Composting Toilets and Water Harvesting: Alternatives for Conserving and Protecting Water in Nogales, Sonora



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help improve the project. We hope that this project helps you fulfill your desire to improve not only the lives of your families and neighborhoods but also those of others who face the daily challenges of living and working in communities along the U.S.-Mexico border. Your willingness to adopt new approaches to the household management of human waste serves as a model and an inspiration for the rest of us.

Introduction

This project was funded through the Border 2012 program, a collaboration between the United States and Mexico to improve the environment and protect the health of border residents. The binational program focuses on improving air quality, providing safe drinking water, reducing risks from exposure to hazardous waste, and ensuring emergency preparedness along the U.S.-Mexico border (see U.S. Mexico Border 2012 Program, www.epa.gov/Border2012/). The specific goals of the project were to demonstrate the feasibility of using composting toilets, combined with rainwater harvesting within the same colonias, to augment existing municipal water and wastewater services. The primary objective of the composting toilet system is to contain, immobilize, or destroy organisms that cause human disease (pathogens) and reduce the risk of human infection without contaminating the immediate or distant environment and harming what lives there. The primary objectives of rainwater harvesting are to manage stormwater runoff and capture rainwater for beneficial use.

Background on the Problem

Many homes in Nogales, Sonora lack connections to potable water supplies and wastewater collection systems. Residents in the outlying, marginal colonias are least likely to have either piped water or sewer connections. A 1999 study by Arizona State University researchers found that fewer than 20 percent of residents in some parts of the municipality received these services (Sadalla, Swanson, and Velasco 1999). Households lacking connections to the sewer system were found to use latrines or open pits for the disposal of human waste, despite the fact that many of those latrines were situated in dense, rocky soil with poor drainage characteristics. Researchers concluded that the widespread use of latrines constituted one of the most significant environmental hazards in the region.

Since the 1999 study was conducted, lack of water and the problems of improper human waste disposal have continued to plague Nogales. Typically, in areas not served by the municipal water distribution system, water is trucked to homes and businesses and then stored in 1,100 liter tanks installed on the roofs of the buildings. Residents pay an average of 70 pesos to fill a 1,100 liter tank with water that has been trucked to the site, and the tank's supply typically lasts three days (USEPA-BECC 2009). In areas lacking sewers, many residents still use latrines or open pits. These overflow during periods of heavy rainfall and discharge raw sewage directly into the communities and the Nogales Wash, ultimately flowing through both Nogales, Sonora and Nogales, Arizona and into the Santa Cruz River (see Figure 1). People can become ill by drinking water contaminated with organisms or parasites found in raw sewage and by eating raw or undercooked foods that have been in contact with contaminated water. In addition, in rare cases children in Nogales, Sonora have drowned in the open pits.

Proposed construction of a wastewater treatment plant and conveyance system south of Nogales at Los Alisos and expansion of the municipal water distribution system in southwest Nogales will increase the number of residents with access to piped water and a centralized wastewater collection system (USEPA 2000, 2009; USEPA-BECC 2009) but will provide no relief for communities elsewhere in Nogales that still lack water and sewer services. With a large proportion of Nogales, Sonora households lacking water 24 hours a day, it is unlikely that the

residents in some of the marginal colonias will receive water and wastewater services in the near term. In addition, the construction and maintenance of such systems is costly, and the system continues to rely on large quantities of water, which is in short supply. Therefore, it is critical that alternatives be identified and implemented. One solution is to develop and install alternative household-level systems for human waste disposal that do not require extensive infrastructure or water and neighborhood-level approaches for safely collecting and storing rainwater.

Beginning in 2002, Francisco Trujillo, then-director of Borderlinks Mexico and the Casa de la Misericordia community center located in Colonia Bella Vista in eastern Nogales, began developing pilot projects to install and test composting toilets at the center and in households in the surrounding neighborhood. Composting toilet systems (also called biological toilets, dry toilets, and waterless toilets) work by providing a closed environment for excrement, toilet paper, and a carbon additive (usually sawdust) and then relying on aerobic bacteria and fungi to break down wastes, just as they do in a yard waste composter. In some countries, such as China, composting toilets have been in use for thousands of years. During the summer and fall of 2006, under the supervision of Diane Austin, associate research anthropologist at the Bureau of Applied Research in Anthropology at the University of Arizona (BARA-UA), a student intern completed an evaluation in Nogales of composting toilets that had been constructed and installed at seven households and at the Casa de la Misericordia. The intern learned that composting toilets were perceived by residents as a positive advancement over the open pit system and that they could be operated inexpensively and safely in Nogales, and identified a number of steps that could be taken to improve residents' understanding and use of household composting toilets.

