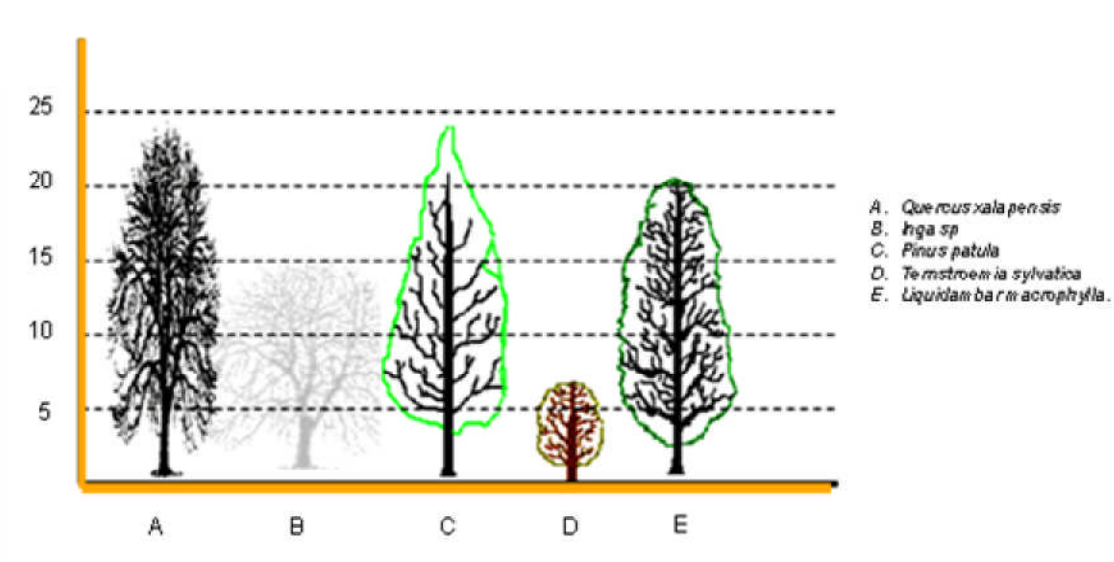
The most important species are the pines: *Pinus pseudostrobus, Pinus patula, Pinus. Ayacahuite* and the tlaxcal *Cupressus benthami*, in addition to other species such as the oaks *Quercus Rugosa, Quercus Crassifolia Quercus sp*. *Ternstroemia sylvatica* and *Alnus acuminata* in the shrub-like stratum there are *Baccharis conferta, B. salicifolia, Crataegus mexicana, Myrica cerifera, Solanum chrysotrichum,* and *Sambucus nigra spp. Canadensis.*

The secondary vegetation is also present, caused by the communities of plants established as a consequence of the total or partial destruction of the primary vegetation or climax, carried out directly by the human being (agricultural activities) or by his animals (cattle breeding activities), it commonly tends to disappear and does not persist during a long period, but gives rise to another one and this, itself, to another one, this way determining a succession that, throughout the time, commonly leads again to the community climax and it is not modified as long as it remains stable.

A profile of the dominant arboreal vegetation present within the research area is shown in Illustration IV. 7, considering the physiognomy observed in field.

In general terms, the use of the local flora is only restricted to the auto-consumption, except for the timber-yielding and combustible species. The property's plain parts are used as housing and for diverse cultivations such as corn, squash, bean, ayocote, sugar cane, coffee as well as several decorative plants.

DIAGRAM IV.7. REPRESENTATIVE PHYSIOGNOMY OF THE MESOPHYLL FOREST



In a research performed in the zone of Zongolica (Navarro, 2002), a total of 154 useful vegetal species were recorded, distributed in 122 genus pertaining to 56 families, the most important being: the Compositae with 24 species, Labiatae (11), Rosaceae (10), Solanaceae (10) and Leguminosae (8). Records were also obtained in 196 plants from which the highest percentage of utility corresponds to the category of medicinal with 88 records, ornamental (28), comestible (23), ceremonial (19) and combustible 15 for firewood and carbon.

TABLE IV.34 KIND OF VEGETATION IN THE PROJECT'S INFLUENCE ZONE

MUNICIPALITY	COMMON NAME	SCIENTIFIC NAME	NOM-059-SEMARNAT-2001
San Juan Texhuacán	Aguacatillo	(*Persea schiedeana*)	
	Poplar	(*Platanus lindiana*)	
	Ceiba	(*Bombax ellipticum*)	
	Drago	(*Croton draco*)	
	Oak	(*Quercus castanea*)	
	Ash	(*Fraxinus uhdei)*	
	Jonote	*(Heliocarpus appendiculatus)*	
	Walnut	(*Juglans pyriformis*)	Threatened
	Palo negro	(*Garrya laurifolia)*	
	Pine	(*Pinus Oaxacana*)	
	Quilite		
	Ramoncillo	*(trophis racemosa)*	
	Timbre	(*Inga spuria)*	
	Yaco	(*Tilia mexicana)*	Endangered

MUNICIPALITY	COMMON NAME	SCIENTIFIC NAME	NOM-059-SEMARNAT-2001
Mixtla de Altamirano	Aguacatillo	(*Persea schiedeana*)	
	Poplar	(*Platanus lindiana*)	
	Oak	(*Quercus castanea*)	
	Ash	(*Fraxinus uhdei)*	
	Liquidambar		
	Walnut	(*Juglans pyriformis*)	Threatened
	Palo negro	(*Garrya laurifolia)*	
	Pine	(*Pinus Oaxacana*)	
	Quilite		
	Ramoncillo	*(trophis racemosa)*	
	Timbre	(*Inga spuria)*	
	Yaco	(*Tilia mexicana)*	Endangered
Zongolica	Red Cedar	*(Cedrela mexicana)*	
	Ash	(*Fraxinus uhdei)*	
	Jonote	*(Heliocarpus appendiculatus)*	
	Walnut	(*Juglans pyriformis*)	Threatened
	Ocozote		
	Primerose		

In accordance with the vegetation and flora inventory, in general in the properties involved during the execution of the Proyecto Hidroeléctrico Veracruz (Chapter VIII) the following were accounted:

From the 1,023 trees involved in the project's outline, the highest affectation percentage corresponds to the Poplar trees *(Platanus lindiana)* (20.27%), followed by Jinicuil (*Inga jinicuil)* with (17.80%) and Xochilcogual with (10.44%). These species are typical of the de mountain Mesophyll Forest ecosystem and represent an approximate volume of rolled wood of 220.794 cubic meters.

With this inventory of species to be affected by the project, it is worthy to mention the Yaco *Tilia mexicana* (0.39%) and the Walnut *Juglans pyriformis* (5.21%), considered by NOM-059-SEMARNAT-2001, as endangered species in the case of Yaco and threatened in the case of the Walnut.

The Yaco or Yaca, are trees of 5 to 22 m height, with star-shaped pubescent stems, densely star-shaped-pubescent back; petioles of 2 to 5 cm long. Inflorescence of 8 to 17 cm long; It possesses flowers with a 0.65 to 1.8 cm diameter; sepals of 0.4 to 1.8 cm long, 0.3 to 0.5 cm width, fascicle with simple and star-shaped hair, core 0.5 to 1.0 cm long and width. Seeds 5 mm long, 3 to 4 mm width, dark hazel color.

TABLE IV.35 FIELD RECORD OF ARBOREAL VEGETATION INVOLVED IN THE PROJECT

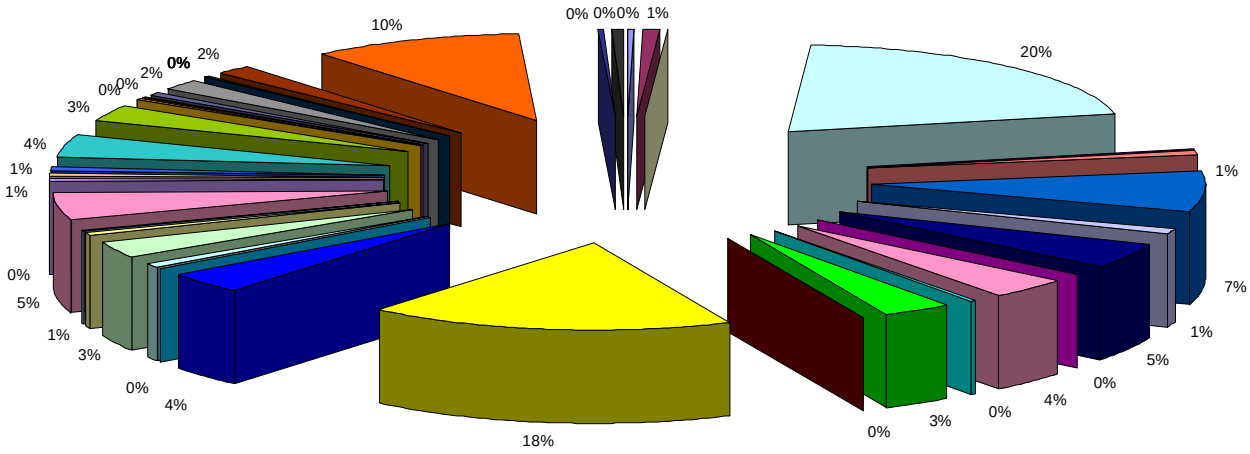
WORK	SPECIES	ASSESSMENT TOTAL VOLUME
DAM (5.05 HA)	*Aguacatillo* (*Persea schiedeana*)	2.541
	Poplar (*Platanus lindiana*)	158.748
	Ceiba (*Bombax ellipticum*)	3.620
	Dragon (*Croton draco*)	0.677
	Oak (*Quercus castanea*)	29.001
	Ash (*Fraxinus uhdei)*	23.449
	Jonote (Heliocarpus appendiculatus)	0.624
	Liquidambar *(Liquidambar macrophylla)*	0.740
	Walnut (*Juglans pyriformis*)*****	12.599
	Palo Negro (*Garrya laurifolia)*	33.045
	Pine (*Pinus Oaxacana*)	24.720
	Quilite	3.593
	Ramoncillo (trophis racemosa)	14.692
	Timbre (*Inga spuria)*	11.909
	Yaco (*Tilia mexicana)*******	0.564
CONDUCTION LINE (2.53 ha)	Avocado (Persea americana)	1.545
	Aguacatillo (Phoebe mexicana)	4.998
	Aile (Alnus arguta)	0.308
	Annona (Anona squamosa)	0.437
	Calabur (Ardicia compressa)	6.616
	Red Cedar (Cedrela mexicana)	32.885
	Ceiba (Ceiba aesculifolia)	6.581
	Chinene (Persea schiedeana)	17.586
	Oak (Quercus castanea)	0.261
	White fraxinella (Fraxinus uhdei)	2.066
	Ash (Fraxinus uhdei)	2.173
	Acacia (Leucaena esculenta)	0.894
	Jinicuil (Inga jinicuil)	0.584
	Jonote (Heliocarpus appendiculatus)	20.351
	Jonuxpepe	0.167
	Macuil (Tabebuia pentaphylla)	7.762
	Mango (Mangifera indica)	12.313
	Orange (Citrus duramtium)	0.513
	Walnut (Juglans pyriformis)*	16.942
	Rose apple (Syzygium jambos)	0.167
	Pototoca	0.167
	Tatil (Comocladia palmeri)	0.102
	Tepehuaje (Lysiloma acapulcensis)	0.753
	Teponaxtle	0.162

