Part B
Chapter 3

Verification with Norms and Regulations on Land Use

3 Compliance with Norms and Regulations on Land Use

This chapter has an object to identify the applicable juridical regime in regard to land use of the portion of territory of the ex-Lake Texcoco in which the project is to be implemented.

The Mexican relevant laws stipulates the following in regard to the federal zone authorized by the CNA.

- Fraction XXIV, Article 32, of the Organic Law of the Federal Public Administration states that the role of the SEMARNAP is: "to administrate, control and regulate of the use of hydraulic basins, springs and waters of national property and the corresponding federal areas, ..."
- Fractions I and VII, Article 40, of the SEMARNAP's Interior Regulation state that the role of the General Subbureau of Administration of the Water of the CNA is: "to administrate and guard the national waters, as well as the goods that are linked to these, of conformity with the applicable juridical dispositions, except for those commended to the General Subbureau of Operation, as well as to watch over the execution of the Law of National Waters and their Regulations ..." and "to promote or carry out the necessary measures to avoid the superficial or the underground waters and the goods subject to protection from contaminated by garbage, waste, residue materials, toxic substances, sludge, and product of the treatments of residual waters, according to the applicable juridical dispositions".
- Fraction I, Article 50, of the SEMARNAP's Interior Regulation, states that the role of the Regional Management of the CNA is: "to exercise, inside the territorial environment that have been assigned, the attributions of the administrative units to which the articles 39 at 40 of this Regulation refer, ..."
- According to Fractions II, IV, V and VII, Article 113, of the Law of National Waters, national goods whose administration corresponds to the CNA are the following ones: the lands occupied by the lakes, lagoons, tidelands or natural deposits whose waters are of national property; the lands of riverbeds or federal zones adjacent to the flows and basins of national property; lands of natural deposits of lakes, lagoons, tidelands of national property, exposed by natural causes or for artificial works; the hydraulic infrastructure works financed by the federal government, such as dams, dikes, channels, drains, gutters, aqueducts, watering units and other built for the exploitation, use, and control of floods and handling of the national waters, together with the lands that occupy these and with the protection areas, in the extension that fixes the Commission in each case;
- According to Article 117, last paragraph of the Law of National Waters: "the Commission will agree with the state or municipal governments or individuals interested through assignation or a public bid, in case where the latter will be in charge of the custody, preservation and maintenance of such goods"

- According to Fraction VIII, Article 3, the riversides or federal areas are the strips of ten meters of contiguous width to the river beds or the deposits of national property, measured horizontally starting from the maximum level of waters".
- Fraction IV, Article 119 of the Law of National Waters considers an administrative penalty "to occupy river beds, natural deposits, canals, federal zones, protected areas and other goods referred to in Article 113 without the license of the Commission".

Under such legal background, the ex-Lake Texcoco area was put under the administration of the CNA, designated as the federal zone. Further, the CNA is appointed to do the following.

- According to the first paragraph, Article 118, of the Law of National Waters: "the national goods..., which the Commission is in charge of, could to be exploited or used, even as the construction materials located there, by any individuals or entities which are granted the concessions from the Commission grants for such an action".

And:

- According to Fractions VII and XV, Article 9, of the Law of National Waters, the role of the CNA is "to grant the titles of concession, assignment or permission as referred to in the present Law, ..." and "issue, in each case, regarding the goods of national property referred to by this Law, the corresponding declaration that will be published in the Official Federation Newspaper".

Understanding that the project site was determined through the discussion between the CNA and the GDF, the use of land by the GDF for the said purpose is considered sufficiently verified.

Part B
Chapter 4

Identification of Environmental Impacts

4 Identification of Environmental Impacts

Approach to be Used

An environmental impact is any alteration of the environmental conditions or the creation of a set of adverse or beneficial environmental conditions caused or induced by a new action or a group of new actions under consideration (BCIE (Banco Centroamericano de Integración Económica), 1988).

Understanding this, the evaluation of environmental impact is aiming to identify, predict and interpret the impacts of a project in the environmental parameters that have a significant implication to the natural and socioeconomic environment.

The development works, as we are concerned, could present diverse impacts to the natural and socioeconomic environment, in stages such as land preparation, construction and operation. In relation with the project type and the characteristics of the land and environment, the impacts can be of diverse magnitude and significance.

This fact brings multiple key issues and disciplines, interactions and complexity among them. Therefore, with a purpose to identify possible environmental impacts, a checkup list is prepared (Table 4-1).

The left end column shows the environmental aspects in which impacts could be observed. They are listed as to cover all possible impacts and not to omit any impact. It should be noted that the list has been elaborated for project in general, not specifically for the present project.

The table also shows the anticipated impacts, or results, of the activities of a solid waste management project during the construction and operation and after the closure of the project. In doing so, the causes and effects become explicit and impact identification is facilitated.

Following the list of environmental aspects, it is attempted to analyze the environmental impacts of the Etapa V landfill project in the following sections.

Table 4-1: Possible Impact by a SWM Project

Evaluation Aspects	Possible Impact (General guide for a SWM project)		
	During Construction	During Operation	After Closure
Social Environment			
Resettlement	Resettlement of people living in the proposed land or on the access route.	Social instability of resettled people.	Social instability of resettled people.
Economic Activities	Disturbance of economic activities. Introduction of new employment.	Introduction of new employment.	Introduction of new activities introduced.
Transport	Increase in traffic and accidents.	Increase in traffic and accidents.	
Public Facilities	Impacts on schools, hospitals, etc. by traffic and noise.	Impacts on schools, hospitals, etc. by traffic and noise.	
Division of Community	Geographical separation of community or interruption of its communication.		Possible re-linkage of divided community.
Historical Heritage/Cultural Properties	Loss and/or devaluation of historical heritage or cultural properties such as churches, archeological remains and historical assets.	Devaluation of them by waste trailers passing nearby.	Restoration of their values to a certain extent.
Water Rights/Access Rights	Obstruction of fishing rights, water rights and rights of common access.	Obstruction of fishing rights, water rights and rights of common access.	Restoration of previously abolished access rights.
Public Health		Degradation of public health due to wastes fallen from the trailers, the existence of a great amount of wastes in a limited area, and/or vermin/ pathogens proliferation there. Prevention of threats to public health which could be brought by uncontrolled waste management (i.e. open dumping, no treatment or no-project option).	
Waste (from the project)	Generation of construction wastes and debris.		
Accidents/Risks		CH_4 explosion, intrusion of CO_2 into residence, refuse fires, landslides, lateral pressure on land.	CH_4 explosion, intrusion of CO_2 into residence, refuse fires, landslides, lateral pressure on land.
Natural Environment			
Topography and Geology	Changes in valuable topography and geology due to excavation.		
Soil Erosion	Increase in soil erosion due to land preparation and/or deforestation.		

	Possible Impact (General guide for a SWM project)		
Evaluation Aspects	During Construction	During Operation	After Closure
Groundwater		Changes in quality and level of groundwater due to leachate.	Changes in quality and level of groundwater due to leachate.
Hydrological Conditions	Changes in river discharge and riverbed condition.	Changes in river discharge and riverbed condition due to in-flow from the site.	Changes in river discharge and riverbed condition due to in-flow from the site.
Coastal Zone	Impacts on coastal environment.	Impacts on coastal environment.	Impacts on coastal environment.
Fauna and Flora	Obstruction of breeding of natural species and/or extinction of them due to interruption or loss of their habitats.	Obstruction of breeding of natural species and/or extinction of them due to interruption by traffic, noise and/or presence of humans.	Introduction of new habitat.
Meteorology	Changes in temperature, wind direction and/or intensity, etc.	Changes in temperature, wind direction and/or intensity, etc.	Changes in temperature, wind direction and/or intensity, etc.
Landscape/ Aesthetics	Changes in landscape.	Changes in aesthetic values due to the existence of the facility.	Changes in aesthetic values due to the existence of the facility.
Pollution			
Air Pollution	Deterioration of air quality due to the increased traffic.	Deterioration of air quality due to the increased traffic and dust from wastes delivered by tracks, the landfill gases and/or smoke/dust from site operation.	
Water Pollution	Deterioration of water quality of surface water and/or groundwater due to the inflow of sand/silt from land preparation work.	Deterioration of water quality of surface water and/or groundwater due to the inflow of sand/silt and leachate from the site.	Deterioration of water quality of surface water and/or groundwater due to the inflow of leachate from the site.
Soil Contamination		Contamination of soil by leakage of leachate.	Contamination of soil by leakage of leachate.
Noise and Vibration	Noise and vibration caused by the construction operation and/or the construction tracks.	Noise and vibration caused by the waste trailers and/or landfill site equipment.	
Land Subsidence	Land subsidence due to land deformation.		
Offensive Odor		Odor caused by scattered wastes from waste trailers and/or wastes accumulated at the site.	

4.1 Socioeconomic Environment

4.1.1 Resettlement

Evaluation: No impact.