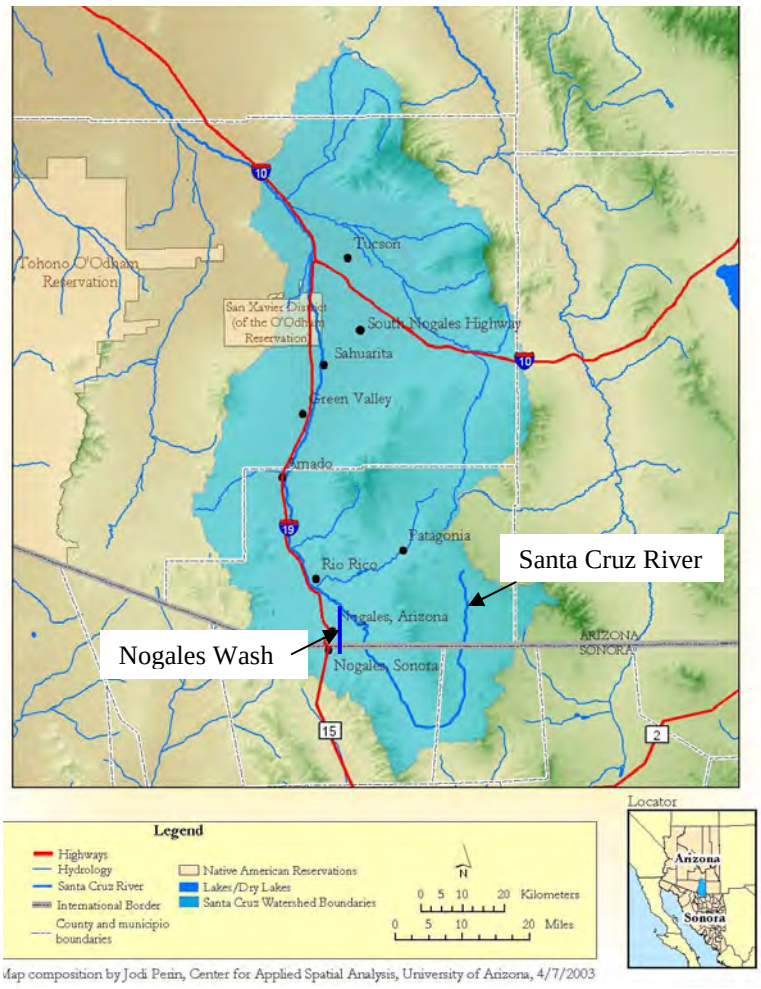


Figure 1. The Santa Cruz Watershed

In a separate effort that began in 2001, Diane Austin and her students began investigating water harvesting as a source of water and mechanism for erosion control. In partnership with members of the Asociación de Reforestación en Ambos Nogales, they installed active and passive water harvesting structures at schools and homes in Nogales, Sonora. Active rainwater harvesting systems channel, collect, and store rainwater for beneficial use and reduce soil erosion during

periods of high stormwater runoff. In 2004, students from BARA-UA and the Instituto Tecnológico de Nogales installed an active rainwater harvesting system at the Casa de la Misericordia community center in Bella Vista to demonstrate the technology in the community.

The aim of this project, Composting Toilets and Water Harvesting: Alternatives for Conserving and Protecting Water in Nogales, Sonora, was to build upon the success of both the composting toilets and water harvesting initiatives. The project was directed by Francisco Trujillo and Diane Austin, working with Francisco Arturo Lujan Fernandez and assisted by students from the University of Arizona and schools in Nogales, Sonora and by residents of the colonias of Nogales, Sonora where the toilets were installed. This project sought to integrate the two technologies, monitor the success of the project, and offer community workshops and outreach about their safe use. By helping provide alternatives to existing latrines and water collection mechanisms, the project was designed to have the direct and immediate effects of reducing environmental contamination and improving human health.

Composting or Dry Toilets as a Solution

Human waste has been composted in countries around the world for thousands of years, avoiding both the use of water and the need for sewage systems. In the 1860s, Reverend Henry Moule invented and patented the Earth Closet (Humanure, www.journeytoforever.org/compost_humanure.html). A century later, in the 1960s, the first commercially designed toilet composting systems were sold in Scandinavia. From there the idea moved to North America, where more models were designed and marketed Today, urban systems include modern buildings such as the three-story Choi Building at the University of British Columbia in Vancouver which has 12 flushless toilets and urinals and saves more than 1,000 liters (264 gallons) of water per day (Marques, Pargani, and Perdue nd).

The principal components of composting toilets are:

- A composting reactor connected to one or more dry toilets;
- A screened exhaust system (often with fan) to remove odors, carbon dioxide, water vapor, and the by-products of aerobic decomposition;
- A means of ventilation to provide oxygen for the aerobic organisms in the composter;
- A means of draining and managing excess liquid and leachate; and
- An access door for removal of the end-product.

Advantages of composting toilets accrue to the household, community, and the larger environment. For the household, the advantages include (1) greatly reduced water storage or supply costs; (2) production of compost; (3) reduced risk of children falling into pit holes; and (4) humus with high nutrient levels to improve soil. For the community, the advantages include (1) elimination of sewage charges, sewage pipe installations, and maintenance costs (especially when combined with graywater systems) and (2) reduction of water costs. Broader environmental benefits also include the minimization of impacts due to storage and piping, as well as the reduction of nutrient flows into washes and rivers.

Because of their high human population density, urban areas require special attention (Cordova 2001). According to Cordova (2001, p. 3): “(D)ry sanitation should at least be considered as a

complementary sanitation option for those cases where: a) local governments and water utilities are not in financial or organizational conditions to build sewage and wastewater treatment systems or to maintain this infrastructure in good operating conditions; b) septic systems or other on-site sanitation systems are consistently failing to function properly and are allowing nutrients and pathogens to leach into the groundwater; c) local water scarcity is so intense that it is no longer reasonable to use water as a means of transportation for excreta, at the expense of other important needs; or d) where dysfunctional or obsolete sewage systems need to be completely replaced or new housing developments are being planned and economical and environmental savings can be achieved by avoiding the use of water for sanitation." Because it is the most comprehensive assessment of the use and application of dry sanitation in Mexico, the following paragraphs summarize results of Cordova's investigation, highlighting findings relevant to Nogales.