WORK	SPECIES	ASSESSMENT TOTAL VOLUME
	Tescohuite	2.048
	Xochilcogual	58.283
	Yaco (Tilia mexicana)**	1.888
	Yolosochit	2.965
	Yonosochit	0.335
	White sapodilla (Casimiroa edulis)	0.261
POWER HOUSE SUBSTATION (3.18 HA)	Red cedar (*Cedrela mexicana*)	2.130
	Chinene (Persea schiedeana)	0.753
	Jinicuil (Inga jinicuil)	11.359
	Mango (Mangifera indica)	0.804
	Xochilcogual	10.386
TRANSMISSION LINE (9.51 HA)	Red cedar (Cedrela mexicana)	22.698
	Chinene (Persea schiedeana)	17.214
	Ash (Fraxinus uhdei)	1.092
	Jinicuil (Inga jinicuil)	126.771
	Jonote (Heliocarpus appendiculatus)	7.421
	Mango (Mangifera indica)	11.351
	Manzanilla olive (Hipomanne Mancinella)	4.149
	Walnut (Juglans pyriformis)*	11.099
	Ocozote-Liquidambar (Liquidambar macrophylla)	3.020
	Obo (Spondias mombin l.)	4.594
	Palo Mulato (Bursera simaruba)	5.218
	Primerose (Tabebuia donnell-smithii)	3.694
	Xochilcogual	12.707
TOTAL		**779.094**

Note: Species included in the NOM-059-SEMARNAT-2001 ***** Threatened; ****** Endangered

The Walnut of the *Juglandaceae* family, are 10-25 m height trees; erect trunk , ramified in the upper part, dark-drab bark, scaly or with irregular longitudinal fissures; branches with abundant lenticels of a light drab color, easily visible. Alternate leaves 27-58 cm long, 14-25 cm width, with one or frequently 2 axillary buds, the young follicles with abundant scales; petiole 3-8.1 cm long, slightly striated, pubescent to scarcely hairy. Inflorescence masculine and increase or aments-shaped raceme in the axilles of the foliar scars, declined, frequently several superposed aments, each of them 9.5-23 cm long, with 38-78 flowers; masculine flowers placed in irregular form on the pedicel, green yellowish, 5-8 mm long, 4-6 mm width; feminine inflorescence one terminal sprig, about. 4 cm long, with three flowers; floral bract and the two amalgamated bracts to the ovary up to its apex, free at the ends; alternate feminine flowers, of green color; sepals 4, oblong-lanceolate, 3-4 mm long, 1.5-2 mm width, glabrescent, with the full margin; bifurcate style, the stigmas plumose, carinal. Fruit one pseudo-drupe, globose to sub-globose, 3.4-5.4 cm long, 3.5-4.5 cm width, sometimes with a neck 0.4-1 cm long in the basis and/or the apex, glabrescent with some star-shaped hairs and small, yellow, with abundant open warts of light drab color; globose nut with longitudinal canals, 2.2-3.7 cm long, 2.2-3.6 cm width, lightly rostrate. (Narave, 1983)

DIAGRAM IV.8. PERCENTAGE DISTRIBUTION OF THE ARBOREAL VEGETATION PER SPECIES INVOLVED IN THE PROJECT



- AGUACATE (Persea americana)
- AGUACATILLO (Phoebe mexicana)
- AILE-QUILITE (Alnus arguta)
- ALAMO (Platanus lindiana)
- ANONA (Anona squamosa)
- CAPULINCILLO (Ardicia compressa)
- CEDRO ROJO (Cedrela mexicana)
- CEIBA (Ceiba aesculifolia)
- CHINENE (Persea schiedeana)
- DRAGO-SANGRE DE DRAGO (Croton lechleri)
- ENCINO (Quercus castanea)
- FRESNILLO (Fraxinus uhdei)
- FRESNO (Fraxinus uhdei)
- GUAJE (Leucaena esculenta)
- JINICUIL (Inga jinicuil)
- JONOTE (Heliocarpus appendiculatus)
- JONUXPEPE
- MACUIL (Tabebuia pentaphylla)
- MANGO (Mangifera indica)
- MANZANILLO (Hipomanne Mancinella)
- NARANJO (Citrus duramtium)
- NOGAL (Juglans pyriformis)
- OCOZOTE-LIQUIDAMBAR (Liquidambar macrophylla)
- OBO (Spondias mombin l.)
- PALO MULATO (Bursera simaruba)
- PALO NEGRO (Garrya laurifolia)
- PINO (Pinus Oaxacana)
- POMAROSA (Syzygium jambos)
- POTOTOCA
- PRIMAVERA (Tabebuia donnell-smithii)
- QUILITE-AILE (Alnus arguta)
- RAMONCILLO (Trophis racemosa)
- TATIL (Comocladia palmeri)
- TEPEHUAJE (Lysiloma acapulcensis)
- TEPONAXTLE
- TESCOHUITE
- TIMBRE (Inga spuria)
- XOCHILCOGUAL
- YACO (Tilia mexicana)
- YOLOSOCHIT
- YONOSOCHIT
- ZAPOTE BLANCO (Casimiroa edulis)

In respect to the **Aquatic Vegetation**, there are few referential papers on aquatic flora. However, three groups of this kind of vegetation may be distinguished and of the floodable zones within the state of Veracruz: Arboreal, Shrub-like and Herbaceous.

In accordance with a research carried out (Lot, 1991) in Mexico 112 species of 19 families of monocotyledon and 13 of dicotyledonous of the more than 32 families are recognized at a world wide level. Some aquatic flora organisms are reported in 17 families in 28 genus with 40 species of strictly aquatic angiosperms. There is a scarce representation of families such as *Leguminosae*, *Compositae*, *Gramínea* and *Cyperaceae*, as well as elements of the aquatic environments vegetation and flora, of typical form, lacking to register some species.

Also 25 species of strict hydrophytes pertaining to the majorly terrestrial families. To this group belong species such as: *Pistia strationes, Callitriche heterophylla, Nasturtium officinale, Scirpus lacustris* and *S. validus, Myriophyllum pinnatum, Neptunia oleracea, Utricularia foliosa* and *U. gibba, Thalia geniculata, Jussiaea natans, Limosella acuática, Lilaeopsis occidentales, Hydrocotyle spp*. Species of strictly aquatic ferns, such as: *Azolla caroliniana, Salvinia auriculata and S. rotundifolia, Marsilea polycarpa* and *M. cuadrifolia* these species are not reported in the NOM-059-SEMARNAT-2001.

The riparian, arboreal and shrub-like vegetation is characterized by the presence of species that are constituted in dominant or co-dominant in the floodable zones also, such as: *Annona glabra, Pachira aquatica, Calophyllum brasiliense, Liquidambar acrophylla, Andira galeottiana, Ficus spp. Taxodium mucronatum, Platanus mexicana, Populus mexicana and Salix spp.,* these species are not reported in the NOM-059-SEMARNAT-2001.

- **Terrestrial and aquatic fauna**

Taking into account the ecosystems present in the research zone, such as mesophyll forests, the fauna characteristic for this ecosystem if the one corresponding to one that live in the Neo-tropical Region of Mexico, which is shown in Table IV.36 in accordance with the CONABIO.

However, the intensive hunting and the gradual disappearance of the vegetal coverage has diminished the fauna population. Oliva, 2005, in report published during the Primer Congreso Internacional de Casos Exitosos de Desarrollo Sostenible del Trópico, states that in the Zongolica zone only some mammals such as the squirrel (*Syurus sp*), rabbits (*Sylvilagus sp*) tlacuaches (*Didelphys marsupialis*) and armadillos (*Dasylpus novemcintus*) are reported.

During the trip on the research zone, it could be observed that it is evident that the region is strongly altered as a consequence of the agricultural activities, because in the region natural vegetation areas are cleared of trees in order to transform them in cultivation zones. During the recognition visit domestic animals such as pen birds, pigs, sheep, goats and horses were seen. Herein below are the tables and lists of fauna described by the researches performed in the zone by several authors, in respect to the species that comprise the Neo-tropical region.

