

Comprehensive Municipal Solid Waste Collection and Final Disposal Project for Agua Prieta, Son.

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Executive Summary

Agua Prieta, Sonora, like other communities and cities in Mexico and other parts of the world, currently faces serious environmental pollution caused in large part by the inadequate and inefficient disposal of solid and liquid wastes in the community. With regard to municipal solid wastes, the Municipal Government of Agua Prieta lacks sufficient economic, material, and human resources, and therefore faces critical problems in providing adequate public maintenance services, such as: street cleaning and collection, transportation, and final disposal of solid wastes.

Because the maquiladora industry in the area has experienced a significant increase in its activities, between 1970 and 1995, the population of Agua Prieta, Sonora increased from 20,754 to 54,000. This increase also extended to the surface area occupied by the city, going from 2,143 to 4,000 acres during the same time period, which signifies an annual average land use rate of 4.3 percent, and a gross average of 13.5 residents per acre. This growth has caused a backlog of urban infrastructure and public services, especially with regard to public maintenance, which requires immediate attention.

The city of Agua Prieta, Sonora, has facilities, equipment, and staff that provide public maintenance services; the department has 12 street sweeper persons and 6 drivers, that provide street cleaning services mainly to public streets and areas in the commercial and downtown sections of town. The department also has 12 collection and compacting trucks, which are between 10 and 28 years old; a CAT D6 tractor which has been in service for 16 years; one front loader with a 1.5 yd³ capacity; four dump trucks, each with a 9 yd³ capacity and which are between 2 and 25 years old; and an open air dump site with a 25 acre surface area. Ten acres of the dump site are currently being used to store scrap automobiles and other large volume items; 15 acres of the dump site are actually used for the disposal of solid wastes.

The infrastructure capabilities allow for daily cleaning of 1.46 acres of public streets and roadways; the collection and final disposal of 32.5 tons of domestic solid wastes generated by approximately 12,131 households and of 12.2 tons of non hazardous solid wastes generated by 597 industrial, commercial, service, hospital, and office facilities as well as by public areas. The 53.7 tons of garbage being handled on a daily basis represent 90.8 percent of the total amount of solid wastes being generated by the community. This means that there are 5.4 tons being deposited in illegal dump sites, which have yet to be identified and controlled by the local authorities.

The collection services provided by the Department of Public Services of Agua Prieta, are aimed primarily at the residential areas and commercial sector in the center of town. The city has been divided into 16 areas which total 4,001 acres. Services are provided twice a week to all 16 areas; and on a daily basis to the commercial sector. Residents must store their garbage for three days which poses a risk to the health of the population and encourages the proliferation of insects and rodents.

The final disposal of solid wastes is carried out in an open air dump site, though the Municipal Government of Agua Prieta has recently carried out efforts to cover the garbage with layers of soil. This will avoid any negative environmental effects that could be caused by the open air dump.

With regard to recycling of byproducts, there are approximately 10 scavengers who sift through the garbage for iron, aluminum, and cardboard without any protection, either technical or sanitary. According to figures provided by these people, they collect 1,760 lb of iron, 176 lb of aluminum (cans), and 2 tons of cardboard on a weekly basis. These amounts have not been considered substantial in terms of the average volume and composition (determined in accordance to standard NOM-AA-22-1985) of garbage being generated by the community.

In Agua Prieta, the lack of technical, sanitary, and environmental controls in the collection and final disposal of solid wastes, has resulted in serious pollution problems, which translate into: deterioration of the landscape, air, ground, and water pollution, negative impacts on the wildlife of the region, proliferation of diseases, and the presence of scavengers at the dump site, working without the proper protection or any type of technical control.

To address these environmental issues and also to ensure the population of Agua Prieta a quality of life, that is represented by the preservation of their environment, through an comprehensive public maintenance system, that is technically and environmentally sound, the project will focus on the following activities:

Restructure the collection service by redesigning routes and purchasing the collection trucks necessary to provide service to the community, based on these routes. This will ensure a timely and continuous collection service.

Equip and construct the landfill in accordance with existing regulations, to avoid negative effects caused by inappropriate disposal of municipal solid wastes.

Close the existing open air dump site to mitigate any negative environmental effects caused by this type of facility.

Strengthen the institutional capacity of the Municipal Public Maintenance Department to guarantee an efficient management and operation of the system.

The project is an environmental infrastructure project and subsequently complies with the objectives of the Border Environment Cooperation Commission (BECC); therefore the Municipal Government of the Agua, Prieta, Sonora, has requested certification, and subsequent financing by the North American Development Bank, through a loan to cover the project capital investment.

1. General Project Information

The primary objective of the project is to give the City of Agua Prieta access to the facilities and equipment necessary for it to provide its residents with an efficient public maintenance service, which would include: street cleaning as well as collection and final disposal for solid wastes. With these means the city will be able to promote and encourage the preservation of the environment.

The project applicant is:

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Pursuant to Article 115 of the Constitution of United Mexican States, this authority has the right and responsibility, among others, to provide public maintenance services. In addition, the Ley Orgánica de Administración Municipal del Estado de Sonora, with regard to the faculties and obligations granted to municipal governments, Article 37, Paragraph XI, states that municipal governments are responsible for providing public maintenance services in their areas of jurisdiction.

The project is located within the city limits of Agua Prieta, Sonora, which is in the northeast area of the State of Sonora, México, 233 miles from the state capital, Hermosillo. The city is located on the border opposite Douglas, AZ, also very near Cananea and Naco, Sonora, as well as Bisbee, Arizona. It can be accessed by federal highway No. 2 to Mexico City and state highway No. 80 to Arizona.

