the resistivity is radically different, since it is recorded at 28 to 61 ohm-m, whereas the CFE still maintains it at 1.5 to 4 for "2R".

Another difference is that the CFE detected unit 3R -regarded as alluvium material- towards the southwest (VES 1201-2510) and northeast (VES 1209), which was formed outside the lake. The first case is located 290 m down and goes down the subsoil indefinitely; the resistivity is 5-14 ohm-m, which is similar to Lesser's unit 4. For the second case, it also matches Lesser's unit 3.

At the northeastern zone, the CFE detected an old stratum (3A) to a depth of 300 m and related it to pyroclastic volcanic rocks with a resistivity of 15-40 ohm-s, which would probably match Lesser's unit 4.

As a conclusion, it can be mentioned that;

- A superficial horizon of altered material can be found, with a resistivity of 0.25 to 0.4 ohm-m and a thickness of 15 m in average.
- A second lacustrian clayey layer is found with a thickness ranging from 60 to 80 meters and a resistivity of 0.2 to 0.4 ohm-m and an average thickness of 15 m.
- A second lacustrian clayey layer is found with a thickness ranging from 60 to 80 meters and a resistivity of 0.2 to 1.6 ohm-m that merges to the ends.
- A third alluvium, sandy-clayey layer is found which forms the aquifer, with its resistivity ranging from 1.5 to 5.8 ohm-m, and its thickness has not been defined yet.
- The thickness of the fourth layer, just like the previous one, has not been defined yet: it is composed by more compacted material, with a resistivity ranging from 28 to 61 ohm-m. This unit may have volcanic rocks towards the east.

2.1.5.8 Prominence

The site for the project is located in a zone with a predominant flat prominence, with no important topographic unevenness.

2.1.5.9 Soils

Soils in the Area

In the Mexico Valley basin most of the soils originate from volcanic ashes and recent soils. Lacustrian soils from the Quaternary period are particularly found at the ex-Lake Texcoco area.

The soil found in the ex-Lake Texcoco is grouped according to FAO's classification as *Solonchak gleyico* and related to orthicon *Solonchak*, with a fine texture. On the other hand, in the surroundings of the project, specially in Ecatepec, there is Lithosol along with *haplico* and calcareous *Feozem*; sometimes these soils also appear along with *Vertisol pelico* and *Feozem haplico* with medium texture lithosol.

The *solonchank gleyico* is characterized for having a high salt content, and it has a bluish gray layer in the subsoil where water stagnates. It has a depth of more than 100 cm, and is limited by the phreatic level; it has an average thickness of 39 cm. Horizon

A is known as *Molico* and reacts slightly when in presence of hydrochloric acid, and with a fine texture. Its structure has fine blocks and a moderate development. It presents cracks, with a slight drainage and is in a sodium stage.

Some aspects analyzed by the former Comision del Lago de Texcoco (Texcoco Lake Commission) at the zone are described next.

Table 2-16: Soil Characteristics

SOIL CHARACTERISTICS		A	B	C	D
DEPTH cm		0 to 20	20 to 40	0 to 20	20 to 40
CONDUCTIVITY mmhos-cm		24.1	74.3	54	70
PH		9.5	9.6	10.2	10.2
SATURATION %		72.5	74.3	69.0	70.5
TEXTURE	Sand %	62.28	66.64	55.28	64.56
	Clay %	21.71	18.07	27.15	23.15
	Silt %	10.00	15.28	17.56	12.28
ORGANIC MATTER %		5.6	4.7	6.0	5.5
SOIL TYPE		sandy-clay	sand	sandy-clay	sand

SOURCE: COMISION DEL LAGO DE TEXCOCO, 1980.
Notes: The sections A and B correspond to a classification of Solonchak gléyico and the others C and D to a classification of Solonchak órtico.

On the other hand, the General Direction of Geography from the Budgeting and Programming Secretariat provided the physical and chemical features of the *solonchak gleyico* that was found at the ex-Lake Texcoco (1983) as Table 2-17.

Table 2-17: Physical and Chemical Features of the Soil

SOIL HORIZON		Cámbrico	Argílico	Argílico II	Cámbrico
DEPTH (cm)		0-13	13-31	31-52	52-100
TEXTURE	Clay %	22	36	34	34
	Silt %	10	22	22	26
	Sand %	68	42	44	40
TEXTURE CLASSIFICATION		Sandy Clayey bits	Clayey bits	Clayey bits	Clayey bits
COLOR WHEN DRY		10YR6/1	10YR5/1	10YR5/1	10YR5/1
COLOR WHEN WET		10YR4/1	10YR3/1	10YR3/1	10YR3/1
ELECTRICAL CONDUCTIVITY mmhos-cm		35.8	50.0	40.0	35.0
pH in water 1:1 ratio		10.3	10.7	10.7	10.7
ORGANIC MATTER %		0.1	1.2	1.3	0.5
C.I.C.T. (meq/100 g)		19.0	27.3	25.8	26.0
SATURATION OF BASES %		100	100	100	100
SODIUM (meq/100 g)		10.9	17.7	19.5	18.3
SODIUM SATURATION %		Greater than 40	Greater than 40	Greater than 40	Greater than 40
POTASSIUM (meq/100 g)		8.1	9.6	6.3	7.7
CALCIUM (meq/100 g)		4.7	4.4	5.3	5.9
MAGNESIUM (meq/100 g)		0.2	0.6	0.1	0.3
PHOSPHORUS (PPM)		53.4	35.8	34.3	not available

SOURCE: SPP (Secretaría de Programación y Presupuesto), 1983.

Although soil studies in the composting plant site was not carried out, oral communication with the DGSU personnel and visual observation concluded that the soil type is fairly similar to that in Etapa IV, the closest landfill site.

Borings and soil analysis were carried out by the JICA team in Etapa IV. The results are shown in the following table. The location of borings is indicated in Figure 2-11.

Table 2-18: Soil Characteristics in Etapa IV

Location / Characters	SM-7		SM-8		
	8.0-9.0m	15.0-16.0m	16.0-17.0m	32.0-33.0m	42.0-43.0m
Type of soil (Visual observation)	clay	clay	clay	clay	clay
Specific gravity	2.48	2.632	2.52	2.54	2.54
Unit weight (ton/m^3)	1.13	1.26	1.18	1.18	1.67
Void ratio	4.037	5.139	10.399	6.28	4.837
Degree of Saturation (%)	102.996	97.7	102.1	100	98.6
Water content (%)	167.7	238	421.3	247.7	187.2
Liquid limit (%)	256	158.3	365.3	270	169.4
Plastic limit (%)	126.7	35	175.9	94.7	76.8
Plasticity index (%)	129.3	112.6	189.4	175.3	92.6
Triaxial undrained C (ton/m^2)	0.3	0.2	1.4	0.9	1.1
Angle of internal friction (deg.)	2	9	4	0	11
Simple compression qu (ton/m^2)	0	2.3	2.03	1.73	8.4
Grain size	100F	100F	100F	100F	-
N value	0	0	0	0	0
Consolidation (compression index)	1.456	3.825	6.395	5.033	3.392

Accordingly, it is understood that the soil type of the area is largely clay which is found down to 50 m depth. This clay formation shows significantly high water content. Therefore it is considered that the stratum is soft and compressible.

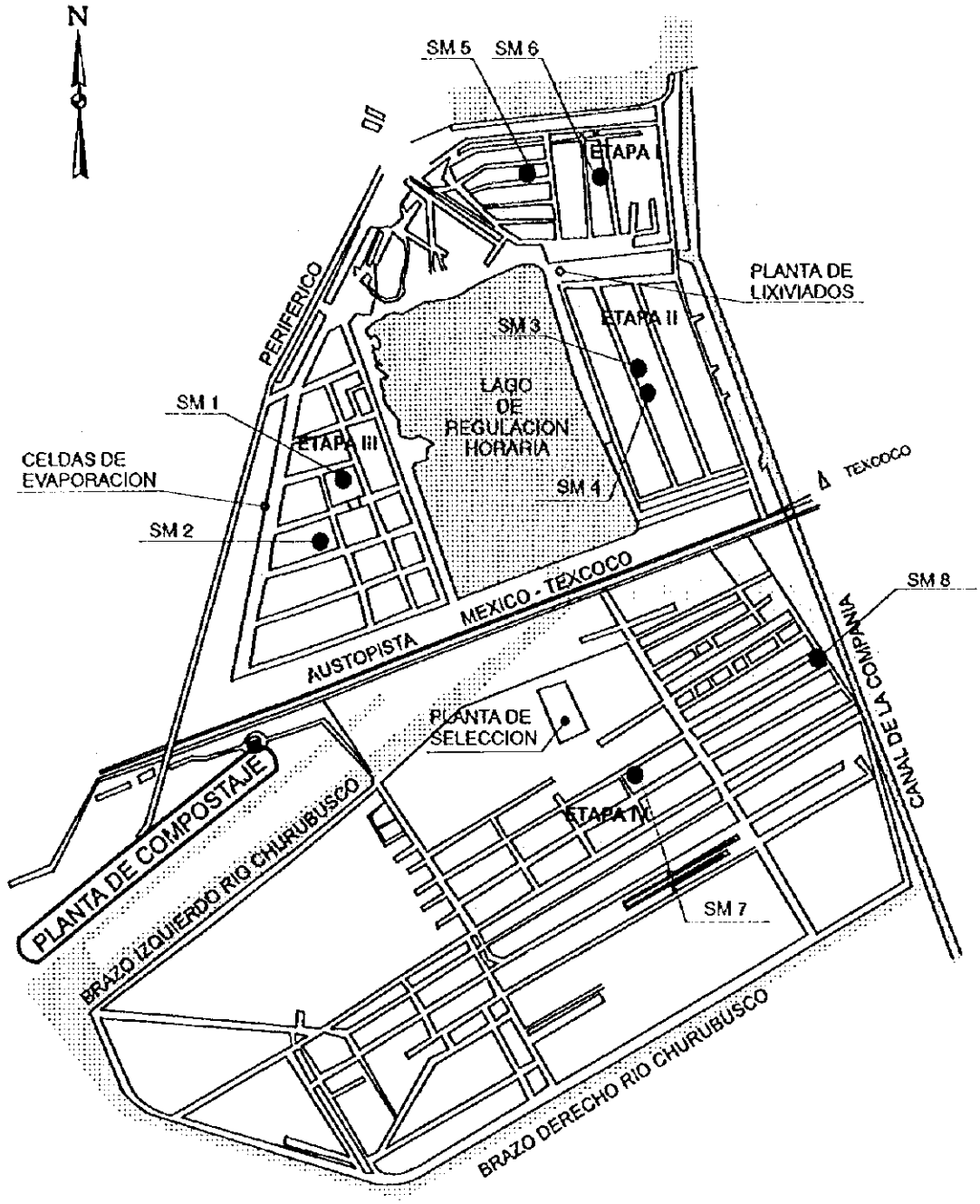


Figure 2-11:
Location of Boring Points

● Core Boring

KOKUSAI KOGYO Co., Ltd.

Soil Quality

Soil samples were taken in the project site of Etapa V landfill during December 1998 and the concentration of some contaminants was analyzed. The results are shown below. The sampling points are just beside the boring points, which is shown in Figure 2-12.

Table 2-19: Results of Sampling Analysis of Surface Soil

Site	CN	Cd	Cu	Pb	Cr(VI)	Hg	As	Total P
SM-1 (mg/kg)	n.d.	n.d.	7.019	27.188	n.d.	0.005	n.d.	139.250
SM-2 (mg/kg)	n.d.	n.d.	12.054	58.881	n.d.	0.001	n.d.	135.180
SM-3 (mg/kg)	n.d.	n.d.	9.053	40.516	n.d.	0.002	n.d.	213.860
SM-4 (mg/kg)	n.d.	n.d.	n.d.	25.462	n.d.	0.001	n.d.	190.490
SM-5 (mg/kg)	n.d.	n.d.	n.d.	28.437	n.d.	0.006	n.d.	376.350
Standard A (mg/kg)	-	9	-	600	-	3	50	-
Standard B (mg/l)	should not be detected		125		0.05		should not be detected	should not be detected*

Notes:
n.d.: not detected.
Standard A: Guide valudes in Japan as threashould to start countermeasures.
Standard B: Environmental standards of Japan to be complied with by any soil expressed as mg per litter of water which is added to the sample soil.
* Only applied to organic phosphorus

The table shows the regulation values used in Japan as a comparison purpose. For the parameters not included in Standard A, Standard B is shown only for reference purpose.

It is concluded from the table that all the values of heavy metals are sufficiently low. As for phosphorus, the measured value is total phosphorus, and it is unlikely that this contains organic phosphorus.

The sampling points are at some distance from the project site. However, the figures in the table will be utilized as reference values for the future investigation at the project site in order to determine the possibility of environmental contamination by the project.

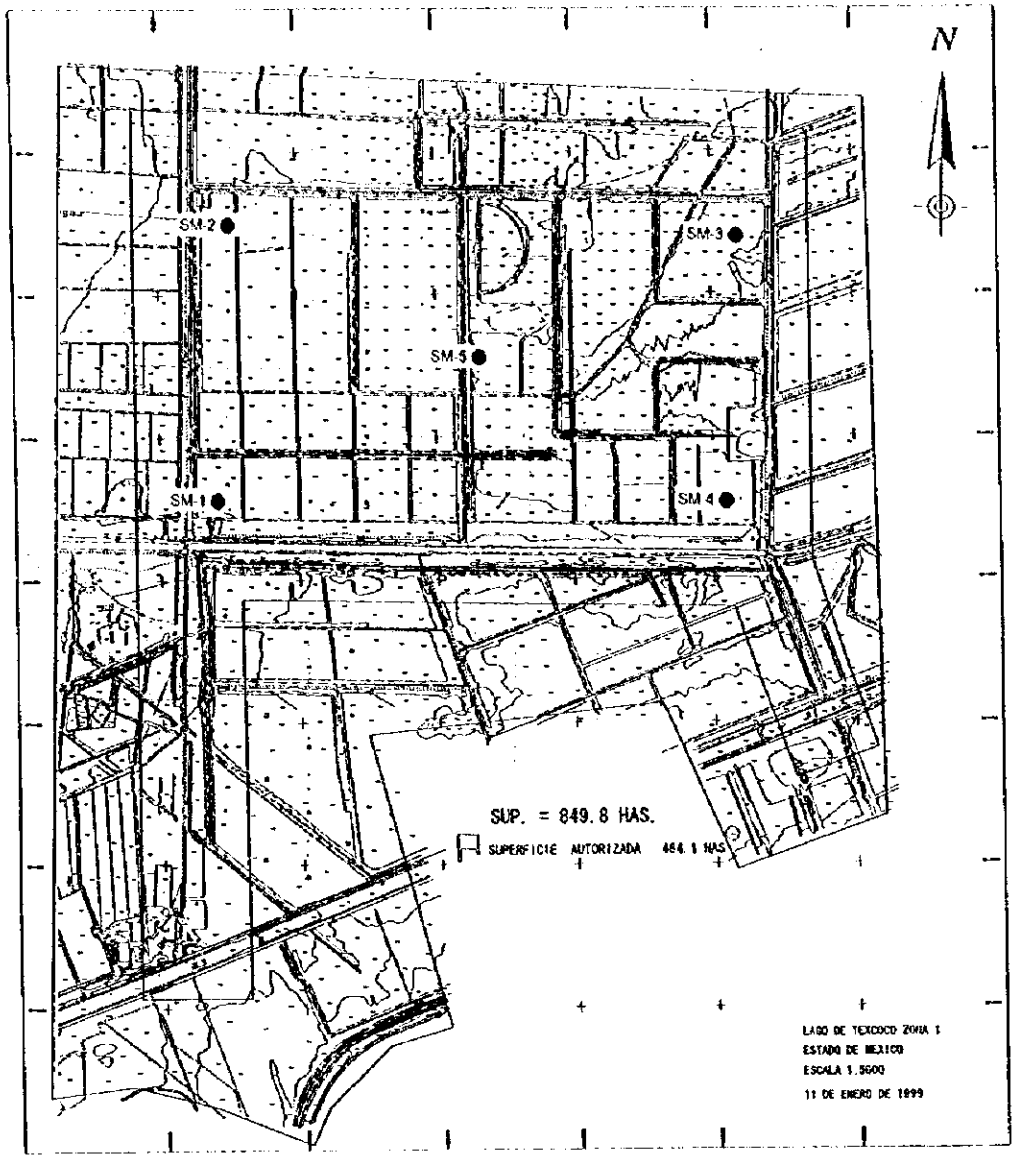


Figure 2-12: Location of Boring in Etapa V

2.1.5.10 Salinity of the Ex-Lake Texcoco

There are diverse theories on the salinity of the ex-Lake Texcoco, being one of them proposed by Aguayo in 1989; he explains that the high salt concentration is due to hydrothermal processes, since the distensible zone was found where were thermal springs such as Pathe, Tecozautla and others in the state of Hidalgo.

