Estudio de prefactibilidad de un relleno sanitario en Tepic-Nayarit

Pre-feasibility study of a sanitary landfill in Tepic, Nayarit

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Resumen

El caso de estudio de la presente investigación es la ciudad de Tepic en el estado de Nayarit. Tras monitorear y determinar la gestión integral de los residuos sólidos en el vertedero el Iztete, se establecieron varios objetivos:

- Realizar un diagnóstico del vertedero el Iztete.
- Estudiar la caracterización física del vertedero.
- Realizar un estudio de prefactibilidad económica del relleno sanitario.

Dichos resultados indicaron la factibilidad de reciclar plásticos, vidrio, aluminio, papel y cartón. El estudio de prefactibilidad económica contempló el diseño de ingeniería de un relleno sanitario, incluyendo la planta de tratamiento de RSU. La base principal para el diseño fue la topografía del terreno y el cálculo de vida útil del relleno sanitario. El estudio demostró la viabilidad de recuperar y vender los materiales reciclados, generando ganancias anuales de aproximadamente seis millones de dólares.

Palabras clave: basura, caracterización física, evaluación económica, diseño arquitectónico, vertedero.

Abstract

The case of the present research study is the city of Tepic in Nayarit State. After monitoring and determining the integral management of solid waste in the landfill El Iztete, several objectives were established:

- A diagnosis of the Iztete Weir.
- Study the physical characterization of Weir.
- A study of economic feasibility of the landfill.

These results indicate the feasibility of recycling plastic, glass, aluminium, paper and cardboard. The economic feasibility study looked at engineering design of a landfill, including the Urban Solid Waste (RSU) treatment plant. The main base for the design was the topography of the terrain and the calculation of service life of the landfill. The study showed the feasibility of recovering and sell recycled materials, generating approximately six million dollar annual profit.

Key words: waste, physical characterization, economic evaluation, architectural design, landfill.

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Introduction

In the beginning, humanity generated waste biodegradable with high degree of decomposition, so that nature could retain its balance. Little by little, with the arrival of new technologies and machineries were generating non-biodegradable waste that have threatened the capacity of nature self-purging and, consequently, created a need for a control that diminish their negative impact (Bernard, 1999).

The system of handling of waste of the majority of the municipalities of Nayarit State consists of subsystems of manual sweeping, collection and final disposal. It currently has 22 final disposal sites, of which only three meet the NOM-083-SEMARNAT-2003, in terms of location, construction and operation restrictions; these sites are located in the

municipalities of Bahía de Banderas, Compostela and pulls, corresponding to the latter the regional landfill made up of the municipalities of Ahuacatlán and Ixtlán del Río and Jala. The rating of the site of final disposal of the municipality of Tepic is open dump (SEMARNAT, 2010).

The management of Municipal Solid Waste (MSW) in the city of Tepic is in charge of the Town Hall, which has serious shortcomings in technical, operational and management, as well as limitations on the availability of resources, equipment and infrastructure. This has led the City Council to a permanent state of technical and economic bankruptcy. To overcome this situation, it is urgent to reformulate the urban solid waste management system and make it more efficient, reduce operating costs and generate additional resources for the Town Hall. The starting point for the reformulation of the management system is to have reliable and up-to-date information on the characteristics of MSW generated in the city of Tepic.

Tepic is the largest city in the State of Nayarit, an urban area where it dominates the economy of the tertiary sector, with different socio-economic levels. The production of MSW in the city is a serious environmental problem, since it has increased from 300 tons in 2003 to 600 tons in 2011 and is expected to rise to 800 ton in 2015 (DAP, 2010). Its population is 380 249 inhabitants (INEGI, 2010).

This research paper provides technical and economic information necessary to verify the feasibility of construction of a landfill on the site of final disposal of MSW, which are currently deposited at the site called El Iztete, located in the city of Tepic.

MATERIAL AND METHODS

The methodology consisted of four major stages:

I. Diagnosis of the current conditions of disposal: where the methodology for physical and chemical characterization of Municipal Solid Waste is included.

II. Evaluation and selection of the site for the landfill.

III. An architectural design proposal based on the stage I and II.

IV. Economic evaluation of the project.

Stage I. Diagnosis of the current conditions of disposal.