The City Government of Agua Prieta submitted an application for certification to the BECC for a landfill project that addresses the basic infrastructure problems of the community; the project, however, did not originally comply with the BECC fundamental criteria for certification. In order to comply, the project applicant submitted a request for assistance to the BECC, especially in areas related to engineering, financing, and institutional capacity building. The assistance was granted as part of the Project Development Assistance Program (PDAP).

Local authorities, responsible for street cleaning, collection, transportation, and disposal of the solid wastes generated in the community, currently face serious problems regarding their ability to offer these services with the required technical, sanitary, and environmental controls. Some of the problems they face are:

Inefficient utilization of available staff capabilities for street cleaning, resulting in the accumulation of trash on public thoroughfares.

Outdated collection equipment, between 10 and 28 years old, which translates into shortages in collection capabilities.

Low efficiency levels of the services being provided, due to outdated collection equipment, causing a reduction in the number of residential area collections.

The existing open air dump is operated without any of the required administrative, technical, sanitary or environmental controls, resulting in the unmanageable dumping of garbage.

The lack of controls has also frequently resulted in fires, which spurred by dominant winds, take the smoke and foul odors to the community.

Lack of equipment to arrange, compact, and cover the solid wastes according with established technical standards.

A collection system for recycling of byproducts without any of the required technical or sanitary control measures.

Institution lacks capacity to maintain an efficient level of operation and control of the system.

These problems are causing continuous environmental pollution, which if not addressed adequately, will cause irreversible damage. Described below are some of the adverse effects:

Fouling of the Landscape. It is caused by the presence of tons of garbage dispersed in a area full of smoke and dust, and in which garbage pickers, insects, rodents and wild animals live together. This situation is not limited to the area occupied by the dump site, it reaches out to a larger surface area, due to the fact that the wind takes paper and other light weight materials a considerable distance from the site.

Air Pollution. In addition to the smoke and gas that is dispersed by the wind, organic matter contained in the garbage produces foul odors during the decomposition process, which are then carried into the outlying areas.

Soil Pollution. The adverse effects on the soil caused by the open air dump site are a direct cause of leachates and dispersion of the waste.

Water Pollution. Leachates, produced during the decomposition of the wastes, contain high concentrations of toxic substances, which are not controlled and are seeping into the groundwater as well as flowing horizontally to surfacewater courses. This problem is critical given that the aquifers and surfacewater resources are the only source of drinking water for the city; the permanent contamination of these sources would create serious health problems. Furthermore, the Agua Prieta River is less than 300 feet from the dump site, and could therefore be affected by this source of pollution.

Flora and Fauna. Uncontrolled dispersion of garbage and leachates are affecting the flora and fauna in the area, particularly leachates with high concentrations of pollutants, such as heavy metals, BOD, COD, low pH levels, among others, and which can be fatal to animal and plant species.

Socio-Economic Effects. An open air garbage dump encourages garbage pickers to move in. These people sift through the garbage and collect material for resale under highly unsanitary conditions; in addition, the surrounding area is no longer a potential site for productive activities or urban development.

Impact on Health. Un-managed garbage dump sites give rise to a large amount of pathogenic micro-organisms; they also create favorable conditions for the proliferation of disease carrying (vector) organisms.

The solution to these problems lies in the selection and construction of the most appropriate solid waste management process, that conforms to the environmental, financial, and social conditions of the City of Agua Prieta. Upon review of the physical, chemical, biological, and thermal processes, it was determined that the most viable process for this landfill is a compacting process. This option also presents the best technical and financial requirements.

Nine possible locations were analyzed during the landfill site location/selection process. These options were evaluated utilizing the criteria proposed by SEDESOL; which include: useful life-time, surface for coverage, topography, access roads, dominant winds, location of site in relation to the urban area, geology, geohydrology, surface hydrology, and land rights. Based on these criteria, the site selected is a plot located 1.9 miles to the southeast of the city limits, adjacent to the Ejido Agua Prieta (public land). It is also close to the city firing range.

The plot selected covers 49.4 acres of public land which have not yet been designated for any specific purpose. In order to legally occupy the site, the Municipal Government of Agua Prieta has arranged with the Ejido de Agua Prieta for the transfer of property rights.

The proposed project will comprehensively solve the problems related to public maintenance services of the City of Agua Prieta and will require the following components:

Collection: Purchase collection trucks to replace the oldest ones in operation.

Landfill: Build basic infrastructure after purchase of property; prepare cells and cover material; construct drainage system and evaporation ponds for leachates, biogas control system, and internal roads; construct secondary projects which include: access roads, control booth, surface drainage system, scales, fence surrounding property, signs, restrooms, landscaping, and structures to contain light materials; and purchase equipment, i.e. trucks, tractors, and compactors.

Closure Program for Existing Landfill: Build maintenance systems to monitor and control leachates and biogas; shape surface layers, and landscape area.

Recycling: Analyze technical and economic feasibility of a collection and recycling system.

Institutional Capacity Building: Develop a user database, a preliminary plan for modifying the public maintenance regulations; design an administrative reorganization program, design a managerial and commercial information system, which will include the necessary training; and purchase the computer equipment required for implementation and operation of the system.