There is no need to resettle any residents, thus no impact caused by resettlement at all.

4.1.2 Economic Activities

Evaluation: No or possibly positive impact.

No economic activities take place in the area which could be affected by the project.

On the other hand, since the project will be located near to the currently operating landfill site (Etapa IV), the condition of the present workers to commute to their workplace will not be significantly changed. Although new job is only expected to be created during the one-year construction stage, the job status of present workers is to be maintained, which should be highly appreciated.

4.1.3 Transport

Evaluation: Negative impact is anticipated, which is temporal and could be minimized.

Change in traffic mode near the site is expected during the construction and operation along the toll road (Autopista México-Texcoco) and a peripheral ring road (called *Periférico.*).

The Periferico and Avenue Peñon-Texcoco are currently used for waste delivery to the BP IV. Therefore traffic load along them will remain the same with slight increase brought by traffic for construction. The increase in traffic load on the Periferico should be negligible.

The Autopista is not used for waste transport at present and should have an increased traffic during the construction and operation. However, the Autopista can be considered to have a capacity to absorb the traffic increase brought by the project.

To give a general idea, the following figures are obtained.

- The maximum capacity of one lane[1]: 2,200 normal vehicles/hr
- The hourly peak traffic at present[2]: 87 large vehicles and 476 normal vehicles (observed in a direction from Texcoco toward the DF during 8:00-9:00 in the morning)
- The peak traffic of waste trailers[3]: about 60 trailers/hour
- The adjusting factors of the road capacity:

[1] An empirical value.
[2] From the DGSU's survey on Wednesday, 27 January 1999.
[3] The daily traffic of waste trailers are 700. Assuming the peak factor of two, 700/24*2=58.3.

Adjusting factor in terms of road width[4]: 0.94
Adjusting factor in terms of the large vehicles ratio to the total traffic[5]: 0.80

- The adjusted traffic capacity of the road with two lane:
  2,200 * 0.94 * 0.80 * 2 = 3,309 (normal vehicles)

Although this is rather a crude estimation, but it will be certain that the road capacity of the Autopista is sufficient. What should be stressed is that the impact by the project is not permanent but restricted in the construction and operation period, and that economic development and population growth particularly in the state of Mexico will bring a much larger impact on the traffic load than the landfill project.

Caution should be exercised to the U-turn area of the Autopista, junction of the Autopista and the Periferico, and the junction of the Autopista and the newly built access road. Since vehicles run the Autopista relatively high speed, any actions which interrupt the traffic flow such as altering lanes and turning of long vehicles should be carefully controlled. **Expansion of part of roads and other traffic control measures such as providing clear signs to call for drivers' attention to the movement of waste trailers are carried out.** In considering those, examination on the fluctuation of traffic loads of normal vehicles and that of waste trailers in a day is taken into account with particular attention.

4.1.4 Public Facilities

Evaluation: No impact because of the scarcity of public facilities and sufficient distance from the project activities.

There is no public facilities affected except gas pipelines of PEMEX, which are buried near the southwest corner of the project site. Because of the traffic of heavy trailers and the presence of huge amount of waste accumulation, pressure could give a stress to the pipelines, leading to an incident.

However, the project plans to locate the entrance of the trailers to the landfill on the southeast corner and no traffic of them near the pipelines is predicted. Further, the land which will actually receive waste the gas pipelines is 100m off from the pipelines.

Therefore, it is unlikely to give any negative impact on the PEMEX gas pipelines.

4.1.5 Division of Community

Evaluation: No impact.

The site is in the federal zone, where is no community. Therefore, there is no possibility to divide any community.

[4] An empirical value for the 3m wide road.
[5] An empirical value for the flat road with a large vehicles ratio of 38%, where one large vehicle is assumed to be equivalent to two normal vehicles.

4.1.6 Historical Heritage/Cultural Properties

Evaluation: No impact.

There are no historical heritage or cultural properties in and around the project site which could be affected.

4.1.7 Water Rights/Access Rights

Evaluation: No impact.

The site is owned by the Federation, and neither water rights nor access rights is associated with the land. Therefore, there is no chance to affect them.

4.1.8 Public Health

Evaluation: Expected impacts are controllable and large benefits to the public health should be brought.

Public health might be affected by the project for the following reasons.

1. Waste scattered from the waste trailers which deliver waste from its origins to the plant due to the mismanagement of waste delivery.
2. Offensive odor emitted from putrescible waste.
3. Proliferation of vermin and/or pathogens attracted to food waste.
4. Dust caused by waste tipping, trailers movement on site, or from cover soil.

Items 1 and 3 are examined below, and the others will appear in the later sections.

a. Mismanagement of Waste Delivery

Careless delivery of waste may allow waste to be scattered along the transportation routes and around the landfill site, resulting into the degradation of city beauty and public health.

Meanwhile, the DGSU has been using the tarpaulin to cover waste on the trailers in order to avoid waste scattering. It is observed that the tarpaulin has been achieving satisfactory result to overcome this problem.

Since **this practice is continued,** waste will not be significantly scattered to degrade the city cleanness or public health. **It is ensured by regular monitoring that the tarpaulin does not have large holes or tears though which waste might escape from the trailers.**

b. Vermin/Pathogen Proliferation

Organic waste attracts wide range of pathogens (i.e. disease-causing bacteria) and vermin (or disease vectors such as fly, mosquitoes, rats, etc. which transmit pathogens) and hence can potentially increase the incidence of diseases in surrounding population and the site workers.

Waste is continuously landfilled (i.e. 24 hours a day) and covered with soil within 24 hours. Cover soil is widely practiced to prevent the population increase of noxious fauna.

Therefore, vermin/pathogens proliferation should be minimum, without posing health hazards to the public. The workers working at the landfill front **are instructed to put appropriate clothes and equipment to avoid any exposure to health hazards.**

Finally, but by far the more importantly, it can not be too stressed that in spite of the two issues pointed out above, *the proposed project of sanitary landfill will be the best available option for waste final disposal* in terms of public health: the other options of waste final disposal, i.e. open dumps, should produce considerably serious public health hazards. Much more should be the no-project option, considering the facts that *waste, which could be minimized, reused or recycled, can not still be totally eliminated, and that waste has to be disposed of ceaselessly with sustainability.*

4.1.9 Waste (from the Project)

Evaluation: Negligible negative impact.

No excavation work is planned, thus there is no construction waste generated, except plants and/or stones which have to be removed from the site before laying impermeable liners in order to reduce physical damage on them. There is no other waste generation expected.

Therefore, the waste generation from the project is minimal and does not pose any significant problem.

4.1.10 Accidents/Risks

Evaluation: Negative and long-term impacts could be anticipated, but they will be well controlled.

Landfill operation can lead to an unexpected incident due to (i) problematic site management and waste collection management, (ii) problematic traffic, (iii) waste load pressure (such as landfill slope slides and lateral movement of soil) and (iv) gas generation. The second issue "problematic traffic" was discussed earlier.

a. Problems of Management

Incidents caused by careless site management can be expected during both the construction and operation phases.

During construction, the operation of construction equipment and machine such as dump trucks, bulldozers and loaders may be a danger to the site workers. **Instructing good site operation to the workers, control of their movement and appropriate site supervision by experienced personnel minimize the potential risk.**

During the operation, waste itself can pose serious risk. Hazardous, chemically active, and/or radioactive wastes are particularly dangerous for the workers and could bring long term risks open to the general public. Since the BP V is not supposed to accept those waste, **proper waste disposal manner will be thoroughly instructed to the generators of such waste.** At the site, **waste is inspected periodically on arrival, and visually monitored by the site workers at the tipping front.**

Even household waste can be hazardous. The site workers may be injured with sharp material and broken glass. Containers with spray cans with remaining gas is

explosive. **The site workers are equipped with adequate clothes and protectors such as gloves and boots in case of such event.**

Glass material is also dangerous setting spontaneous fire to waste under the sunlight. **Soil cover** should minimize this risk.

The general public is prohibited from entering the site as practiced in Etapa IV, thus danger to them will be also minimized.

b. Waste Load Impact

As waste is accumulated, its gravitational force turns to be a significant stress to the land. The EIA study previously carried out prior to the construction of BP IV stressed a possible risk of land subsidence by the waste landfill and impact on the canals running in and around the ex-Lake Texcoco area.

Examination of influence on the canal, Dren Texcoco Norte, which is flowing the south side of the site, caused by the New Landfill Development was carried out by using soil data acquired through the soil survey. Conditions set for estimation of subsoil settlement and the results of the examination are presented below.

Conditions for Estimation of Influence

Data on soil layers at SM-1 bore hole are employed for the estimation. The alluvial layer is subdivided into 8 layers as shown in Table 4-2. The waste load is assumed to be the one when the landfill becomes 24m high and the unit weight of waste after initial compression at landfill is assumed to be 0.8 ton/m^3. And two cases are set depending on whether buoyancy caused by the groundwater is considered or not. Case 1 ignores such buoyancy, on the other hand, Case 2 takes buoyancy into consideration.