Between August 1999 and December 2000, Cordova (2001) conducted a study of six urban, large-scale dry sanitation program sites throughout Mexico to characterize program implementation and identify barriers and opportunities. In a review of dry sanitation programs, Cordova found that most of the programs were located in irregular settlements where the local authority had been unwilling or unable to provide public services to rapidly growing urban and peri-urban populations, though she also identified a few cases of programs for high-end housing developments. The programs were initiated by community-based organizations, non-governmental organizations, local governments, dry toilet producers, international agencies, and a university, with financial support from private foundations, international agencies, and individual private companies. The primary motivation for developing dry sanitation projects in urban areas was to increase public health or environmental protection. Key differences among programs included the dry toilet model used, the cost of the toilet to the user, user training techniques, technical support or follow-up to user needs after toilet installation, and management of the toilet end-product. Even in some of the programs that provided technical support to the users, support decreased significantly or was discontinued after a period of two to five years. Most of the programs faced similar problems, and several were abandoned before they could overcome the obstacles; most were initiated by people and organizations outside the community and the community as a whole neither chose to participate in the project nor participated in discussions of problems that arose or the search for solutions. In all programs, Cordova found both very satisfied and unsatisfied users and toilets that were functioning perfectly and those in very bad condition and with problems.

Based on the results of the study, Cordova (2001, p. 12-13) proposed the following recommendations:

- Funding should be secured in advance for all phases of a program, including a user follow-up program to be continued for at least two years, or until the first batch of solids has been removed from the toilets, that incorporates training, problem-solving, and technical assistance; funds should be made available for personnel as well as promotional and educational materials.
- Toilets should be completed and delivered soon after requested by users and should be fully functional at the time to increase the likelihood of careful use by the owner.

- Toilet selection should take into account the climatic and cultural conditions under which it will be used, and a pilot program should precede large-scale installation of toilets to allow the selected model to be tested.
- Users should be trained in the use of the toilet and incorporated into a feedback system between them and the promoters and toilet designers in order to improve toilet design and program implementation.
- The program planners should anticipate and prepare for all steps in the toilet use, including where and how users will obtain the cover material for the toilets and will manage and dispose of the final product.
- Programs, especially those initiated by local governments and/or dependent on a highly motivated charismatic individual, should provide for long-term continuity in the program.

The Nogales project was carried out with these recommendations in mind. While separation of urine has been found to be beneficial to composting toilet operation (see also Salmon et al. nd), due to the desire to minimize the technological complexity of the project and to minimize the differences between the use of the composting toilets and that of regular flush toilets or pitholes, as well as the arid conditions of Nogales, the Nogales project utilized toilets that combine liquid and solid waste.

Design and Implementation of the Nogales Project

The Nogales, Sonora composting toilets and water harvesting project was developed and implemented in such a manner as to maximize the likelihood for success and avoid problems identified in other programs in Mexico and elsewhere. The key elements of the project are:

Task 1. Establish Advisory Board, Hold Quarterly Meetings, and Ensure Communication Among Project Partners
Task 2. Colonia and Household Selection
Task 3. Conduct Workshops to introduce the technologies and train household members in their use
Task 4. Construct Composting Toilets
Task 5. Construct Water Harvesting Systems
Task 6. Monitor Use of Toilets and Water Harvesting Systems
Task 7. Conduct Outreach within Nogales, Sonora and the border region to share the results of the project

The project plan was developed in the spring of 2007, and the project leaders were notified in November that the project would be funded. Shortly afterward, however, due to major changes in the leadership of the non-governmental organization that was to be the Sonoran project lead, the project had to be reorganized. The final workplan was approved and the agreement between the Border Environment Cooperation Commission and Francisco Arturo Lujan Fernandez issued in May 2008. Francisco Trujillo served as the project manager, responsible for overseeing all aspects of the design and construction of the composting toilets and water harvesting systems, and led the community outreach efforts. Diane Austin helped manage the project, led the effort to develop the initial household assessments monitoring program, and helped with the outreach efforts. By the time resources were available for purchasing materials for the project, the price of

wood, cement, and other materials had gone up considerably (almost doubled, in some cases), so only 35, rather than 50, toilets could be completed.

Upon learning that the project would be funded, the project leaders met with Nogales municipal government officials who recommended that the composting toilets be installed first in Colonia Colinas del Sol, a neighborhood on the east side of Nogales which lacks water and sewer and, due to the hilly topography within which it is located, is unlikely to receive services in the foreseeable future. The project leaders met with the leaders of the Asociación de Vecinos (AVES) for the colonia. The colonia leaders enthusiastically accepted the project and began notifying residents and gathering the names of those who wished to learn more about the project.

Establishment of Advisory Board and Finalization of Design

The project Advisory Board was organized to include representatives of governmental, non-governmental, academic, and business organizations; the project leaders solicited participation from individuals and organizations with knowledge of and an expressed interest in addressing environmental issues in Nogales and the needs of the residents of low-income neighborhoods in the city (see Table 1). The Advisory Board was responsible for overseeing the project, including helping to select the final designs for the composting toilets and water harvesting systems and to develop a plan and criteria for selecting the households that would receive composting toilets. The Advisory Board met quarterly throughout the project.