With the intention of having specific information to measure the effectiveness of service demand clean and know the type and amount of waste that is collected in the dump Iztete City of Tepic, Nayarit, we proceeded to perform sampling random to determine the per capita generation of municipal solid waste, as well as the characterization and quantification of them. Figure 1 shows the methodology of physical characterization of MSW. The following steps are described:

A) The quantification and characterization of total solid waste was conducted in accordance with current Mexican regulations (SECOFI 1985 I, II, III), with a random sampling.

B) Sample and physical sorting

a representative sample for characterization by the quartering method was selected as the Official Mexican Standard NOM-AA-015 (SECOFI, 1985 I). The total sample for cracking was 8000 kg and sample characterization was 52.5 kg. Sample for characterization by-products were selected according to the classification of Gallardo (2006). The sample obtained at the site moved to the spaces of the Autonomous University of Nayarit and on a clean surface covered with polyethylene bags proceeded to physical and chemical characterization classification. Different screenings were performed and residues were classified into categories, describing each of the individual components constituting the MSW sample mass, and their relative distribution in weight percent.

FIGURA 1. Methodology physical characterization RSU

Stage II. Evaluation and selection of the site for the landfill: at this stage the morphology of the land and the life of the landfill was evaluated.

1. The delimitation of the land was mapped by a GPS (Satellite Positioning System), whereby the morphology and elevations that form it was obtained.
2. The life of the landfill was estimated using the equations described (Sandoval, 2011; Jaramillo, 2002).

Stage III. The architectural model was designed with respect to the results of the physical characterization and the life of the landfill (Cataño and Renteria Rodriguez Ibarra, 2012).

Stage IV. Economic assessment (Rodriguez Ibarra and Renteria Cataño, 2012). The first step to economically evaluate the landfill was to make the following assumptions:

- The cost structure and project evaluation are done in US dollars.
- 100% of the capital investment is from the beginning.

- The future costs of operating and maintaining the plant for solid waste treatment increase with respect to inflation at 4.5% annually, according to the Bank of Mexico (Mexico, 2013).
- The project's cash flow is calculated: Net Present Value and Internal Rate of Return by equations 1 and 2.

RESULTS AND DISCUSSION

The maximum solid waste generation The Iztete typical, according to the study, amounting to 414.5 tons / day. Figure 2 shows the distribution in weight percent by-product type of MSW sample. With regard to per capita generation, a population of 380,249, with which he was 1.09kg / per capita was considered.

STAGE I. Physical characterization was performed for three socioeconomic levels (high, medium and low) and noted variation in the type of waste. Figure 2 shows the result of the physical composition of MSW.