Table 4-2: Subsoil Conditions

Layer	Thickness of layer (m)	Unit weight (ton/m^3)
1	5.0	1.14
2	5.0	1.23
3	5.0	1.25
4	5.0	1.17
5	5.0	1.25
6	6.8	1.25
7	0.7	1.60
8	4.1	1.24

Note: The water level is assumed at 0m depth, because the groundwater level at SM-1 was 0.35.

Results of the Estimation

The results are schematized in Figure 4-1. The result of Case 1, without consideration of the buoyancy, is that the final subsoil settlement (theoretical maximum) will be 13.82 m in the landfill center which may cause 5mm settlement at the 100m off-set drainage canal. Meanwhile, the final subsoil settlement (theoretical maximum) of Case 2, with consideration of the buoyancy, will be 9.35m in the landfill center which may cause 2mm subsidence at the 100m off-set drainage canal.

The duration of settlement was also estimated. The result shows that it will take 3 to 4 years to reach 60% settlement (See Table 4-3). Therefore, in order to secure enough interval before waste placement on a next lift, alternate use of Etapa IV and V is planned.

Table 4-3: Duration of Settlement

Consolidation (%)	10	20	30	40	50	60	70	80	90	100
Duration (days)	19	74	186	384	726	1378	2667	5072	9879	-
Settlement (m)	1.38	2.76	4.14	5.52	6.91	8.29	9.67	11.05	12.44	13.82

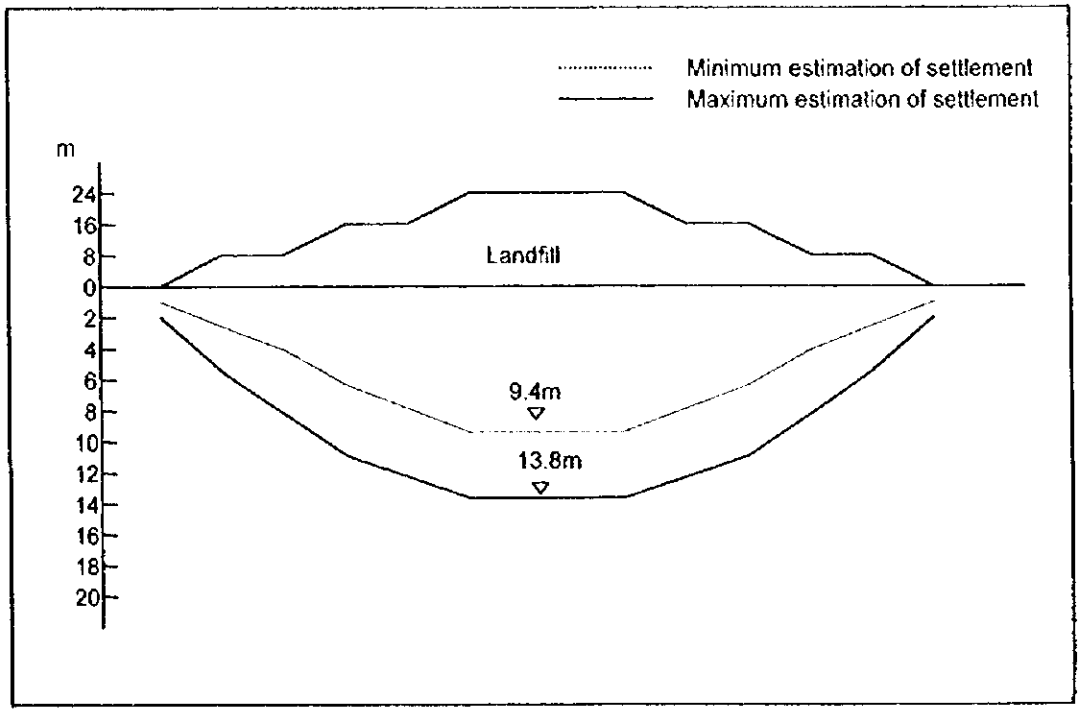

Figure 4-1: Subsoil Settlement

Influence on the Canal (Dren Texcoco Norte)

In conclusion, the estimation shows only 5mm subsidence of the drainage canal under the theoretical maximum subsoil settlement caused by the New Landfill Development. So, it can be said that the New Landfill Development will not pose a serious problem on the drainage canal structure.

The other possible concerns in regard to the compression effect are derived from the presence of wells within the site, which were previously used to extract salty groundwater. Without properly dealing with those wells, the following is anticipated.

- The impermeable liner at the bottom of the landfill is pressed down, scratched with the sealed wells, and damaged. It may have a fault, or may become susceptible to a fault.

- Change in subsoil structure by weight pressure may result in cracks or fissures of the wells. If leachate should be leaked into groundwater, such cracks or fissures would act as a migration pathway towards underlying strata.

The landfill plan states that **the well casings are totally removed and the boreholes are filled with bentonite**. If the work is successfully done, the worry mentioned above can be ignored.

c. Gas Generation

The biological process taking place in a landfill with municipal solid waste results in the generation of so-called "landfill gas" or "biogas" which contains CH_4, CO_2, and small quantities of CO, N_2, O_2, ammonia, sulfide and other trace gases. Primary concern regarding the biogas is CH_4 and CO_2. The proportion of these varies with the composition of waste and the age of the landfill, but in general, CO_2 becomes the principal gas (about 60% on dry volume bases) in the earlier stage of anaerobic decomposition. After this, CH_4 exceeds CO_2, remaining about 60% for a fairly long period.

CH_4 is, if present in the air in concentrations between 5 and 15 %, explosive. Within a landfill, oxygen depletion acts as an impedance of CH_4 explosion. Once CH_4 migrates to the outside of the landfill and meet with air, however, there is a large risk of explosion.

CO_2, being a heavier than air, tends to migrate downwards and remain in the lower portion of the landfill for long time. When there is a chance of migration and contact with grounewater, it will be partly solved or precipitated as calcium carbonate on soil. However, if it finds a pathway to enclosed sections (houses and/or buildings), CO_2 will be concentrated up to over 0.5% and it is asphyxiant.

Migration pathways for those gases can be geological formation (fissures, joints, caves, etc.) and man-made structures (boreholes, wells, sewer, etc.), and also can be found on site such as monitoring sumps, ventilation facilities and crackes created by settlement at site margins.

The proposed landfill design incorporates **passive ventilation facilities** in order to prevent unexpected gas migration. As far as the ventilation is exercised in a controlled manner, landfill gas will be trapped and dispersed before migrating and risks due to the landfill gas will be minimal.

Besides, due to the presence of the geomembrane liner on the bottom of the landfill, the chance of biogas migration through underground pathways is also minimal. Further, as for CO_2, there is a sufficient distance between its source and the residential area, which is an anticipated target of CO_2 impact.

It should be stressed that landfill gas formation generally lasts for nearly 15 years or more after the site closure, depending on the decomposition speed of waste. Therefore, **ventilation facilities are kept maintained and regular monitoring of gas composition is carried out.**

4.2 Natural Environment

4.2.1 Topography and Geology

Evaluation: Negligible negative impact.

Change in topography is inevitable, but the topography and geology of the site is not particularly valuable. Further, 24m height should not be significant change in topography of the vast and totally flat ex-Lake Texcoco area. The impact should be discussed not in terms of topography but of landscape, which will appear later.

4.2.2 Soil Erosion

Evaluation: No impact.

Vegetation, which scarcely exists in the project site, will be removed for landfill cell preparation. But the landfill work starts right after the cell preparation, thus it is unlikely to cause soil erosion.

4.2.3 Groundwater

Evaluation: Negative and long-term impacts could be anticipated, but they will be well controlled.

The possible environmental impact on groundwater is twofold: change in the phreatic water level and change in groundwater quality.

a. Groundwater Table Level

Change in the groundwater table level may have a serious imprecation for the hydraulic structures owned by CNA in ex-Lake Texcoco area.

One of the priority issues of the BP V landfill design is to minimize the volume of leachate by minimizing rainwater infiltration. As a result, water recharge into the shallow groundwater will decrease, then water table will be lowered. However, the landfill site is only a small portion of the whole ex-Lake Texcoco area from which groundwater recharge takes place.

Therefore, the decrease in the water table level will be too small to give any influence to the local groundwater hydrology, and an adverse impact is null.

b. Groundwater Quality

When water passes through waste which is under biological decomposition, a wide variety of substances present in waste, of which heavy metals are of particular concern, will be dissolved into water. As the decomposition of relatively young waste produces carbon dioxide and organic acids, pH of water drops and toxic constituents, particularly heavy metals, become readily soluble. The impact of leachate on underlying groundwater should be considered in terms of quantity and quality of leaked leachate.