Table 1. Initial Members of the Project Advisory Board

Sector	Organization	Name of Individual
Neighbors	Colinas del Sol AVES	Cristina Rico Velazquez
	Colinas del Sol AVES	Martha Hernandez Lamas
Government - local	Municipio de Nogales	Adriana Guerrero Martinez
Government – state	Arizona Dept. of Env. Quality	Hans Huth
Business/Industry	Associación de Profesionales en Seguridad y Ambiente (APSA)	Celia Gastelum Alejandro Almaguer
Non-governmental	Frente Cívico Municipal	Sergio Parra
Academic - Nogales	Instituto Tecnológico de Nogales (ITN)	Irma Fragoso
	Colegio Nacional de Educación Profesional Técnica (CONALEP)	Rosalva Leprón

Due to other demands, the APSA members withdrew from the project in the early stages of its development. Otherwise, participation in the advisory board was generally high; though the local government representative was unable to attend advisory board meetings, she was sent copies of the notes from all meetings and provided with regular updates of the project's progress. The benefit of the regular communication with city officials became evident during the spring of 2009 when the city approached the project leaders about utilizing government funding to expand the scope of the project (see Conducting Outreach With Decision Makers below).

Prior to presenting a design to the advisory board, the project leaders conducted research to identify composting toilet models that would be most likely to function well in the climate and

environment of Nogales. The advisory board members reviewed and discussed toilet designs and approved the design shown in Figure 2, which included the following features:

- Two chambers, one in use and the other within which the aerobic process of decomposition takes place, plus four walls and the roof.
- The back side of the facility from which the compost is drawn out oriented toward the sun whenever possible.
- Two chambers made of cinderblock 44in deep x 80in wide x 27in high, divided to create two sections, open at the bottom and with a cement slab placed on top to serve as the toilet seat. The chamber structure functions as the foundation for the walls that can be made of cinderblock or fibrous concrete blocks.
- A 4 inch PVC pipe from inside the chambers to the outside to promote ventilation.
- Two deposit chambers, each with a 20 by 24 inch back door to be used in taking out the compost.
- A gasketed toilet seat and lid.
- A screen placed over the ventilation opening.
- Careful sealing of cracks and openings.
- Facilities can be located next to a house with access from the inside or outside and either connected to or separated from the main house.

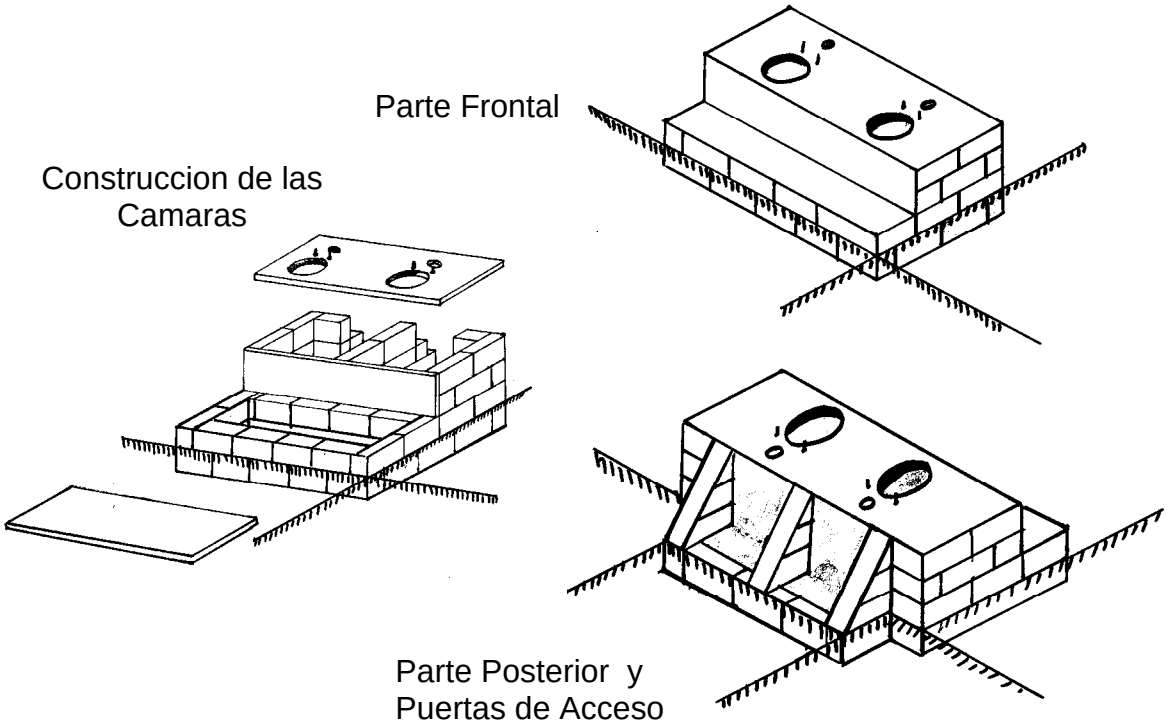


Figure 2. Sketch of Composting Toilet

Based on assessments of other composting toilets projects and discussions with colonia residents, the project leaders and advisory board members agreed to construct not only the tanks but also the walls of the bathroom in order to ensure that the bathrooms would be completed within the project period so that monitoring could begin and an evaluation of the project completed, and so that tanks would be used for their intended purpose. This decision meant that the cost of construction of each toilet would be higher; due to this and the desire on the part of advisory board members to avoid a charity model and ensure that people receiving the toilets would use and care for them, the board members agreed that each household receiving a toilet would have to contribute labor, materials, or money toward the construction of the toilet.