The total cost estimated to be necessary to implement this project is \$2 million dollars; the breakdown for this amount is the following:

\$0.51 million - solid waste collection services,
\$0.91 million - landfill,
\$0.16 million - closure program for the existing landfill,
\$0.12 million - institutional capacity building, and
\$0.30 million - unexpected expenses, oversight of construction, taxes.

The required time frame for project implementation is approximately 12 months, as described below:

Construction Program

ITEM/MONTH	1	2	3	4	5	6	7	8	9	10	11	12
1. Collection						X	X	X				
2. Landfill												
2.1 Basic Infrastructure	X	X	X	X	X	X	X					
2.2 Supplemental Projects		X	X	X	X	X	X	X				

2.3 Equipment			X	X	X	X	X	X				
3. Closure of Existing Dump Site						X	X	X	X	X	X	X
4. Institutional Capacity Building			X	X	X	X	X	X	X			

2. Environment and Public Health

The environmental problems currently experienced by the community of Agua Prieta, generated by the inadequate disposal of its solid wastes, are critical due to their negative impact. An immediate solution to these problems requires the construction of a landfill that complies with existing regulations.

This project aims to avoid the progressive environmental degradation which is currently experienced; in addition, closure of the existing open air dump site implies that the necessary measures will be taken to mitigate and restore the area.

Compliance with different standards and laws, relating to pollution prevention and control is required. The Norma Oficial Mexicana NOM-083-ECOL-1994, defines the required conditions for sites that will be used as landfills for the final disposal of municipal solid wastes. The site selected for the landfill complies with the specifications outlined in this NOM, in relation to soil, groundwater tables, useful life-time, location in relation to water bodies and urban areas, as well as surface drainage and topography.

Compliance with NOM-084-ECOL-1994 is also required; this standard establishes the landfill design and supplemental projects. The design of the proposed landfill is subject to the guidelines and procedures established under this NOM.

With regard to the Ley General del Equilibrio Ecológico y la Protección al Ambiente, the article pertaining to the public maintenance law is: Article 6, Section XII, which addresses environmental preservation and protection in urban areas; and Articles 110, 117, and 134 pertain to prevention and control of air, water, and soil pollution.

In addition, the project falls under Chapter III of the Ley 217 del Equilibrio Ecológico y Protección del Ambiente for the State of Sonora, which pertains to the prevention and control of soil pollution by non hazardous solid waste, specifically in articles 106, 107, 108, and 109. Furthermore, under Article 22, Section IV, Paragraph VII, which pertains to environmental impact assessment requirements.

Currently, the general format of the Environmental Impact Assessment is being developed and will be submitted for authorization to the Secretariat of Urban Infrastructure and Environment of the Government of the State of Sonora. The National Anthropology and History Institute (Instituto Nacional de Antropología e Historia), has been requested to certify that the project has no impacts on historical or cultural resources. In addition, the National Water Commission (Comisión Nacional del Agua) has also been requested to certify that the project has no impacts on any surface or ground water resources.

The project area is located in the Sub-Province of the Sierras and Valles Paralelos, which is a part of the Provincia Fisiográfica de la Sierra Madre Occidental; this region is characterized by valleys surrounded by mountains and isolated mountains. The geology is sloped with alluvial formations caused by the rocky formations in the surrounding areas; there are no structural characteristics that would have any negative effect on the construction of the landfill. Geologic and geophysical studies have indicated that the project area is made up of a layer of sandy clay with low permeability making it appropriate for construction of the proposed project. The site is located 3.4 miles away from the closest surface water course, the Agua Prieta River; the water table is 477 feet below the surface.

The project has no impact on the physical environment; it does, however, have a positive impact on the social and economic conditions within the project sphere of influence. Based on studies carried out by SEDESOL, the environmental, sanitary, and social benefits resulting from a landfill, when compared to the existing open air dump in Agua Prieta, are outlined below:

Environmental, Sanitary, and Social Benefits of a Landfill

FACTORS	OPEN AIR DUMP SITE	LANDFILL
Ground	Serious pollution, loss of value.	Avoids pollution, recovery of unused land.
Water	Pollution of surface and ground water sources.	No pollution is caused.
Air	Fires produce dust, smoke, and toxic gases.	No emissions caused by fires.
Wild Flora & Fauna	Poisoned and die.	Not affected
Dangerous Animals	Proliferation of flies, rats, etc.	Controlled
Sanitary	Proliferation of disease carrying vectors and other types of rodents.	Complete rodent control
Socio-Economics	Effects on agriculture, fishing, commercial, and recreational activities and on populated areas. Encourages economic activities under deplorable conditions.	Minimal effects
Landscape	Negative impact.	Minimal effects.

Source: Manual Técnico-Administrativo para el Servicio de Limpia Municipal. SEDESOL. November, 1995.

3 Technical Feasibility

For the final disposal of municipal solid wastes generated by the community of Agua Prieta, the process being proposed is physical and is carried out through the compacting of waste at the site of the landfill.

The landfill process is a technique used for the disposal of garbage into the ground, without affecting the environment, and without causing problems or a danger to public health and safety. This method also incorporates engineering principles to confine solid wastes into the smallest surface area possible; it reduces the volume of solid wastes by compacting them into the smallest volume possible, and covers the wastes, deposited in this manner, with a layer of dirt as often as required, or at the end of every day. The objective of having a landfill is to establish a barrier between the environment and the waste, reduce and control gas emissions, and avoid seepage and leaking of leachates produced during the decomposition of the wastes.