In general, origins of water (or leachate) can be waste itself, rain, surface water body, or groundwater, but the first one is usually negligible. In the present case of BP V, neither surface water nor groundwater will be the source of leachate as there is no

major surface water body around, and groundwater infiltration into the landfill is to be cut off by an impermeable liner laid at the landfill bottom. The remaining possible origin of leachate is rainfall, but its percolation into the waste is considered to be small. This is because cover soil and intermediate cover soil will act as waterproofing. Therefore, leachate generation amount is controlled in first place.

Generated leachate will gradually travel downwards through waste, reaching a permeabilization system. The system consists of a synthetic liner of 10^{-13} cm/sec permeability with 1mm thickness, and the original clay formation of with about 0.5 m thickness, below which exists the shallow groundwater. **As far as the liner functions in a normal manner**, the system should be enough to prevent leachate from leaking, hence preventing groundwater contamination.

Abnormal function of the liner can be anticipated in case where the liner gets damaged by hard objects or pressure given by waste and/or accumulated leachate. The proposed design attempts to protect the liner from physical damage by providing a 0.5 m thick tepetate layer over the liner, and to control the water head of leachate by extracting it. Waste load will not cause land subsidence large enough to make a fault to the liner (see above). Therefore, the possibility of leachate leakage is substantially small.

In conclusion, the possibility of contaminated groundwater will be negligibly low.

ABC study (1993) pointed out that the abandoned wells existing in the surrounding area might act as a migration pathway for leachate. It would be problematic only if a certain amount of leachate with significant contaminants reached one of the wells. However, because of what has considered above, such event is implausible.

4.2.4 Hydrological Conditions

Evaluation: No impact.

The project is not such type of activity as causes alteration of hydrological conditions (e.g. water flow volume, flow speed and river bed conditions). Further, there are no surface water bodies whose hydrological conditions is to be affected.

4.2.5 Coastal Zone

Evaluation: No impact.

This is not relevant since there is no coast near the site.

4.2.6 Flora and Fauna

Evaluation: No or possibly positive impact on flora; on fauna, negative impact in short and medium-term which will be minimized, and possibly positive impact in long-term.

a. Flora

The natural condition in the site where the landfill in question is to be established will be altered. The alteration will be in general observed by the reduction of the vegetable cover and change of the composition of flora species, which will be incurred at different stages by different activities.

The causal project activities and their effects will be as follows.

i. Land preparation will eliminate the vegetable cover which may include ecologically valuable species.
ii. Land preparation will eliminate the vegetable cover which was placed with a purpose to prevent a storm dust, and re-introduce that problem.
iii. Traffic during the construction and operation along the access road from the Autopista may produce suspended particles and dusts and affect plant growth.

As for the first issue, there was no biotic population observed in the project site referring to the list of flora defined in the NOM-059-ECOL-1994. Thus, no impact on ecologically valuable species is predicted.

Regarding the second, it should be noted that the project site is currently mostly naked. The increase in the probability of storm dust due to the vegetation elimination is deemed to be considerably small. Further, the land is eventually covered with impermeable liners which will shut out dusts.

Regarding the third, the occurrence of particles and dusts should be minimum because the access road is paved with asphalt. Besides, as mentioned, there are no plants of particular ecological interest.

On the other hand, the project is aiming to establish a new green area after the closure. Since the present project site has only limited vegetation because of the salinity of the soils, the introduction of plants should be a long-term positive impact.

b. Fauna

The implementation of the project inevitably occupy and disturb part of habitat of wildlife by land occupation and employment of heavy machinery and trailers.

Contrary to flora, and in spite of human intervention for decades, or in fact centuries, in the area, the field reconnaissance and bibliographical study revealed the presence of a variety of fauna. It was also found, however, that not a few vertebrates are the species which are tolerant of external interference, and that birds, which is the dominant group of observed fauna, should easily escape from their unfavorable environment due to their mobility.

Considering in this way, a bird *Buteo jamaicensis*, which was found in the project site and is designated by the NOM-059-ECOL-1994 as a species which requires special protection, will be able to flee from adverse impacts.

The other species which were found in the project site and on the list of the norm are the following reptiles:

Guerrhonotus liocephalus
Salvadora bairdii
Thamnophis eques
Thamnophis scaliger
Pithuophis deppei

The first three are regarded rare, and the rest are considered to be threatened. The definitions of these two categories, according to the norm, are as follows.

Rare: Those species whose population is biologically viable, but very scarce in a natural way, which could be restricted to an area of reduced distribution, or of very specific habitats.

Threatened: Those species whose population could end up in extinction if factors which cause the deterioration or modification of the habitat or that reduce their population persist.

In order to minimize the adverse effect on their survival, the project considers the program of **their relocation to the outside of the project site prior to the project implementation**. The decrease of their population will be prevented.

A stress should be placed on the fact that the impact on fauna are rather temporary since the project site after the landfill closure will be turned to a new green habitat for fauna. The long-term overall impact could be positive.

4.2.7 Meteorology

Evaluation: No impact.

The scale of the project is not large enough to cause any change in meteorology.

4.2.8 Landscape/Aesthetics

Evaluation: No Impact.

As the project site is almost flat, the presence of 24m high landfill must be a significant change in the appearance of the area.

In considering an issue of landscape, however, not only the simple appearance but also, or with higher attention, how the appearance appeals to peoples' perception should be taken into account.

Although the latter is highly subjective and difficult to be discussed in general terms, a good attempt will be to employ a photomontage technique to compare the landscape before and after the project. The results are found in the plates attached to this report. It can be deemed that since the ex-Lake Texcoco area is vast, the elevation of 24m is not significant. Further, vegetation developed on the landfill is expected to improve the aesthetics of the area.

As the landfill is 2.2km away from the nearest residential area, it is not be well seen by the residents. It will be most visible from the Autopista, hence the car drivers and passengers will be those who perceive the landscape. Since the site is not regarded as a scenic spot, it is considered that any impact to the drivers and passengers given by the change in landscape will be relatively small.

4.3 Pollution

4.3.1 Air Pollution

Evaluation: Insignificant negative impacts anticipated, but prevented by control.

Air pollution may be caused by two factors: traffic and site operation.

a. Air Pollution by Traffic

It is generally known that vehicle transportation pollute the atmosphere due to the exhaust gas containing SOx, NOx and CO. The presence of these may increase the occurrence of respiratory diseases or eye irritation in population and damage vegetation.

Since Etapa V is to be used as an alternative to Etapa IV, waste trailers will be simply diverted from the present access road to the Autopista toll road and a new access road. Although the travel distance will increase by about 10km for one round trip, the increase of pollutants emission in populous areas due to the project will be only slight.

b. Air Pollution by Operation

Air pollution caused by landfill operation is attributed to the generation of noxious gases and dust.

Regarding the former, the concern is twofold. One is major biogas components, namely methane and carbon dioxide, and already discussed earlier. The other is about trace gases with offensive odor, which will be independently considered later.

In respect of dust problem at the site, it is anticipated that dust will be raised at the tipping front, from the soil cover, and/or from the inner roads when a vehicle passes (the outer road, paved with asphalt, will not be a dust source). For the first issue, it will be more or less inevitable due to the nature of the operation, but the problem is very local and **the impact can be minimized by workers' using appropriate masks**. Dust from the soil cover will be insignificant since the proposed project **sprays leachate over the landfill**. Spraying leachate and **the control of vehicle movement within the site** will limit the dust form the inner roads.

4.3.2 Water Pollution

Evaluation: Negative, and possibly long-term, impacts anticipated but to be well controlled.

Water pollution could be found in groundwater and surface water, and the former was already discussed.

There are three canals along the west, east and south sides of Etapa V. Possible effect on surface water will be caused by the following.

- Overflowed leachate migrates over the land surface to reach the canals.
- Infiltrated leachate migrates via unsaturated pore spaces toward the canals.
- Infiltrated leachate migrates to the shallow groundwater and contaminated groundwater reaches the canal.

On the other hand, the design of the Etapa V landfill includes **the soil cover over the waste and an impermeable HDPE liner at the bottom of the landfill**. Therefore, leachate generation within the landfill and migration out of the landfill should be well controlled. It is unlikely for leachate to cause surface water contamination.

However, surface water pollution might be also occurred by the ingress of runoff. It is unlikely that runoff water becomes contaminated with leachate or particles of the soil

cover. This is because firstly runoff water does not have a contact with leachate due to the presence of the soil cover, and secondly the final cover is firmly compacted not to be eroded. Further, since rainfall in the region is few, the problem will be only occasional. Therefore, the impact of surface runoff on the surrounding canals is insignificant.

4.3.3 Soil Contamination

Evaluation: Negative, and possibly long-term, impacts anticipated but to be well controlled.

Soil contamination matters because if it occurs, groundwater will be degraded, soil ecosystems will be affected and the future land use will be restricted.