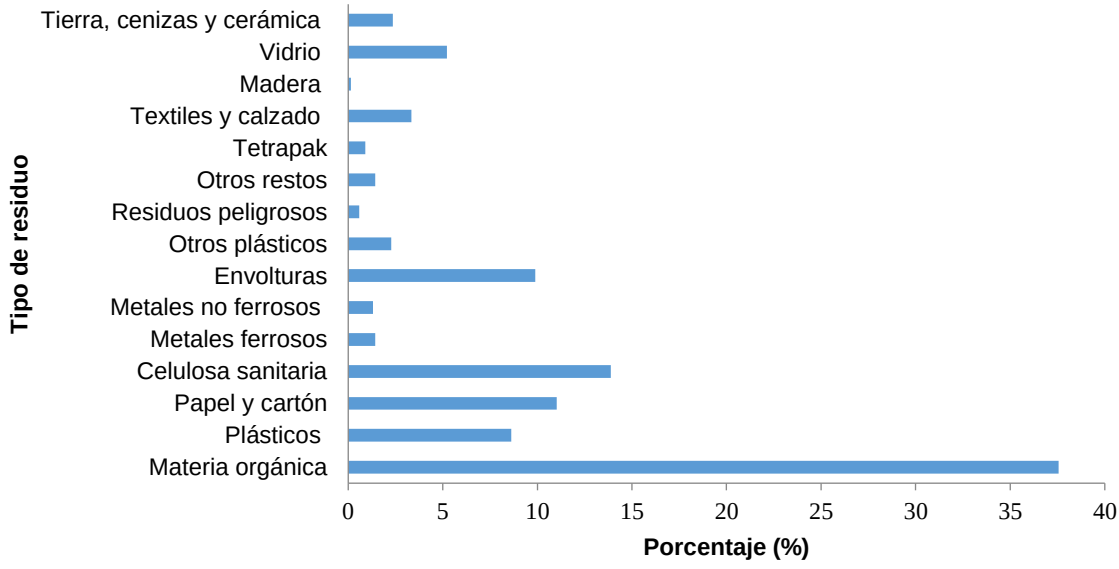

FIGURA 2. Physical composition RSU

The results of the physical characterization of MSW, components and percentages of the 16 main categories were: food scraps and pruning; Sanitary cellulose; paper and paperboard; plastics; glass; tetra pack; wood; footwear; textiles; rubber, rubber and leather; metals, RP (hazardous waste); earth, ashes and ceramics; and others. Subcategories as plastic PET, HDPE or HDPE, PVC or V, LDPE or LDPE, PP, PS, wraps, bags and other

disposable plastic that may be important for future applications as selective separation programs also represent origin, and the potential for the recycling market. The results determine alternatives that can improve the management of MSW. Organic matter represents the largest waste generation with a contribution of 37.56%. The volume of organic waste is significant and there is an urgent need to treat and to sustainable management for disposal.

The sum of the subcategories of plastics with 10.9% significantly contributes to the production, volume and space in the disposal of waste, however, most of these could be recycled at a transfer station. Moreover, the category of wastes for health cellulose (diapers, sanitary towels and napkins, in general) represents the third production with 13.88%, this material is compatible with all waste management options: in landfills, recycling, and composting and incineration. The categories of lower contribution rates, but they are significant for recycling were: paper and paperboard 11.03%, 5.22% glass, metals 2.74%, with 0.92% tetra pack, wood, footwear, textiles, rubber, footwear with 17.75%, etcetera.

STAGE II. The study area is located northwest of the city of Tepic, in the Ejido H. Casas. The land is comprised of a natural ditch, which serve as the basis for starting the landfill as shown in Figure 3. A total area was determined 82 874 m^2.

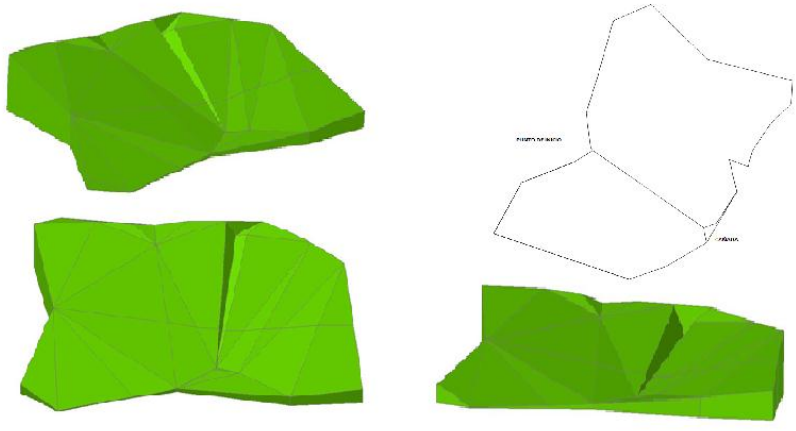

FIGURA 3. Morfología del terreno

The useful life of the landfill was obtained from the 414.5 tons of solid waste generated daily in the city of Tepic, of which 37.56% is organic matter; this organic matter will be

retrieved for generating biogas. The 30.81% are recyclable materials to be separated before entering the landfill process, while 31.63% is waste that is no longer possible to recover, so will be buried in the landfill. The life of the landfill is 10 years and will be operating 365 days a year. The total area of land the result shows that an area of 22 243.88 m2 and 7 meters deep is required, leaving the possibility of expanding the fill area up to 5 years. The capacity of the area should be large enough to allow its use for a period equal to or greater than five (5) years to life that is consistent with management, the costs of adaptation, installation and infrastructure works (Sandoval, 2011).

Site life depends on several variables, such as the available volume thereof, the amount of solid waste to be disposed and the operation method. For research and calculation were taken into account these factors. See Table I.