Based on analysis of the physical, social, and environmental surroundings of the project, and also on the program relating to development of the south side of Agua Prieta, the most feasible location to implement the landfill was chosen from among 9 choice sites. The selected site is located next to "firing range II" (campo de tiro II), which is 1.9 miles away from the city limits and within the limits of the Ejido Agua Prieta.

Basic evaluations were carried out to determine whether the selected site complies with conditions outlined in the Norma Oficial Mexicana NOM-083-ECOL-1994. The evaluations include: topography, to determine whether the natural slope was less than 30 percent; geotechnical, determined whether the subsoil material in the area has a permeability coefficient of 3.9×10^{-6} in/s; geophysical, determined that through 9 vertical electrical drillings (VED), distributed in four 164 ft deep profiles, three units or strata were identified, containing material showing low levels of permeability; no structural anomalies; and the geohydrology, determined that the slope of the surface, in relation to the groundwater tables, is approximately 477 feet, it also determined that the layers under the landfill site are impermeable and the Agua Prieta aquifer will not be affected by leachates caused by the landfill.

According to available information provided by INEGI, and the Population and Housing Census, during the last four decades the City of Agua Prieta, has experienced a rapid growth in population. Between 1950 and 1990, the population grew from 10,469 to 37,664. Furthermore, according to the 1995 Census, the population was at 56,228; 96 percent (54,000) of the population is urban while the remaining 4 percent (2,228) is rural and living in small communities located within the city limits. Based on the this information, the growth rate for Agua Prieta is 3.7 percent.

Due to development prevalent in the area, specifically in the maquiladora/export industry, projections indicate that these conditions will remain constant. The average population growth rate will remain at a constant annual rate of 3.7 percent. Based on this annual growth rate, for 1996, the population is estimated at 56,003, and by 2016, it is expected to reach 116,045. This is also the last year of the project useful life-time.

STREET CLEANING

Sweeping services for public streets are provided primarily in the commercial district and downtown area of the city. Streets are cleaned manually by a 12 person public maintenance staff. According to data provided by the Public Services Department, service is provided to 0.61 miles/day, equal to 0.05 miles/sweeper/day. It must be noted, that the surface cleaned sums up 1.8 percent of the 34 miles of paved city streets and represents a considerable shortage in the service provided.

Based on data developed by SEDESOL, the efficiency levels for this service are 0.32 miles/sweeper/day; considering that the city has 34 miles of paved avenues and streets it has been determined that a public maintenance staff of 98 would be necessary to provide daily service to 100 percent of the public streets. However, given the accumulation of trash on city streets, a 30 member staff would be able to provide daily service to all streets in the downtown area and service the remaining paved streets only twice a week.

GARBAGE COLLECTION

Collection services are the most important element of an integral public maintenance system requiring between 60 and 80 percent of the total costs. Currently, collection services for the City of Agua Prieta, utilize a direct sidewalk pick up service. This service consists in vehicles going through the city streets with operators picking up garbage that has been placed in either trash cans or plastic bags along the sidewalk. Each truck has an assigned sector or zone. Once the truck is full, it transports the garbage to the final disposal site.

The City Government of Agua Prieta has 13 collection trucks, though only an average of 9 are in working condition at a given time; these trucks provide service to the 16 areas of the city that have been zoned for collection service. On the average, seven trucks must work double shifts. Because routes are long and efficiency levels low in all the sectors, only two pickups per week are feasible; users must store their garbage between 2 and 3 days before their next pickup.

Collection services are provided to 91 percent of all residential areas, as well as to some businesses and offices located in the downtown area of the city. The daily collection of garbage totals 44.7 tons, 24.7 tons during the first shift and 20.0 during the second shift; considering there are nine trucks during normal operations, efficiency levels are 5 tons/truck/day. This is a low collection rate equal to 2.8 tons/trip/truck.

Based on measurements in May, 1996, the basic information on collection provided the following results:

Weight of garbage in truck sampled 6147 lb

Truck Capacity : 20 yd³

Mean density of garbage: : 309 lb/yd³

In addition to the solid waste being handled by the collection system, there are businesses and private citizens that take their garbage directly to the city dump. According to estimates from the measurement study mentioned above, this form of disposal reaches a total of 9.1 tons/day.

Based on these volumes of garbage and also according to local authorities, illegal dumping reaches 9 percent of the total amount of garbage being disposed of in the city dump. It has also been estimated that the City of Agua Prieta generates 59.2 tons of garbage daily, equal to 2.33 lb/person/day, given a population of 56,003.

The project proposes to provide collection service to 100 percent of all generators of solid waste, but assumes that 9 percent of all wastes will continue to be deposited directly by users into the landfill. Basic information on the collection project was defined under this consideration.

The project proposes the immediate purchase of seven collection trucks to replace the existing fleet and includes the stepwise purchase of the remaining trucks, until a total of 13 is reached at the life cycle of the project.

INFORMATION ON COLLECTION SYSTEM

ITEM	UNITS	CURRENT STATUS 1996	PROJECT STATUS 1997	PROJECT STATUS 2016
Population (1995)	Capita	56,003	58,081	116,894
Rate of Garbage Generation	lb/caput/day	2.33	2.33	2.33
Amount of Garbage Generated	Ton/day	59.2	61.6	123
Collection Requirements	Ton/day	53.8	56.0	112
Mean Garbage Density	lb/yd ³	308	308	308
Total Collection Req. (Volume)	yd ³ /day	385	400	801
Capacity of Trucks	ton	6.0	6.0	6.0
Trucks Required	#	9	9	19
Available Trucks	#	9	7	13
Double Shifts	#	7	3	6

FINAL DISPOSAL

In spite of efforts being carried out by authorities in Agua Prieta, currently 53.8 tons of solid wastes generated by the community, are being disposed of in an open air dump without any technical controls.