However, the most widely accepted theory explains this salt concentration as a consequence of the evaporation of great amounts of water during long drought seasons, or even due to a restricted circulation of water in the area. On the other hand, erosion and carriage of salts from the buried Huatepec volcano, which is northwest of the ex-Lake Texcoco, might have contributed to its salinity, as well as the volcanic zones and gaseous emissions that impregnated the rocks in the subsoil.

The salinity of the ex-Lake Texcoco is as high as two-folds that of the sea, and the Sosa Texcoco pumped up this highly mineralized underground water (brine) with a considerable amount of bicarbonates and sodium chloride to obtain sodium hydroxide (soda).

2.1.5.11 Superficial Hydrology

Rivers and Canals

In general terms, there is considerable variations in the hydrology of Mexico Valley Basin, despite of its reduced area if compared with other basins in the country; i.e. there exists a broad diversity among the streams formed in the basin because of the climatic variations and the geological and orographic features, which cause pronounced slopes of river beds and reduced catchment areas of the sub-basins that integrate them. Due to the aforementioned characteristics, almost all the streams in the valley are torrential and intermittent flows. This is why these rivers have water during the rainy season and are dry in the rest of the year. In spite of the above, they still represent a problem for the zones where they cross through, since their river beds are silted up or obstructed and can not control them adequately. Fortunately, this situation is being solved through hydraulic works.

The ex-Lake Texcoco is located within the "Alto Panuco" hydrological region (No. 26), which is one of the most important regions within the Mexican Republic, both for the volume of its superficial flows -ranged within the biggest five in the country- and for its surface.

It has the following sub-basins: Rio Prieto (26DF), Arroyo Zarco (26DG), Tula river (26DJ), Rio Rosas (26DK), Tlautla river (26DL), El Salto river (26DM), Tepotzotlan (26DO), Texcoco and Zumpango lakes (26DP), Rio Salado (26DQ), Rio Tezontepec (26DT) and Tochac and Tecomulco lakes.

Several rivers flow into the ex-Lake Texcoco area. Although they are called rivers (Ríos), as a matter of fact, it should be more appropriate to call them canals. Their prime role is to serve as open sewerage receiving wastewater from residential areas of the DF and some of the municipalities of the State of Mexico. For this reason, they are found to be a nuisance for residents who are exposed to their unfavorable odor.

Those canals are, from northeast, the Río San Juan Teotihuacán, Río Papalotla, Río Xalapango and Río Coxcacoaco; from east, the Río Texcoco, Río Chanpingo, Río San Bernardino, Río Santa Mónica and Río Coatepec; and from south, the Río San Francisco, Río Churubusco and Río de la Compañía. In terms of the flow volume, Río Churubusco and Río de la Compañía are the main water ingress into the area, with flow volume of 10.0 and 4.2 m^3/sec on average[7], while the total flow volume of the others is merely 0.4 m^3/sec and it could be nearly zero in dry season. The location of rivers is illustrated in Figure 2-13.

[7] Data from Texcoco Project

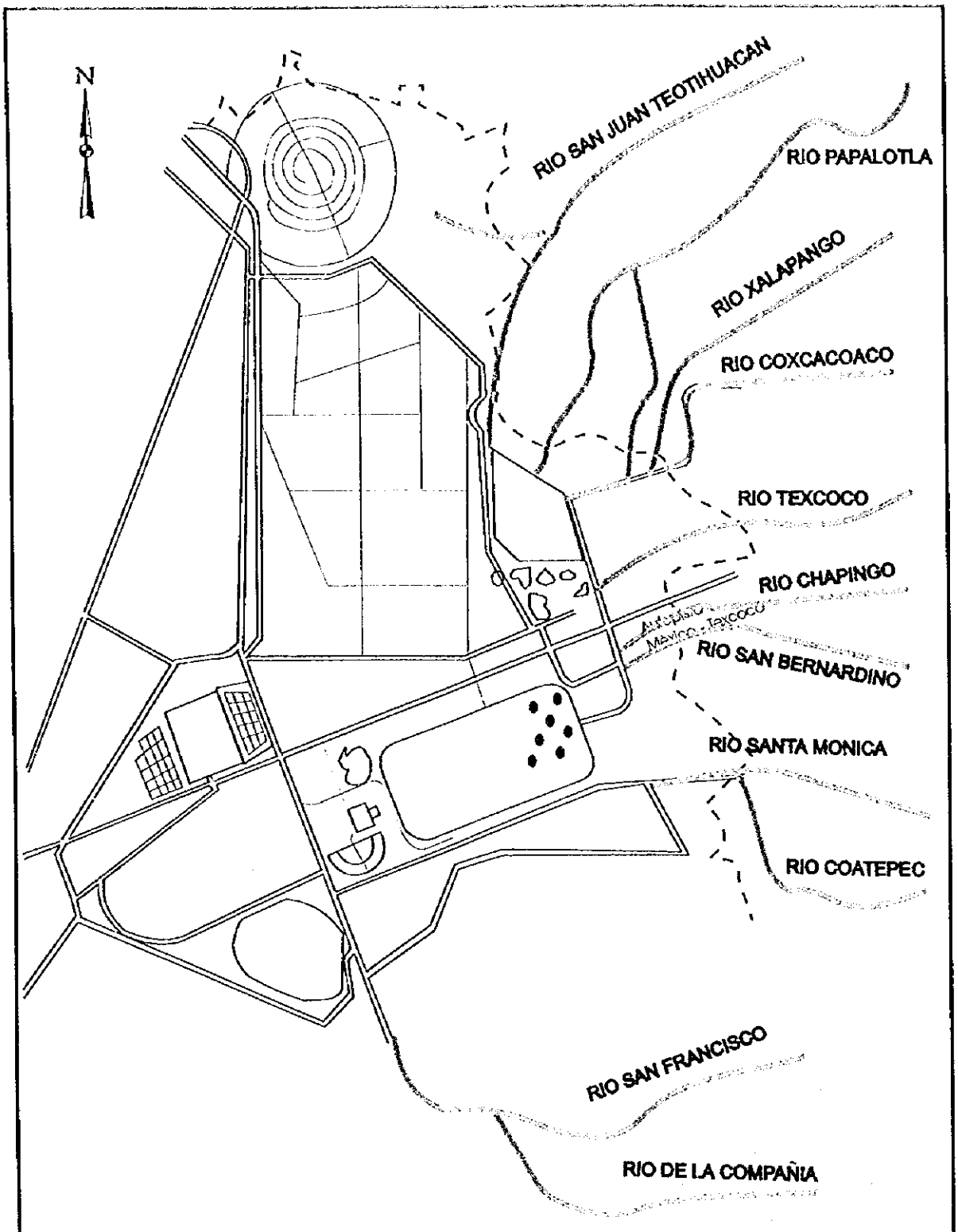


Figure 2-13:
Location of Rivers

Water flown by those canals partly goes to several artificial lakes namely Lago Churubusco, Lago de Regulación Horaria, Lago Xolapango and Lago Nabor Carrillo, and water treatment facilities. The rest of water and some water from those water reservoir flow via canal network within and on the periphery of the ex-Lake Texcoco area. In the canal network, *Brazo Izquierdo Río Churubusco* will be of particular concern since it flows the northwest limit of the composting plant site.

In general, water in the area finally finds its way at canals *Canal de Desagüe* or *Canal de las Sales* both of which flow from south to north on the west edge of the ex-Lake Texcoco area. They join the another large canal *Gran Canal* in the north of the Solar Evaporator (*Caracol*), and the Gran Canal runs towards a lake Lago Zumpango and further north.

Water Bodies

As stated above, there are four major water bodies in the area; Lake Churubusco, Regulation Lake, Lake Xolapango and Lake Nabor Carrillo. All of those are the major accomplishment of the early 80s by the Texcoco Project to control the surface hydrology of the area. Apart from the hydrologic purpose, they are also important in serving as a host of migratory birds during winter.

Lago Nabor Carrillo, with an area of 1,000 ha and a storage capacity of 36 million m^3, stores mainly treated wastewater as well as runoffs of pluvial waters of rivers coming from the east. Water, after collected here, is carried towards the Texcoco lake through a collection canal.

Lago Churubusco, with an area of 267 ha and a capacity of 5 million m^3, was formed by means of the consolidation of clays, originated by the water extraction from the subsoil. It also stores mainly treated water in addition to rainwater from Río Campañía.

The Hourly Regulation Lake (*Lago de Regulacion Horaria*) was constructed within a two-year lapse, excavating 4.5 million m^3 within a surface of 150 ha by means of a suction dredging machine. Crude wastewater flows into this lake together with rainwater from Brazo Derecho Río Churubusco.

These two lakes regulate the overflows from Rio Churubusco, which drains the southern zone of Mexico City's metropolitan area and whose controlled runoffs are incorporated to the Dren General del Valle to be discharged in the Gran Canal de Desagüe.

Lago Xalapango, whose sueface is 240ha and capacity is 3.6m^3, receives residential wastewater and rainwater from rivers coming from the eastern part of ex-Lake Texcoco area.

Surface Water Quality

Water samples were taken from the canals flowing beside the project site of the Etapa V landfill. The table below shows the results, followed by a figure to indicate the sampling sites.

Table 2-20: Results of Sampling Analysis of Surface Water

Site	pH	Cl mg/l	Total P mg/l	Total N mg/l	BOD mg/l	COD mg/l
Site 1	9.33	1,509.00	2.640	n.d.	25.00	398.00
Site 2	8.96	2,386.00	1.050	n.d.	6.20	311.00

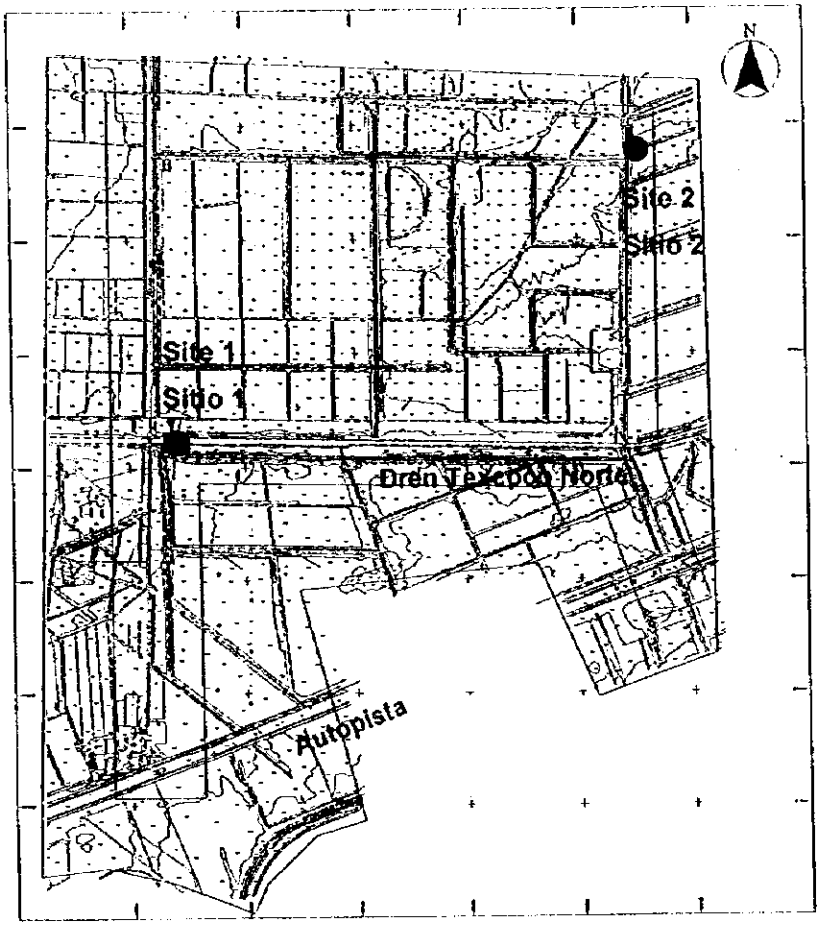


Figure 2-14: Surface Water Sampling Points

The outstanding feature will be the high COD values and large gap between COD and BOD, suggesting the high concentration of organic matter which is resistent to the biological breakdown. Some artificial input of such organic matter along the canal is suspicious, although it is not identified.

The sampling points are at some distance from the project site. However, the figures in the table will be utilized as reference values for the future investigation at the project site in order to determine the possibility of environmental contamination by the project.

2.1.5.12 Underground Hydrology

Lacustrian Deposits

The top section (lacustrian deposits, corresponding to Texcoco Anhydrite) of the hydrogeological system is constituted of an *aquitard* of lacustrian material, formed by clay, silty-sandy layers, volcanic glass and scarce gravel, apparently with diverse compression levels. The stratum has a depth of more than 50m according to the JICA Team's field survey, and 40 to 90m according to Moro company (1992).

This geological formation was classified by Marzal and Mazari (1969) as follows: Top layer, Top Clayey Formation, Hard Layer, Lower Clayey Formation and Deep Deposits. According to additional studies by Murillo (1978), Morales (1991) and Torres (1992), a second hard layer was defined between the Lower Clayey Formation and Deep Deposits. (See section 2.1.5.4)

Geometry of the described layers is semi-horizontal, with a slight slope towards the south. The slope increases considerably at the zone of Sosa Texcoco and approximately 3 km away from the Caracol towards the same direction.

The boundaries of this lacustrian area are the following: towards the east is Cerro Chimalihuache, where lacustrian materials merge; the package merges towards the west at Peñon de los Baños, and towards the north and south of this area no limit has been detected within the study zone, since the lacustrian plain goes beyond this range. Its lower boundary is constituted of the top section of the main aquifer, at a depth of 90 m.

Using the divisions established for top lacustrian sediments, in 1989 Rudolph made an hydrogeological interpretation in which he states that the top and lower clayey formations and deep deposits work as *aquitards* and also boundaries of hard layers, which are regarded as aquifers. He also defined the aquifer in alluvium deposits below these layers.

The hydraulic parameters obtained by Rudolph are shown next:

Table 2-21: Hydraulic Parameters by Rudolph

UNIT	PERMEABILITY K (m/sec)	STORAGE COEFFICIENT (Ss)
Aquitard 1	5.0×10^{-9}	0.05
Aquifer 1	8.0×10^{-5}	0.002
Aquitard 2	5.0×10^{-9}	0.05
Aquifer 2	1.0×10^{-4}	0.001

Source: Rudolph

Figure 2-15 shows the stratigraphic section of the aquifer system of the ex-Lake Texcoco (Rudolph, 1989).