Selection of Colonias and Households

The Advisory Board helped guide and oversee selection of the colonias and households where the toilets were to be constructed. The Board approved the following criteria for selection of the households to receive the initial toilets:

1. The family has no bathroom or is using a pithole.
2. There is sufficient space for a bathroom.
3. The site is ready.
4. The family has the resources (materials or cash) to contribute toward the cost of the bathroom, or someone in the family can help with the construction so the families invest in the project from the beginning.
5. Households with more residents will be given preference as more people will benefit from the toilet.
6. The household members own their land; the house is not being rented.

Using those criteria, and working from a list of people who had attended an information session and submitted their names to receive a toilet, the Advisory Board and project leaders identified the first group of 12 households to receive toilets and the first three households at which the first composting toilets would be constructed.

The following is the process by which households became aware of and involved in the project.

1. Representative(s) from the household attended an introductory meeting and workshop. The workshops were advertised within the colonia via flyers and word-of-mouth by members of the Asociación de Vecinos (AVES).
2. Following the workshop, household representatives who were still interested in participating in the project and receiving a toilet met with students from the Bureau of Applied Research in Anthropology at the University of Arizona (BARA-UA) and Nogales high schools to sign up for a household visit.
3. BARA-UA and Nogales students visited the households to complete the Household Assessment (see Appendix 1).
4. BARA-UA and Nogales students and faculty entered the assessment data into a database and prepare a summary for the members of the Advisory Board.
5. Advisory Board members reviewed the household data and prioritized the households that should receive a toilet according to the criteria for selection.

6. BARA-UA and Nogales students visited the households to inform them of the Advisory Board's decision and confirm when the selected households would be ready for construction to begin.
7. BARA-UA and Nogales students met with project and construction managers to finalize a timeline for construction of each toilet, taking into account information such as whether the household's site was ready, when the household would have at least a portion of the money or materials ready, and where the house was located.
8. Construction team members built the toilets.
9. When construction was finished, BARA-UA and Nogales students visited the households and began monitoring (weekly for the first month, monthly for the next three months and every two to three months for the rest of the year).

The project leaders and Advisory Board members also agreed that it would be beneficial to construct a few toilets in public locations in order to spread information about the toilets (see Construction of Toilets below).

The project had been designed initially to include sample active water harvesting systems at households and a community location as well. The project leaders and colonia representatives tried to get permission to install a composting toilet and water harvesting system at the community center within the neighborhood. However, that center had been constructed with funds from the state of Sonora, so it was necessary to obtain permission from officials in Hermosillo before making any modifications to the building. The local representatives were supportive of the project, but due to delays in gaining the necessary permission and the short time frame for the overall project, the project leaders and Advisory Board members had to seek other alternatives.

The project leaders and advisory board members decided that the active water harvesting systems should be constructed/installed at both public and private locations. They selected two houses within Colonia Colinas del Sol, the first being a home across the street from the community center which the resident agreed could be used as a demonstration site. The second residence was on the other side of the colonia and was selected to receive the second system because the homeowner operated a store out of her home, had already constructed a rudimentary system, purchased the tank for her system, and agreed to allow her home to be used as a demonstration site. The site selected for the public system was a church located across town in Colonia Las Torres because the priest secured funds for a 10,000-liter tank and the colonia had sewer services but no running water; the water from the system would be used for the toilets that were already installed at the church and for which the church was having to pay for water.

Introductory and Training Workshops

The project leaders organized workshops on composting toilets and water harvesting to introduce the technologies. The first introductory workshop was held March 8, 2008 and attended by approximately 50 people (see Appendix 2 for slide presentation). Beyond the introductory workshops, most of the training for this project was related to the composting toilets; training for the water harvesting systems was conducted individually at each site. On Sunday, April 20, once the initial group of 12 households was selected to receive the toilets, project team members,

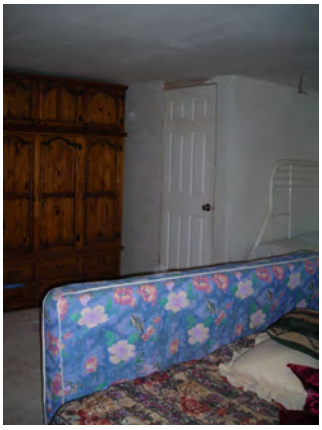
under the supervision of Trujillo, Lujan, and Austin, held a training session to ensure that household members would have the information necessary for them to feel comfortable using their toilets. They discussed with the residents a couple of sites where their compost might be used in the future, including the community center at which the residents had intended to plant trees. Of the initial 12 families, only half ended up getting toilets in the first stage; 2 later decided they did not want the toilets, 1 moved out of the colonia before the toilet was built, 2 were unable to come up with the matching contribution and withdrew their names (as discussed below, efforts were later made to help raise funds for these families and others in their situation), and 1 requested that construction of the toilet be delayed until the fall. A second introductory workshop was held May 31 and attended by around 20 people. Following the workshop, University of Arizona and Nogales students began conducting household assessments for those who expressed interest in participating in the project, and an additional 9 households were selected to receive the toilets. After the initial workshops and construction, additional households were selected to receive toilets by the construction manager and AVES leaders using the criteria established by the advisory board.

Construction of Toilets

Construction of the toilets took place in two stages – the first 12 toilets were constructed in June and July. Between September and November, the next 15 toilets were completed and two more were almost completed; in an effort to promote the adoption of the toilet design and construction by individuals within the colonia who were building their own homes, the project leaders and advisory board members offered support to one individual who had expressed interest in the project and had the skills to build his own toilet, using the design and materials from the project. Unfortunately, that individual ran into problems unrelated to his toilet and did not complete his toilet during the project period.