Soil contamination is probable only if substances present in the leachate from the tipped waste intrude into the soil. However, **there is an HDPE liner** to confine leachate within the landfill, hence it is very unlikely that leachate finds a way to the soil.

In regard to the land use, the site is currently already restricted due to the high salinity. The landfill development may even improve the land condition since vegetation will be introduced on closure.

4.3.4 Noise and Vibration

Evaluation: Insignificant negative impact anticipated, but controlled.

There is a sufficient distance from the site to the adjacent population. Therefore, there will no impact by noise or vibration on residential areas.

However, noise and/or vibration caused by heavy machinery might have health effects on the workers at the work front. **An appropriate health control for them should be practiced.**

4.3.5 Land Subsidence

Evaluation: No impact.

Land subsidence is only limited to the landfilled area and was already discussed earlier.

4.3.6 Offensive Odor

Evaluation: Negative impact on limited recipients (site workers) and to be minimized with care.

Although organic waste generated in the sub-system is to be separately collected and delivered to the composting plant, organic waste will still be a large proportion of waste to be disposed of at Etapa V. Therefore, production of offensive odor is anticipated.

However, it is observed that the dry climate of the Mexico City helps decrease odor. Further, once tipped at the landfill, **waste is compacted and covered with soil at fairly short interval**. These practices should minimize odor problems.

Offensive odor may also result from the production of landfill gas. However, landfill gas should not cause a significant odor problem as they will be ventilated in a controlled manner and will be adequately treated.

Part B
Chapter 5

Countermeasures of Prevention and Mitigation of the Anticipated Impacts and Monitoring Program

5 Measures of Prevention and Mitigation of the Anticipated Impacts and Monitoring Program

The previous chapter described the possible causes and effects on the environment given by the landfill development at Etapa V and the extent of the problems. Figure 5-1 is a diagram to show the discussion on negative environmental impacts schematically.

Besides cause and effect relations, the figure includes arguments against the anticipated environmental effects. These effects would be brought about under the generally presumed circumstances, but in the specific case of the Etapa V landfill project proposed here, it is unlikely that they will occur.

The figure also shows countermeasures (typed in bold letters in Chapter 4) which are incorporated in the design of the project in order to prevent or mitigate the negative effects. Assuming that these countermeasures are satisfactorily implemented, any significant environmental negative impacts are not envisaged, as set forth in Chapter 4.

Recognizing the importance in this light, the countermeasures are presented in depth in this chapter, together with approaches to ensure their performance.

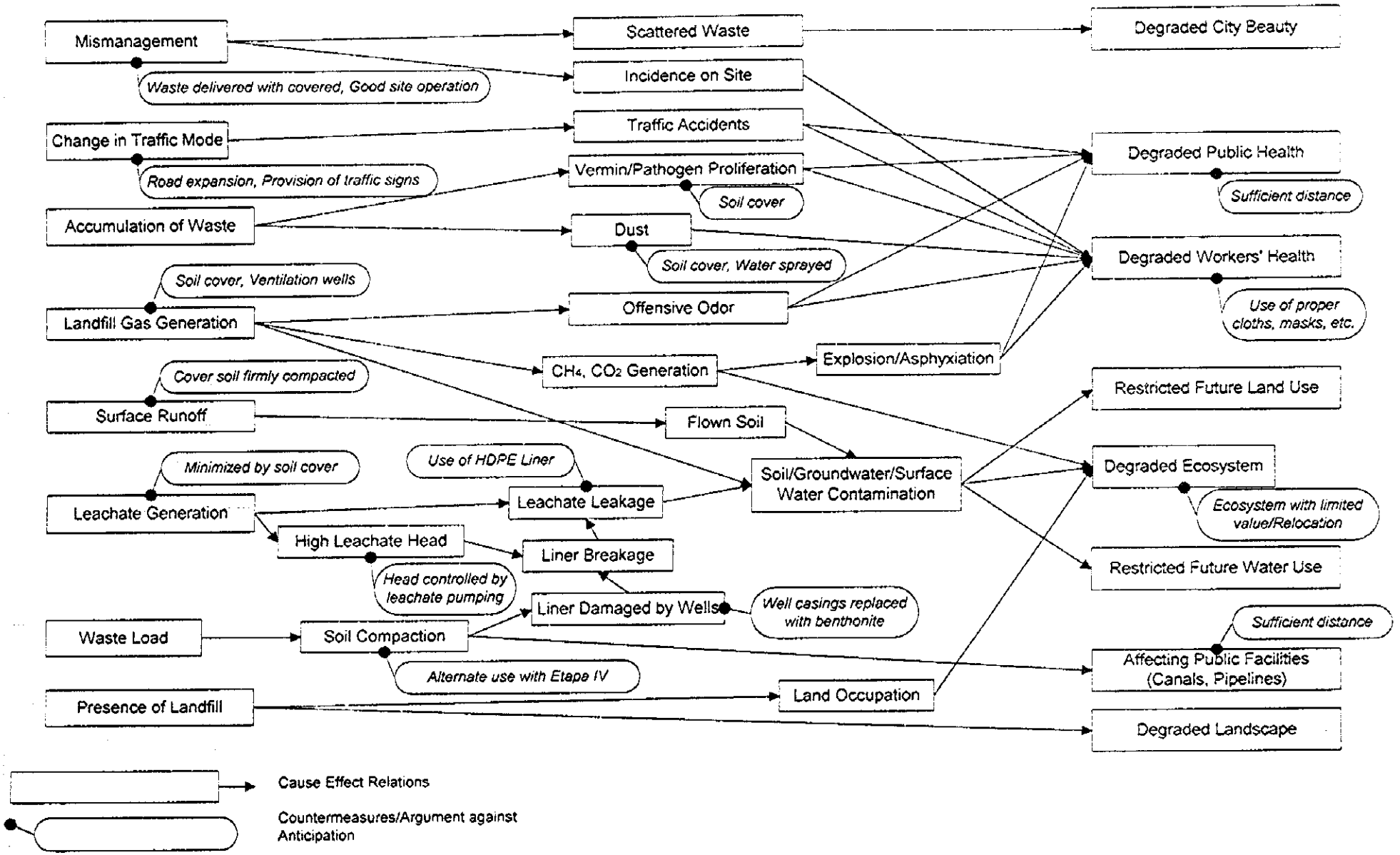

Figure 5-1: Cause Effect Relations (Etapa V Landfill Project)

5.1 Countermeasures

5.1.1 Use of Tarpaulin over the Delivered Waste

Effect: Sanitary waste delivery

Ensured by: Supervision of operation and instruction to the workers.

As the DGSU has been practicing so far, use of tarpaulin over the waste on the trailer during its delivery is continued. Experience of the DGSU suggests that this method works satisfactorily to prevent waste from scattering.

The execution of this practice is routinely checked and the tarpaulins are inspected to see if there are holes or tears. The workers are encouraged to follow this rule all the time of waste delivery.

5.1.2 Distance from Anticipated Impact Receptors

Effect: Prevention of impacts on adjacent residents, lowering visibility, and protection of public facilities.

Ensured by: Supervision of qualified engineers over the design and implementation procedure.

The location of the landfill allows a distance from three groups of receptors of anticipated impacts: residents, passers-by and public facilities.

The most adjacent population is found in Ecatepec municipality at a distance of about 2.5 km from the site. This distance will significantly reduce possible impacts on their health, including offensive odor and noxious fauna, to a negligible level.

The viewers of landfill could be the passers-by along the Autopista. Due to the distance from the highway from the site, about 0.6 km at minimum, its visibility is fairly small. This suggest that no significant impact on the perception of those people in terms of landscape or aesthetics is foreseen.

The design also leaves a distance of 70m from the public facilities, i.e. gas pipelines of PEMEX and canals, which otherwise could be distorted by the waste load stress.

5.1.3 Control of Waste Access

Effect: Prevention of landfill of unintended waste.

Ensured by: Instruction to the workers.

With a purpose to avoid the entrance of solid wastes which should not be disposed of at the landfill Evapa V because of their hazardous characteristics, a routine visual inspection will be made on two occasions.

In the inspection on the arrival of the waste trailers at the weighbridge, the following is observed:

- Type of vehicles (origin, relevant authority (delegation or municipality))

- Type of area from which waste was collected.
- Type of waste (either normal household waste, liquidish, powdery, oily, or any other).

In the inspection at the work front during the waste unloading:

- Type of waste.
- Presence of dangerous materials (sharp metal, glass, etc.).

In the event of identifying suspicious waste, the following actions are taken.

- Stop the disposal of the concerned waste.
- Obtain general data of the trailer and the waste (origin of trailer, place from which waste was collected, character and weight of the waste, etc.).
- Direct the waste to personnel of appropriate responsibility.
- Follow the relevant laws on penalty.
- Consider the preventive measures to be taken.

The site workers are instructed in advance how to carry out inspection, together with the knowledge about what kind of risk is accompanied by what type of waste.