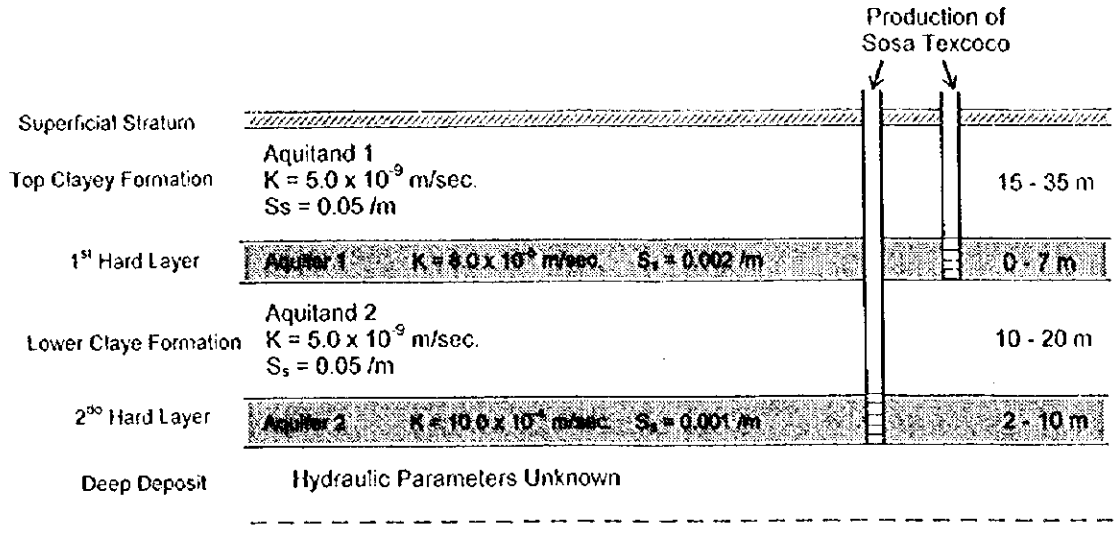


Figure 2-15: Stratigraphic Section of Aquifer System of ex-Lake Texcoco

On the other hand, Zacaula (1977) and Arias (1990) obtained other hydraulic parameters for the same layers, which are shown next.

Table 2-22: Hydraulic Parameters by Zacuala and Arias

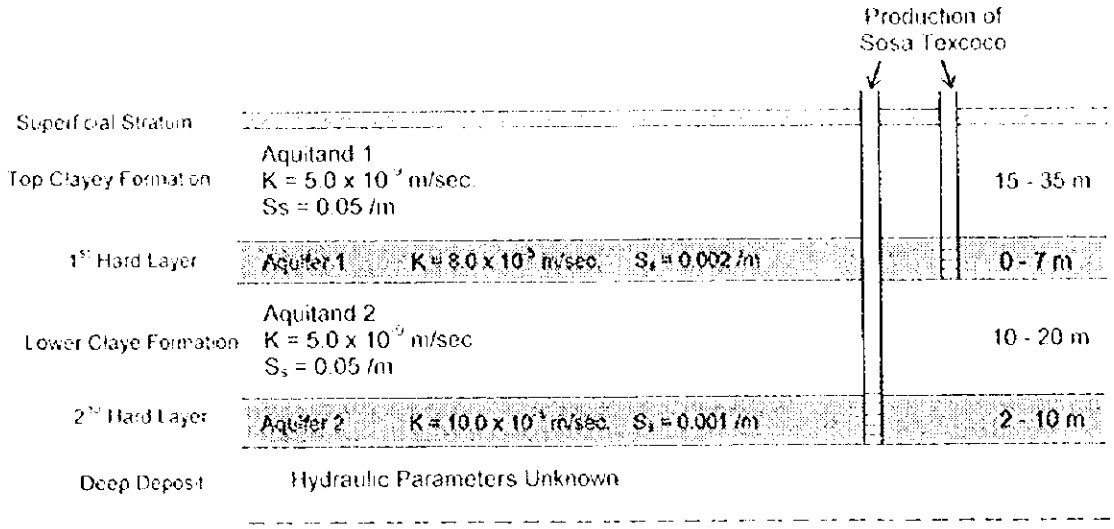
UNIT	PERMEABILITY K (m/sec)	STORAGE COEFFICIENT (Ss)
Aquitard 1	7.0×10^{-9}	0.9
Aquifer 1	8.0×10^{-5}	0.006
Aquitard 2	5.5×10^{-9}	0.8
Aquifer 2	1.0×10^{-4}	0.006

Source: Zacuala and Arias

The values of the different authors are quite similar and, as expected, the permeability figures are higher for the aquifers. The storage coefficient increases at the clayey layers that form *aquitards*.

The water (referred to be "shallow groundwater") in this geological clay formation is so saline that salt making was actively operated in the area. Alkalinity is also high. Rudolph, *et al.* (1989) reported 80,500 ppm and Moro company (1992) reported 90,000 ppm. Because of the high salt content in this shallow groundwater, it is not used for human consumption.

From the hard layers mentioned, Sosa Texcoco extracted brine with a high content of alkaline substances; up to 90,000 ppm of total alkalinity was expressed as sodium carbonate.



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Permeability in Bordo Poniente Landfills

Although permeability is not measured in the project site, that in the Bordo Poniente Landfill Etapas I, II and III will give reference values. The results are as shown below. The location of samples is found in Figure 2-11.

Table 2-23: Permeability in Bordo Poniente Landfills

	Bore Hole Number	Depth (m)	Permeability (cm/sec)
Etapa I	SM-5	14.00 to 17.10	4.45E-05
	SM-5	17.00 to 20.00	2.77E-05
	SM-6	14.00 to 17.00	4.44E-05
	SM-6	17.00 to 20.00	1.37E-05
Etapa II	SM-3	14.00 to 17.00	2.06E-05
	SM-3	17.00 to 20.00	9.85E-06
	SM-4	14.00 to 17.00	2.41E-05
	SM-4	17.00 to 20.10	2.62E-05
Etapa III	SM-1	13.85 to 17.20	3.71E-05
	SM-1	16.85 to 20.00	1.90E-05
	SM-2	14.00 to 17.00	3.19E-05
	SM-2	17.00 to 20.00	1.39E-05

Deep Aquifer

The materials that form this aquifer have an alluvium, volcanic and volcanoclastic origin, and they are constituted of sand, gravel and silt with clayey horizons. These materials are considered to belong to Tarango Formation (Mooser, 1975), which is in turn believed to derive from coalescent alluvium sections and from the volcanic emissions of the surrounding sierra chains.

The unit in this zone has a depth that ranges from 100 to 400 m, being the thickest section at the central zone of the ex-Lake Texcoco federal zone and gradually decreases towards the north of this area -in the area for the development of this project, close to El Caracol-; towards the southeast, it merges with the volcanic materials from Cerro Chimalihuache, to the west and south it extends indefinitely, although it partially merges with the materials derived from Peñon de los Baños.

On the other hand, the northwestern limit is formed by Sierra de Guadalupe and the lower limit is considered to be constituted by tuffs and marls.

Permeability of the materials is considered to have a low to intermediate quality, since there are no permeability tests available to a depth greater than 80 m (DGCOH, 1992).

Regarding the regional flow, studies conducted at the ex-Lake Texcoco have determined that the underground water flow converges in a radial manner towards the central part of the area (Ortega, 1989, DDF, 1990 and Arias, 1990).

On the other hand, Mexico Valley Water Management Office (*Gerencia de Aguas del Valle de Mexico*) made another configuration for the water flow in this aquifer; it can be observed that there is a hydraulic wall with diverging flows in all directions: there is a hydraulic shoal to the east of El Caracol where water flows concentrate; to the west of Cerro Chimalihuache another shoal with flow concentration was detected. The movement heads towards the southwest in this point.

This aquifer extends not only the ex-Lake Texcoco area but also wide part of the Mexico Valley. This is the aquifer from which water has been exploited for years to serve for public and industrial use particularly extensively in the south of Mexico City, although there is now restriction to extract this groundwater due to the land subsidence caused by over exploitation.

The information on wells, that was obtained from several governmental bodies, is shown next.

Table 2-24: Information on Wells from Lake Texcoco Commission

WELL	DEPTH (m)	N.E. (m)	N.D.(m)	METERING DATE
CL-1	200	16.80		1982
		18.90		1983
		20.23		1984
CL-3	200	19.39		1982
		19.61		1983
		20.80		1984
CL-4	200	18.26		1982
		19.18		1983
		20.19		1984

Notes: N.E.: Static level.
N.E.: Dynamic level.

Table 2-25: Information on Wells from Mexico Valley Water Management Office

WELL	DEPTH (m)	N.E. (m)	N.D.(m)	FLOW (lps)	METERING DATE
P-6 bis	200				
P-37	282	27.60	28.30	18.20	1987
VC-1	126				
TXS-3	162	2.30	24.80		1957
CH-3	88				
CH-5	64				
TXN-2	106	12.60	16.60	90.0	1979
TXN-3	162	2.30	24.80	105.0	1979
TXN-4	115.5	11.80	17.40	84.0	1979
VCH-1	115	14.35	20.24	57.9	1979
VCH-2	130	13.50	19.10		
VCH-4	82.5				
SCE-4	207				
GC-1	257				
GC-2	193	2.20	30.15	75.0	1957
GC-3	321	1.95	19.00	80.0	1958
P-11	400	21.0	58.00	148	1985
		22.50			1987
P-12	392	22.11			1987
P-13	400	22.03			1992
		28.00			1992
P-14	402	22.60			1987
		28.00			1992
PP-1	2,065	7.00			1967
		19.70			1983
		21.10			1984
		28.96			1992

PP-3	589	5.96			1967
		19.40			1983
		21.37			1984
		28.05			1992
PA-1	151.95				1985
PA-2	299	6.88			1967
		22.80			1985
PA-3	302.5	7.32			1967
		21.66			1984
PRA-2	200				1988
P-1 bis	404	28.86	40.22		1988
P-1	250	11.60	33.30	140.0	1979
		17.24			1982
		21.55			1984
P-2	250	19.78	40.25	192.0	1982
P-3	250	2.9	42.00		1982

Table 2-26: Information on Wells from Water and Cleaning State Commission

WELL	DEPTH (m)	N.E. (m)	N.D.(m)	FLOW (lps)	METERING DATE
P-305TX			34.40		1992
P-306TX	250		35.80		1992
P-323TX	186	25.00	28.00	120.0	1987
			40.70		1992
P-324TX	175	32.41	37.68		1987
P-326TX	204	22.25	25.60	132.57	1987
			31.50		1992
P-327TX	200	27.60	28.30	182	1987
P-329TX	250	22.61	27.18	159	1987
P-330TX	250	23.89	34.65	152	1987
			35.00		1992
P-334TX	120	37.88	41.11	143.72	1987
			46.60		1992

Figure 2-16 illustrates the location of the wells.

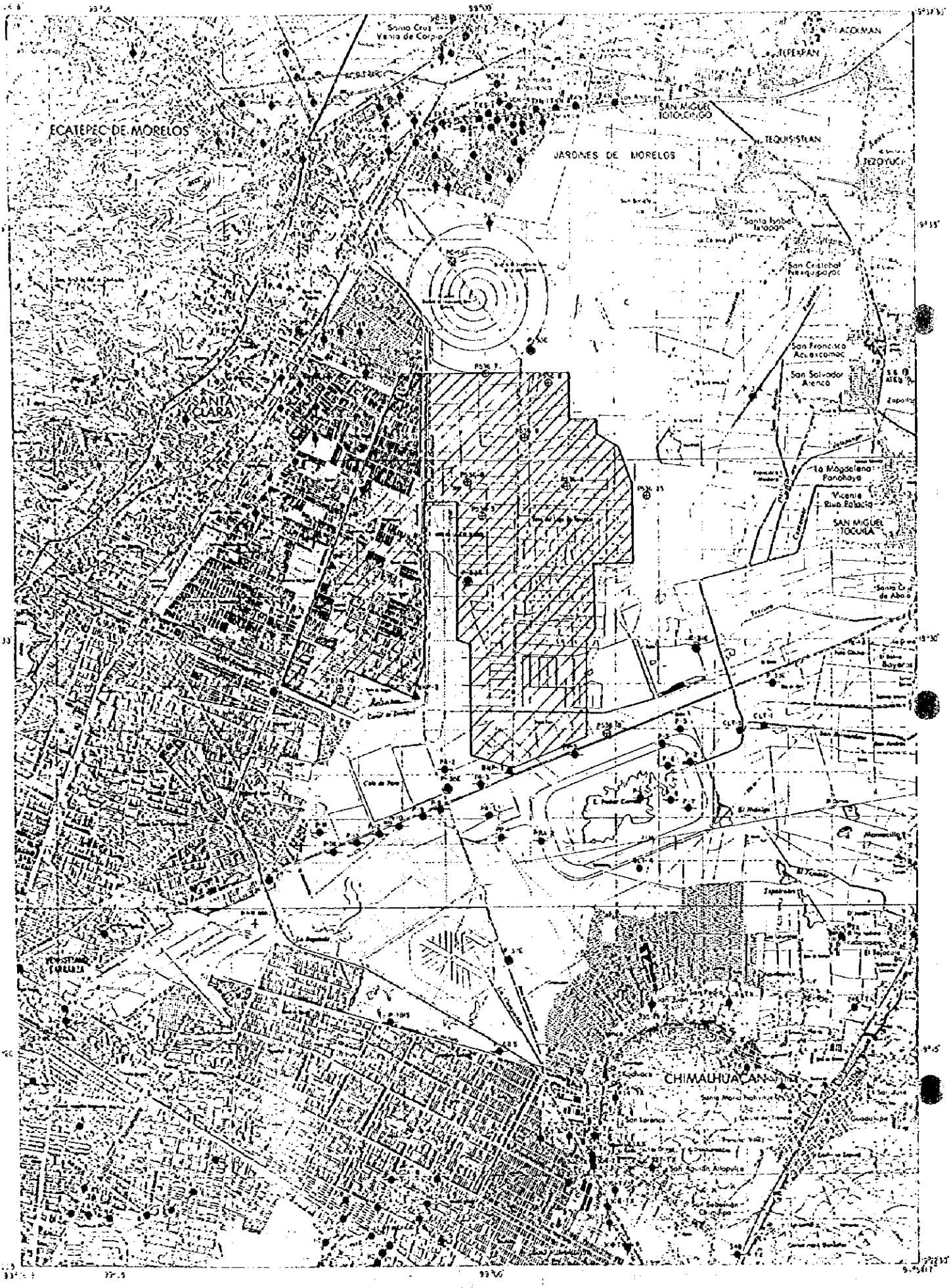

Figure 2-16: Location of the Wells

ESCALA GRAFICA

Quality of Underground Water

Quality of water in the aquifers located in the hard layer that were exploited in the study by Sosa Texcoco has a considerable concentration of alkaline substances of up to 90,000 ppm in total (expressed as sodium carbonate); besides, a salt concentration of 29.5 g/l and 87 g/l of sodium chloride and sodium carbonate respectively.

In 1989, Rudolph obtained the following ion concentrations in the zone.

Table 2-27: Ion Concentrations

PARAMETER	CONCENTRATION mg/l
Chlorides	47,730
Sulfates	30
Sodium	51,840
Magnesium	1.33

On the other hand, the following results were obtained from brine analysis and delivered to Sosa Texcoco laboratory on August 25, 1992.