Based on information collected, currently garbage is collected with trucks and compacted to an average density of 308 lb/yd³; during the disposal process it increases in density to 843 lb/yd³; and then increased by an additional 169 lb/yd³ to 421 lb/yd³, when the garbage is covered with top soil material. Pursuant to Official Mexican Norm NOM-083-ECOL-1994, which establishes landfill volume requirements, it is advisable to consider a density of 843 lb/yd³ in an open, daily cell design. To determine the landfill useful life-time, the density should be considered at 1,264 lb/yd³.

Considering disposal in rectangular cells, the spatial and volumetric characteristics have been established for the daily cell for each year of useful life-time of the project, considering thicknesses of 5.6 ft of garbage, 1 ft of cover material between layers, and 52 ft wide daily cells of variable length.

Characteristics for the daily cell during the life of the landfill are the following:

DESIGN FOR DAILY CELL PROCESS

Year	Population Inhabitants	Garbage Generated Ton/day	Volume of Garbage yd ³ /day	Volume of Top Cover yd ³ /day	Total Volume yd ³ /day	Surface of Daily Cell ft ²
1997	56,003	62	160	47	207	1,412
2000	64,788	69	179	51	229	1,568
2005	77,732	82	214	59	273	1,870
2010	93,262	99	257	68	325	2,233
2011	111,894	119	308	82	390	2,764

Based on topographic surveys of the selected site, 49.4 acres of surface area are available for the landfill project; surveys also indicate the feasibility of disposing of solid wastes in four layers. Each of the four layers will be 4 feet deep; the middle/interval layers will be 1 foot deep; and a top cover seal will be 2 feet deep. Furthermore, in order to obtain the highest efficiency levels of the surface area and given the natural slope of the selected site, the project proposes to develop the landfill with 5 layers that will be 21 feet deep each, with a 3:1 slope. The first three layers will be buried under the natural terrain and the two subsequent layers will be placed on top of the first three; this layering will leave a horizontal step 59 feet high.

Under these conditions, the landfill useful life-time was established based on the total volume capacity of the site, the amount of waste that will require disposal, and the volume of cover material required by standard NOM-084-ECOL-94. The results indicated that for a mean required volume of 211yd³/day and an available volume of 1,013 acre-ft, within an area of 49.4 acres, the useful life is 21.2 year:

In order to guarantee proper operation of the landfill, the following measures have been considered necessary:

Purchase of the 49.4 acre plot of land from the Ejido Agua Prieta.

Clean up of vegetation from 11 acres and excavation of 18 acre-ft of material in order to open up the first stage and have an adequate stock of cover material.

Construction of a drainage system for leachates with 0.95 mile of PVC pipelines of different size diameters.

Construction of leachate evaporation ponds with 0.9 acre-feet capacity and levees that will have 1.4 acre feet of material.

Construction of 60 biogas control/monitoring devices.

Construction of 0.55 acres for internal roads.

Control booth with 194ft² of floor space.

Supply and installation of a 40 ton capacity weigh platform.

Construction of general services consisting of a 40 HP electric sub-station and 0.34 miles of power line, 5,284 gallon water cistern with pump, 1,321 gallon fuel storage tank, and radio communication system.

Construction of 1.4 miles of access roads.

Landscaping of 500 trees in the form of a barrier.

Construction of a 1.4 mile enclosure fence.

Construction and placement of 20 signs.

Equipment consisting of one pick-up truck, 2,114 gallon fuel truck, one front chain loader with 120 HP motor and with a 2.3yd³ scoop for landfill operation capabilities and a 165 HP bulldozer which should also have landfill operation capabilities.

RECYCLING

Recycling can be defined as a process the reincorporates solid waste products back into the consumption cycle that had already been disposed of and that can be used to generate other products.

According with the results of the study to establish the quantities of solid wastes generated, based on the official Mexican Standard, NMX-AA-22/85, for the selection and quantification of municipal solid waste by-products, which was carried out in August of 1996, it is deemed that the garbage in Agua Prieta consists mainly of domestic and/or commercial wastes, generated by residential units, businesses, and maquiladoras. The solid waste has the following principal components:

organic material: 45 percent

paper: 6.95 percent,

cardboard: 5.88 percent

glass (colored and clear): 6.8 percent

aluminum cans: 2.35 percent

hard plastic: 2.95 percent

tin: 5 percent,

plastic film: 4.36 percent

textiles: 1.86 percent

other: 4.11 percent

By-products that could potentially be recycled are: paper, cardboard, glass, plastic, and aluminum, and represent 30 percent of all wastes being generated.

These numbers suggest that, before allowing the removal of by-products by garbage pickers, the advantages of recycling be evaluated. However, preliminary financial estimates, as well as visits to several collection and recycling centers, indicate recycling systems are not cost effective due to the low commercial value of by-products, therefore it was assumed that recycling is not a feasible component of this project. The commercial value of the scavenged by-products is:

cardboard	\$38/ton
paper	\$23/ton
glass	\$34/ton

<i>aluminum</i>	<i>\$52.40/ton</i>
<i>plastic</i>	<i>\$88/ton</i>

The distance to collection centers, such as Hermosillo and Navojoa, Sonora, Mexicali, B.C., Monterrey, N.L., and/or Phoenix, Arizona, ranges between 248 and 932 miles. The distance factor relates directly to the high transportation costs, which are currently running approximately \$0.59/ton for the 1st mile and \$0.27/ton for each additional mile.