5.1.4 Control of Vehicle Flow

Effect: Avoiding congestion of trailers and traffic accidents.

Ensured by: Supervision of qualified engineers over design and implementation of road engineering, supervision over vehicle movement and instruction to the drivers.

Expansion of the Autopista at the U-turn part and road signs along it to call attention of the general drivers to the movement of the waste trailers will facilitate the lane crossing by the trailers and minimize the possibility of traffic accidents.

The access road from the Autopista is 30m wide and 1.5km long. The space around the weighbridge is sufficiently large. Therefore, the entrance and exit area, where a lot of traffic can be expected at peak hours, has enough room to absorb and regulate the vehicle flow, and to ensure the safe traffic.

Inside and around the working cells, the movement of the trailers and other machinery is controlled to be one-way and at low speed by signs, instructions to the drivers and operators in advance and visual supervision by site managers.

5.1.5 Signboards

Effect: Minimizing risks.

Ensured by: Inspection of signboards

Inside the sanitary landfill, it will be indispensable to provide an indication system, basically for security of traffic (see above) and site workers to prevent accidents. Indications for the workers include "no smoking", "use of protection", "no enter", "attention to trailers", and others.

The system should be based on the nationally or internationally accepted symbols using standard figures and colors. The indication are clearly expressed on the signboards, which are made of resistant materials. They are placed at strategic points

which are perfectly visible at convenient distances but should not obstruct site operation. For this purpose, some will be fixed, while the other will be mobile.

Appropriateness of their expression, location and visibility of the signboards is regularly checked.

5.1.6 Daily Soil Cover

Effect: Prevention of odor emission, control of noxious vermin and pathogens, and control of rainfall infiltration.

Ensured by: Supervision of qualified engineers over operation and scheduled supply of material.

Within 24 hours after being disposed of into the working cells, waste is covered by soil, called tepetate, with thickness of about 30cm. By doing so, offensive odor emission is cut off, the development of disease-causing vermin and pathogens is prevented, and rainfall infiltration into the waste is minimized, hence so is the leachate generation.

The amount of storage of tepetate depends on the availability of the land. Considering that there is a vast space in the early operational stage of the first lift, 70m wide buffer area outside of the outer road, and 100m wide offsets on the first and second lifts, the room is abundant and can not restrict the tepetate storage amount.

The tepetate is supplied by private entities on contract basis through a bidding. The compliance of the contractors' performance with the contract is supervised by the GDF so that the supply is not suspended.

5.1.7 Impermeabilization

Effect: Prevention of groundwater intrusion into the waste, groundwater and soil contamination with leachate and migration of landfill gas.

Ensured by: Inspection of liner quality, supervision of qualified engineers over secured impermeabilization implementation and water quality monitoring.

The impermeable liner (geomembrane) of HDPE with 1mm thickness is laid over the cells before waste is landfilled. Since the permeability of this type of membrane is at the order of 10^{-13}cm/sec, there is virtually no passage of media. In other words, (i) groundwater does not intrude into the waste, thus leachate generation amount is reduced, (ii) the leachte is not allowed to flow out of the cell (together with an effect of the pumping and spraying method explained later), and (iii) migration pathway of landfill gas is intercepted. Therefore, the anticipated impacts caused by leachate and landfill gas, both of which are in fact the principle concerns of waste landfill, are significantly minimized, and it can be concluded that the employment of the geomembrane is a fundamental element of the proposed design of Etapa V.

Prior to the construction, land preparation is carried out by removing rocks or plants which might affect the liner. Besides, the casings of the existing wells are removed and replaced with bentonite. Before being employed, the liner is thoroughly inspected to see if there is a fault. After the inspection, it is anchored with sufficient depth at 4m distance from the cell edge. The liner is covered with tepetate with thickness of 50cm under the

road, 30cm under the cell slope and 50cm inside the cell in order to avoid physical damage.

Whether the impermeabilizatioin is functioning or not is monitored by regular analysis of groundwater and canals outside the landfill (see later).

5.1.8 Treatment of Leachate

Effect: Minimization of possibility of leachate infiltration.

Ensured by: Supervision of qualified engineers over the design, construction and operation of leachate treatment system and regular mechanical inspection

Leachate, collected on the bottom geomembrane, is lead to the 131 leachate suction pits prepared on the corner and intersections of the inner roads through the leachate drainage lines laid along the inner roads. Although the land is at first fairly flat, waste load will produce small gentle slope toward the center. Vertical pump-up shafts are equipped at 15 suction pits located in the central portion of the landfill, and the accumulated leachate is pumped up. The leachate is then sprayed over the landfill, encouraged to be evaporated.

In this manner, the undue accumulation of leachate, which would increase the possibility of leachate infiltration through the geomembrane, is avoided.

The functions of mechanical equipment (i.e. pumps and sprays) are regularly checked.

5.1.9 Landfill Gas Control

Effect: Prevention of unexpected landfill gas migration.

Ensured by: Supervision of qualified engineers over design and construction of ventilation wells and monitoring of wells' function.

The suction pits mentioned above also work as landfill gas ventilation wells. When biogas is generated, the air pressure becomes high, and acts as a driving force of gas movement in an opposite direction of gas pressure. Therefore, the suction pits, in which air pressure is the lowest inside the landfill, smoothly draw and vent gas.

Without such method, gas pressure inside the landfill becomes uneven. It can be partly so high that gas is forced to be concentrated in migration pathways of limited number. Consequently, the risk caused by gas migration, i.e. explosion by methane and asphyxiation by carbon dioxide, is raised.

In the ventilation wells, gas composition is monitored in order to see whether the ventilation system is functioning well.

5.1.10 Protection of Fauna

Effect: Protection of ecologically valued fauna species.

Ensured by: Supervision of experienced personnel over the design and implementation of fauna protection plan.

Before the project implementation, fauna species found in the project site and listed in the NOM-059-ECOL-1994 are trapped and escaped to the outside of the project site and its influencing area.

During the operation, instructions will be given to the personnel that works in the sanitary landfill not to bother, mistreat, kill or perturb the wildlife in the property or along the access road.

Such protection plan should be directed by experienced personnel to ensure its efficiency.

5.1.11 Reforestation

Effect: Avoidance of loss of cover soil, increase in green area, and introduction of a new habitat for wildlife.

Ensured by: Supervision of experienced personnel over reforestation planning and implementation.

After the closure, the landfill surface is planted. The vegetation cover will reinforce the stability of the cover soil, avoiding soil loss. It also provides a new green area which attracts wildlife. This measure, to be considered as environment enrichment rather than mitigation, should be highly evaluated considering the current poor vegetation at the site.

The reforestation plan is executed under the supervision of experienced personnel.

5.1.12 Access Control

Effect: Avoidance of accidents.

Ensured by: Instruction to the guards and inspection of the signboards.

Entrance of the general public is restricted by control of the guards and signboards at the entrance of the access road. The duty is instructed to the guards and the signboards are inspected regularly to make sure that they are visible by people.

5.1.13 Safety Surveillance

Effect: Prevention of risk for the workers.

Ensured by: Instruction to the workers and site supervisors.

Safety manuals are prepared which indicate actions to be taken in case of fire, injure, and other contingencies affecting the workers' safety.

Through the manual, and also oral instructions, the workers are urged to use appropriate clothes to protect themselves from injure, dust, heat, offensive odor, vermin/pathogens and any other health danger raised at the landfill. Such clothes will include gloves, masks, and boots.

5.2 Monitoring Programs

Monitoring program is undertaken with three purposes. One is to understand the ongoing activities inside the landfill so that the prediction of the impacts and planning of next actions to be taken are possible. Another is to ensure that the countermeasures are working properly, in other words, no contaminants that may affect public health and the surrounding natural environment are escaped outside the landfill. Finally, the collected data are to be interpreted so that they are reflected to the future landfill plans. Elements to be monitored are elevation of lifts, groundwater, surface water, leachate and landfill gas. The monitoring program is shown in Table 5-1.

i. Monitoring of Waste Decomposition

Monitoring settlement of the landfill is important in this site. The settlement will be caused by decomposition of waste and subsidence of the subsoil. Data obtained by this monitoring can be useful for the future landfill operation and land use after closure.

In addition to the monitoring of settlement, leachate and landfill gas quality, which can show the progress of waste decomposition, are also monitored.

ii. Monitoring of Environmental Quality

This monitoring will be conducted in view of environmental protection. It is recommended to monitor the quality of:

- groundwater at upstream and downstream of the site.
- surface water of drainage canals around the site at upstream and downstream.

In order to get samples of groundwater, four monitoring wells with 40m in depth are to be installed around the landfill because direction of the groundwater under the site is indefinite.

No evidence of groundwater contamination with leahate implies that the impermeabilization is working adequately. This further suggests that landfill gas migration through the liner is unlikely.