Table 2-28: Water Analysis

PILOT WELL NO.	TOTAL ALKALINITY (g/100 ml)	CHLORIDES (NaCl) (%)
1	7.50	7.80
2	1.90	2.20
3	0.90	2.10
4	3.65	4.30
5	3.20	3.20
6	3.20	3.20

Further, the quality of groundwater in the project site was conducted by the JICA team at the boring points shown in Figure 2-12. The results are presented in the next table.

Table 2-29: Results of Sampling Analysis of Groundwater

Site and Depth	pH	Cl mg/l	Total P mg/l	Total N (Kjeldhal) mg/l	BOD mg/l	COD mg/l
SM-1						
1.5 m	8.79	10,716.00	38.300	3.50	*	698.40
10 m	9.67	23,046.00	34.950	25.00	196.50	4,531.00
SM-2						
1.5 m	9.13	10,763.00	34.500	8.70	*	737.20
10 m	9.70	33,340.50	6.300	12.20	195.00	1,629.00
SM-3						
3 m	9.57	14,389.00	57.640	3.10	52.00	768.00
10 m	9.52	23,631.00	38.300	24.00	213.00	2,381.00
SM-4						
1.5 m	9.21	12,400.00	41.130	20.00	**	730.00
10 m	9.57	21,993.00	58.110	36.00	88.00	2,381.00

* Below 40 mg/l
** Below 13 mg/l

As seen in the table, all parameters are high and chlorine, nitrogen, BOD and COD are particularly high in the deep part. Decay of large quantity of plants during the drying up process of Lake Texcoco and human intervention are suspected, although they are not identified.

The sampling points are at some distance from the project site. However, the figures in the table will be utilized as reference values for the future investigation at the project site in order to determine the possibility of environmental contamination by the project.

2.1.6 Flora and Fauna

2.1.6.1 Flora

Type of Flora of the Zone

The study area is presented in Figure 2-17; the area is found to be divided physically by a series of dikes built by the CNA in order to regulate the runoff during the event of rains. These dikes have created a physical division of the land into three large zones: the first stands from the north end of the land until the transverse road which is one a line towards the toll gate of the *Autopista*; zone two stands beside the dike that runs in a longitudinal way along the drainage channel to the sanitary landfill Etapa IV; and zone three stands between zone two and the Autopista to Texcoco.

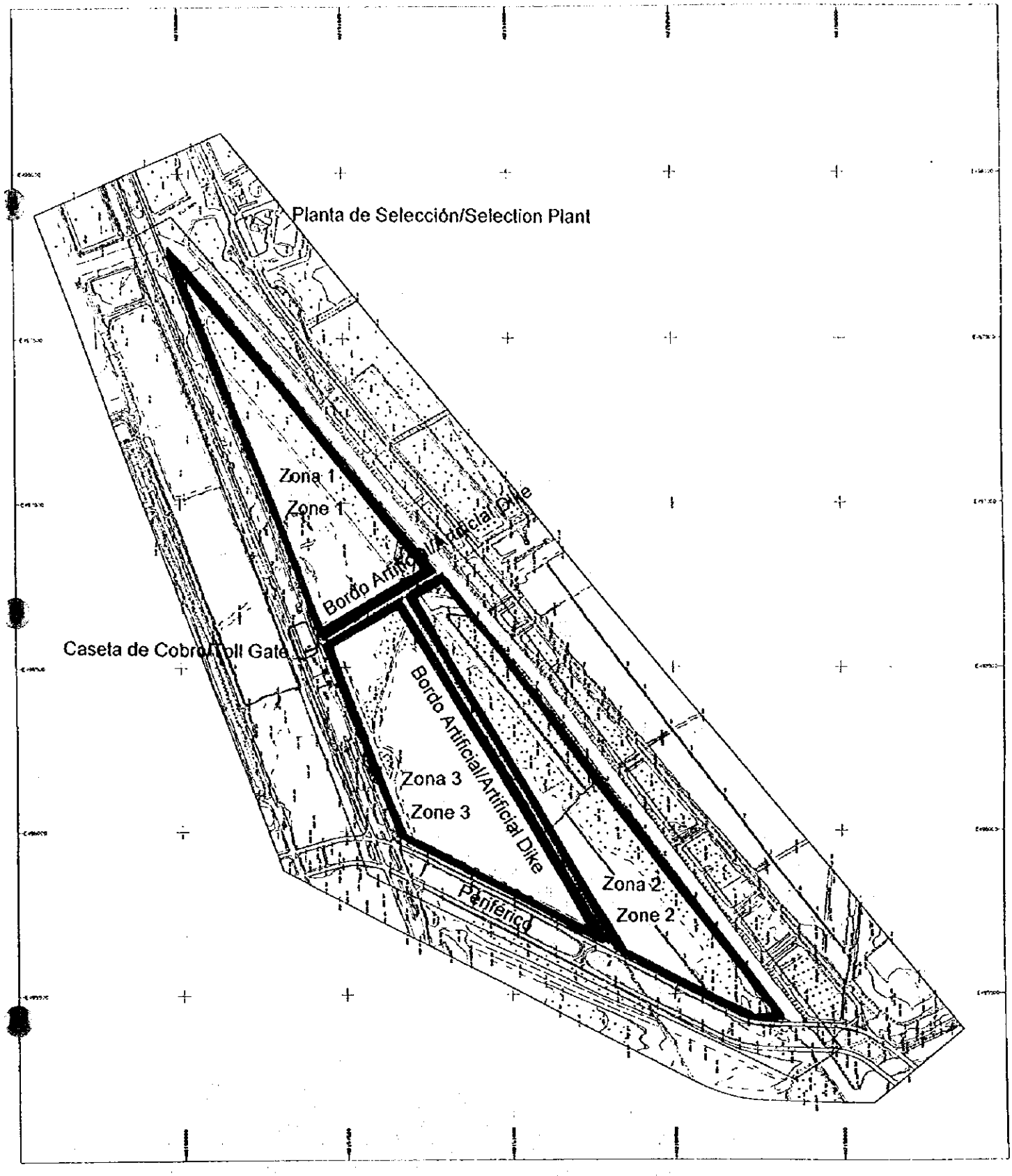

Figure 2-17: Zone of the Fauna and Flora Studies

These three zones can be distinguished by several vegetable communities, some being terrestrial, hydrophilic or aquatic to be found in very wet or deluged lands; in Zone one there can be appreciated a same vegetable cover that maintains a large percentage of protected soil and a minimal part of deluged soil; Zone two is, for the most part, devoid of vegetation since it is considered as a zone subject to flooding; and Zone three was found to be totally deluged with a plenty of water more than 90 cm depth at the moment of field surveys. It should be mentioned that although these divisions in the area exist, the vegetable cover as a whole is maintained uniform presenting vegetation of bush and shrub exclusively.

In this zone there are extreme ecological conditions that limit the establishment of numerous vegetable communities. As a result, it is important to indicate the differences between the indigenous species of the region and those which were introduced to be used as biological indexes for resource management and recovery tasks during a variety of projects. According to the species which are observed, there is a dominance of *Distichlis spicata* (salty hay) in all the area associated with *Argemone tenuifolia, Bouteloua simplex, Cynodon dactylon, Hordeum jubatum* and *Sporobolus pyramidatus.*

In the site surrounding the zones where flood is present, *Distichlis spicata* continues to be dominant but associated with *Echinochloa crusgalli, Chenopodium mexicanum* and *Polygonum sp. Eragrostis obtusifolia* pastures are also found in the area. This specie is present in small hills or mounds, and it is sometimes intermingled with *Distichlis spicata.* However, *Eragrostis obtusifolia* has different habitat than *Distichlis spicata*, i.e., the latter can not resist any type of flooding. Additionally, *Suaeda nigra* can be found in flooded areas which have dried and present high salt concentrations. *Mexican Suaeda* can also be found in similar habitats.

In the deluged zones, there are small communities of rooted and floating aquatic vegetation; as for those of floating, *Eichhornia crassipes, Lemma gibba, Lemma minor, Lemma valdiviana* and *Wolffia columbiana;* and as for those of rooted, *Scirpus lacustris, Scirpus pungens, Typha latifolia, Juncus balticus,* and *Echinochloa crusgalli.*

As product of the different programs of the use of introduced species for the reforestation of the zone, it can be found within property and mainly in the sites of the dikes several exemplary species such as *Casuarina esquisetifolia, Eucalyptus camaldulensis, Fraxinus uhdei, Schinus molle, Populos dawn,* and *Tamarix juniperiana* are found among others.

Based on the foregoing, the result of the photo interpretation and the field tours, the area could be divided into the three zones with frequently found species as mentioned before. They are:

Zone 1. - Vegetation composed mainly with bushy and grassy species of *Distichlis spicata, Eragrostis obtusifolia, Chenopodium mexicanum, Cynodon dactylon, Hordeum jubatum, Echinochloa crusgalli, Chenopodium, mexicanum, Aganippea bellidiflora, Lemma gibba,* and *Eleocharis dombeyana.*

Zone 2. - *Distichlis spicata, Sporobolus pyramidalus, Suaeda nigra, Mexican Suaeda, Polygonum sp, Potamogeton pectinatus,* and *Azolla caroliniana.*

Zone 3. - *Distichlis spicata, Echinochloa crusgalli, Chenopodium mexicanum, Typha latifolia, Juncus balticus,* and *Myriophyllum hipparoides.*

In addition to these:

Artificial Dike. - *Casuarina esquisetifolia, Eucalyptus camaldulensis, Fraxinus uhdei, Schinus molle, Populos alba,* and *Tamarix juniperiana*

Referring to the existing bibliography for the zone of the ex-Lake Texcoco, the following list of flora is presented for the study zone.

Table 2-30: List of the Vegetation in the Study Area

Family and Species	Mexican Common Name	Observation
ARBOREAL (TREE)		
Family Betulaceae		
Alnus acuminata.	Aile	Indigenous
Family Casuarinaceae		
Casuarina esquisetifolia.	Casuarina	Introduced
Family Cupresaceae		
Cupressus lindleyi.	Cedro blanco	Indigenous
Family Myrlaceae		
Eucalyptus camaldulensis.	Eucalipto	Introduced
Family Oleaceae		
Fraxinus udhei.	Fresno	Introduced
Ligustrum japonicum	Trueno	Introduced
Family Salicaceae		
Populus alba.	Chopo	Introduced
Salix bonplandiana.	Sauce	Indigenous
Family Anacardiaceae		
Schinus molle	Pirul	Introduced
Family Taxoidaceae		
Taxodium mucronatum	Ahuehuete	Indigenous
SHRUB		
Family Compositae		
Baccharis glutinosa	Jarilla	Indigenous
Family Loganiaceae		
Buddleia cordata	Tepozán	Indigenous
Family Leguminosae		
Mimosa biuncifera	Uña de gato	Indigenous
Family Solanaceae		
Nicotiana ldalus	Tabaquilla	Introduced
Family Gramineae		
Phragmiles communis	Carrizo	Introduced
HARBACEOUS		
Family Gramineae		
Agrostis semiverticillata		Indigenous
Bouteloua simplex		Indigenous
Cynodon dactylon	pata de gallo	Introduced
Distichlis spicata	pasto salado	Indigenous
Echinochloa crusgalli		Indigenous
Eleusine indica		Introduced
Eragrostis obtusifolia	Zacahuistle	Indigenous
Hordeum jubatum		Indigenous

Leptochloa dubia		Indigenous
Panicum repens		Indigenous
Sporobolus pyramidalus		Introduced
Family Compositae		
Ambrosia peruviana		Indigenous
Aster evilis		Indigenous
Erigeron bonariensis		Indigenous
Galinsoga parviflora	Estrellita	Indigenous
Xanthocephalum humile		Indigenous
Sanvitalia procumbens		Indigenous
Family Papaveraceae		
Argemone mexicana	Chicalote	Indigenous
Argemone tenuifolia		Indigenous
Family Chenopodiaceae		
Chenopodium mexicanum	Quelite	Indigenous
Suaeda nigra	Romerillo	Indigenous
Family Cyperaceae		
Cyperus sculentus		Indigenous
Family Polygonaceae		
Polygonum elongatus	Chilillo	Indigenous
Rumex mexinanus	Lengua de vaca	Indigenous
Setaria geniculta		Indigenous
Family Rananculaceae		
Ranunculus cymbalaria		Introduced
Family Cruciferae		
Raphanus raphanistrum		Indigenous
Family Solanaceae		
Solanum rostrarum	Duraznillo	Indigenous
Family Leguminosae		
Trifolium amabile	Trébol	Indigenous
AQUATICS		
Family Compositae		
Aganippea bellidiflora		Indigenous
Family Pontederlaceae		
Fichornia crassipes		Indigenous
Family Umbellifera		
Hydrocotyle verticillata		Indigenous
Family Onagraseae		
Jusiaea repens		Indigenous
Family Lemnaceae		
Lemna gibba	Lentejilla	Indigenous
Lemna minor	Lentejilla	Indigenous
Lemna valdiviana	Lentejilla	Indigenous
Family Nymphaeaceae		
Nymphaea sp.	Cabeza de negro	Indigenous
Family Cyperaceae		
Cyperus bourgaei	Tule	Indigenous
Scirpus lacustris	Tule	Indigenous
Scirpus pungens	Tule	Indigenous
Family Typhaceae		
Typha latifolia	Tule	Indigenous

Species of Commercial Interest

Taking into account of the record of the area as reference as well as the serious environmental deteriorations that the area has suffered for long time, it can be mentioned that in the area of study there are no species exist with commercial interest that are currently considered to be an advantage; previously the species known as *Spirulina platensis* was marketed, which was utilized to obtain a nutritional complement known as Spirulina of high value. Within property and specifically in the deluged zone (zone 3) this species was not present.

Species of Ecological Interest

The SEMARNAP has established the Mexican Official Norm NOM-059-ECOL-1994, that determines the species and subspecies of land and aquatic wildlife in danger of extinction, threatened, rare and requiring special protection, and that establishes specifications for their protection. Within the study area and pursuant to the accomplished observations endemic species or species in danger of extinction were not observed.

2.1.6.2 Fauna

Characteristic Fauna by Zone

The study zone has an extension of 85 ha which have experienced changes in the natural conditions of the hydraulic resources, vegetation and the landscape because of the land use conditions and the rapid urban growth of the city of Mexico during the last 30 years. Together with these, the modifications has suffered the area by the transition process and has fragmented the lacustrine zone that in ancient time was present into what are seen now as small water bodies separated by artificial dikes. The direct influence resulted into the disappearance of some species of vertebrates and the establishment of others better adapted to the new conditions. Therefore the observations of the vertebrates found and reported in this property are a reflection of the conditions that prevail currently there.

To carry out a better analysis of the observed vertebrates, a general tour all over the zone was proceeded and according to the air photograph it was possible to determine the conditions and to delimit the different zones to accomplish the study and the observations. Those zones are corresponding to those three principal zones that were shown in Figure 2-17.

In these three zones, the presence of vertebrates and invertebrates were observed in different proportions and quantities depending mainly on the conditions of the habitat and opportunities to obtain the food. This is intimately linked to the presence of water bodies and to the diversity of vegetation that give the opportunity for the establishment and permanency of some organizations.

With respect to the invertebrates observed in the field study of the three zones, the presence of *grillos* could be noted (*Gryllodes sp.)*, and the dragonfly or *caballito del diablo* (*Aeschna sp.*), and mosquito (*Culex sp.* or *Hydrometra sp)*. Also in the water bodies and vegetation areas, some species of birds which take aquatic and terrestrial invertebrates were found; and according to the consulted bibliography, the presence of water thumbtack (*Corisella sp)*, and molluscs (such as *Physa sp.*, *Planorbis sp.*, *Limanaea sp.*, and *Helix sp.*) among major species is reported.