TABLE IV.36 FAUNA CHARACTERISTIC OF THE NEO-TROPICAL REGION IN MEXICO

COMMON NAME	SCIENTIFIC NAME	NOM-059-SEMARNAT-2001
Mammals		
Jaguar	Felis onca,	Endangered

COMMON NAME	SCIENTIFIC NAME	NOM-059-SEMARNAT-2001
Ocelot	*Felis pardalis*	Endangered
Coati	*Nasua nasua*	Threatened
Tapir	*Tapirus bairdi*	Endangered
Spider monkey	*Ateles geoffroyi*	Endangered
Howler monkey	*Aloutta spp*.	
Vampire	*Desmodus rotundus*	
Tepezcuintle	*Cuniculus paca*	Threatened
Armadillo	*Dasypus novenicintus*	
Tlacuache or opossum	*Didelphis virginianus*	
Tlacuache	*Didelphys marsupialis*	
Squirrel	*Syurus sp*	
Rabbit	*sylvilagus sp*	
Reptiles		
Garrobo	*Ctenosaura spp*	
Boa	*Constrictor constrictor*	Threatened
Iguana	*Iguana iguana*	Subject to Protection

Source: (CONABIO, 2008)

Herein below are the lists of the fauna characteristic for the mountain Mesophyll Forest ecosystem present in the research site in accordance with different authors.

TABLE IV.37 BIRD SPECIES

FAMILY	SPECIES	NOM-059-SEMARNAT-2001
Accipitridae	*Sarcoramphus papa*	Endangered
Ardeidae	*Bubulcus ibis*	
Ardeidae	*Jabiru mycteria*	
Emberizidae	*Dendroica chrysoparia*	Threatened
Ardeidae	*Ardea ibis*	
Ardeidae	*Agamia picta*	
Columbidae	*Columba flavirostris*	
Cracidae	*Ortalis v. vetula*	
Cracidae	*Hortalis vetula*	
Mimidae	*Mimus polyglottos*	
Momotidae	*Eumomota superciliosa*	
Odontophoridae	*Cyrtonyx montezumae*	Subject to special protection
Pandionidae	*Leucopternis albicolis*	
Psittacidae	*Ara macao*	Endangered
Psittacidae	*Amazona a. autumnalis*	
Psittacidae	*Amazona albifrons nana*	
Rallidae	*Aramides cajanea mexicana*	

FAMILY	SPECIES	NOM-059-SEMARNAT-2001
Tinamidae	*Tinamus mayor*	Subject to special protection
Tynoidae	*Tyto alba pratincola*	

Source: (CONABIO, 2008)

TABLE IV.38 REPTILE SPECIES

FAMILY	SPECIES	NOM-059-SEMARNAT-2001
Colubridae	*Drymarchon corais*	
Colubridae	*Oxybelis fulgidus*	
Crotalidae	*Bothrops schlegelli*	
Crotalidae	*Bothrops asper*	
Crotalidae	*Crotalus asper*	
Iguanidae	*Iguana iguana*	Subject to protection
Iguanidae	*Ctenosaura similis*	Threatened

Source: Población faunística (Oliva, 2005) Primer Congreso Internacional de Casos Exitosos de Desarrollo Sostenible del Trópico

TABLE IV.39 MAMMAL SPECIES

FAMILY	SPECIES	NOM-059-SEMARNAT-2001
Caluromyidae	*Caluromys derbianus*	Endangered
Cervidae	*Odocoileus virginianus*	
Cervidae	*Mazama americana*	
Dasypodidae	*Dasypus novemcinctus*	
Desmodontinae	*Desmodus rotundus*	
Didelphidae	*Didelphys marsupialis*	
Leporidae	*Sylvilagus floridanus*	
Leporidae	*Sylvilagus brasilensis*	
Molossidae	*Tadarida brasiliensis*	
Mustelidae	*Mustele frenata*	
Mymercophagidae	*Tamandau tetradactila*	
Procyonidae	*Procyon lotor*	
Procyonidae	*Nasua narica*	
Sciurinae	*Sciurus aureogaster*	
Sciurinae	*Sciurus deppei*	

Source: Población faunística (Oliva, 2005) Primer Congreso Internacional de Casos Exitosos de Desarrollo Sostenible del Trópico

TABLE IV.40 MAMMALS SPECIES

FAMILY	SPECIES	NOM-059-SEMARNAT-2001
Marmosidae	*Marmosa mexicana*	

FAMILY	SPECIES	NOM-059-SEMARNAT-2001
Caluromydae	*Caluromys derbianus*	Endangered
Myrmecophagidae	*Tamandua mexicana*	Endangered
Emballonuridae	*Balantiopterix plicata*	
Phyllostomidae	*Carollia subrufa*	
Procyonidae	*Bassaricus sumichrasti*	Subject to special protection
Procyonidae	*Procyon pigmeaus*	Peligro de Extinción Especie restringida a México
Sciuridae	*Sciurus deppei*	
Sciuridae	*Sciurus yucatanensis*	
Geomidae	*Orthogeomys hispidus*	
Muridae	*Oryzomys melanotis*	
	Otonyctomys hatti	Threatened
	Reithrodontomys mexicanus	
	Reithrodontomys microdon	
	Reithrodontomys spectabilis	Threatened especie restringida a México
	Tylomys nudicaudatus	
	Xenomis nelsoni	Threatened especie restringida a México
Erethyzontidae	*Coendou mexicanus*	
Agoutidae	*Agouti paca*	
Dasyproctidae	*Dasyprocta mexicana*	

Source: Establecimiento de prioridades para la conservación de mamíferos terrestres neotropicales de México

The Apatlahuaya river is formed with the accumulation and addition of a series of rivulets and water filtrations coming from the mountains, and estimates a health status for the permanence of aquatic life, based on the physical-chemical characterization shown in Table IV 33. However, in the field trips no fish communities, nor fishing communities were seen in the zone or in the region that derived in a composition of low richness, but with presence of small sensible species.

Thus, downstream the environmental conditions change due to the increase in the environment and water temperature, partly due to the anthropogenic activity and the closeness to human settlements (the most important and significant one being the town of Zongolica) it is possible to carry out a fish breeding utilization of its currents with a benefit in the environmental protection to the hydric and social resource.

IV.2.3. Socio-economic aspects

Regional Context

- **Economic Region (in accordance with INEGI) to which the site for the realization of the project belongs.**

In the Economic Zone (7) East Veracruz and Tabasco.

- **Distribution and location in a map scale 1:50,000 of population nucleus near to the project and its area of influence.**

- **Number and density of inhabitants per population nucleus identified.**

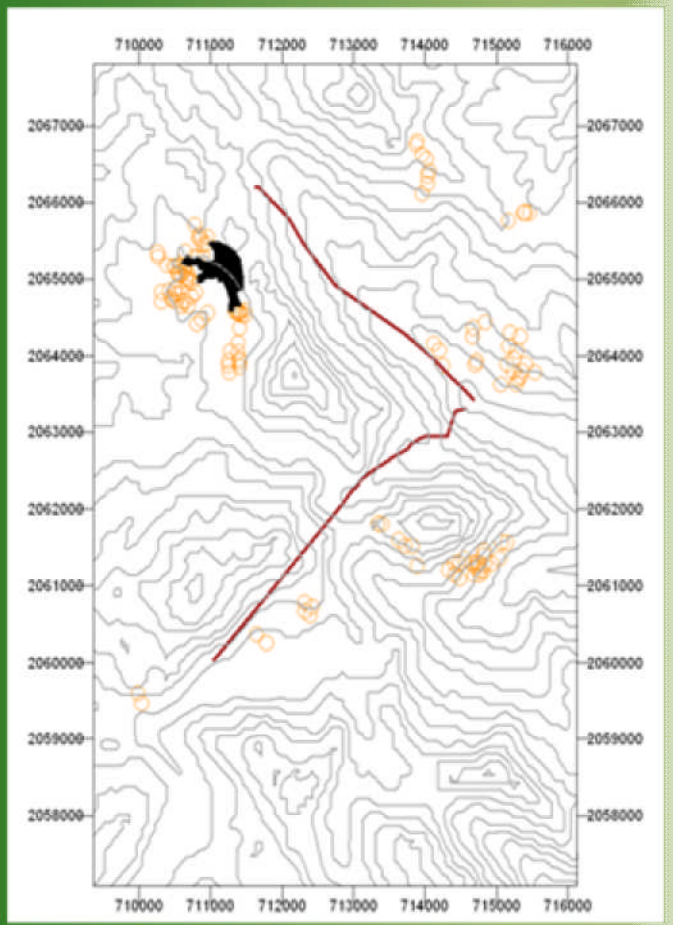
In accordance with the results submitted by the Conteo de Población y Vivienda 2005, the municipalities record the following data:

TABLE IV.41 REGIONAL DEMOGRAPHY

MUNICIPALITY	POPULATION NUCLEUS	NUMBER OF INHABITANTS
RESERVOIR AND TUNNEL ENTRANCE PORTAL		
Texhuacán	Aticpac	55
Texhuacán	Apoxteca	160
Mixtla de Altamirano	Ayahualulco	350
Texhuacán	Equimititla	73
Texhuacán	Palulca	82
Mixtla de Altamirano	Mixtla	505
Mixtla de Altamirano	Xala	328
TUNNEL EXIT PORTAL AND SUPERFICIAL TUBE		
Zongolica	Acontla	70
Mixtla de Altamirano	Xochitla	496
POWER HOUSE AND ELECTRIC SUBSTATION		
Zongolica	Atonacalco	153
Zongolica	La Granja	59
Zongolica	Zacatal	410
Zongolica	Zongolica	5,891

A rural community is the one that has less than 2,500 inhabitants a urban community is the one that has more than 2,500 inhabitants.