Table 5-1: Monitoring Program

Subject	Monitoring item	Frequency (per year)
Settlement	Elevation of lift(s)	1
Landfill gas	Temperature	2
	CH_4	2
	CO_2	2
	N_2	2
	O_2	2

Monitoring item	Frequency (per year)		
	Leachate	Groundwater	Surface water
Temperature	2	1	1
Color	2	1	1
pH	2	1	1
BOD_5	2	1	1
COD	2	1	1

	Frequency (per year)		
T-N	2	1	1
T-P	2	1	1
Cl^-	2	1	1
CN	1	1	1
Cd	1	1	1
Cu	1	1	1
Pb	1	1	1
Cr^{6+}	1	1	1
Hg	1	1	1
As	1	1	1

Part B
Chapter 6

Conclusion

6 Conclusions

The previous chapters discussed the benefits brought by the project, its importance in the urban society, and the anticipated influences of the modification of the natural and socioeconomic environment.

In concluding impact assessment, it should be emphasized that **the impact is a function of the character of recipients and the type of activities.** If the recipients are vulnerable or sensible, they can be affected however small the intended activities are, and vice versa. Therefore, impacts can not be assessed by looking at only one side: both the character of recipients and the type of activities have to be taken into account.

The recipients will be, in the present case, the environment, people, and the metropolitan society. The vulnerability or resistance of the environment at the site was assessed by referring to the NOM-059-ECOL-1994 in Chapter 1 and also reflected by the description of the current environmental status. It was inferred that the site is not particularly susceptible to the human interventions. Recipient people are at a distance from the site, which considerably reduces their vulnerability. Since all members of the metropolitan society produce wastes, it will be directly influenced by the project.

On the other hand, the activities at the site involves a number of preventive actions against negative impacts, such as the impermeabilizacion of the land with a geomembrane over the compacted clayey soil, construction of leachate collection and treatment facilities, the establishment of a buffer area around the landfill, site management measures as well as the implementation of monitoring programs will minimize threats on the human health and the risks of environmental contamination in the site and its influence area. Thus, the negative influence for the environment and people is largely suppressed. Besides, since environmental enhancement by reforestation after closure is also contemplated, the overall influence could be positive. On the other hand, for the society, the principle activity, i.e. disposal of municipal waste, is fundamental and indispensable and should have an invaluable influence.

In conclusion, the impact as a result of the character of recipients and the type of activities is, therefore, not significantly negative but could be even beneficial for the environment and people, and highly positive for the society.

Bibliography

Bibliography

ABC Estudios y Proyectos, S.A. de C.V., Marzo 1993, *Estudio de Impacto Ambiental del Sistema Integral de Manejo de Desechos Sólidos Bordo Poniente*, Contrato N. SU-2-31-1-800

BCIE, 1988. *Manual de evaluación ambiental,* Banco Centroamericano de Integración Económica. USA-Honduras.

Banco Mundial, 1992. *Libro de Consulta para Evaluación Ambiental,* Lineamientos Sectoriales. Departamento de Medio Ambiente. Trabajo Técnico Número 140

Berry, Horton, 1974. *Urban Environmental Management, Planning for Pollution Control,*. Ed. Prentice-Hall, New Jersey.

Ceballoz-Gonzalez G. 1984. *Mamíferos silvestres de la Cuenca de México,* Ed. Limusa. México. 299 pags.

Cedillo -SOSA, R.1978. *Investigaciones para el establecimiento de especies arbóreas en el Vaso del exLago de Texcoco.* SARH. México.

Comision para el Conocimiento de la Biodiversidad. 1999. www.conabio.gob.mx/biodiversidad

Camarillo, R. J. L. 1988. *Anfibios y Reptiles del Valle de México: Diversidad, Estado Actual y Conservación.* Pp. 330-345. EN: Segundo Simposium Internacional de Vida Silvestre. Acapulco, Guerrero (Memoria). (Coords., The Wild Life Society). SEDUE., :xxx+1-766.

Ceballos, G. G. y C. Galindo L. 1984. *Mamíferos Silvestres de la Cuenca de México.* Edit. Limusa, México. :1-299.

Chávez, C. M. T., A. Huerta L. y E. Valles-Rosales. 1985. *Evaluación Ecológica del Estado Actual del Ex-Lago de Texcoco y Alternativas Para su Manejo.* Pp. 884-903. EN: Memoria del Primer Simposium Internacional de Fauna Silvestre, Volumen 2. (Coords., The Wild Life Society y SEDUE). SEDUE., :xvi+633-1093.

Comisión Ambiental Metropolitana. 1998. *Programa para mitigar la emisión de partículas suspendidas en el Valle de México. Proyectos prioritarios en la Zona Federal del Ex – Lago de Texcoco.*

Consejo Nacional de Población. 1991. *Sistema de ciudades y distribución espacial de la población en México.*

Cruickshank, M. 1981. *Contribución al Conocimiento del Estado Actual de la Composición Florística del Ex-Lago de Texcoco. UAM-IZTAPALAPA, México.*

Diario Oficial de la Federacion 1998. *Acuerdo por el que se establece el calendario de aprovechamiento cinegético y el de aves canoras y de ornato para la temporada 1998-1999.* México.

Departamento del Distrito Federal. Secretaría General de Obras. Dirección General de Servicios Urbanos, 1992. *Planeación Estratégica del Relleno Sanitario de Bordo Poniente, Cuarta Etapa.*

Diario Oficial 25 de diciembre de 1996. *Norma Oficial Mexicana NOM-083-Ecol-*

1996, que establece las condiciones que deben reunir los sitios destinados a lla disposición final de los residuos sólidos municipales.

Diario Oficial de la Federación. 1994. *Norma Oficial Mexicana NOM-059-ECOL-1994, que Determina las Especies de Flora y Fauna Silvestres Terrestres y Acuáticas en Peligro de Extinción, Amenazadas, Raras y Sujetas a Protección Especial y que Establece Especificaciones para su Protección.*

Diario Oficial de la Federación. 1997. *Acuerdo por el que se Establece el Calendario para la Captura, Transporte y Aprovechamiento Racional de Aves Canoras y de Ornato, para la Temporada 1997-1998.*

Diario Oficial de la Federación. 1997. *Acuerdo por el que se Establece el Calendario Cinegético Correspondiente a la Temporada 1997-1998.*

Diario Oficial de la Federación. 4 de octubre de 1998. *Decreto por el que se desincorpora de los bienes de dominio público de la Federación, y límites de la Zona Federal del Ex – Lago de Texcoco.*

Estudios y proyectos Moro, S.A. de C.V. 1992. *Estudio Geológico – Geohidrológico de detalle en la zona de Bordo Poniente, Estado de México*

Flores-Villela, O.1993. *Herpetofauna Mexicana. Lista anotada de las especies de Anfibios y reptiles de México, Cambios Taxonómicos recientes, y nuevas especies.* Special publication No. 17. Carnegie Museum of Natural History.

Flores-Villela, O. 1993. *Herpetofauna Mexicana. Lista Anotada de las Especies de Anfibios y Reptiles de México, Cambios Taxonómicos Recientes, y Nuevas Especies.* Carn. Mus. Nat. Hist. Pittsburg., 17:iv+1-73.

Flores-Villela, O. y P. Geréz. 1994. *Biodiversidad y Conservación en México: Vertebrados, Vegetación y uso del Suelo.* 2ª ed. Comisión Nacional Para el Conocimiento y Uso de la Biodiversidad y UNAM, México., :xvi+1-439.

Gaceta Ecológica. SEMARNAP: 1989. *Instructivo para desarrollar y presentar la manifestación de impacto ambiental en la modalidad intermedia a que se refieren los artículos 9°., 10 y 11 del Reglamento de la Ley General del Equilibrio Ecológico y la protección al ambiente en materia de impacto ambiental.*

García, E. 1988. *Modificaciones al Sistema de Clasificación Climática de Köppen.* UNAM. México.

Geo Ingeniería Internacional, S.A. de C.V. 1992. *Proyecto de Instrumentación y caracterización de los sedimentos lacustres para el relleno sanitario IV Etapa, Bordo Poniente, en la Zona Federal, Lago de Texcoco.*

Geo Ingeniería Internacional, S.A. de C.V. 1992. *Proyecto de Instrumentación y Caracterización de las capas arenosas de los sedimentos lacustres Relleno Sanitario Etapas I y II Bordo Poniente en la Zona Federal del Lago de Texcoco.*

Geo Ingeniería Internacional, S.A. de C.V. *Características, migración y transformaciones del lixiviado generado por los rellenos de desechos sólidos urbanos de Bordo Poniente en sus etapas I y II, hacia el subsuelo lacustre y su impacto en el acuífero de la Ciudad de México.*

Geosol, S.A. de C.V. *Proyecto estructural de los caminos interiores para la cuarta*

etapa Bordo Poniente.