In regard to the vertebrates species observed, fowls are found in larger number than others given that the lacustrine conditions still persisting at present have favored numerous species of migrant aquatic fowl that arrive to the area during the autumn migration season (August to November) to spend winter there for 8 to 9 months. The area also is additionally used as a step site by migrant fowls that spend winter in further south part of the country or of the continent (especially in months of August - November and March - May) such as ducks, herons, coots, plovers, swallows and coastal and marine gulls. They come to the sites to stay during the winter or to have a rest on the way of their migration toward their definitive winter sites.

Other large migrant fowls that inhabit on land and also can be observed in all the area are: the common *aura* (*Cathartes aura)*, the common *carroñero* (*Coragyps atratus)*, *aguililla colirrufa* (*Buteo jamaicensis)*, and the *garza ganadera* (*Bubulcus ibis)*. The last one is considered to be migrant in an direction of altitude since it breeds in the coastal zone of the Gulf of Mexico and after the reproduction they are dispersed toward the plains of the heartland during the winter months.

The same does not happen to the amphibians, reptile and mammal because the pressure that has been exercised by the human onto their populations in transforming and altering the habitat of these vertebrates has provoked. Some species will be difficult to be observed every time because they are currently rare or some others have disappeared or migrated to other regions.

Observations of the Vertebrates Accomplished in the Zone 1

This zone is bordered by a federal highway to Texcoco, a channel that leads the black waters of the city and by the artificial dike toward the northeast that separates and divides the whole triangle area into two parts (see Figure 2-17).

It is characterized by a form of vegetation composed basically of different types of grass adapted to saline environments, and plants characteristic of flooding areas can be observed which remain even after the majority of the water has been evaporated or absorbed by soil merely remaining small scattered water pool in the area. All this type of vegetation presents a biotope appropriate for the establishment of invertebrates, some amphibians, reptiles, fowls, and mammals that take advantage the scarce available nutritional resources.

During the field survey accomplished in this zone reptiles or amphibians were not observed although this does not mean that they are totally absent, since by personal communication and according to the bibliographical consultations, the presence of a toad (*Comic sp.*) is reported. With respect to the reptiles, low and aquatic habits for them to live could not be observed, but according to personal communication, some species can be observed in this zone on some occasions such as water snakes *Salvador bairdii* and *Thamnophis sp.* and also viper usually designated as *cincuate* (*Pituophis deppei)*. Also in the parts where the water has been evaporated and dry sand soil is remained, traces of reptile, fowl and small mammal such as field mice that is the basic food of some reptile of the zone can be seen.

The group of vertebrates most representative in the zone is the fowl due to their easy displacement and responses adaptable for some species. They were the most abundant in the studied area of the property and especially in this Zone 1.

Among the most common birds that were observed by having gregarious habits, the swallow *tijereta (Hirundo rustica)* can be pointed out; this specie flies in flock of 50 members in different direction and they trap insects during their flight. Another very common bird was the *tordo cabecicafé (Molotrus ater)* that was observed eating in groups of more than 120 individuals on the dry grass that has a whole slew of seeds. Other three species that prefer this type of habitat because of the availability of seeds and insects are the melodic sparrow *Melospiza melodia*, the sparrow of Lincoln (*Melospiza lincolnii)*, the domestic *carpodaco (Carpodacus mexicanus)* and the dapple-gray sergeant (*Agelaius phoeniceus)* which also use this type of vegetation as refuge. Within the species that have taken advantages of the opportunities of the habitat change by the human action upon introducing species of plants from outside to the zone and due to the drying of the lake, the following fowls were observed: the kestrel hawk *Falco sparverius*, the *tortola colilarga (Columbina Inca)*, the *colibri latirostre (Cynanthus latirostris)*, the tyrant squealer (*Tyrannus vociferans)*, the American *verdugo (Lanio aurantius)*, the *centzontle aliblanco (Mimus polyglottos)*, the *bisbita llanera (Anthus spragueii)*, the Mexican *zanate (Quiscalus mexicanus)*, and the domestic sparrow *(Passer domesticus)*, the last being found only where are found the human constructions.

Within this same zone a water pool is located that is still conserved and is found very nearby the toll gate of the Autopista to Texcoco, but it has very few depth and vegetation, consisting basically of aquatic and grassy plants that sustain in inundation zones.

It could be observed with the visits made to the site that the water is being lost quickly according to the time elapse. In spite of these conditions some fowl still take advantage of the small water pool, as found to the following species: *garza dedos dorados (Casmerodius albus)*, the *garzón cenizo (Ardea herodias)* in the borders of the water body, the obscure ibis (*Plegadis falcinellus)* feeding on the shallow parts of the water body in groups of 10 to 15 individuals, the *pato golondrino (Ells acuta)*, dipper duck (*Ells clypeata)*, and the *cerceta aliazul clara (Ells discors)* resting, and feeding in the water body of more than 30 individuals, the dapple-gray sergeant (*Agelaius phoeniceus)* in groups of more than 60 individuals which rest on tule and other aquatic vegetation near to the water.

The *avoceta piquirrecta (Himantophus mexicanus)* and *chorlito tildio (Charadrius vociferus)* were very common in the water bodies where they can obtain their food; furthermore, they have been reported nestling in the region during the summer when their migrant populations already have returned to the reproduction areas in the United States and Canada. Other fowl that use the shallow water bodies with presence of mud are the *playerito alzacolita (Actitis macularia)*, the *falaropo (Phalaropus tricolor)*, and the *playerito (Calidris minutilla)* that seek their food filtering the mud and the water in search of small invertebrates such as water flea and *artemia* in groups of more than 40 individuals or solitary. The gull (*Larus pipixpan)* and the marine swallow (C *hlidonias niger)* were observed in groups of more than 20 individuals that flying from a water body to the other in search of food.

With respect to the mammals of Zone 1, they were not observed directly but their presence could be detected by the traces of their footprint on the dried sand of the bed of the water bodies. Also through personal communication with the workers of the nearby waste separation plant, reduction in the number of rabbits (*Silvilagus*

floridanus) is known through the observation of some excrete on the dikes, as well as the *tlacuache (Didelphis virginiana).* Besides the presence of bats is reported such as *Myotis lucifugus* and *Myotis velifer* the last being with migrant populations and feeding very abundant insects during the time of rains.

Several species of field mice as *Perognathus flavus, Liomys irroratus, Baiomys taylori, Peromiscus maniculatus, Reithrodontomys megalotis,* and *Microtus mexicanus* are found due to the characteristics of the land and the type of present vegetation toward the artificial dikes where the vegetation is more abundant and the presence of food favors their presence. The presence of the Shrew (*Cryptotis heap)* that is frequently found in the zones of pasture has reported.

The only one carnivorous mammal that still can be observed but every day less frequently (personal communication) is the weasel (*Mustela frenata)* that feeds on small vermin, fowl, lizards and invertebrates but because of the intensive movement of vehicles and people, the weasel is migrating to quieter places.

These same human activities have brought the presence of and the growing increase in the harmful fauna such as the street dogs that in the zone have killed, and eliminated this wildlife to other sites. Equally it could be proven that the study zone is used as refuge of some street dog herds, and the increasingly frequent presence of rat (*Rattus norvegicus)* is found.

Observations of the Vertebrates Accomplished in Zone 2

The zone 2 is found bordered with the black waters channel (Río Churubusco), the peripheral ring road (Periferico), the artificial dike of Zone 3 and the dike that divides the property into two parts (See Figure 2-17).

It is characterized by having a very scarce vegetation of grass adapted to extremely saline conditions, and the presence of water is not observed except for small bodies that are dried quickly. Apparently during the era of all rains this zone is filled thoroughly with water but as time passes, the land loses water and at the end of year water has been evaporated thoroughly. For the conditions that are currently presented and due to the extreme salinity of the earth, the water shortage and to weak presence of soil adequate for the establishment of other type of vegetation, the presence of fauna that could find some type of food is limited in drastic way. In this site, a shortage of vertebrates is clearly noticed, and only some birds were observed which use mainly the artificial dikes where is the most abundant and various vegetation compared to the rest of the zone.

Toward these edges, the following fowls were observed: the *tortolita colilarga (Columbina Inca)* that seeks their small seeds food of the grass that grow in the dike; the tyrant squealer (*Tyrannus vociferans)* which feeds from flying insects, for that purpose the *Tyrannus vociferans* would wait for its prey on top of trees growing along the dike; the *verdugo americano (Lanius ludovicianus),* the *bisbita (Anthus spragueii)* that seeks small insects in the soil. The melodic sparrows and sparrow of Lincoln (*Melospiza melodia, M. Lincolnii),* and the domestic *carpodaco* (*Carpodacus mexicanus)* were the three fowls most common in the areas with bushy vegetation as much on the dike as the borders of the water bodies. The Mexican *zanate* (*Quiscalus mexicanus)* and the dapple-gray *cabecicafé* (*Molthrus ater)* were also other two species very common in all the property since they can be displaced easily from one

to the other side in addition to having gregarious habits. Other fowl that was observed only individually, since they often inhabit in cultivation or pasturage areas, was the *pradero* (*Sturnella magna*).

Observations of the Vertebrates Accomplished in Zone 3

This zone is delimited by the Periferico and the continuation of the Autopista to Texcoco, the artificial dike that divides Zone 2 and Zone 3 and the dike that divides Zones 1 and 2 (See Figure 2-17).

This zone is characterized by the similarity to the characteristics of the water body of Zone 1 with difference in that in this zone, the depth is greater and the water covers the majority of the area. However, as in the previous zone, this also tends to be dried quickly. The vegetation is very similar to Zone 1; additionally, we could observed that this part of the water pool was separated by the dike that delimits the two zones and divides the property almost into two parts; this situation provides the site 2 with a larger water retention capacity, furthermore, a water channel 2 mts. wide crosses this section.

The presence of greater depth and the vegetation presence in that have favored the fowl with more specific habitat requirement such as the coot called *gallareta frentirroja (Gallinula chlrophus)* and the American coot (*Fulica americana)* which were only observed in this site. Besides, there are the following species: *Casmerodius albus* and the *garzón cenizo* (*Ardea herodias)* in the borders of the water body, the duck *altiplanero* (*Ells diazi),* the duck *golondrino* (*Ells acuta)*, the dipper duck, (*Ells clypeata)* and the *cerceta aliazul clara* (*Ells discors)* resting and feeding of the water body in couples of more than 50 individuals and *volando yerito* (*Calidris minutilla)* that seek their food by filtering the mud and the water in search of small invertebrates in groups of more than 40 individuals and other solitaries such as the *playerito alzacolita*. Gulls (*Larus pipixpan)* and marine swallows (*Chlidonias niger*) are found in groups of more than 20 individuals.

A series of present emerging vegetation and other that grow in the borders of the water bodies with plenty of seeds are used by terrestrial fowl as food, of which the melodic sparrow *Melospiza melodia*, the sparrow of Lincoln (*Melospiza lincolnii)*, and the *carpodaco domestico* (*Carpodacus mexicanus)* are found.

Some species which utilize this resources due to the desiccation of the zone and to the increase in the pasture are: the kestrel hawk *Falco sparverius*, that feeds small insects and vermin, the *tortola colilarga* (*Columbina inca)*, the tyrant squealer *Tyrannus vociferans*, the American *verdugo* (*Lanius ludovicianus)*, the *centxontle aliblanco* (*Mimus polyglottos)*, the *bisbita llanera* (*Anthus spragueii)*, and the Mexican *zanate* (*Quiscalus mexicanus)*.

Between the limits of Zones 2 and 3 there is located the dike that travels the property from the east to the west and is composed of tepetate due to its artificial conditions. The land has favored the establishment of a very characteristic type of vegetation with opportunist plants that also create a favorable environment for insects and vertebrates which only can be adapted to these conditions. In this site it was possible to observe the presence of several colonies of the red ant and some mammal such as: the rabbit (*Silvilagus floridanus)*, whose excretes were observed, *Murcielagos* (*Myotis velifer* and *Myotis lucifugus)*, and various species of field mice such as *Perognathus flavus,*

Liomys irroratus, Baiomys taylori, Peromuscus maniculatus, Reithrodontomys megalotis, and *Microtus mexicanus* that are located toward the artificial dikes due to the characteristics of the soil and to the type of present vegetation, the shrew (*Cryptotis heap)* and very possibly the weasel (*Mustela frenata).*

Overall Characteristics

The field survey did not detect any species of amphibians, reptiles and mammals because of the time constraint and the nocturnal habits of some of them. Therefore, bibliography review and personal communication were carried out as supplement and Table 2-31 and Table 2-33 were obtained.

Table 2-31: Taxonomic Structure of the Vertebrates of the Study Area

Taxonomic Group	Observed	Bibliography	Personal Communication	Total
Amphibians	0	1	1	1
Reptiles	0	7	7	7
Fowl	36	25	0	36
Mammals	0	10	13	13
Total	36	43	21	57

It can be said that there exists a greater abundance of species in Zone 1 (32 records), followed by Zone 2 (13 records) and finally Zone 3 (23 records). This is because, in this zone, water and pasture and bushy areas are present which provide conditions and habitat requirements appropriate for the fowls; this situation favors their temporal establishment, taking into account that the most structurally complex habitat lures more species, regardless whether they are resident or migratory organisms. (Rappoleet *et al.* 1993).

Out of the observed species, 23 are migrant fowls and 18 are aquatic. Therefore it can be deduced that the region is being used, due to such presented characteristics, as a winter site and/or a stepping site for most of fowls. Consequently the aquatic habitat is indispensable for their subsistence.

For the amphibians and reptile, the aquatic conditions are also of considerable importance since 4 of the aquatic species that are reported although they could not be observed. They equally require water bodies for their permanency in the area.

As for the mammals, although 13 species are reported for the area and they do not have directly aquatic habits, they indirectly need water bodies since the subsistence of the species of plants and animal which the mammals feed depend on a semi-arid and aquatic media typical in the area.

With relation of the diversity of the vertebrates with respect to the registration in the Mexican Republic and the State of Mexico (Figure 2-18), it is appreciated that in the study area, the group which was most frequently observed is the fowl (36 observed out of 117 registered for the State). This is because these have sustain well the pressure of the human activities and the change of the habitat. Besides they have daytime habits so that it is easy to observe them and the conditions present in the influence area provides sites adapted for their permanency. On the other hand with

respect to the amphibians (1 reported out of 26 registered for the State), reptiles (7 reported out of 44 registered for the State) and mammals (13 reported out of 28 registered for the State), their presence in the area is smaller due to the adverse conditions that are presented for these populations and that some may have nocturnal habits therefore their observation is hindered.

In the study area, the vertebrates observed and reported have aquatic and terrestrial habits. 22 vertebrates are using the present water bodies in the area and 37 require the area not subject to inundation, that are located mainly near the artificial dikes and the vegetation growing on the borders of the water bodies (Figure 2-19 to Figure 2-21).