FIGURA IV.12. UBICACIÓN DE ASENTAMIENTOS HUMANOS



PROYECTO HIDROELÉCTRICO VERACRUZ

N

Proyección: UTM
Zona: 14
Datum: ITRF92

0 1500

SIMBOLOGÍA

AsentamientosHumanos

Octubre 2008

TABLE IV.42 HISTORY OF THE MUNICIPALITIES POPULATION

YEARS	ZONGOLICA (inhab)	MIXTLA (inhab)	TEXHUACÁN (inhab)
1980	2,437	15,226	3,032
1990	3,418	17,109	3,904
2000	8,364	39,562	4,642
2005	9,572	39,156	4,740

- **Kind of population center in accordance with the cities scheme system (in accordance with SEDESOL).**

SEDESOL has developed the “100 - Cities Program” (“Programa de las 100-Ciudades”), which tries to correct the heavy population concentration and the economic activity in four great metropolitan zones (Mexico City, Guadalajara, Monterrey and Puebla) encouraging a “more balanced urban growth”, emphasizing the development of medium size cities, specially in the south and southeast, in order to reduce the migration to the north.

However, putting in place the Free Trade Agreement (NAFTA) has modified this strategy, the dilemma derives from the fact that the Programa de las 100-Ciudades, by definition, puts attention in 100 cities, while only 26 cities may be benefited from NAFTA. Likewise, none of the benefited cities is located south from Mexico City.

- **Poverty index (in accordance with CONAPO).**

Only after the states of Chiapas and Oaxaca, the state of Veracruz is located in the third national place with a greater poverty index and lowest human development index, as revealed by the Secretaría de Desarrollo Social figures (SEDESOL, 2007).

Among the country’s 100 poorest municipalities, 15 correspond to the state of Veracruz, and from these 9 are located in the Sierra de Zongolica, which reflects the high degree of poverty and one of the zones with the lowest human development in the county (SEDESOL, 2007).

Recently, in 1999, the National Priority Regions Attention Program (Programa Nacional de Atención a Regiones Prioritarias) came into effect, including the Sierra Negra Zongolica Veracruz. This governmental effort intended to coordinate social development actions and concentrate resources to attack poverty in 91 regions identified as of mayor social exclusion (SAGAR, et. al. 1999).

TABLE IV.43 SOCIAL EXCLUSION DEGREE AND INDEX

MUNICIPALITY[1]	SOCIAL EXCLUSION INDEX	SOCIAL EXCLUSION DEGREE
Zongolica	1.33278	Very high
Mixtla de Altamirano	2.92723	Very high
Texhuacán	1.18371	Very high
TOWN[2]		
Mixtla	0.35954	High
Ayahualulco	1.47056	Very High
Xala	1.95189	Very High
Xochitla	1.46969	Very High
Texhuacán	-0.15208	High
Apoxteca	0.86068	Very High
Palulca	0.69832	Very High
Equimititla	0.49726	Very High
Aticpac	1.22654	Very High
Zongolica	-1.22649	Medium
Zacatal	1.2973	Very High
Acontla	0.23173	High
La Granja	0.11036	High

SOURCES: 1.- CONAPO 2005; 2.- CONAPO 2000

- **Feeding index, expressed in the population that covers the minimum feeding.**

TABLE IV.44 SOCIAL EXCLUSION DEGREE

MUNICIPALITY	PERCENTAGE OF FEEDING POVERTY	MUNICIPALITY WITH INTENSITY OF FEEDING POVERTY
Zongolica	54.29	High
Mixtla de Altamirano	62.69	Very High
Texhuacán	55.23	High

SOURCE: CONAPO 2005

- **Equipment: Location and capacity of services for handling and final disposal of waste, water supply sources, power, etc.**

Sanitary Fill:

In accordance with information of the Secretaria de Desarrollo Social y Medio Ambiente of Veracruz, in the district XVIII Zongolica, where the project is immersed, only in the Municipality of Nogales there is a sanitary fill operated by particulars, which provides service to 14 adjacent Municipalities, but is far from the project site.

The municipalities located in the Zongolica sierra deposit their wastes in open air garbage dumps.

Final disposal of construction waste:

The location of the sites for the placement of material derived from the excavation may be observed in the maps PHV-05 “Veracruz, Impounding Zone, DDV affectations” and in the map PVH-06 “Conduction Zone DDV affectations” included in the relevant annex.

Urban waste:

The solid wastes generated must be classified for their reuse and deposited in containers that shall be strategically placed to have easy access thereto. Such containers will facilitate the classification of the non hazardous solid waste, at least into organic, inorganic and sanitary.

Hazardous Waste:

In case of waste considered as hazardous, in accordance with la NOM-052-SEMARNAT-2005, as for example, used oils, oils and fuels packages, paint cans, paint remains, materials impregnated with such waste, among others, shall be handled in an environmentally appropriate manner and through a hazardous waste recollecting company acknowledged by SEMARNAT and SCT.

Water supply:

The consumption of hard water for the site preparation stage is base don the application of periodical irrigations in the excavations zone and access roads to avoid the generation of dusts.

During the construction the utilization of hard water is being considered, mainly for the manufacture of concretes and humidifying of earthwork roads. The amount marked in the table refers to the total volume of water required for this stage. Water used will receive no prior treatment because it satisfies the quality specifications for the preparation of concretes.

Water will be obtained through direct pumping from the river to storage tanks in the site. It will also be transported in pipe with a capacity of 6,000 liters in order to irrigate roads.

It will need no treatment prior to its use, but for human consumption bottled water of a known trademark will be acquired.

Electric power:

For the site preparation and construction stages electric power will be required for the office, lighting and handling of tools activities. The supply will be provided by the 13.8 kv lines that currently arrive to the three main work sites, that is: dam and intake work; tunnel exit portal that is also an end of the pressure tube and power house and substation, which also covers the other end of the pressure tube. The estimated consumption of power is of 24000 Kw/month.

- **Territorial reserves for human development.**

The diversity and dispersion characteristics of Veracruz imply to attend regions and territorial reserves with high contrasts that make difficult to put in place urban development, investment and public policies programs.

The geographic situation and the distribution of the population and of the economic activities of Veracruz, consequently result in an uneven development that privileges 14 urban zones and makes the development of almost 21,757 towns of less than 2,500 inhabitants lethargic. From these urban zones, seven correspond to intra-state join urban zones that, together represent almost 41% of Veracruz's population.

Veracruz population distribution makes difficult to carry out regional coverage works that allow to timely and efficiently take care of the population demanding services from the State. Additionally, the lack of well remunerated employments in rural zones inhibits the settlement of the population in their places of origin, favoring an elevated mobilization of the population in Veracruz, both among State cities and outside the State.

In respect to urban space of the main cities of the State of Veracruz, a double problematic exists:

- The growth of urban stains to unplanned zones and with legal uncertainty on the possession of land and housing.

- Insufficiency in the rendering of basic services, both of the infrastructure and equipment, which generates low levels of social welfare and vast zones of urban poverty.

- **Population's growth rate considering 30 years as minimum before the project's execution date.**

In the municipality of Zongolica:

In the periods of:

1950 - 1960 an annual medium growing rate of 3.3%,

1960 - 1970 an annual medium growing rate of -6.3%,

1970 - 1980 an annual medium growing rate of 1.3%,

1980 - 1990 an annual medium growing rate of 3.7%,

1990 - 2000 an annual medium growing rate of 1.5%

- **Migration processes, specify if the project will provoke substantial emigration or immigration, in affirmative case, estimation of magnitude and effects thereof.**

The project will not provoke emigration or immigration in the towns the following migration processes are recorded:

TABLE IV.45 MIGRATION PROCESSES IN THE PROJECT'S TOWNS

TOWN	Population resident more than 5 years in the entity	Population resident 5 and more years in another entity	Population 5 years and more in the United States of America
Zongolica	5,138	74	9
Tonaca	135	0	0
Zacatal	363	0	0
Acontla	62	0	0
La Granja	54	0	0
Xochitla	422	1	0
Xala	283	0	0
Mixtla	440	0	0
Ayahualulco	295	0	0
Aticpac	49	0	0
Palulca	73	0	0
Equimititla	65	0	0
Apoxteca	142	0	0
Texhuacán	1,433	9	7

SOURCE: INEGI 2005

- **Kind of predominant social organizations.**

Coordinadora Regional de Organizaciones Indígenas de la Sierra de Zongolica (CROISZ)

Organización Indígena Náhuatl de la Sierra de Zongolica (OINSZ)

- **Housing**

The majority of the houses are owned and of fixed type, materials mainly used for their construction are cement, partition walls, brick, wood, plates. As well as region's materials are used, such as: wood; for roof, cardboard plates, palm, shingle, cane hay and earth floor.

In accordance with the results obtained by the II Conteo de Población y Vivienda del 2005, in the municipality Mixtla de Altamirano there are a total of 2,048 houses from which 2,008 are privately owned, and in the municipality of Zongolica there are a total of 8,655 houses, from which 8,370 are privately owned.