CLOSURE OF THE EXISTING OPEN AIR DUMP SITE

The construction of a new landfill requires closure of the existing open air dump site, in order to mitigate any negative environmental effects and prevent the continuation of illegal dumping of solid wastes at the old site.

In this regard, the required studies will have to be carried out to establish the current status of composition, humidity, and the degree of decomposition of the different garbage layers. The system has been designed with a gas control system, final top cover seal, landscaping components, and facilities for shelter and site control.

4 Financial Feasibility

The project preliminary budget, which includes the proposed infrastructure and equipment components for the maintenance system, is \$2 million dollars. The largest part of the investment costs are for the landfill equipment: \$0.45 million dollars; supplemental infrastructure: \$0.45 million dollars; and garbage collection equipment: \$0.51 million dollars.

INVESTMENT SUMMARY

ITEM	AMOUNT (dollars)
<i>1. Collection</i>	<i>\$508,667</i>
<i>2. Landfill</i>	<i>\$901,080</i>
<i>2.1 Basic Infrastructure</i>	<i>\$106,504</i>
<i>2.2 Supplemental Projects</i>	<i>\$345,576</i>
<i>2.3 Equipment</i>	<i>\$449,000</i>
<i>3. Closure of Existing Dump</i>	<i>\$160,263</i>
<i>4. Institutional Capacity Bldg.</i>	<i>\$123,840</i>
<i>Sub Total</i>	<i>\$1,693,850</i>
<i>Unforeseen Expenses 5%</i>	<i>\$84,693</i>
<i>Construction Oversight 6%</i>	<i>\$36,741</i>
<i>I.V.A. 10% (Value Added Tax)</i>	<i>\$181,528</i>
<i>Total Investment</i>	<i>\$1,966,812.00</i>

It is proposed that the project have, with regard to the financing sources, 50% of total costs covered by federal and state grants and the remaining amount with a NADBank loan.

FINANCIAL STRUCTURE

Source	Amount (dollars)	Contribution (%)
<i>Federal Grants</i>	<i>\$998,406</i>	<i>50</i>
<i>NADBank Loan</i>	<i>\$998,406</i>	<i>50</i>
<i>Total</i>	<i>\$1,996,812</i>	<i>100</i>

Since the City of Agua Prieta is currently in the process of holding its second public meeting, regarding this aspect of the project, as well as the public maintenance rates that will be applied to satisfy the NADBank loan requirements, the financial structure is still preliminary. The meeting has been scheduled for September 30, 1996.

The NADBank loan terms, for financial projections are as follows:

Term: 20 years

Payment: equal payments

Annual Interest Rate: UDIS + 12 points

Annuity: \$223,844

The project total operation and maintenance costs for the first year have been estimated at \$0.36 million/year; these costs will increase gradually to \$0.56 million during the last year of project implementation. The City Government of Agua Prieta, just collecting domestic solid wastes and providing an inadequate disposal service, spends approximately \$0.18 million annually; this amount is insufficient, reflected in the inadequate maintenance of existing equipment and their low performance levels, which in general affects the entire public service, regarding street sweeping and clean-up, as well as garbage pick-up.

PROJECTED OPERATION & MAINTENANCE COSTS
(DOLLARS/YEAR)

ITEM	1 st YEAR	20 th YEAR
1. Street Clean-Up	\$86,460	\$86,460
2. Garbage Collection	\$199,806	\$379,641
3. Final Disposal	\$68,718	\$97,778
Total	\$354,984	\$563,869

Note: Costs do not reflect capital equipment replacement costs.

The financial analysis to determine the project viability, without reducing the investment amounts, and to establish a rate model in accordance with the needs of the community, is based on the following:

Guarantee the required minimum resources for efficient operation and maintenance of the infrastructure and equipment.

Cover the debt service and create a fund for equipment replacement and construction of new facilities with the project estimated income.

Avoid excessive increases in established rates.

Distribute fairly the public maintenance service costs based on volume of garbage generated and economic conditions.

Rate schedule should not include administrative, or operation and maintenance inefficiencies, which translate into higher costs and thus higher rates.

User Rates

Currently, the Municipal Government of Agua Prieta does not directly bill users for public maintenance services. Property taxes should supposedly include payment for this service, however, a specific line item contribution is not included. Normally, costs for each one of the public maintenance components have been subsidized by the city administration. This has turned into an economic burden on the city and has had a substantial effect on the city public finances, as well as on the efficiency level of all the services provided by the city. Based on this, it has been considered necessary to establish a rate system that will allow the Municipal Government of Agua Prieta to bill for street cleaning, and solid waste collection and final disposal, in order for the system to operate efficiently and profitably.

The total cost of the service was estimated at \$33.18/ton of garbage handled, based on the methodology proposed by SEDESOL for establishing a rate structure.

Cost of the Comprehensive Maintenance Service

ITEM	COST (dollars/month)	COST (dollars/ton)
1. Street Sweeping	2,902	0.96
2. Garbage Collection	55,589	18.44
3. Final Disposal	41,550	13.78
Total	100,041	33.18

The rates that are required to cover operation and maintenance, as well as the capital investment repayment of the comprehensive maintenance service, considering the amount of federal subsidies and loan, are indicated in the following table.