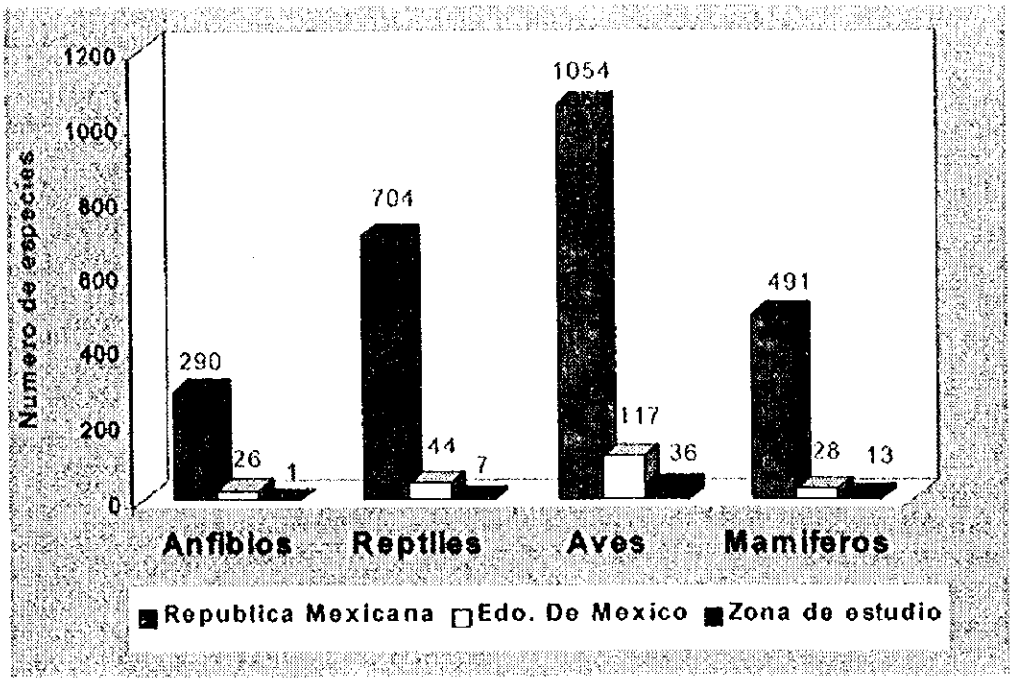

Figure 2-18: Comparison of the Biodiversity of the Vertebrates Recorded in Mexico, State of Mexico and the Study Area

Notes: afibios: amphibians, aves: fowls, maniferos: mammals, Republica Mexicana: Mexican Rpublic, Edo de Mexico: State of Mexico, Zona del:Estudio: Study area, Numero de especies: Number of species.

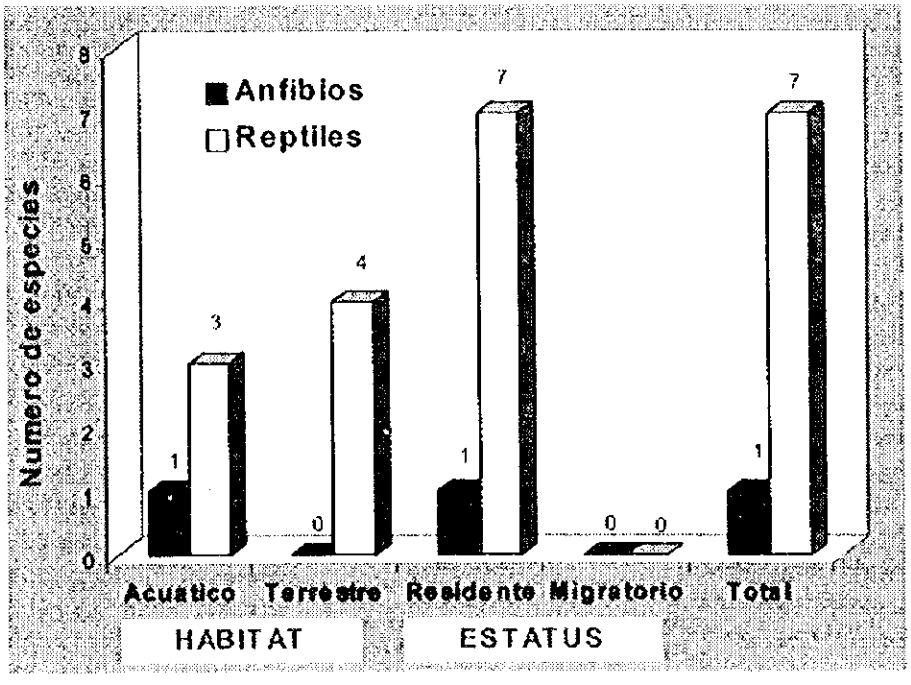

Figure 2-19: Number of Species of Amphibians and Reptiles Reported in the Study Area According to Their Habitat and Status

Notes: Acuatico: Aquatic, Terrestre: Terrestrial, Residente: Resident, Migratorio: Migratory, Estatus: Status

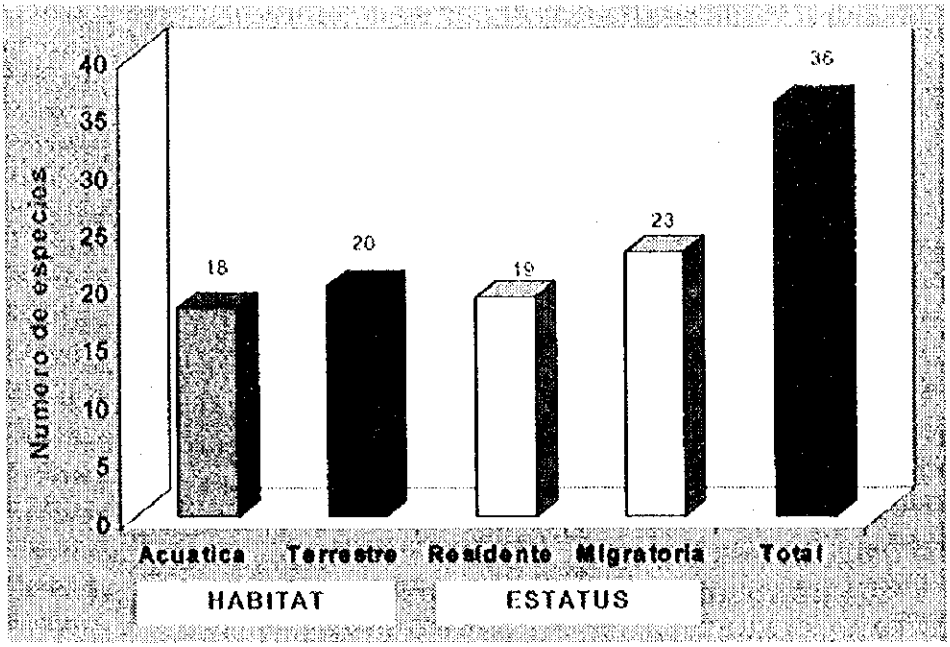

Figure 2-20: Number of Species of Fowl Reported or Observed in the Study Area According to Their Habitat and Status

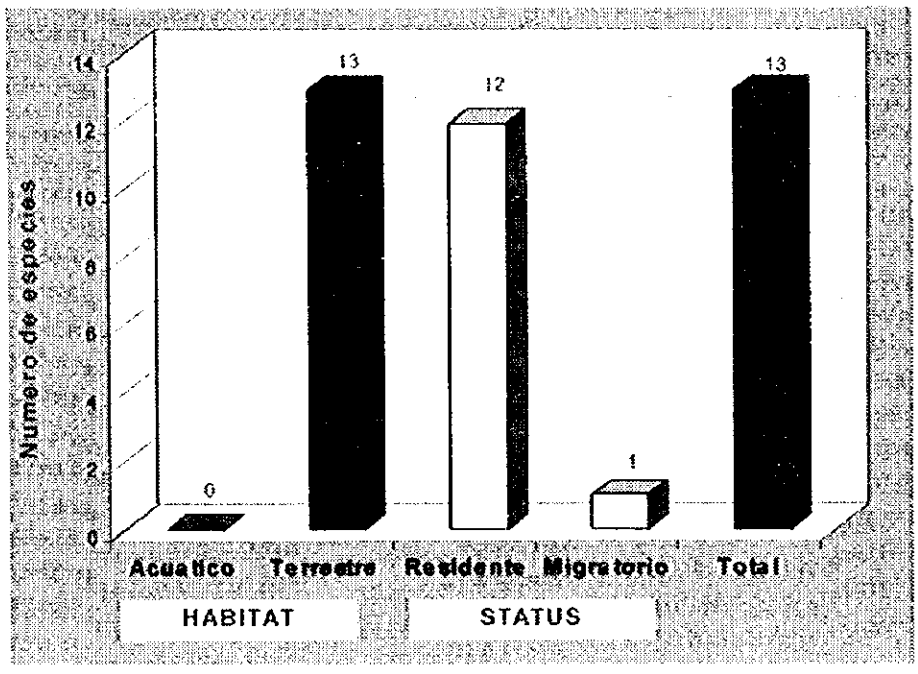

Figure 2-21: Number of Species of Mammals in the Study Area According to Their Habitat and Status

Species of Commercial Interest

Since the establishment of the pre-Hispanic cultures, the fauna in the basin of Mexico has been utilized with a purpose of subsistence constantly. Currently, due to demographic growth and to the transformation of the natural habitat which has suffered the zone of Lake Texcoco, the conditions have changed much and the lake that previously occupied the majority part of the basin has been reduced to small lakes separated by large human establishment.

According to the hunting schedule established for the August season of 1998 to May of 1999, referring to the State of Mexico in which the project is to be located, the site is found in region No. 1 which is part of Texcoco basin and is considered to be an area where hunting is prohibited.

Referring to the commercial utilization of the fauna in the zone, it is not practiced, since currently it is taken care of by the CNA. However, and with agreement to the Schedule of Melodious and Ornamental Fowl Utilization, the Secretariat authorizes a given number of species that will be able to be used for their capture and utilization with a commercial purpose. Equally it establishes the areas preserved for their utilization by an agreement with the State.

In the State of Mexico, the area of the Lake Texcoco is considered as an area not permitted for the capture of melodious and ornamental fowl with a commercial purpose.

Out of the species of fowl observed in the study property and are found in the list of permitted fowl are:

- Dapple-gray sergeant — *Agelaius phoeniceus*
- Mexican Zanate — *Quiscalus mexicanus*
- Dapple-gray cabecicafé — *Molothrus ater*
- Mexican Carpadaco — *Carpodacus mexicanus*
- Domestic sparrow — *Passer domesticus*

Species of Ecological Interest

The study area in which the project is to be located presents a type of fauna that has been adapted to xerófitas and lacustrine conditions that still prevail in the area. However, due to utilization and damages that have been provoked to the natural resources of the area and the country, in general, protection measures of the flower and fauna of the nation have to be implemented. For this reason, as a protection measure of the species, the SEMARNAP established the Mexican Official Norm NOM-059-ECOL-1994, that determines the species and subspeciess of terrestrial and aquatic flora and fauna which are in danger of extinction, threatened, rare and subject to special protection, and establishes specifications for their protection.

Species in Danger of Extinction

A species in danger of extinction is considered to be that whose areas of distribution or population size have been reduced drastically, putting a risk on their biological viability in all their distribution range by multiple factors, such as the destruction or drastic modification in their habitat, severe restriction in their distribution, over exploitation, diseases, and depredation, among others.

In the study area, no species is found that is included in this category.

Threatened Species and Subspecies

Threatened species and subspecies is the one which would turn to be found in danger of extinction if factors continue operating which cause the deterioration or modification of the habitat or reduce their populations. It is understood that threatened species is equivalent to vulnerable species.

In the study are, the following species are reported under this category according to the personal communication.

- Culebra de agua (Water snake) *Thamnophis scaliger*
- Zincuate *Pituophis deppei*
- Ratón (Mouse) *Peromiscus maniculatus*

Rare Species and Subspecies

The rare species and subspecies are those whose populations are biologically viable, but very scarce in natural manner, being able to be restricted to a reduced distribution area, or very specific habitats.

Within this category, the presence of the following is reported according to the personal communication:

- Escorpión (Scorpion) *Guerrhonotus liocephalus*

Species and Subspecies Subject to Special Protection

The species and subspecies to be specially protected are those which are subject to limitations or restrictions of their utilization due to their reduced populations or a restricted geographical distribution, or to the facilitation of their recovery and conservation or the recovery and conservation of associated species.

Within this category, the following species were found in Zones 1, 2 and/or 3:

- Pato golondrino (Duck) *Anas acuta* (Zones 1 and 3)
- Cerceta aliazul clara (Duck) *Anas discors* (Zones 1 and 3)
- Aguililla colirufa *Buteo jamaicencis* (Zones 1, 2 and 3)

Table 2-32: Species Reported or Observed in the Area of Ecological Interest According to the NOM-059-ECOL-1994

	In Danger of Extinction	Threatened	Rare special	Subject to Protection
Amphibians	0	0	0	0
Reptile	0	2	1	0
Fowl	0	0	0	3
Mammal	0	1	0	0
Total	0	3	1	3

Table 2-33: List of Vertebrates in the Project Site for the Composting Plant

FAMILY AND SPECIES	MEXICAN COMMON NAME	RECORD			HABITAT	STATUS
		ZE	CP	BI		
ANFIBIOS						
Family Bufonidae						
Bufo sp.	Sapo		X	X	A	R
REPTILES						
Family Phrynosomatidae						
Sceloporus scalaris	Lagartija		X	X	T	R
Family Anguidae						
Guerrhonotus liocephalus	Escorpión		X	X	T	R
Family Colubridae						
Salvadora bairdii	Culebra listada		X	X	T	R
Thamnophis eques	Culebra de agua		X	X	A	R
Thamnophis scaliger	Culebra de agua		X	X	A	R
Thamnophis melanogaster	Culebra de agua		X	X	A	R
Pituophis deppei	Zincuate		X	X	T	R
AVES						
Family Ardeidae						
Ardea herodias	Garzón cenizo	1, 3		X	A	M
Casmerodius albus	Garzón blanco	1		X	A	M
Bubulcus ibis	Garza ganadera	1, 3		X	T, A	Ma
Family Threskiornithidae						
Plegadis falcinellus	Ibis obscuro	1, 3		X	A	M
Family Anatidae						
Anas diazi	Pato altiplanero	1		X	A	R
Anas acuta	Pato golondrino	1, 3		X	A	M
Anas discors	Cerceta aliazul clara	1, 3		X	A	M
Anas clypeata	Pato cucharón	1, 3		X	A	M
Family Cathartidae						
Cathartes aura	Aura común	1, 2, 3			T	M
Coragyps atratus	Carroñero común	1, 2, 3			T	M
Family Accipitridae						
Buteo jamaicensis	Aguililla colirrufa	1, 2, 3			T	R, M
Family Falconidae						
Falco sparverius	Halcón cernícalo	1, 2			T	M
Family Rallidae						
Gallinula chloropus	Gallareta frentiroja	3			A	R
Fulica americana	Gallareta americana	3		X	A	R, M
Family Charadriidae						
Charadrius vociferus	Chorlito tildío	1, 3		X	A	R, M
Family Scolopacidae						
Actitis macularia	Playerito alzacolita	1, 3		X	A	M
Calidris minutilla	Playerito	1, 3		X	A	M
Family Recurvirostridae						
Himantopus mexicanus	Avoceta piquirrecta	1, 3			A	R, M
Family Phalaropodidae						
Phalaropus tricolor	Faláropo	1		X	A	M
Family Laridae						
Larus pipixpan	Gaviota	1, 3		X	A	M
Chlidonias niger	Golondrina marina	1, 3		X	A	M

Family Columbidae						
Columbina inca	Tórtola colilarga	1, 2		X	T	R
Family Trochilidae						
Cynanthus latirostris	Colibrí latirostre	1			T	R
Family Tyrannidae						
Tyrannus vociferans	Tirano gritón	1, 2		X	T	M
Family Hirundinidae						
Hirundo rustica	Golondrina tijereta	1		X	T	R, M
Family Mimidae						
Mimus polyglottos	Centzontle aliblanco	1			T	R
Family Lanidae						
Lanius ludovicianus	Verdugo americano	1, 2		X	T	R
Family Motacillidae						
Anthus spragueii	Bisbita llanera					
Family Ploceidae						
Passer domesticus	Gorrión doméstico	1		X	T	R
Family Icteridae						
Molothrus ater	Tordo cabecicafé	1, 2, 3			T	R
Quiscalus mexicanus	Zanate mexicano	1, 2, 3		X	T	R
Agelaius phoeniceus	Tordo sargento	1, 3		X	T, A	R
Sturnella magna	Pradero gorjeador	2			T	R
Family Fringillidae						
Melospiza melodia	Gorrión melódico	1, 2, 3		X	T	R
Melospiza lincolnii	Gorrión de Lincoln	1, 2, 3			T	R
Carpodacus mexicanus	Carpodaco doméstico	1, 2, 3		X	T	R
MAMIFEROS						
Family Soricidae						
Cryptotis parva	Musaraña			X	T	R
Family Vespertilionidae						
Myotis velifer	Murciélago		X		T	R, M
Myotis lucifugus	Murciélago		X		T	R
Family Leporidae						
Lepus californicus	Liebre		X	X	T	R
Sylvilagus floridanus	Conejo		X	X	T	R
Family Geomyidae						
Pappogeomys tylorhinus	Tuza		X	X	T	R
Family Heteromyidae						
Perognathus flavus	Ratón espinoso		X	X	T	R
Liomys irroratus	Ratón		X	X	T	
Family Cricetidae						
Baiomys taylori	Ratón de campo		X	X	T	R
Peromyscus maniculatus	Ratón		X	X	T	R
Reithrodontomys megalotis	Ratón de campo		X	X	T	R
Microtus mexicanus	Ratón de campo		X	X	T	R
Family Mustelidae						
Mustela frenata	Comadreja		X		T	R

Notes:

ZE: Observed in the study zone
- 1:Observed in Zone 1
- 2: Observed in Zone 2
- 3: Observed in Zone 3 STATUS

CP: Personal communication
Reptile B1: FLOWERS-VILLELA, O.1993
Fowl B1: WILSON,R.G and H. Ceballos-Lascurain. 1986
Mammal B1:RAMIREZ - POLISHED, Jr.I.Wilchis, C. Mudespacher and I. Lira.1982
HABITAT

A: Aquatic
T: Terrestrial
STATUS
R: Resident
M: Migratory
Ma: Migratory of altitude

2.2 Socioeconomic Environment

This section is developed from two points of view; on one hand it is considered that the Bordo Poniente Etapa V shall receive the wastes that are generated in the DF and some municipalities of the State of Mexico. Therefore, the operation of this landfill should give benefits to the population that inhabits in this area. In this connection, the first part of this section will take a look at socioeconomic aspects of the DF and involved municipalities.