TABLE IV.46 MUNICIPAL LEVEL PUBLIC SERVICES

PUBLIC SERVICES	ZONGOLICA					MIXTLA					TEXHUACÁN				
	100%	75%	50%	25%	0%	100%	75%	50%	25%	0%	100%	75%	50%	25%	0%
Public lighting		X							X				X		
Drainage maintenance		X								X					X
Recollection of Garbage and Public Cleaning.		X								X				X	
Public Safety.		X				X						X			
Paving				X						X				X	
Markets and Supply Centrals				X						X					X
Slaughterhouses.					X					X					X
Parks and Gardens Services.				X						X					X
Monuments and Fountains.				X						X					X
Drinking Water				X									X		
Drainage				X											X

SOURCE: Portal de los municipios del Estado de Veracruz .Gob. 2008

TABLE IV.47 PERCENTAGE OF THE SERVICES AVAILABLE IN THE TOWNS

TOWN AND PERCENTAGE	PRIVATE HOUSING	DRINKING WATER	HAVE SANITARY SERVICE	HAVE DRAINAGE	HAVE ELECTRICITY	HAVE TUBE DRAINAGE, WATER AND Y ELECTRICITY	HAVE NO TUBE DRAINAGE, WATER AND ELECTRICITY
Zongolica	1,288	1,025	1,273	1,223	1,249	1,000	11
%	100	79.5	98.8	95	97	77.6	0.85
Tonaca	41	4	41	21	25	1	9
%	100	9.7	100	51.2	60.9	2.44	21.95
Zacatal	100	59	99	3	90	3	7
%	100	59	99	3	90	3	7
Acontla	17	13	17	1	14	1	2
%	100	76	100	5.8	82.4	5.88	11.8
La Granja	15	5	13	5	13	2	0
%	100	33.3	86.7	33.3	86.7	13.3	0
Xochitla	496	2	105	77	84	0	25
%	100	0.4	21.17	15.52	0.17	0	5.04
Xala	328	2	67	41	9	1	8
%	100	0.6	20.43	12.5	2.74	0.3	2.44
Ayahualulco	74	4	72	1	60	1	12
%	100	5.4	97.29	1.35	81.08	1.35	16.21
Aticpac	13	13	11	11	4	3	0
%	100	100	84.6	84.6	30.7	23	0
Palulca	23	10	20	13	13	6	2
%	100	43.4	86.9	56.5	56.5	26	8.7
Apoxteca	34	23	31	5	17	3	8
%	100	67.6	91.1	14.7	50	8.8	23.5
Equimititla	17	14	17	2	17	2	1
%	100	82.3	100	11.7	100	11.7	5.8

- **Existing communication road systems and means, availability of basic services and equipment, existence of irregular human settlements and the location thereof.**

Communication Means in the municipality of Zongolica:

Receives the signal of 8 radio stations in A.M. frequency and 4 of F.M, as well as journalist publications and T.V. channels signal. It has telephone service with automatic dialing in the capital and 27 towns, as well as rural telephone; in addition to 8 post offices and 7 telegraph offices.

The communication road system in the municipality, it has infrastructure of highway systems formed by 107 Km. of highway.

Communication Means of the municipality of Mixtla:

The municipality does not receive journalistic publications, only radio signals 15 of AM and 10 of FM; as well as TV signal.

It has telephone service through automatic dialing in the capital and in 3 towns, as well as rural and cellular telephone; in addition to 1 post office.

The municipality of Mixtla has a total of 6 Km. of highway infrastructure.

There are two earthwork roads that communicate to Mixtla, such as the Mixtla-Zongolica one, at and approximated distance of 17 Km. and 1 hour time journey; the other ones if Mixtla-Tehuipango, at an approximate distance of 15 a 17 Km. and a 1 hour time journey.

Communication Means of the municipality of Texhuacán:

The municipality receives the signal of 4 A.M radio stations and six F.M, as well as 4 T.V. channels. It has telephone service by automatic dialing in the municipal capital and 5 towns, as well as rural telephone; in addition to 1 post office.

The municipality of Texhuacán has 10.1 Km. of highway infrastructure.

Particularly access to the project's zone is carried out from the city of Orizaba to the town of Zongolica through the federal highway No.150 and from Zongolica there are three access ways to the works, one to arrive to the reservoir, dam wall and tunnel entrance portal, a different one for the tunnel exit portal and beginning of the pressure tube and one more for the final portion of the pressure tube, power house and substation.

- **System and coverage in Social Health and Safety**

TABLE IV.48 HEALTH AGENCIES WITHIN THE STATE

HEALTH DEPARTMENT	VERACRUZ
IMSS	4
ISSSTE	4
Red Cross	1
Secretaria de la Defensa Nacional	2
Secretaria de Marina	2
Municipal Public Health Centers	46

SOURCE: INEGI 2005

The following tables show the personnel and infrastructure of the health institutions within the State of Veracruz and the municipality of Zongolica

TABLE IV.49 PERSONNEL ASCRIBED TO HEALTH AGENCIES

HEALTH INSTITUTE	VERACRUZ	ZONGOLICA
I.M.S.S.		
Medical personnel	9,589	0
Paramedic personnel	7,300	0
Aux. Serv. Diagnosis and Treatment.	663	0
Other personnel	3,606	0
Total	18,322	0
ISSSTE		
Medical personnel	3,602	1
Paramedic personnel	909	0
Other personnel	107	0
Total	2,590	1
GOVERNMENT MEDICAL UNITS		
Medical personnel	3,646	16
Paramedic personnel	4,060	15
Other personnel	180	5
Total	10,660	36

SOURCE: INEGI 2000

TABLE IV.50 PHYSICAL INVENTORY OF HEALTH ASSISTANCE CENTERS

INSTITUTE	VERACRUZ	ZONGOLICA
I.M.S.S.		
Census beds	1,599	45
Consulting rooms	780	19
Radio diagnosis rooms	49	1
Laboratories	46	2
Operating rooms	54	1
Delivery rooms	33	11
I.S.S.S.T.E.		
Census beds	255	0
Consulting rooms	276	1
X Ray rooms	8	0
Laboratories	9	0
Operating rooms	11	0
Delivery rooms	6	0
GOVERNMENT'S MEDICAL UNITS		
Census beds	1,855	0
Consulting rooms	1,656	10
Laboratories	51	0
Radiology cabinets	40	0
Operating rooms	81	0
Delivery rooms	437	7

SOURCE: INEGI 2000

- **Morbidity and mortality and their possible causes.**

TABLE IV.51 INFANTILE DEATH RATE

TOWN	INFANTILE DEATH RATE 2005
(Decease of younger than one year, for every one thousand born alive)	
Mixtla de Altamirano	47.62
Texhuacán	35.47
Zongolica	29.77

SOURCE: CONAPO 2005

Main infantile mortality causes: Asphyxia and birth trauma, heart congenital malformations, low weight when born and prematurity, Anencephaly and similar malformations e low acute respiratory infections.

- **Education**

TABLE IV.52 COURSES OF 15 YEAR OLD POPULATION

TOWN	15 year and older analphabet population	15 year and older with incomplete basic education population	15 year and older with complete basic education population	15 year and older with after basic education population
Altamirano	159	116	24	28
Ayahualulco	106	79	12	13
Xala	142	61	2	4
Xochitla	159	148	14	9
Texhuacán	287	359	119	288
Apoxteca	41	45	8	288
Palulca	20	22	8	21
Equimititla	13	25	5	2
Aticpac	10	21	3	1
Zongolica	460	998	665	1960
Tonaca	30	55	17	13
Zacatal	101	140	5	12
Acontla	11	24	8	11
La Granja	7	19	4	12

SOURCE: INEGI Censo de Población y Vivienda 2005

- **Cultural and aesthetical aspects.**

  - **Presence of ethnic, religious groups.**

In accordance with the year 2000 census reports in the municipality of Zongolica there are 24,591 speakers of Nahuatl and Mixteco ethnic language from these, 12,295 are men and 12,296 women, that represent 79.2% of the ethnic population older than 5 years of the municipality.

In the municipality of Mixtla there are 5,856 that speak Nahuatl ethnic language, from these 3,059 are men and 2,797 women that represent 82.3% of the municipal ethnic population.

And in the municipality of Texhuacán it was reported an ethnic population of 3,166 with Nahuatl ethnic language.

In accordance with the results presented by the II Conteo de Población y Vivienda 2005, in the municipality of Mixtla there are a total of 7,953 and in Zongolica a total of 26,251 persons that speak an ethnic language.

TABLE IV.53 POPULATION THAT SPEAKS AN ETHNIC LANGUAGE

Town	More than 5 year old ethnic population	5 year old population that does not speak Spanish	More than 5 year old population with unspecified ethnic language
Veracruz State	605,135	57,290	533,807
Mpio. Zongolica	2,220	26	2,148
Tonaca	63	0	57
Zacatal	300	8	291
Acontla	43	1	42
La Granja	35	1	29
Mpio. Texhuacán	2,990	195	2,745
Aticpac	39	0	32
Palulca	39	3	35
Equimititla	34	0	34
Apoxteca	91	5	84
Texhuacán	990	28	925
Mpio. de Mixtla	7,953	3,571	4,164
Xochitla	422	79	339
Xala	281	142	138
Mixtla	7953	3571	4164
Ayahualco	283	57	221

SOURCE: INEGI Censo de Población y Vivienda 2005

- **Cultural Traditions**

As all the Mesoamerican origin ethnic groups, the nahuas of Zongolica perform religious practices that come from two synthesized flows in a reinterpretation process: the Pre-Hispanic Mesoamerican religion and the Hispanic-European Roman Catholicism. The nahuas of the Sierra Negra of Zongolica built their belief system with the selective appropriation of the European-occidental religiosity, creating and recreating ceremonies, beliefs and rituals imbued of these two origins, resulting in the so called by several authors, popular religiosity religiousness.

- **Identification, location and characterization of cultural and religious resources identified in the site where the project will be located.**

Within the religion in the municipality of Zongolica, in the 1990 census there was a more than 5 year old total population of 28,829 inhabitants, from which 27,018 are catholic, 1,021 protestant, 143 other religion and 291 none, it has more than 100 catholic chapels. And in the municipality de Mixtla a more than 5 year old total population of 5,902 that is divided among the following religions: catholic 5,305, evangelic 335 and none 105.

- **Describe the landscape value in the project site.**

The landscape may be analyzed from two different aspects: a) Where the landscape value corresponds to the group of interrelations of the rest of the elements (water, air, plants, rocks, etc.) and its analysis requires the prior investigation thereof; and b) Where the landscape encompasses an important fraction of the plastic and emotional values of the natural environment, therefore, it is recommended to carry out the analysis based on visual qualities or values.

Likewise, in the analysis of the current landscape and the future scenario of the project, we consider three different points of view:

- The purely aesthetic landscape, that refers to the harmonic combination of the territory's forms and colors, and even the artistic representation thereof.
- The landscape as ecologic or geographic term, that refers to the analysis of the natural systems that form it, that is, the interrelation among water, air, land, plants and animals.
- The landscape as cultural status, that is, "The scenario of the human activity " (Laurie, 1970)

The landscape present within the area of influence of Proyecto Hidroeléctrico Veracruz, was addressed from the information related to the inventories and qualities such as visibility, fragility and quality.