User Fees for Maintenance Service

User Category	Solid Waste Generation (Ton/month)	Total Cost (\$/Ton)	Weigh Factor	Management Factor (%)	Unit Fee (\$/month)
High Income	0.107	33.18	1.00	5.00	3.73
Medium Income	0.107	33.18	0.75	5.00	2.80
Low Income	0.107	33.18	0.50	5.00	1.86
Commercial	0.473	33.18	1.50	5.00	24.72
Industrial	8.387	33.18	2.00	5.00	584.44
Direct Disposal		13.78	1.00	10.00	16.22

The above table shows that through the weigh factor a scaled fee structure is used, based on the income level of the population y the type of solid wastes generator. It will be necessary to establish that the wastes collected from industrial and commercial clients are not hazardous. On the other hand, the weigh factor is also intended to avoid undue duress on the family economics of the lower income population. The user identified as "direct disposal" is the one that takes the garbage or solid wastes directly to the landfill site, whereby the fee only includes the cost of street sweeping and final disposal. Also, the management factor is applied as an additional percentage charge to the fee, which is intended to obtain income that will allow coverage of the administrative costs.

The application of these fees should consider that:

Of the total population 8.3% has a high income, 34.5% medium income and 57.2% low income.

The number of commercial and industrial establishments is 439 and 31, respectively.

The amount that is directly disposed of at the landfill amounts to 259 tons per month.

Garbage generation and income are increasing at an annual rate of 3.7%.

The projected billing and collection efficiency is 80% of the total.

The financial feasibility of the project was analyzed based on cash flow. The results show that the projected cash flow balance is positive during all of the years, with the exception of the year 2002 that corresponds to the first equipment replacement period. The project generates sufficient resources to cover operational and financial costs. Finally, the rate of debt coverage for the project, based on the amount of cash available for loan repayment, after covering operation and maintenance costs, is over 1.73 during all of the years of the project.

5 Social Aspects

Economic development of Agua Prieta, like the majority of other communities along the northern border of the county, has increased constantly during the fifteen year period between 1980 and 1995. This increase has been spurred primarily by the 31 maquiladora industries that have established themselves in the area. The industries currently employ 7,000 workers, equal to 48 percent of the work force.

Because of this, the primary sector, which includes agriculture, livestock, and forestry has lost ground in the economic development of the area, and only employs 4.8% of the work force; the industrial, business, and service sectors employ 56.5% and 38.6% of the work force, respectively.

Based on information provided by the Population & Housing Census, between 1950 and 1995, Agua Prieta experienced an increase in population, from 10,471 to 54,000, equal to an annual average growth rate of 3.71%.

Residents of the city are able to rely on all basic services; 95 percent of the community has water supply; 70 percent has sewage and wastewater collection services, as well as solid waste collection and disposal services. All of these services are offered on a restricted basis due to problems in operation that local authorities face in the provision of these services. These issues must be addressed to avoid negative impacts on the environment.

The project proposes to address problems related to public maintenance: street cleaning and solid waste collection and final disposal, which translates into an overall benefit to the entire population of Agua Prieta, Sonora. Furthermore, the neighboring community of Douglas, Arizona should no longer be affected by smoke coming from fires being burned at the existing open air dump site.

The most significant socio-economic benefits of the project are:

Improving quality of life for residents of the community; residents will not have to endure foul smells and smoke currently being dispersed by the existing open air dump into the city.

Collection services will be more constant; garbage will not have to be stored. Diseases and harmful fauna will be eliminated.

The land surrounding the dump site will gain any value it may have lost; it could conceivably be utilized for urban commercial purposes.

Closure of the existing open air dump site will eliminate a source of pollution to the water and soil and no significant economic investment will be required to treat contaminated soil or water sources.

There is no effect on restricted environmental areas, archaeological sites, or cultural or historical resources.

The site of the landfill will be better utilized.

Risks to health will be reduced once source of disease carrying rodents is eliminated.

25 permanent jobs will be created for landfill operations.

6 COMMUNITY PARTICIPATION

On May 17, 1996 a draft Comprehensive Community Participation Program was submitted to BECC. Recommendations were made to define specific outreach strategies as well as public opinion surveys regarding the solid waste issues and on the land fill project. The program also included the rate impacts. The final draft of the program was received on May 28, 1996, and was modified and improved by BECC Advisory Council Member, Josefina Guerrero.

The Comprehensive Community Participation Program was designed to present the Comprehensive Public Maintenance Project to all the residents of Agua Prieta, Sonora, as well as to encourage the community to play an active social role in the planning, programming, certification application, financing and construction stages of the project.

The project applicant established an outreach strategy as well as the Municipal Follow Up Committee, made up of representatives from the City Government, Professional Civil Engineering Associations, Architects, NGO's and other members of the community.

Some of the Committee goals are the following:

Develop an opinion survey that indicates community support for the project; provide written report to BECC.

Implement media campaigns.

Hold informational meetings regarding the project in the various sectors of the community.

To date, the following measures have been implemented:

150 families from different social and economic levels and 50 commercial establishments participated in the studies on waste generation.

Held meetings on June 15, August 22 & 30, 1996, with private bi-national companies interested in the environment.

Hold weekly evaluation meetings with members of the Municipal Follow up Committee. Present at the meetings were local and state authorities, representatives from the Department of Public Services from Douglas, Arizona, the NGO community from both sides of the border (Border Ecology Project and Arizona Toxics) in order to evaluate the financial structure and recycling program.

Broadcast weekly, Saturday radio outreach program with listener call in regarding the landfill project.