On the other hand, a characterization of the social and economic environment of the adjacent area to be possibly affected by the development of the project is carried out. Therefore, the information of the municipalities of Nezahualcoyotl and Ecatepec was presented to achieve a proper evaluation of the project.

The methodology that was followed is as below:

Documentational Investigation

- Gathering and reviewing the information of the socioeconomic aspects of the DF and of the adjacent municipalities to the area where the project is to be implemented.
- Analyzing and systematizing the material.

Field Investigation

- Travel to the colonies near to the project to define the work scope and to define how many and which human *settlements* will be subject to the investigation. This activity was done in the municipality of Ecatepec.
- Travel to the *colonia* Ampliación del Lago, and municipality of Nezahualcoyotl to verify socioeconomic aspects, and to detect possible impacts on the population living near to the project.
- Use of the theory of the sampling, which will define such as population group that contains the same physical and social characteristics theoretically, and it was decided to carry out a sampling for clusters or municipalities.
- The survey followed a technique that uses gathered information on the population group through a tool of the application of a questionnaire containing questions directed to know the socioeconomic aspects and the social problems; the type of questions was classified both in closed and open questions.

Statistical Work

The analysis of the work was conducted with the obtained information from documents and field following the methodology as below:

- Statistical technique.
- Analysis and interpretation of data.

The systematic structure of the indicators was organized and they gave coherence to the positions of the interviews, allowing to take the control and the pursuit of the investigation, taking into account the following variables: Population, education, health, characteristic economic, housing, and type of development of the surroundings.

2.2.1 Socioeconomic Environment in the Beneficiaries Area

2.2.1.1 Population

Retrospective of the Population

During the first three decades of this century, the development of the capital was embraced within the boundaries of Mexico City's downtown, which at that time was constituted of wards. However, starting from the 1940s, the urbanization phenomenon began to integrate the neighboring political-administrative units with which the most important metropolitan area of the country has been formed.

In 1940, with a force of the urbanization, the following units were incorporated to the Central City: the delegations Azcapotzalco, Gustavo A. Madero, Alvaro Obregon, Magdalena Contreras, Coyoacan and Iztacalco. Later on the delegation Iztapalapa was added, and by 1950 the metropolitan development crossed a north limit of the DF when urban stretch grew over the municipality of Tlalnepantla in the State of Mexico. Little by little, in their physical expansion, the City has been absorbing the entire surface of the DF and 21 municipalities of the State of Mexico.

The urban area occupied approximately a surface of 650 km^2 in 1970, and it included the municipalities of the State of Mexico: Naucalpan, Tlalnepantla, Atizapan de Zaragoza, Ecatepec, Nezahualcoyotl, Chimalhuacan, Huixquilucan and La Paz.

For 1980, the total surface of the metropolitan area became to be 1,114.96 km^2, that is 71.5% more than that of 1970, implying the expansion and the incorporation of eight municipalities of the State of Mexico. During 1990, the expansion of the urban stretch already includes 21 municipalities of the State of Mexico.

Total Population

The Metropolitan Area of Mexico City, constitutes one of the cities nowadays most populated at international level. From the 1960s, it has kept extending to surpass the limit of the DF and to integrate the municipalities of the State of Mexico into its territory.

According to the last Census of Population (1990) and considering the rate of population growth defined by the DGSU of the Government of the DF for each delegation, the population estimated in the DF is as follows.

Table 2-34: Population Forecast in the DF

Delegation	1995 *	1999 (Estimated)	2010 (Estimated)
Alvaro Obregón	676,930	694,999	731,600
Azcapotzalco	455,131	441,387	455,100
Benito Juárez	369,956	378,461	390,200
Coyoacán	653,489	709,428	755,100
Cuajimalpa	136,873	152,452	184,500
Cuauhtémoc	540,382	541,550	561,400
Gustavo A. Madero	1,256,913	1,217,056	1,234,300
Iztacalco	418,982	414,296	431,800
Iztapalapa	1,696,609	1,735,510	1,867,100
M. Contreras	211,898	227,169	244,600
Miguel Hidalgo	364,398	369,703	383,300
Milpa Alta	81,102	77,990	91,200
Tláhuac	255,891	271,803	326,600
Tlalpan	552,516	612,535	684,000
V. Carranza	485,623	473,694	488,900
Xochimilco	332,314	335,868	375,900
Total in DF	8,489,007	8,653,901	9,205,600

* Annual Statistics of the DF

Population Growth

The total growth of the population of Mexico City is composed of two factors: the natural growth and the growth for migration or social growth.

The first factor in Mexico City had a similar behavior to the one observed in the whole country: it stayed near the very high levels of 3% yearly. It was not until the second half of the seventies when, with the support of family planning policy, an abrupt drop of the birthrate began to be observed; this fact is reflected in smaller growth rates of the population in the capital city.

This decrease is most notable in the delegations of the DF than in the metropolitan municipalities of the State of Mexico, since in the latter the population's rural component is highest and an effect is observed very slowly in the decrease of the births. The rates of smaller natural growth are observed in the delegations that form downtown and in Milpa Alta, the farthest delegation where very high rate of mortality is observed.

The growth due to migration will be discussed in the next section.

The behaviors of the growth rates in the delegations and municipalities of the Metropolitan Area of Mexico City, in the last 30 years, has marked an opposed tendency because while in the former the rates diminishes notably down to 0.00 in the last decade, in the latter it is observed, in general terms, an marked increase of the urban-rural migration.

It is not possible to imagine a demographic growth without considering parallel processes of territorial expansion and intra-urban development. The physical expansion of the City has happened in all directions but mainly toward the North and East, in the area where the place of the project is located, because the topographical conditions of this area offer bigger advantages for the urbanization. The Sierra of the

Cruzes al Oeste in the West and that of *Ajusco* in the South constitute mountainous barriers that limit the basin and it is difficult to endow the urban infrastructure. During the first three decades the development of the capital stayed within the limit of the city center, which at that time was constituted of wards. However, starting from the 1940s, the urbanization phenomenon begins to involve neighboring political-administrative units with which the most important metropolis of the country was formed.

Population Distribution

In the Metropolitan Area of Mexico City, the female population is slightly over the male population, (for the year of 1995 in the DF 4,413,105 women and 4,075,902 men). As for the distribution for age groups, a younger group (25 years old or below) has a bigger proportion.

As for population density, Table 2-35 shows the current data in delegations in 1990. Estimated population density in the DF is 56 person/ha in 1997.

Table 2-35: Population Density in the DF

Delegation	Area (ha)	1990		1997	
		Population (persons)	Population Density (persons/ha)	Population (persons)	Population Density (persons/ha)
Alvaro Obregon	8,586	642,753	74.86	688,923	80.24
Azcapotzalco	3,451	474,688	137.55	439,188	127.26
Benito Juarez	2,750	407,811	148.29	376,576	136.94
Coyoacan	5,540	640,066	115.54	703,086	126.91
Cuajimalpa	7,700	119,669	15.54	147,340	19.14
Cuauhtemoc	3,309	595,960	180.10	538,315	162.68
Gustavo A.Madero	8,700	1,268,068	145.75	1,214,625	139.61
Iztacalco	2,306	448,322	194.42	414,048	179.55
Iztapalapa	11,940	1,490,499	124.83	1,717,259	143.82
M.Contreras	7,004	195,041	27.85	221,463	31.62
Miguel Hidalgo	4,764	406,868	85.40	367,495	77.14
Milpa Alta	27,820	63,654	2.29	75,866	2.73
Tlahuac	9,300	206,700	22.23	264,349	28.42
Tlalpan	31,200	484,866	15.54	600,703	19.25
V.Carranza	3,442	519,628	150.97	471,241	136.91
Xochimilco	12,740	271,151	21.28	326,658	25.64
DF Total	150,552	8,235,744	54.70	8,567,135	56.90

Population Immigration

The growth due to population ingress (immigrants minus emigrants) experienced in Mexico City has a decisive importance, because its direct impact on the total growth is considered around 35% for the last 30 years. The capital of the Mexican Republic has been the favorite place for immigrants in the country, both from rural as well as from urban zones. The concentration of economic, cultural and political activities generated and spurred the attraction of Mexico City until recent years, when costs - mainly ecological ones- and the deterioration of life quality brought by the excessive crowd became evident.

The regions of the population inflow origin are located mainly in the center of the country: State of Mexico, Tlaxcala, Hidalgo, Puebla and Morelos, the Bajío Guanajuato and Michoacán, the State of Veracruz and the State of Oaxaca.

This large immigration process also takes place at the surrounding municipalities, with population coming from the DF or other states -the former constitutes the inter-metropolitan flow- and represents almost half of total immigration in the zone.

The main factor that stimulates the population movement is the pursuit of employment opportunities and the improvement of the level of life. For this reason, immigration not only comes from the vicinity with other States, but from the loss of better life expectations at their place of origin. The latter is based on the fact that 84.3% of the immigrant population came from 34 areas with smaller wages; 35.8% had been born in areas of subsistence agriculture, in 13.1% in areas of commercial agriculture. As for the urbanization degree, 16.4% came from areas with certain urbanization degree while 8.1% in areas with an important urban structure.

It is important to highlight that the flows coming from urban nuclei had been declined in terms of importance year by year, while those originated in rural areas have been increasing.

2.2.1.2 Urban Infrastructure and Public Services

Road Network

The main road system of the city at the moment is constituted with two concentric rings, radial roads and a series of traverse axes that form a grid (the axes roads), besides other important roads.

The concentric rings is *Periférico*, with 78.5 km of planned total longitude. The other ring is the interior circuit *Circuito Interior* with a planned total longitude of 34.5 km The radial roads are: Río San Joaquín, Calzada Ignacio Zaragoza and Avenida Aquiles Serdan.

The axes roads constitutes blanches of communication network from North to South and from East to West that has allowed the population to communicate throughout of the City. Among other roads, they are mainly: viaduct Miguel Alemán, Calzada de Tlalpan, Avenidas Insurgentes, Paseo de la Reforma, Avenida de los Constituyentes, Calzada de los Misterios, Avenidas División del Norte and University.

Transport

The system of transport of the Metropolitan Area of Mexico City is integrated with the private system, massive public system and those on hiring bases.

Table 2-36: Transport System by Ownership Types

Private Transport	Transport on Hire	Public Transport
Particular automobile Particular truck Motorcycle Bicycle	Collective taxi Free taxi	Subway Urban bus Suburban bus School bus Trolley bus Tram

Air Communication

Mexico City has the Benito Juarez international airport where commercial flights of passengers and freight are received. It is located approximately 9.5 km away from the place of the project.

Terrestrial Communication

The Metropolitan area enjoys access to the interior states of the country through the highway system, where the main routes of the country depart. It also has a railroad station that receives load transport and affluence of passengers coming from the whole country.

Systems of Communication

The Metropolitan Area of Mexico City has a modern system of communications, including the telephone network, newspapers, Mexican Postal Service, television and radio, cinema, printed media and communication via satellites.

Especially, Mexico City centralizes and distributes a bulk of various, persistent and oneway information toward the interior of the Republic.

2.2.1.3 Educational Services

The Metropolitan Area of the Valley of Mexico constitutes the most important educational area of the country, although the profile of ages of their inhabitants shows a smaller population proportion in age of studying than in the rest of the country. This is the reason behind the high demographic concentration in the region, with 17% of the national total of elementary students and teachers concentrated within this zone.

Mexico City has educational infrastructure in all the levels from the pre-school up to university. It has public educational services provided in all the levels.

In the public or private universities as well as in the National Polytechnic Institute, multiple technical and social careers as well as graduate degree programs can be obtained.

Table 2-37 shows the number of pupils that registered in the different educational levels, teachers, schools and classrooms in the DF for the 1995-96 period.

Table 2-37: The Number of Pupils Registered, Teachers, Number of Schools and Classrooms in the DF (1995-96)

Educational level	Pupils registered	Teacher staff	Schools	Classrooms
1. Preschool	307,808	12,026	2,513	11,865
2. Primary level	1,105,368	39,421	3,336	41,945
3. Training for work	183,269	4,710	594	3,447
4. Secondary	522,634	34,582	1,279	13,247
5. Intermediate Professional	62,030	6,481	151	1,944
6. High school	325,103	21,697	506	8,820
Total DF	2,506,212	118,917	8,379	81,268

Source: Prepared by the Study Team, based on INEGI's "Anuario Estadistico del Distrito Federal", year 1997.

2.2.1.4 Healthcare System

The institutions that assist the public health in Mexico and provide the services of social security are basically categorized in three forms of services: (i) government, represented by the Secretariat of Health and the Medical Services of the GDF; (ii) the institutions of social security, integrated basically by the Mexican Institute of the Public Health (IMSS) and the Institute of Security and Social Services for the Workers of the State (ISSSTE) and the services offered by Mexican Petroleums (PEMEX), National Railway of Mexico, The Secretary of the National Defense and the Secretary of Marine; (iii) and finally, the private sector.

The approaches to classify those units by level of attention to health vary according to the institutions. In general terms, however, it is considered as first level when the unit grants external consultation exclusively; second level when in addition to the consultation it offers the four basic services of hospitalization (i.e. internal medicine, pediatrics, surgery, gynecology and obstetrics); and third level when any above-mentioned service of specialized hospitalization is given with investigation facilities.