Two styles of toilet were constructed, within the house and outside the house, as shown in Figure 3. Initially, most residents were reluctant to construct the toilets within their houses, either because their house was constructed of wood and other materials and they planned to upgrade it or because they perceived the composting toilets to be like pitholes and could not imagine one within their homes. As the project progressed and residents were able to observe how the toilets of their friends and neighbors were operating, several more individuals requested toilets inside their homes. In addition, several residents who were constructing cinder block homes began to build their homes around their toilets.

Inside the house



Outside the house

Figure 3. Photos of Composting Toilets

Two major obstacles to toilet construction were the inability to use volunteer labor and the rising cost of materials throughout 2008 and into 2009. The project was initially developed with the intent that residents would supply someone to help with toilet construction, reducing the costs of the toilet and spreading knowledge about how to build the toilet within the community. However, most residents work outside the colonia, especially those with any construction experience, so the only time the households could provide helpers was outside the workday (which could be morning, afternoon, or night) or on Sunday. It proved very inefficient for the construction team leaders to start multiple toilets simultaneously and move from toilet to toilet as the household helpers were available. The advisory board therefore decided to have the residents contribute money or materials instead of labor, in exchange for their toilets. Very few of the residents were able to pay the entire sum up front, or to purchase all the materials at one time, so the advisory board agreed to establish a bank account and have the residents make deposits as they could until they had paid their full contribution. It proved most efficient and effective to pay the construction workers per completed toilet, rather than hourly, allowing two construction team

leaders to hire their own workers and build the toilets at a pace that ensured they would complete the toilets in a timely manner. In order to keep the workers on the job and to gain some savings by purchasing in bulk, the project began to purchase materials for the toilets before the families had come up with their contribution. The community center within the colonia was used for the management of the materials as well as the community workshops.

By early December, the project was nearing completion, winter and the Christmas holidays were approaching, and based on the agreement to construct 35 toilets, three toilets had to be finished and five toilets remained to be built. Construction was paused in December and January due to weather and the holidays when the skilled construction workers left town for several weeks, and then it proved difficult to restart; the construction workers, realizing that the work was almost over, had begun taking other jobs by that time. Also, construction of the remaining toilets was slowed because a number of households were unable to contribute money or an equivalent amount in materials toward the costs of their toilets and the final project funds did not arrive until the third week of January. It was clear that some families would never be able to come up with the money to complete their toilets, so the advisory board and project leaders developed strategies to cover those costs. The project leaders worked with a southern Arizona non-governmental organization (Friends of the Santa Cruz River, see Outreach below) to raise funds to help families pay their portion of the toilets.

Also, in request to a solicitation from organization, project leaders developed and submitted a proposal to Fondo Acción Solidaria/ Global Green Grants Mexico for resources to develop alternative toilet designs to include a larger model for families with more than five members and a design that separates urine from feces. In January, the project leaders received word that the project had been selected for funding, but email and phone messages to the organization were never returned and the money was never received.

In addition, due to significant interest in the toilets by city officials, residents, and neighborhood leaders in other parts of the city, the advisory board and project leaders decided to work with individuals from other neighborhoods to provide design and construction experience so that toilets could be built elsewhere. Site visits were made to all locations, designs for three toilets were begun, and construction started on two of the toilets. Each site faced unique problems – at one site access was blocked when a neighbor filed a lawsuit against the land owner, for example. In addition, transporting materials and arranging for the construction workers to go to the other neighborhoods proved time consuming and expensive. After several months of effort, the project leaders, with the agreement of the homeowners, discontinued the work at the three sites and turned their attention back to Colinas del Sol.

In early spring, project leaders were contacted by officials from the city of Nogales, Sonora regarding the potential for receiving funds from the Mexican government to build another 25 toilets. The city officials requested that the remaining materials from this project be utilized as a match for the funds to build the additional toilets; the government funds were targeted for unemployed laborers, and only 20 percent of the money could be utilized for materials. The materials that had been purchased for this project but had not been utilized for the remaining three toilets were included as match for the new project; the household owners were contacted and the situation explained. None of them had the resources to cover their contributions for the

toilets, so they agreed to have construction on their toilets delayed until the city project began. The project leaders were asked to help coordinate the selection and training of the new households. Construction of the second phase began in May 2009; an engineer from the Nogales municipal government took over managing construction of the toilets, in coordination with the manager of this project. By September, the five remaining toilets for this project had been completed and monitoring was begun. Phase Two of the project continues and the city anticipates that it will complete the remaining 20 toilets by the end of January 2010. Remaining funds from this project were dedicated to fixing problems with the toilets built in the second phase and purchasing wooden toilet seats to replace the plastic toilet ones used by the city; the plastic seats cannot be completely sealed when placed on the toilet tanks, enabling insects to enter the toilet.

Construction of Water Harvesting Systems

Three active water harvesting systems were constructed between July 5 and October 31 (see Figure 4). All three systems have gutters, downspouts, and a large tank for storing rainwater. Construction at all three sites was delayed due to irregularities in the initial construction of the buildings, problems coordinating work schedules for those constructing the systems, problems finding materials in Nogales, Sonora, and challenges faced by those receiving the system in pulling together the resources to obtain the tank (being able to commit resources toward the purchase of the tank was one of the criteria used for selecting the recipients of the systems). The systems were designed to include a first flush system, but the first flush devices had to be ordered and shipped from Australia, and those were designed to be used with 3 inch tubes. Because 4 inch tubes are much more common, and less expensive, in Nogales, Sonora, and one of the three buildings already had pipes to which to connect, constructing systems that could incorporate first flush devices proved difficult.