TABLA I. Total area required for the life of the landfill

Años	Desechos sólidos (kg/día)	Área total (A_T en m^2)
1	121 821	20 338.46
2	123 039.01	20 541.85
3	124 269.60	20 747.27
4	125 512.09	20 954.74
5	126 767.42	21 164.29
6	128 035.09	21 375.93
7	129 315.44	21 589.69
8	130 608.60	21 805.58
9	131 914.68	22 023.64
10	133 233.83	22 243.88

Stage III. The architectural design, distribution comprise 2 sections (I and II). Figure 4 shows the section I called Treatment Plant Solid Waste, located northeast and with an area of 2985 m2. Also, section II called fill area with an area of 22 243.88 m2 is located.

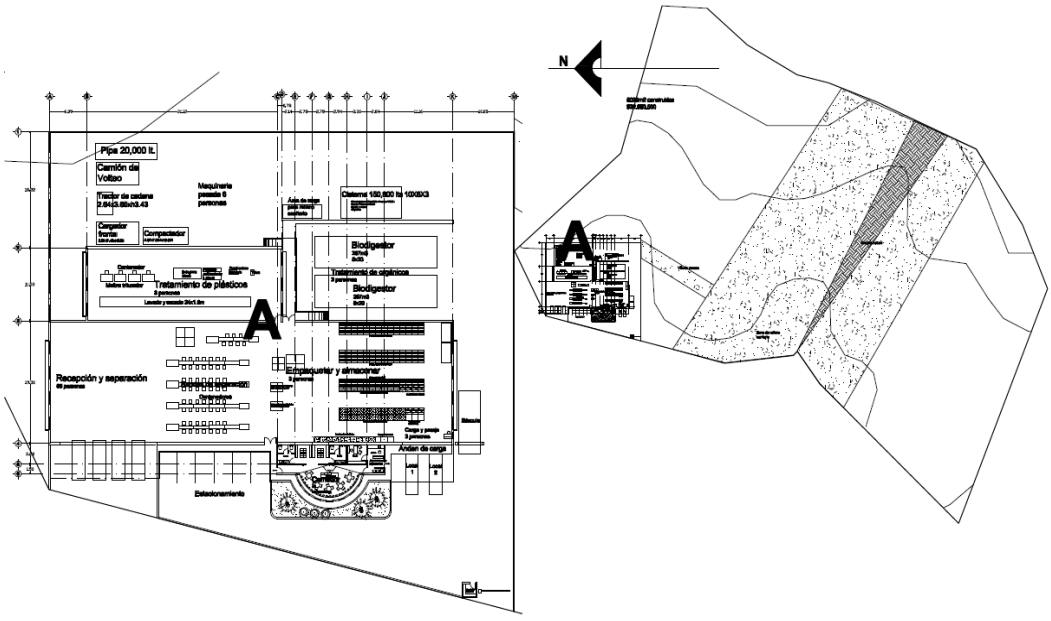

FIGURA 4. RSU treatment plant and landfill

The design of the treatment plant Solid Waste shown in Figure 5, the distribution consists of 3 sections: B, C, D; in Section B (Reception and separation) a specialized weighing tons that are received daily scale as well as marketing material is placed. The loading dock is ready to receive waste as well as for loading and unloading, comprising receiving hoppers waste.