Held meeting on May 29, 1996 with leaders of the garbage pickers.

Held public meeting on May 30, 1996; 80 persons attended, including Senator Leonardo Yañez.

The project applicant has scheduled a second meeting on September 30th which includes a media and information program as well as support by BECC and Josefina Guerrero. A survey will be handed out at the meeting; results will be included in the project opinion poll. Furthermore, in addition to submitting the Final Program Report, the project applicant will also establish a post-certification community participation program.

7 Operation and Maintenance

The Administrative Section of the Municipal Government of Agua Prieta has under its charge the General Department of Public Works and Services which is directly subject to the Mayor's Office. This division is in charge of the Public Service Department which is in charge of managing and operating the public maintenance system: street cleaning and solid waste collection and disposal.

The Public Services Department has an 82 member staff; 12 of the employees are street cleaners (sweepers) and 8 work as drivers for the street cleaning operations; 48 work in collection, 1 is in charge of equipment that is utilized for final disposal; and 13 employees are in charge of maintenance of the facilities and equipment.

The project proposes keeping these employees, however hiring an additional 18 will be necessary for the street cleaning operations and 7 more for final disposal: 2 operators, 2 drivers, 2 assistants, and 1 supervisor or foreman.

All staff members will receive required training regarding detailed landfill operations, safety, fire prevention and control, and environmental protection.

Operation of the landfill shall be carried out in an organized and disciplined manner. The manager or supervisor shall be required to have the technical knowledge to facilitate, among other things:

Control of all solid waste delivered to landfill,

Control of all vehicles and persons passing through the gates,

Traffic control and unloading.

The project start up operations program will begin once the first stage of the landfill has been leveled and the leachate collection pipes have been installed. The portion of waste discharged and taken by bulldozer to the landfill location, will be arranged and distributed homogeneously in 1 foot layers; the bulldozer will then pass over the parallel strips 4 or 6 times in order to compact the surface of the extended garbage.

To conclude one day's worth of filling, the bulldozer will extend a 1 foot layer of soil, and will compact it so that it covers the garbage entirely and uniformly. Once this first stage is concluded, this section will be covered again with a 2 foot layer that will level and support the vegetation that will be planted; this vegetation should be native to the surrounding area. Pedestrian and vehicle access means shall also be designed, depending on the size of each section; an iron mesh will be installed to protect the gas discharge pipes.

The control system for the landfill shall include operational, administrative, and environmental aspects. The operational controls will facilitate continuous and permanent operations of the equipment; the administrative controls will facilitate the efficiency through the use of statistics that indicate yields, as well as all output and input. Environmental controls will consist of verification of adequate permeability of the sub-soil and efficient operations of the leachate and biogas control systems; biogas and water quality monitoring will be mandatory at different distances as well as depths of the landfill.

The site of the landfill shall be linked, at least by portable radio; it is also advisable to implement required fire control measures to control any fires starting in the garbage itself, the equipment or facilities. Fire extinguishing equipment should be readily available at the landfill, including volume required to cover given surface, and a water line. Close communication should be maintained with the Fire Department in order to respond immediately to any emergency. The landfill will also have a guard booth at the entry which will have three extinguishers ready for any type of emergency. The system also includes the installation of a permanent tank truck that will be used to compact the soil applied for daily coverage. Therefore, water will always be readily available for any type of emergency.

Furthermore, non-organized garbage picking will not be allowed at the landfill.

8 SUSTAINABLE DEVELOPMENT

The National Development Program for 1995-2000, defined the Environmental Policy for Sustainable Growth, in order to make better use of the natural resources. The Policy also warns against the drastic degradation of the ecosystems caused by inadequate and illegal disposal of 5.4 tons of a total of 59 tons of all municipal solid wastes that are not collected. Based on this, it has been considered that the project complies with this policy and contributes directly to the strengthening of sustainable growth of the area which include some of the following actions:

Elimination of air, water, and soil pollution caused by solid waste disposal in the existing open air dump site.

The public maintenance system will be efficient and decrease the amount of illegal dumping; it will also improve the image of the community by having cleaner streets; the community will not have to store its garbage for several days. The system will also provide final disposal services that are controlled and will mitigate any risk of pollution.

The solid waste disposal process that will be utilized is the most viable and economically feasible because of the level of training required.

Control of all leachates will mitigate any risk to the wild fauna y flora.

The project fully complies with existing standards and design for confinement and final disposal facilities as well as with prevention of soil, water, and air pollution caused by the disposal of solid wastes.

The project will create 25 permanent jobs.

The project will control infectious carrying rodents that pose a risk to the health of the community.

Closure of the existing open air dump will eliminate a source of air, water, and soil pollution and avoid the proliferation of insects.

During the project useful life-time, recycling will be encouraged if recycling of by-products is economically feasible.

*The 3R Culture, **Reduce, Reutilize, and Recycle**, will be promoted and encouraged within the community in order to address problems relating to solid wastes and also to reduce negative environmental effects.*

INSTITUTIONAL CAPACITY BUILDING

One of the project highlights is its effort aimed at institutional capacity building. Through the Department of Public Services of the City Government of Agua Prieta, the project will increase efficiency levels of its assigned operations. Some of the identified actions include: development of a user database, establishment of a rate structure, organizational and procedures manual, management information system, billing and collection system, inspection and purchase of transportation equipment.

A public para-municipal organization is currently being defined which will manage the city's public maintenance system and will also cover the project described in this document.