Visibility Conditions. Making use of the in site observation and the cartographic search by quadrilles, the project from different angles is visible in segmented form for the human community and in the establishment of the possible interrelations with other factors such as wind, humidity, road system, pedestrian and vehicular mobility, presence of fauna. The dam project, is comfortably integrated as a new artificial element, of less physical perceptibility for the population.

Landscape Fragility. Through the integration of the territory's features with its response ability to the change of its landscape characteristics, the landscape's fragility may be medium-high considering the constructive element, its proximity and the visual exposition.

Landscape Quality. The aesthetic quality or beauty of the landscape is good.

The assessment of the current landscape is made in direct form as of the contemplation of the whole landscape, notwithstanding that within the environmental impact assessment it possesses the disadvantage that the appreciation is subjective, because it depends on the observer and the characteristics of the zone observed.

It is important to consider that the formal quality of the objects that form the landscape and the relationships with its surrounding, are described in terms of design, size, form, color and space, great differences exist when measuring the relative value of each of then and their weight in the whole composition.

In complement, also the landscape's physical features are considered, the topography, the land uses, the presence of water, etc. Each unit is assessed in terms of the components and

afterwards the partial values are added to obtain a final data. The difference among the several methods lays in the selection of the components and the from to valuate them.

The landscape analysis includes the delimitation and determination of the landscape units, of core importance in the landscape treatment. These landscape units are the basis for the detailed diagnosis of the current landscape. No landscape units in excess are designated in order not to complicate the handling of the subsequent projects, and also it is not operative to define landscape units in excess, because the utility thereof is lost by making impossible to use it for the planning, which required appreciable acting units.

Even though in illustrations IV.10 – IV.11, the landscape group must be understood as hierarchy arrangement element that encompasses those landscape units integrated with a series of heterogeneous characteristics up to certain limit, and in one or several concrete lines, mainly defined by the Mesophyll Forest and the gallery forest. In general, the landscape does not represent a major problem considering that the actions of human features have been moderate. Within the framework of the different forms present in the landscape, the volume or surface of the objects appear unified, such as some basis geo-forms, diverse and divided by sectors vegetation in some cases and the rivers, roads and highway outlines, among others.

The landscape assessment in the research site is related to the utilization of the forests, considering not only the commercial value thereof but also based on the social and ecosystem scope that they provide to the human beings and to the nature.

The mountain mesophyll forests are of outstanding importance due to their environmental or socio-economic value, to their biodiversity and to their value as landscape. The forest value in the research zone is considered based on:

- The conservation of species, to the ecosystem and the area's representative landscapes.
- The protection of people in case of flooding and avalanches, the protection against soil erosion.
- The conservation of the natural resources of importance for the communities.
- The assessment of the non timber-yielding forestall products and of the environmental services.
- The conservation of the most valuable identity and cultural inheritance of one area.

The landscape lines present abrupt changes on the imaginary course of the observer on visual elements (color, form, texture). In addition to the north south plane vision, with background on the mounts do not define a border and the edges appear in bands of different levels, that as a whole, with the landscape color allow the human eye to differentiate near and far away objects.

DIAGRAM IV.10. LANDSCAPE UNITS IN THE ELECTRIC TRANSMISSION LINE ZONE

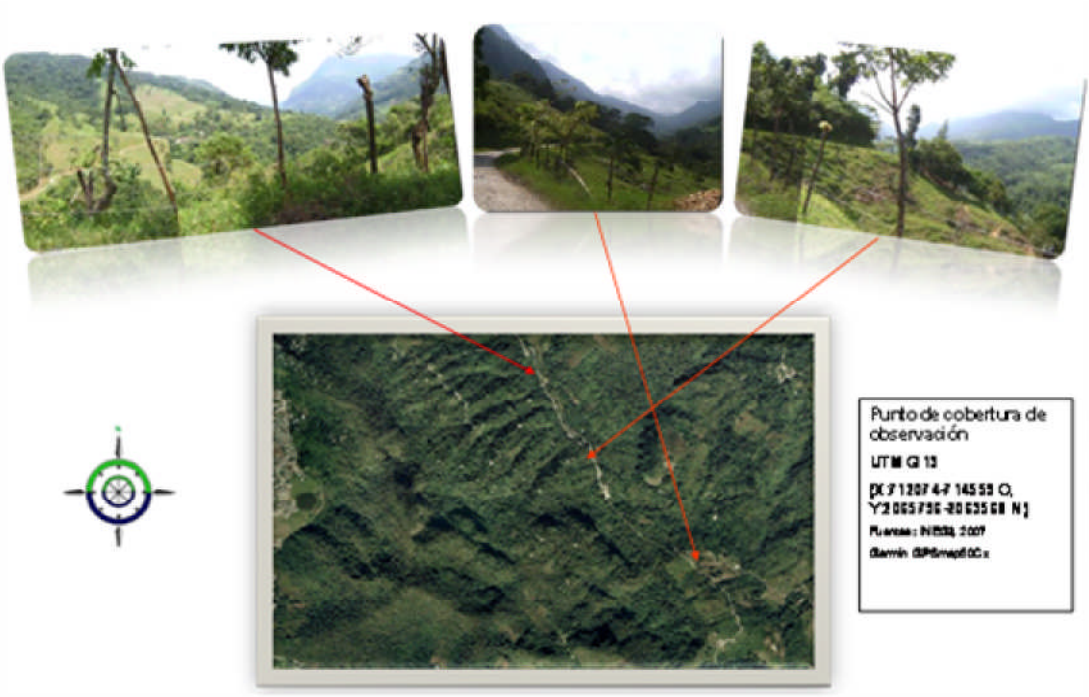
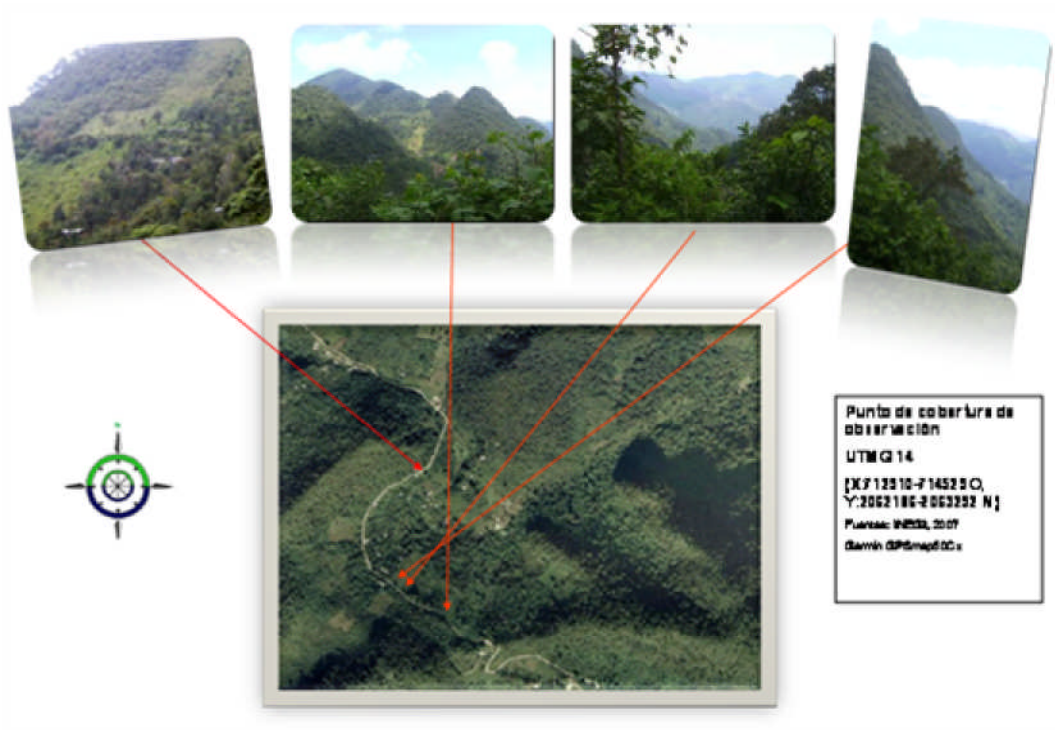


DIAGRAM IV.11. LANDSCAPE UNITS IN THE TUNNEL EXIT ZONE



The visual properties of the elements in the landscape units, their visibility degree and the vision sharpness, are defined in the zone by:

The Color: is the ability to of reflect the light with a particular intensity and wave length, which allows the human eye to differentiate objects that otherwise would be identical. It is the main visual feature of a surface.

The Scale: is the relationship between the size of an object and the surrounding where it is located. The scale may be absolute, relative, with distance effect or with location effect. (Smardon, 1979; MOPT, 1996)

The Space: The complex visual element called space, which integrates a group of the landscape's qualities determined by the tridimensional organization of the solid bodies and the free or empty spaces of the scene, define fro the zone a panoramic landscape in which there are no apparent limits for the vision, prevailing horizontal elements with the fist plane the sky dominating the scene.

A key aspect of the current landscape related with possible landscape contaminants, is not evident nor physical (roads, agricultural cultivations, human settlements) or biological (absence of natural fauna and vegetation) that the property and its surrounding present.

In the application of the Fines methodology, the Absolute Value (Va) of the landscape is SUPERB with a value of 9, which is in relation with the closeness with human settlements such as Zongolica and small towns, vehicular transit and the potential population of observers and accessibility to the observation points. The equation applied to find the Relative Value (Vr) in a scale of 0 – 100, results from the calculation of a constant (K) determined by:

$$\mathbf{Vr = K.\ Va}$$

$$\mathbf{K = 1.125 * [\ P/d * Ac * S]^{0.25}}$$

Where:

P = Function of the near towns size (P = 6)
d = Function of the medium distance in Km to the near town (d = 4)
Ac = accessibility to the observation points (Ac = 4)
S= Surface from where the action is perceived (S=4)

$$\mathbf{Vr = 2.51*16 = 40}$$

In general, the landscape possesses a good visual quality level, considering the high variability of the landscape unit, integrated on mountain and hillocks geo-forms of Mesophyll Forest and gallery forest, divided by properties involved in agriculture cultivations a few of them little productive and useless, and rural road outlines.