Figure 4. Photos of Active Household Water Harvesting Systems

Monitoring Use of Toilets and Water Harvesting Systems

Toilets

BARA-UA students, under the direction of Dr. Austin, designed, pilot tested, and implemented a monitoring program for the households receiving the toilets (see Appendix 3). Two high school students living in Colonia Colinas del Sol were identified to work on the monitoring program as well. By the summer of 2008, three BARA-UA and two CECYTES students had been trained and began pilot testing a household monitoring program. The program was designed to continue for more than a year and continued throughout the project period. The program included three stages – an initial household assessment to ensure that the household members understood the features of a composting toilet and wanted one; weekly household visits for the first month; and then monthly and bimonthly visits afterwards. Regular and continuous monitoring of all toilets was interrupted by changes within individual households, such as when individuals from the community left temporarily to find work or care for sick relatives elsewhere or moved away, and also by events that affected everyone, such as holidays or severe rainstorms that prevented travel into the colonia. For example, one family moved out of the house where a toilet had been constructed and the house remained empty for several months. When the new occupants moved in, the project monitors met with them to discuss the project and monitoring program and they agreed to be included; they were monitored twice in the first month and then once a month until the summer. Despite the changes, by the beginning of September 2009, 24 of the households had monitored at least 8 times, 2 had been monitored 7 times, and the 2 households whose members had most recently begun using their toilets (including the who one had moved into a household with a toilet during the study period) had been monitored 5 times. The people at the remaining 2 households were not using their toilets regularly; the occupants of one household were rarely in the colonia. The monitoring program helped project leaders identify problems with the toilets stemming from issues created during construction (doors that were not hung correctly or missing windows) and those stemming from problems with participant understanding and use of the toilets (see results below). The household visits were supplemented by community workshops and gatherings.

Project leaders also secured funds from the Bureau of Applied Research in Anthropology, School of Anthropology, at the University of Arizona to support one graduate student to work with a student from the Instituto Tecnológico de Nogales and University of Arizona interns to continue monitoring, work with residents who have already received their toilets and are producing compost, and hold community workshops for families receiving toilets from the municipal government. As the new toilets are completed, the families are approached by the student monitors and, if they agree, they are added to the monitoring program.

Water Harvesting Systems

The water harvesting systems were monitored by University of Arizona students. The students visited the homes and the church where the systems had been installed to find out how the systems were working and respond to any questions posed by the recipients.

Conducting Outreach

Numerous outreach efforts were undertaken throughout the project, to ensure that residents of Colonia Colinas del Sol were familiar with the project, to share information about the project with others who might want toilets, and to ensure that decision makers in government and the non-profit sector were aware of the project and its outcomes. As described above in the section on toilet construction, efforts to construct toilets in other neighborhoods proved challenging as the cost of transporting materials and workers to distant sites proved prohibitive. Nevertheless, due to the involvement of city officials, by the end of the project toilets were being constructed in neighborhoods beyond Colinas del Sol.

Within Colonia Colinas del Sol

Outreach efforts within the colonia proved very successful. The workshops drew some residents and provided opportunities for them to have their questions answered. However, most effective were the monitoring visits, during which residents could ask questions and receive information, and the informal sharing of information of toilet recipients with others in the colonia. Throughout the project, the number of households who wanted a toilet exceeded the capacity of the project to construct the toilets. At the time the city engineer took over the construction of the toilets, using funds from the Mexican federal government, the project leaders shared with him the list of names of people wanting toilets.

With Residents of Other Colonias

Outreach to residents of other colonias began informally as residents of Colonia Colinas del Sol and members of the advisory board invited those residents to community meetings and workshops within Colinas del Sol where the toilets were being discussed. As described above in the section on toilet construction, in December the project leaders and advisory board members decided to dedicate project resources to the construction of toilets outside the colonia. None of the three toilets that were begun were completed during the project period; transportation of materials and workers proved particularly challenging. Because of the inability of project leaders and construction workers to keep up with the demand for toilets within Colinas del Sol, no additional outreach efforts were undertaken in other neighborhoods. Still, project and colonia leaders, along with the residents who had received toilets, hosted a number of tours to the colonia and gave presentations at local high schools and the Instituto Tecnológico de Nogales. One such event, an April 25, 2009 tour of environmental projects in Nogales organized by the Asociación de Reforestación en Ambos Nogales, involved more than 50 people from Nogales. Other events involved college and university students from Arizona as well.

With Decision Makers

Due to the need for additional resources and the desire to gain support for the composting toilets from government officials, outreach to decision makers continued throughout the project period. To begin, advisory board members were kept aware of all project activities. Project leaders also worked with the Nogales municipal government to try and construct a composting toilet at the city nursery where it could be used by staff at the nursery and seen and used by members of the

public who would be visiting the nursery. The project leaders shared plans for the toilet and had preliminary meetings with city officials, but construction of the toilet was not completed during the project period. Project leaders gave a presentation about the project at the Good Neighbor Environmental Board's September 23 meeting in Rio Rico, Arizona, and then later that week responded to a request from the Arizona Sonora Border 2012 Water Task Force for information to be shared at the Border 2012 National Coordinator's meeting; the project is featured in the report, *U.S.-Mexico Environmental Program: Border 2010* (Special Edition – Fall 2009, p. 1).