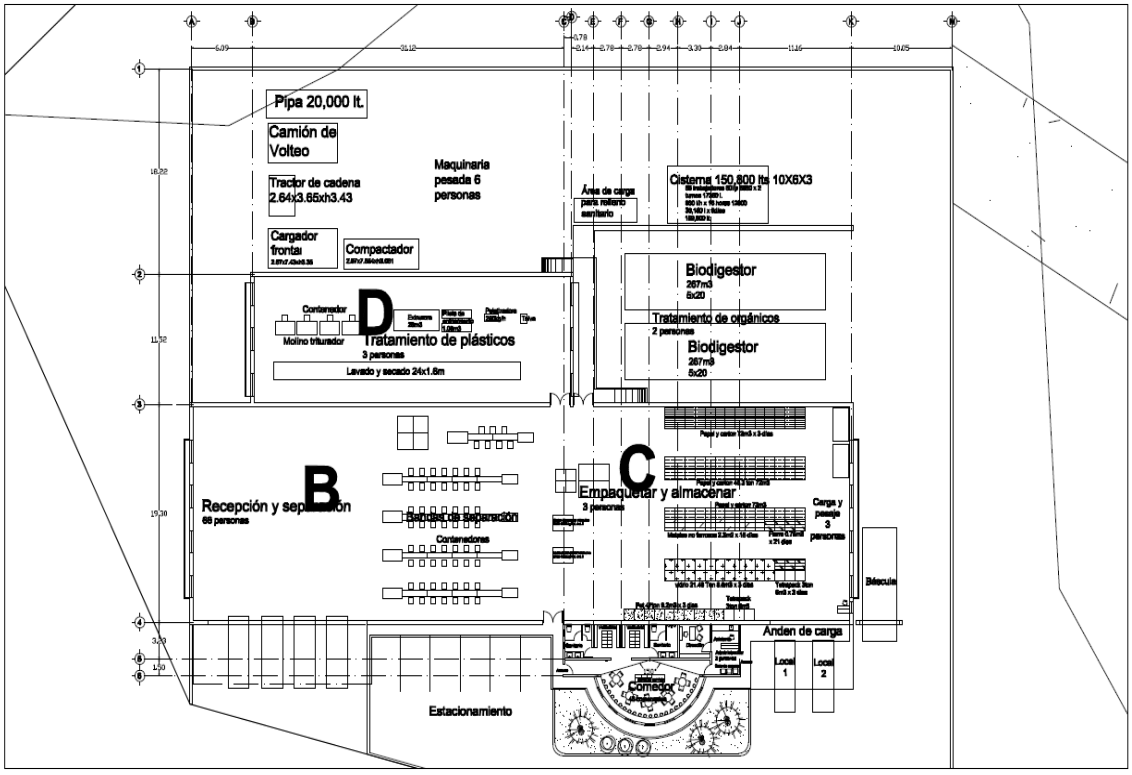

FIGURA 5. Planta de Tratamiento de RSU

Stage IV. Economic evaluation of the project. Total investment is estimated at an amount of $ 4,650 771.00 USD discrimination. Project income would be obtained from selling the material removed and properly treated, then in Table II prices are displayed for each kilogram of recovered material.

Retrieve paper, various plastics, PET, glass, ferrous metals, non-ferrous and tetrapack, brings the dilemma of a new alternative industry. The cost benefit was not calculated; however, the study was generated with a constant flow of economic benefit, as investment returns were positive. The cost-benefit does not require a government subsidy, because the investment is profitable and recoverable in less than 3 years. The cost-benefit and investment indicate that the regional TIR is highly feasible and suggests an investment in the company of other states or municipalities.

TABLA II. Year capital recovery

Tipo de residuo	Costo($USD)/Kg	Toneladas recuperadas /día	Recuperación por día ($USD)	Recuperación anual ($USD)
Papel y cartón	0.4	45.3	1 294	472 414.29
Otros plásticos	2	44.2	6 314	2 304 714.29
PET	9	3	1 929	703 928.57
Aceros o metales diversos	0.3	5.88	126	45 990.00
Metales no ferrosos	6.21	20	8 871	3 238 071.43
Vidrio	0.1	21.46	153	55 949.29
Tetra pack	2.8	3.77	754	275 210.00
TOTAL	---	143.61	---	7 096 277.86

* The price of recyclable materials are handled in Mexican pesos so that there is discrepancy in the recovered tons per year. Eventually they converted into dollars (USD).

CONCLUSIONS

- With respect to the physical characterization of MSW, it was determined by the method of quartering that biomass accounted for the largest percentage of the physical composition of MSW with 48.74%; Plastics 10.9%, 17.01% non-recoverable materials, recyclable materials 8.88%, 13.88% and 0.59% cellulose health hazardous waste. It is concluded that organic matter is the main material generated by the city of Tepic, representing an issue of high contamination due to decomposition, because there is not a separation plant, recycling and treatment of MSW in the current mess " The Iztete ".

- For the engineering design, the physical characterization allowed to calculate the area required for the life of the landfill, which was 10 ± 5 years.

- The investment required for the proposed architectural design was $ 4,650 771.00 USD, total revenues of $ 7,096 277.86 USD with an annual increase of 1%, total expenditures of $ 211 670.29 USD, calculated wages, maintenance costs and annual inflation of 4.5%, which allowed generating cash flow.

- The physical characterization of MSW, the proposed engineering design and analysis of economic feasibility study, led to the conclusion that the approach of a new landfill is

highly profitable and viable; in addition, it meets current regulations, allowing the municipality of Tepic medium term counter environmental problems in your community.

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