- **Economic Aspects**

Main productive activities, indicating their spatial distribution.

The municipality of Zongolica:

Has a surface for agriculture in a total of 23,295.034 hectares, from which 17,051.780 hectares are cultivated, in the 4,384 production units. The main agricultural products in the municipality and the surface harvest in hectares is as follows: corn 5,025, orange 15 and coffee 6,060 and mango 4. In the municipality there are 3,546 rural production units with forestall activity, from which 40 are engaged in timber-yielding products.

For cattle breeding it has a surface of 3,968 hectares used for cattle breeding, where 3,401 rural production units are located with the activity of breeding an utilizing animals. It has 1,082 cattle heads of double purpose, in addition to breeding of pigs, sheep, horses and goats. The poultry-breeding and apicultural farms have certain importance.

In fishing the municipality has *mojarra* and *pepexca*. And in industry in the municipality industries have been established among which we find 1 micro, 1 small, it is important to mention that within these there is 1 with exportation quality, highlighting the coffee benefit industries, it has coffee benefits, tortilla production places.

Within the hotel infrastructure, as of December 31, 1996, there is 1 lodging place, amounting a total of 21 rooms available

Commerce there is an average of 3 small stores, some grocery stores, milk stores, tortilla stores.

The municipality of Mixtla:

It has a total surface for agriculture of 7,923.166 hectares, from which 1,861.826 hectares are cultivated, in the 1,608 production units. The main agricultural products in the municipality and the surface harvest in hectares is as follows: corn 800, coffee 524. In the municipality there are 693 rural production units with forestall activity, from which 55 are engaged in timber-yielding products.

Within cattle breeding it has a surface of 395 hectares engaged in cattle breeding, where 998 rural production units are located with the activity of breeding and exportation of animals. It has 185 cattle heads of double purpose, in addition to breeding of pigs, horses and goats. The poultry-breeding and apicultural farms have certain importance.

Its commerce has 14 stores that produce 113 thousand pesos as total annualized income, 16 workers are employed in this activity.

The economic activities of the municipalities by sector, are distributed as follows:

TABLE IV.54 ECONOMIC ACTIVITIES OF THE MUNICIPALITIES BY SECTOR

Activity	Zongolica	Mixtla	Texhuacán
Primary sector. (Agriculture, cattle breeding, hunting and fishing.)	77 %	88 %	93%
Secondary sector (Mining, oil and natural gas extraction, manufacture industry, electricity, water and construction)	5.05 %	1.48 %	6.71%
Tertiary sector. (Commerce, transportation and communications, financial, public administration and defense services, common and social, professional and technical services, restaurants, hotels, maintenance personnel and other.)	14 %	13.19 %	11%
Not specified	2.02 %	1.65 %	2.14%

- **Income *per cápita*.**

TABLE IV.55 OCCUPIED POPULATION WITH INCOME

OCCUPIED POPULATION WITH INCOMES OF UP TO TWO MINIMUM WAGES	
TOWN	**PERCENTAGE**
Mixtla de Altamirano	85.0
Ayahualulco	92.7
Xala	100.0
Xochitla	99.4
Texhuacán	78.8
Apoxteca	88.8
Palulca	87.8
Equimititla	86.9
Aticpac	100.0
Zongolica	56.1
Zacatal	84.6
Acontla	78.5
La Granja	88.2

SOURCE: CONAPO 2000

- **Employment: PEA occupied by productive sector, unemployment index, relationship supply – demand**

Municipality of Zongolica Working Population: 14,409 hab.

Municipality of Mixtla de Altamirano Working Population: 2,573 hab.

Municipality of Texhuacán Working Population: 1,167 hab.

- **Competence for the utilization of natural resources. Identification of the possible conflicts due to the use, demand and utilization of the natural resources among the different productive sectors.**

Due to the generalized disorderly growth in the country, generated by the competence for the space and the utilization of the natural resources, which derives in social conflicts that impact the life quality of the communities and diminish the competitiveness of the economic sectors.

That in order to make the country's economic growth compatible with the conservation and rational utilization of the resources, it is necessary that the forests have planning and order processes, as well as tools that allow the State to prevent, minimize and face the risks for the population and the public and private infrastructure derived from the hydro-meteorological phenomenon. (SEMARNAT 2008).

There are no legal impediments nor work or services requirements by the municipality, state or federation; nor competence situations for the resource or affectations to third parties nor transcendent contaminant emissions in the region are identified.

IV .2.4 Description of the structure and function of the regional environmental system.

The physical environment and in particular the geo-morphologic features present within the project's area of influence, and that involve the municipalities of San Juan Texhuacan, Mixtla de Altamirano and Zongolica, are determinant in the structure and function of the regional environmental system. It will be formed, of the structure, distribution and diversity of the vegetation given by the diverse topography, distribution of rains, temperature regime and marked differentiation of soils.

The complexity of the group of abiotic elements and the bio-geographic processes have resulted into several kinds of vegetation where the mountain Mesophyll Forest is predominant, several shrubs, and riparian vegetation with arboreal elements and zones with different perturbation degrees. The region in general and from the biologic point of view results representative of the Mexican diversity and may be considered as a transition zone of the Neo-tropical and Neartic regions that possess several types of vegetation. From the Orizaba Volcano points several kinds of vegetation are present with well conserved forestall massifs, remains of the mesophyll forest, of the medium rain forest of the country's northwest and possible endemism.

The project is to be located in the mountain chain that corresponds to the Zongolica and Mazateca sierras. The research zone is found in the north portion of the Papaloapan hydrologic basin, as affluent of the Axalticpac river and then the Tonto river until arriving to the Alvarado sandbar. The local drainage network includes the Apatlahuaya rivers that will supply the hydroelectric plant, the Zongolica river where the turbine water will be discharged and the Moyotepec, Coyolapa and Altotonga rivers, all of them tributary of the Tonto river, important affluent of the Papaloapan river regulated by the Miguel Alemán dam before its discharge to the Papaloapan.

The project area is identified as an heterogeneous environmental unit, with a significant value of biological diversity and hydrologic potential, both in utilization and conservation prevailing conditions as restoration in isolates events. To arrive to this statement we were base don the

superposition of maps technique under one same scale, using the thematic parameters of the area's physical (climate, geology, soils and hydrology), biological (vegetation, fauna) and socio-economic environment.

The main biological modifier of the region has been the human being. The forestall species have experimented a reduction of the occupied areas, due to the utilization of wood with combustible or artisanal or ornamental purposes. Together with environmental developments such forestall fires, which affect not only the forestall richness, but also the land, the hydrologic regime thereof, the populations of flora and fauna and to the landscape's architecture because they produce strong alterations to the ecosystems' natural status causing deterioration and weakening the forestall resource, to make it more vulnerable to plagues, deceases and the clandestine activities. Other anthropogenic events are the clandestine felling of trees, as well as deforestation due to land use change, that is still currently happening. Some properties that have suffered a severe land use change present argil features and abrupt and stony lands.

The Mesophyll Forest and species both of pines and oaks are important within the system's functioning, considering their high economic potential and that justifies to observe their protection and conservation as indicators of conserved sites.

IV.2.4.1 Analysis of the components, resources or relevant and/or critical areas

Local Flora: In general terms, the use of the local flora is only restricted to auto-consumption, except for the timber-yielding species with artisanal s purposes, fuels and species considered as no timber-yielding, such as fungus, epiphytic (bromeliads and orchids), with ornamental and medicinal purposes. This activity may be profitable if in the future reforestation programs were carried out and adequate handling strategies that allow to utilize and conserve these resources were developed.

Forestall: Without doubt it is the region's most important resource, not only because of its utilization as timber-yielding but also as recollection zone and because of the value it prints into the landscape as touristic potential. The forestall resource has decreased due to the forest extraction in clandestine form for the sale of wood and firewood and in few cases as carbon. Among the most affected species there are native trees such as the pines *Pinus pseudostrobus, Pinus patula, Pinus ayacahuite* and oaks such as the *Quercus rugosa, Quercus crassifolia* and *Quercus castanea*.

Species found that have been categorized as threatened or endangered, have been affected by the above mentioned phenomenon of deforestation, immoderate felling of trees, and destruction of the habitat with agricultural and cattle breeding purposes. In particular, the Yaca, is a species characteristic of the Mesophyll Forest that serves as indicator of danger of other species to which it is associated such as *Liquidambar macrophylla, Clethra sp. Cornus sp. Ilex sp.* and *Quercus spp.*

Thus the forestall species have seen their space each time more reduced as a consequence of antropic actions that hinder their development.

IV.3 Regional Environmental Diagnosis

Under Rzedowski (1978) the vegetation is represented by the mountain Mesophyll Forest and by a part of riparian vegetation with arboreal elements of the gallery forest, and zones with different degrees of perturbation. The property's plain parts are used as housing and for several cultivations such as corn, squash, bean, ayocote, sugar cane, coffee as well as several ornamental plants. The region's most important resource is the forestall not only because of its utilization as timber-yielding but also as recollection zone and because of the high value that it prints into the landscape as touristic potential.

In general terms the use of the local flora is only restricted to the auto-consumption except for the timber-yielding species and combustible that in great part are sold at low prices in other municipalities. This activity could be profitable in the future if the governmental reforestation programs were respected and adequate handling strategies are developed, which allow to utilize and conserve these resources.