Gobierno del Distrito Federal. Gobierno del Estado de México. Organización Panamericana de la Salud. 1997. *Análisis Sectorial de residuos sólidos en la Zona Metropolitana del Valle de México y Anexo B, Perfiles de Proyectos Prioritarios.*

Gobierno del Distrito Federal. Secretaría General de Obras. Dirección General de Servicios Urbanos. 1998. *Reporte de resultados de monitoreo ambiental del Sitio de Disposición Final Bordo Poniente.*

Gobierno del Distrito Federal. Secretaría General de Obras. Dirección General de Servicios Urbanos. 1998. *Monitoreo ambiental.*

Gobierno del Distrito Federal. Secretaría del Medio Ambiente. 1997. *Informe anual de la calidad del aire en el Valle de México.*

Gobierno del Distrito Federal. Secretaría del Medio Ambiente. 1996. *Informe anual de la calidad del aire en la Zona Metropolitana de la Ciudad de México.*

Gobierno del Estado de México. 1995. CD.Rom.Su inversión florece en el Estado de México.

Grassetti Eduardo R., 1998. *Estudios Ambientales.* in Editorial Heliasta Argentina Peter Wathern., 1988. *Environmental Impact Assessment. Theory and Practice.* Ed. Routledge

Hernandez M.A. 1970. *El hábitat de las aves acuáticas migratorias en el Valle de México.* Informe Abril 1970. SAHR. Subsecretaría Forestal y de la fauna. Dirección de Fauna Silvestre. 34pags.

Howell, N:G:S: y S.Webb. 1995. *The birds of Mexico and Northern Central America.* Oxford University Press. Pp.851.

Huerta, L. A. M. T. Chávez y J. M. Chávez C. 1985. *Plan de Manejo y Desarrollo para la Conservación y uso Público de la Comunidad de Aves Acuáticas del Ex-Lago de Texcoco.* Pp. 678-903. EN: Memoria del Primer Simposium Internacional de Fauna Silvestre, Volumen 2. (Coords., The Wild Life Society y SEDUE). SEDUE., :xvi+633-1093.

INEGI, 1987. *Geología de la República Mexicana.* Instituto Nacional de Estadística, Geografía e Informática-UNAM (Facultad de Ingeniería). México.

INEGI, 1996. *Resultados definitivos tabulados básicos, Conteos 95, de Población y Vivienda.* Estado de México, Tomos I y II

INEGI, 1997. *Perfil Sociodemográfico.* Estado de México. Instituto Nacional de Estadística, Geografía e Informática.

INEGI. 1997. *Anuario Estadístico del distrito Federal.*

Lizárraga Jorge, 1981. *Evaluación de Impacto Ambiental.* UNAM-Facultad de Ingeniería. México.

Matamoros, T. G. y F. A. Cervantes. 1988. *Estudio Comparativo de la Dieta de una Comunidad de Roedores Silvestres del Ex-Lago de Texcoco,* Edo. de México. Pp. 425-434. EN: Segundo Simposium Internacional de Vida Silvestre. Acapulco, Guerrero (Memoria).(Coords., The Wild Life Society y SEDUE).

SEDUE., :xxx+1-766.

National Geographic Society.1989. *Field guide to the birds of North America.* National Geographic Society. Washington D.C. pp.464.

Peterson, R. T. y E. L. Chalif. 1989. *Aves de México. Guía de Campo de las Especies Encontradas en México, Guatemala, Belice y El Salvador.* Edit. Diana. México., :xxiv+1-473.

Poder Ejecutivo Federal. 1996. *Programa Nacional de Desarrollo Urbano 1995-2000.*

Ramirez-Pulido, Jr.l.Wilchis, C. Mudespacher y I. Lira.1982. *Catalogo de los Mamíferos nativos de México.* Ed. Trillas. México.

Rappole J. H., E.S. Morton, T.E. Lovejoy III and J.L. Rous. 1993. *Aves Migratorias Neárticas en los Neotrópicos.* Conservation and Research Center. Smithsonian Institution.

Robbins, C.S., B. Brunn y H.S. Zim 1983. *A guide to field identification. Birds of North America.* Golden Press. New York.

Rovirosa-Wade L. 1971. *Estado agrológico especial del ExLago de Texcoco.* SARH, México.

Rzedowki, J. 1978. *Vegetación de México.* Ed. Limusa, México.

Reyes-Castillo, P. y G. Halffter. 1976. Fauna de la Cuenca del Valle de México. *Instituto de Ecología.*, (1):135-180.

Rudoph, Herrera, y Yates, 1989. *Groundwater flow and solute transport in the industrial well fields of the Texcoco saline aquifer system near Mexico City,* Geofiscica International, vol. 28-2

Rzedowski, J y Rzedowski G. C. 1985. *Flora Fanerogámica del Valle de México.* Vol I. Escuela Nacional de Ciencias Biológicas (IPN) e Instituto de Ecología. :5-403

Rzedowski, J y Rzedowski G. C. 1985. *Flora Fanerogámica del Valle de México.* Vol II. Escuela Nacional de Ciencias Biológicas (IPN) e Instituto de Ecología. :7-674.

Rzedowski, J y Rzedowski G. C. 1990. *Flora Fanerogámica del Valle de México.* Vol III. Escuela Nacional de Ciencias Biológicas (IPN) e Instituto de Ecología. :7-494.

Rzedowski, J. 1988. Vegetación de México. Limusa, México. :9-397.

Sada A:M:, Phillips, A.R. y Ramos, M.A. 1984.*Nombres en castellano para las aves mexicanas.* Instituto Nacional de Investigaciones sobre recursos Bióticos. Cuadernos de divulgación No. 17. Xalapa,Ver. 54 pags.

SEDESOL, 1994. *Norma Oficial mexicana NOM-059-ECOL-1994, que determina las especies de flora y fauna silvestres y acuáticas en peligro de extinción, amenazadas, raras y las sujetas a protección especial y que establece las especificaciones para su protección.* Secretaria de Desarrollo social. Diario oficial de la federación. Mayo 16, 1994.

Secretaría de Desarrollo Social. Dirección General de Infraestructura y Equipamiento. Dirección de Residuos Sólidos. 1996. *Manual para la evaluación de los estudios*

de impacto ambiental aplicados a rellenos sanitarios

Secretaría de Desarrollo Social. Dirección General de Infraestructura y Equipamiento. Dirección de Residuos Sólidos. 1996. *Guía para la evaluación de un proyecto ejecutivo y estudio de impacto ambiental para un relleno sanitario.*

Secretaría de Desarrollo Urbano y Ecología 1989. *Información Básica sobre las Areas Naturales Protegidas de México. Secretaría de Desarrollo Urbano y Ecología.*

Secretaría de Desarrollo Urbano y Ecología. 1989. *Guía de Aves Acuáticas Cinegéticas de México. Dirección General de Conservación Ecológica de los Recursos Naturales*, México. :3-53.

Secretaría de Medio Ambiente, Recursos Naturales y Pesca, 1996. *Programa de Areas Naturales Protegidas de México (1995-2000).* Secretaría de Medio Ambiente, Recursos Naturales y Pesca.

Secretaría de Obras y Servicios. Dirección General de Servicios Urbanos. 1997. *Servicios Urbanos en la Ciudad de México.*

Secretaría de Programación y Presupuesto. 1981. *Síntesis Geográfica del Estado de México.* Secretaría de Programación y Presupuesto, México. :1-174.

Sistema Meteorológico Nacional. *Consulta directa de climatología de las estaciones ubicadas en el Aeropuerto Internacional Benito Juárez y la estación de Nezahualcóyotl.*

TGC Geotecnia, S.A. 1992. *Estudio geotécnico para el análisis de asentamientos en el Relleno Sanitario Bordo Poniente Etapa IV.*

Valles-Rosales, E. 1994. *Migración de Aves Playeras en el Lago de Texcoco, México.* Bol. Humedales de México., 5(2):6.

Vega, L. A. 1998. Aspectos Reproductivos y Ambientales de las Colonias de Anidación de Monjitas *Himantopus mexicanus* y de Avocetas *Recurvirostra americana* en el Ex-Lago de Texcoco (1987-1988). *Memorias de Experiencia Profesional* (Tesis). Esc. Nac. Cienc. Biol., IPN., :1-83.

Villa-Ramírez, B. 1952. *Mamíferos Silvestres del Valle de México.* An. Inst. Biol., Univ. Nal. Autón. México., 23:269-492.

Villegas, M. 1979. *Malezas de Cuenca de México.* Instituto de Ecología, México. :9-136.11

West, R.C. 1971. *The natural regions of Middle American.* P. 363-383, in Hanbook of Middle American Indians. Volume I. Second edition (R. Wauchope, ed), University of Texas Press,. Austin, Texas.

Wilson R.G., and H. Ceballos-Lascurain. 1986. *The birds of México City.* An annotated checklist and bird-finding guide to the Federal District. BBC Printing & Graphics Ltd.86 pp.