The medical services offered by the institutions of social security in Mexico have increased their coverage gradually: in 1950, the assisted population was 4.3% of the existent total population; in 1970, it rose to 25.3%; in 1981, it reached to 47.8% and, in 1990, increased up to the 59% of population in general.

2.2.1.5 Recreation Areas

The surface occupied by the different types of green areas in the delegations and municipalities that form the Metropolitan Area of Mexico City are parks and gardens, ridges and squares; national parks and forests among others.

The national parks of the metropolitan area are listed below.

Table 2-38: National Parks in the Metropolitan Area of Mexico City

Name	Surface Area (ha)
Desierto de los Leones	1,866
Cumbres del Ajusco	920
Fuentes Brotantes de Tlalpan	129
El Tepeyac	294
Cerro de la Estrella	1,100
El Coyoacán Histórico	584
Molino de Belem	17
Lomas de Padierna	670
Miguel Hidalgo y Costilla	1,750
Los Remedios	400

2.2.1.6 Economic Features

Economy of the Region

Being the area most populated of the country, the Metropolitan Area of the Valley of Mexico concentrates an important part of the national productive activity of the secondary and tertiary sectors. In relation to the manufacturing industry, trade and

services, the occupation generated in this region is, in relation to the total of the country, highly superior to the city population participation in the national total.

Of the economic Censuses of 1995, this area has more than massive scale of industry, trade and services, and concentrates almost 30% of the national employment generated in the three sectors. This is much significant if the DF is considered exclusively, where 8.4% of national population resides, and 21% of the secondary and third sectors of the country is there.

The manufacturing industry absorbs 2,104,691 employment which represents 24.5% of the secondary occupation of the country. Out of them, 1,050,883 are located in the DF and the remaining 1,053,808 in the co-urban municipalities of the State of Mexico. The trade sector has 5,073,818 occupations, almost a fourth part of the employment generated at national level in this activity, or equivalent to 27% of total. The economic Censuses have contained information of the formally established economy, but they have not counted the informal occupation that is significant for this area.

The evolution of the GRP (Gross Regional Prduct) in this period stayed stable, with an average of 20.9% keeping the top level of the country. The contribution of the ZMVM to the GDP of the country is reflected mainly in the secondary and tertiary sectors, representing on the average during the period 1988-1992 21.2 and 23.4% respectively.

The behavior of the GRP of the Metropolitan Area of the Valley of Mexico is illustrated in the following table:

Table 2-39: Rate of GRP of the ZMVM to the GDP of the Country

Years	Primary	Secondary	Tertiary	Total
1988	0.3	20.9	24.6	21.4
1989	0.3	21.3	22.8	20.6
1990	0.3	20.9	22.7	20.4
1991	0.4	20.9	23.0	20.6
1992	0.5	21.3	23.9	21.5
Average	0.36	21.2	23.4	20.9

The contribution of the primary sector is below that of the country, and the importance of the secondary and tertiary are outstandingly high.

The GRP of the ZMVM along the period shows an average growth of 3.3%, while the average of the country is worked out to be 3.6%.

The Economy in Mexico City presents an activity of local, regional and national market, since it is the Center of economic distribution of the country.

Only in areas far from the urban area economic activities of self-consumption are practiced, especially the areas near to the delegations Xochimilco and Tlahuac, but in the rest of the Metropolitan area the large commercial activities proliferate day by day.

As for the regional economy of the DF, GRP in 1997 represents 24.1% of the total of the country. From this total, the most representative part is the sector of services (23.1%), followed by manufacturing (21.6%), trade (21.3%), bonds and insurance (16.7%), communications and transportation (10.8%), construction (6.1%), mining (0.3%), and agricultural (0.2%) sectors.

Nominal per capita GRP of the DF in 1997 was US $11,426, which is 2.6 times greater than the total for the nation.

Productive Activities

As implied in the previous section, in the Metropolitan Area of the city of Mexico, the predominant productive activities are the commercial one and of services, followed by the industrial ones.

As for the areas near to the project, commercial activities are active and the population of Ecatepec also depends on the industrial activity. They do not practice forest or agricultural activities or hunting except in the areas adjacent to the Lake of Texcoco. This area has conformed to the Agricultural Region Texcoco No. III of the State of Mexico where in the period from spring to summer the following are cultivated: corn, bean, trenches grain, tomato, pumpkin, carrot, lettuce, cauliflower, cabbage, trenches forrajera, medic and corn forrajero mainly.

Cattle activities are also present in this region: bovine livestock of meat and milk; ovino for meat and wool; caprino for meat and milk, equine, swinish, meat birds and posture, and beehives for the production of honey.

2.2.1.7 Economically Active Population

One of the most significant characteristics of the economic concentration in Mexico City is that approximately 50% of the national industrial production is located in its metropolitan area. In 1980, 35.2% of the GDP of the country was generated alone in the DF.

At national level, in 1990, the Economically Active Population (PEA) amounted to 29.6% of the total population of the country, while in 1970, it was of 26.8%. In a same way, in 1990, the PEA of the area of interest increased.

In 1990, the economically active population of the DF showed a marked prevalence (70.3% of the total PEA) of the activities of the third sector, i.e. trade and services, followed by the secondary activities (29.6%) and finally, the primary activities (.09%).

Especially, in the case of the metropolitan municipalities of the State of Mexico, and Ecatepec in particular in the area of interest in 1990, they had 380,350 of PEA, and out of these, most is devoted to the commercial and service activities.

2.2.1.8 Employment

Table 2-40 shows the percentage distribution of economically active population by sector in the study area. As shown here, the commercial and service activities occupy the largest proportion of employment while the industrial ones and the primary sector are not significant.

Table 2-40: PEA by Sector

Sector	% of PEA
Agriculture, cattle raising, hunting and fisheries	8.40
Mining	0.12
Extraction of Petroleum and Gas	0.02
Manufacturing Industry	20.00
Electricity and Water	0.81
Construction	6.88
Trade	22.3
Transport and Communications	5.58
Financial Services	1.46
Public Administration and Defense	4.41
Communal and Social Services	7.67
Professional Services and Technicians	2.08
Services of Restaurants and Hotels	2.97
Personal Services and Maintenance	9.67
Not Specified	7.53

2.2.1.9 Land Ownership

The dominant form to hold a land in the Metropolitan Area is the private one; in a specific area adjacent to the Lake of Texcoco, however, they coexist the communal and private ownership.

2.2.2 Socioeconomic Environment in Neighboring Communities

The ex-Lake Texcoco area is within the Mexico Valley Metropolitan area and lies next to Ecatepec and over the borders of other several municipalities in the state of Mexico, namely Nezahualcoyotl, Texcoco, Atenco and Chimalhuacan. Being adjacent to the DF where massive scale of productive activities concentrate, those municipalities have been accepting overflowed population from the DF.

To give an overall socio-economic feature of those municipalities, Table 2-41 is given. As it shows, almost all households enjoy electricity supply. Except Chimalhuacan, the provision rate of public sewerage of the other four is higher than the average of the State of Mexico. Ecatepec, Nexahualcoyotl and Texcoco have higher provision rate of piped water in house.

As for minimum wages, the administrative units of the country are divided into three groups A, B and C. Only Ecatepec among the five municipalities is classified as Region A with highest value, while the others as Region C with lowest minimum wage.

Table 2-41: Socioeconomic Indicators in Neighboring Municipalities (1995)

	Public Sewerage	Piped water in house	Electricity	Minimum wage
	(unit: % of households)			(pesos per day)
State of Mexico	*84.9*	*49.1*	*97.6*	-
Atenco	86.3	37.0	99.1	29.70
Chimalhuacan	82.8	11.5	98.7	29.70
Ecatepec	93.5	57.6	99.4	34.45
Nezahualcoyotl	99.2	57.6	99.7	29.70
Texcoco	88.3	59.7	98.9	29.70

Source: INEGI

In the following sections, socioeconomic environment of municipalities of Nezahualcoyotl and Ecatepec are described in depth.

2.2.2.1 Socioeconomic Environment in Nezahualcoyotl

a. Cultural Background

It was called Nezahualcoyotl after the Poet King, meaning "the fasting Coyote"; from "Nezahualo" -to fast- and "coyotl", coyote.

In 1963, there was a population impulse from the City toward this area, resulting in the *settlement* of Nezahualcoyotl city and the development was horizontal-oriented. This is still visible nowadays, as 1 or 2-story houses can be seen, and buildings are seldom found in this area.

b. Population

b.1 Trends

According to the data of Population's General Censuses and Housing in the municipality of Nezahualcoyotl in 1990, there is a population of 1,256,115 inhabitants, with an annual rate of growth of -0.65% if compared with that of 1980, in which there were 1,341,230 inhabitants with a 8.74% growth rate.

Table 2-42: Population in Nezahualcoyotl Municipality

	1970	1980	1990	% 80/70	% 90/80
Total	530 436	1 341 230	1 256 115	8.74	-0.65
Men	295 078	666 106	615 947	8.48	-0.78
Women	285 358	675 124	640 168	8.99	-0.53

The municipality of Nezahualcoyotl, according to Population's Count and Housing of 1995 carried out by the INEGI, has a total population of 1 233 868, of which 604 881 are men and 628 987 women.

b.2 Population Density

The population density in the municipality reaches the figure of 19 800 inhabitants for a square kilometer and in the urban areas it rises to 28 933 inhabitants for square kilometer.

b.3 Pyramid of Age Groups

Table 2-43: Population by Age Group and by Sex in Nezahualcoyotl Municipality

Age	Population	Men	Women
0-4	133 547	67 849	65 698
5-9	126 317	64 035	62 282
10-14	120 086	60 294	59 792
15-19	130 667	64 813	65 854
20-24	153 922	74 502	79 420
25-29	127 915	62 775	65 140
30-34	100 416	48 895	51 521
35-39	81 480	39 047	42 433
40-44	61 280	29 182	32 098
45-49	51 310	24 313	26 997
50-54	42 613	20 453	22 160
55-59	32 045	15 369	16 676
60-64	27 093	12 875	14 218
65-69	18 177	8 411	9 766
70-74	11 798	5 576	6 222
75-79	6 268	2 847	3 421
80-84	3 643	1 474	2 169
85-89	2 076	770	1 306
90-94	815	312	503
95-99	363	128	235
100 and above	73	20	53
Not specified	1 964	941	1 023

b.4 Economically Active Population

Table 2-44: Economically Active Population of and over 12 year-old in Nezahualcoyotl Municipality

unit: % of the municipality total

Activity condition	Population 12 year-old or above
Economically active population	45.41
Economically inactive population	53.09
Not specified	1.49

b.5 Birthrate and Mortality

The rates of birthrate and mortality registered in 1990 constitute important additional elements for the population analysis. In the following table, the comparison is presented with the resulting average for the State of Mexico, as well as the values for infantile mortality. The behavior of these variables, both for their magnitude as well as their comparison with state averages, explains not only their population growth but also represents a well-being indicator of the municipality.

Table 2-45: Birthrate and Mortality in Nezahualcoyotl and State of Mexico

As for the population of 1,000

	Birthrate	Mortality	Infantile mortality
Nezahualcoyotl	22.02	2.41	24.62
State of Mexico	24.52	3.84	35.32

Likewise, a significant drop is observed in the birthrate. Taking the alive born children by segment of the mother's age, the women of 50 to 54 years had 6.0 children, while those of 25 at 29 have 1.7.

Table 2-46: Age of Mothers and the Average Number of Children

Age of Mothers	20-24	25-29	30-34	40-44	50-54
Number of Children	0.7	1.7	2.6	4.3	6.0

The decline in the birthrate is reflected in the population pyramid of the municipality and also explains the composition of its structure.

b.6 Ethnic Groups

The municipality of Nezahualcoyotl has a population of 15,070 that speaks indigenous language, of which 7,722 are men and 7,353 women. The type of languages that prevail in the municipality is: zapoteco, totonaca, mixteco, tlapaneco, purepecha, mazateco, nahuatl, and mazahua.

It can be said that the municipality of Nezahualcoyotl has a minimum population that speaks such indigenous languages. However, the language Nahuatl is spoken by 3,830 people followed by the mixteco with 3,342. It is necessary to mention that being a municipality which receives a great number of people, it is obvious that Nezahualcoyotl has a mixture of cultures and therefore it cannot be characterized by one specific cultural type.

b.7 Population Movement

The population inflow process has meant the incorporation of new residents, because as of 1990, 59.46% of the residents of the municipality had been born outside the State of Mexico, and for those born before 1985, 8.90% of them did not live in the State of Mexico. However, these figures do not explain the sharp growth rate drop; therefore, it can be assumed that a considerable inter-municipal migration flow has taken place in the State, contributing also to the decrease in population.

c. Employment

According to 1990 information census for the population aged 12 and older, the total number of persons in economic activities within the municipality represents a bigger proportion, if compared with that of the State; this activity structure reflects an increasing incorporation of women to remunerated works.

It highlights the highest proportion of students, implying the young population's significant permanency in the educational system.

Table 2-47: Level of Employment and Underemployment

	Number	Nezahualcoyotl (%)	State of Mexico (%)
Occupied	399 797	44.03	42.13
Unoccupied	12 510	1.38	1.28
Home	246 286	27.12	29.57
Student	188 834	20.80	19.53
Others	60 581	6.67	7.48
Total	908 008	100.00	100.00

The main activities carried out by the economically active population, as well as the sector in which they perform is remarkable. The following information dates from 1990 and does not include unspecified works:

Table 2-48: Distribution of Employed Population by Work Type and Sector

	Industrial	Services	Agricultural	Total
Professionals and technicians	6 272	35 499	47	41 818
Officials and clerks	10 548	40 764	60	51 372
Merchants	8 710	75 394	104	84 208
Agricultural workers	38	162	582	782
Industrial workers	95 887	37 119	136	133 142
Serv. Publ. and personal	1 361	27 138	57	28 556
Others	6 469	40 411	60	46 940
Total	129 285	256 487	1 046	386 818

The population's distribution occupied by sectors of economic activity reveals a proportional structure different from that of the state average. In Nezahualcoyotl, the population occupied in the agricultural sector is minimum, and since it is an eminently urban municipality, it is supposed that it carries out its activities outside the geographical boundaries of the municipality. As a compensation, the service sector concentrates 64% of employed population, a percentage greater than that of the state average. The industry, although important, has a smaller participation than the corresponding figure of the State in their group.

d. Services

d.1 Media and Transport

In addition to the coverage of the basic services, information on highways, postal and telephone services and the electric power consumption will give a global panorama of the infrastructure of the municipality. Those are detailed in the following tables, in which figures of transport are also included, basically of vehicles registered in the municipality.

Table 2-49: Highways in Nezahualcoyotl Municipality

Highways	km
Paved	0
Rural	3.10
Total	3.10

Table 2-50: Vehicles in Nezahualcoyotl Municipality

Vehicles	Number
Particular cars	93 485
Public cars	5 210
Van and trucks	23 469
Others	418
Total	122 582

Table 2-51: Electric Power in Nezahualcoyotl Municipality

Electric power	Number
User (persons)	254 699
kWh per year	385 727

Table 2-52: Postal Services in Nezahualcoyotl Municipality

Postal services	Number
Administrations	5
Branches	0
Agencies	4

Table 2-53: Telephone Services in Nezahualcoyotl Municipality

Telephone services	Number
Apparatuses	49,888
Lines	34,519

The previous information allows to obtain indicators that reflect the relative readiness of infrastructure in the municipality and facilitate its comparison with the prevailing global situation in the State as below.

Table 2-54: Comparison of Some Infrastructural Indicators with State of Mexico

	Nezahualcoyotl	State of Mexico
Inhabitant for lined phone	36.4	21.7
Inhabitants for vehicle	10.2	8.1
kWh per inhabitant	307.1	908.1
km of highway for km^2	0.0	0.4