Notwithstanding the immoderate felling of trees for the manufacture of furniture, the timber-yielding trees, such as the oak and the ocote, are an important source of income for the ethnic groups of the cold zone. In the mixed mild forest different species of conifer grow, such as the oyamel, the panacea and the oaks. The low part is characterized by having a tropical rain forest vegetation, which favors the cultivation of sugar cane and rubber. In fact, the utilization of the forest or the silviculture activity is present as an alternative in the region. Its commercial utilization was intensified due to the opening and construction of communication systems and to the introduction of the electricity in the use of sierras and equipment for the exploitation of the forest, with the obligated temporary emigration, in order to sell the artisanal production of rustic furniture, and with the consequent previously mentioned problem.

The area where the project is placed has been a zone gradually affected by land use changes that have modified the dripping and receives the severity of the meteorological changes that have caused certain degradation, which is not compared with the deforestation shown in the air photograph.

In the zone material banks inventoried by the Secretaría de Comunicaciones y Transportes exist and the location of which is shown in illustration 12, in table IV. 56, the nearest ones to the research area are indicated. There are several rural roads that communicate the communities of the zone.

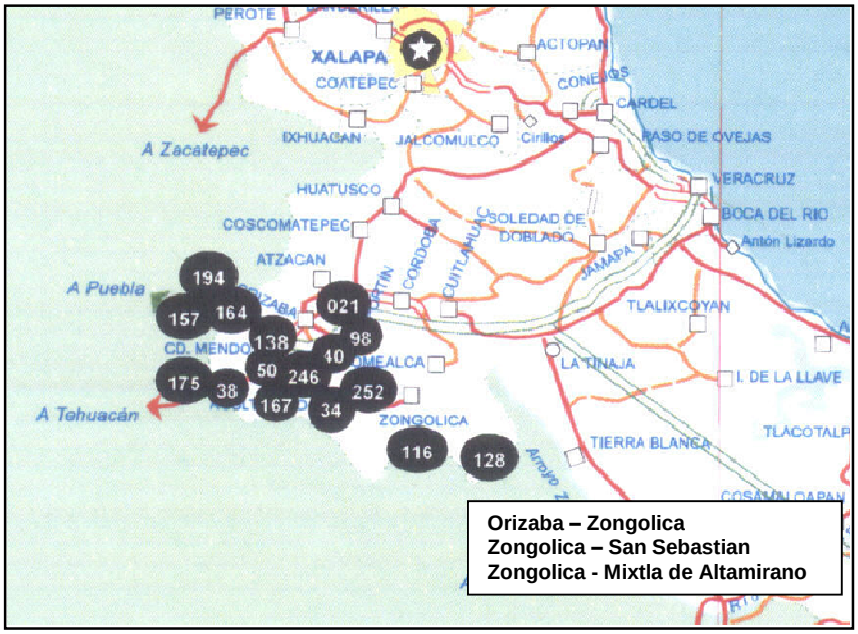
TABLE IV. 56 MATERIAL BANKS IN OPERATION IN THE RESEARCH ZONE

NAME	KM.	DEVIATION	RESEARCH DATE	UPDATING DATE	MATERIAL TYPE	TREATMENT	VOLUME X 1000 m3	THICKNESS FELL TREES (m)	PROBABLE USES	EXPLOSIVES USE	ECONOM ASPEC.
HIGHWAY: ZONGOLICA - SAN SEBASTIAN											
16 Archichipilco	006+500	I 00060	Jun-95	Jul-07	Limestone	Total triturating and sieving	100	0.4	Coating and base	Without restriction	Convenient
HIGHWAY: ORIZABA - ZONGOLICA											
19 Atlanta	024+500	D 00000	May-00	Jul-07	Limestone	Total triturating and sieving	35	1.5	Coating and base	Without restriction	Convenient
191 Tlilapan	004+200	D 00800	Mar-00	Jul-07	Limestone	Total triturating and sieving	150	0	Coating sub-base, base and hydraulic concrete	Without restriction	Convenient
HIGHWAY: ZONGOLICA - MIXTLA DE ALTAMIRANO											
116 San Juan	006+000	I 00000	Jun-00	Jun-07	Conglomerate	Partial triturating and sieving	50	0.5	Coating and base	Does not require	Acceptable

Note: The kind of ownership in the indicated banks is private

Source: Secretaría de Comunicaciones y Transportes Dirección general de planeación Subdirección de Cartografía 2007

DIAGRAM IV.12 MATERIAL BANKS



Source: Secretaría de Comunicaciones y Transportes Dirección general de planeación Subdirección de Cartografía 2007

IV.4 Identification and analysis of the change processes in the regional environmental system.

TABLE IV.57 ANALYSIS OF THE CHANGE PROCESSES IN THE ENVIRONMENTAL SYSTEM

CONCEPT	ANALYSIS IN THE RESEARCH AREA
Natural deterioration	o Land use change of the forestall areas of 14 ha, because the elimination of vegetation is required both in the reservoir zone and in the location areas of the proposed infrastructure in the project . Permanent damages of the works in: o Reservoir (Dam wall and intake work, conduction tunnel entrance portal) o Special structures (Oscillation ditch, tunnel exit portal, superficial conduction line, power house, vent canal and electric substation. o Transmission lines (electric transmission line)

CONCEPT	ANALYSIS IN THE RESEARCH AREA
Life quality	Benefits to the communities because of: o Work opportunities and attraction of economic resources in the nearby communities. The hydroelectric projects have positive impacts in the society, because they contribute to increase the richness of the local communities not only with the maintenance of the premises derived from the construction and the maintenance of the premises, but with the fact that since it is a private investment project, it will provide a local power source that will indirectly benefit with electricity the nearest surroundings. o Water supply. To the communities to be supplied with water as support provided by the project.
Demographic	Increase of the coverage of basic services such as electricity and water are indispensable elements for the subsistence of all living beings, for the social and economic development of all the community.
Productive activities	The project includes the reservoir of the Apatlahuaya river aquaculture activities where this artificial mean is utilized.

It is highlighted that within the project's zone, the perturbation of the environmental scenario is evident because the access roads reflect human short-time activities; the presence of old logs from pines and leafy of a diameter exceeding 30 cm., are an additional evidence of forestall utilization activities in the past. However, also a forest surface is observed with components (soil, vegetation, fauna, temporary currents), that demonstrate its unaltered conservation (without utilization or opening of clearings) which has contributed to maintain the natural conditions and the landscape characteristic of this state region.

IV.5 Construction of future scenarios

The construction of the future scenario depends on the identification of the environmental factors sensible to the preparation, construction and operation activities of the Proyecto Hidroeléctrico Veracruz to be developed, and that include the zones of the dam wall axis and tunnel entrance portal, oscillation ditch and tunnel exit portal, pressure tube, power house, transmission line and substation, within a total area of 24.38 Ha. The following table shows each of the environmental base lines, the subjects of attention that might suffer alterations.

TABLE IV.58 SUBJECTS OF ATTENTION IN THE MODIFICATION OF THE SURROUNDING

PHYSICAL ENVIRONMENT	BIOTIC ENVIRONMENT	SOCIO-ECONOMIC ENVIRONMENT
Atmosphere	Flora	Population
Geomorphology	Fauna	Services
Lands	Landscape	Local economy /regional
Hydrology		

In general, the project's region will invariably have modifications to their current natural conditions, considered of low magnitude, little perceptible because there will be local; However, in the project's property in particular it will result with a modification to its biotic components and on its relief due to the removal of superficial material, including the vegetation and soil horizons.

These changes will become evident during the site preparation and construction of works stages for the operations; the landscape's composition and harmony will be impacted by modifying the structure of the forestall area, the dam up and utilization of a flow, and the construction of the premises, as well as the greater mobilization of trucks and persons that will break the landscape's harmony.

The modifications, however, are of medium magnitude in the arboreal stratum with association of pine-oak because the trees to be eliminated to allow the continuity of the project are few, of small size and within an extension of surface comprised significantly small.

Within this future scenario, factors such as geo-forms will not show a great alteration. The soils might suffer the alteration of their current use and the potential minimized to certain conditions established by the safety and muffling areas inherent to the conduction line.

The development potential of the Proyecto Hidroeléctrico Veracruz analyzed herein, is promising , in case it is developed in a sustainable manner, this possibility, would open new improvement expectations of the employment opportunities and would imply injection in respect to investments as well as the creation of a positive and major dynamism, socio-economic to the region with the utilization of the water resource and conservation of soil.

In the micro-region located west and east from the project there are no ethnic groups that might be affected (negatively). The communities are small and of low population density.

A better handling and care of water is foreseen, and its potential use in fish breeding activities. Therefore, it will be important to regulate the exit flows that do not imply the modification of the natural hydraulic talus or the formation of meanders, considering the percentage of the monthly medium ecologic consumption in respect to the monthly medium consumption of income to the drifting dam, where it is appreciated that such percentage varies from 10% in the months from October to June and in August, up to 36% in July and 27.5 in September. In annual average, this ratio is of 20.6%. These estimations of the ecologic consumptions show that the operation policy proposed in the drifting dam of the Veracruz project leads to that at all times there is a consumption that drips until the dam's downstream, the monthly medium ecologic consumption varies from 10% to 36% of the monthly medium consumption of income to the drifting dam and lastly, that the annual medium ecological consumption represents between 20% and 29% of the annual medium consumption of income to the dam. It this regard it will be important to consider the time

required to achieve the total change of water in the inside, mostly regarding an open water corps, with an approximate water storage capacity of 200,000 m^3. The possibility of a high impact of an aquiculture activity is low on the dam's hydrologic system.

Flora will not be significantly altered, mostly if the project is accompanied with a compensation and forestall recovery proposal, which directly benefits the recovery of habitats for the possible dispersion of avifauna particularly, that due to the works inherent to the construction in the moving of land, vehicles and gas, dusts and noise emissions, might produce.

Due to the Dam's engineering outline in its different divisions, it does not generate strong impacts on the landscape units, and in the future the scenario will tend to improve with the application of the forestall recovery and compensation programs.

The local economic and social scenario will improve for the towns that will see in the development of the project an employment opportunity and utilization of the water resource.