Project leaders also worked closely with leaders of local non-governmental organizations in both Sonora and Arizona. One challenge was to address the concerns of advisory board members and residents that some households would be unable to receive toilets because they could not contribute money toward the purchase of a toilet, and to supplement the cost of the toilet for the families who had received toilets but could not pay their portion. By November, the project leaders met with members of the Board of Directors for the Friends of the Santa Cruz River (FOSCR), a non-profit environmental organization formed in 1991 in Santa Cruz County, Arizona to protect and enhance the flow and water quality of the river, to talk about whether they would help with fund raising. FOSCR's board members agreed that the project would help keep raw sewage out of the river and its tributaries, and therefore directly address its mission as well as protect public health on both sides of the border. They agreed to participate in a holiday fundraising campaign through which individuals could contribute toward the purchase of a toilet in the name of someone else. A FOSCR member designed cards (see Figure 5) which were sold online and at an annual holiday festival held in Santa Cruz County. The campaign netted nearly $1,000, enough to pay the household contributions for five toilets. In addition, it helped raise awareness of the needs of Nogales, Sonora residents and opportunities for binational cooperation to help address local problems. Fundraising by FOSCR continued through the spring and summer of 2009, providing additional support for the project and increasing awareness of the project and water quality issues within southern Arizona.

Figure 5. Holiday Card and Website Prepared by Friends of the Santa Cruz River

Results of Monitoring

Composting Toilets

Thirty toilets were completed and monitored during the first project phase, an additional five were completed and monitoring had begun by September 2009, and at least a dozen additional toilets are under construction or recently completed within Colonia Colinas del Sol and other neighborhoods within Nogales. Twenty-six households were monitored at least 8 times over a period of at least 9 months, so the data from those households will be discussed here.

Monitoring of the toilets was conducted in two parts. The first part involved visual inspection of the bathrooms and toilets. Because composting toilets require some observable change in behavior – residents must use sawdust after each time they use the toilet and they must ensure that the toilet seat is closed and the seal tight – the monitors recorded the condition of the toilet when they arrived. The monitors also recorded information about the physical condition of the tanks, walls, roof, and door as well as the presence of insects, sawdust, and toilet paper (see Appendix 3). The second part involved an interview with the household resident who was responsible for maintaining the toilet and included questions about the use and maintenance of the toilet as well as level of satisfaction with the toilet and any problems. In an effort to understand whether and how information about the toilets was being spread, residents were also asked if they had shown the toilet to anyone else during the previous week and if anyone else had come to use their toilet.

On over 85 percent of the visits the residents reported daily use of the toilets; in the first few weeks, some households did not use the toilet daily, either because they were still using their old pithole or because they did not have sawdust. Other reasons for not using the toilets included being at work or otherwise not home to use the toilet and problems with the toilet cover.

Overall, residents reported being very pleased with their toilets. Over 86 percent of the responses regarding satisfaction with the toilets were positive. Still, all but three people reported problems at one point or another and almost one-third (32.5%) of the total responses indicated problems with the toilets. Three people reported problems on more than half of the monitoring visits; when those individuals are removed, just under one-fourth (24.5%) of the responses indicated problems. Almost all the problems occurred in the first two months after the individual owned the toilet and included cracks in the walls, leaking roofs, impartial seals, and the lack of a window. Problems related with use of the toilet included forgetting to close the lid and not knowing how much sawdust to use, and most commonly they were attributed to children using the toilet; all such problems diminished rapidly as the families became accustomed to using the toilets.

The most common non-construction-related problem observed and reported was the presence of insects, mostly flies, within the bathrooms. Forty-nine percent of the responses indicated insects had been seen either during the monitoring visit or during the week prior to that visit. Despite efforts to keep them out, and especially during the rainy season, flies were reported in all but one bathroom at one time or another. In eighteen percent of the responses, the resident reported the use of insecticide. Because of delays in getting project funding, toilet construction began in June

and continued through the rainy season of 2008. Many of the problems reported in the initial months were resolved once the rains subsided. Fewer problems were reported in the summer of 2009, though precipitation was much lower than normal during that period.

Monitors reported few problems with how the toilets were being used; in only 7 percent of the visits did the monitors find the toilet seats raised when they arrived. Lack of sawdust was a more significant problem. Initially, a number of households reported problems getting sawdust, so the AVES president and project manager arranged for sawdust to be made available at the community center. After that point, some residents began getting their sawdust there; others continued to get it from local carpenter and wood shops. Over time, the provision of sawdust at the community center was discontinued and residents either got the sawdust on their own or made arrangements with their neighbors to acquire it. Because sawdust is readily available in lumber yards and carpenter shops near the colonia, only a few households continued to report problems obtaining sawdust throughout the project period.

In almost a third (30%) of the responses the residents indicated that someone other than members of the household had used the toilet in the previous week, and 42 percent reported having shown the toilet to someone outside the household in the previous week Almost all responses indicated that the reaction of others to the toilet was positive. This sharing of information from person to person proved to be among the most important forms of outreach for the project.

Compost was removed from the first toilets in May 2009, and, by October, 16 households had removed the compost from at least one toilet tank; one household had removed the compost from both tanks by that point. Other than problems opening the back doors for the first time, the residents reported no problems with the compost. The residents consistently reported that the compost had no odor. Some residents who had not yet removed their compost by that time reported that they were unsure what to do with the compost. One suggested organizing a community forum to talk about the toilets and options for using the compost; events such as this are being planned as part of the efforts to expand the project.

The households varied considerably in how long it took them to fill the toilet tanks, from around 4 months to over 14 months. The average of 17 households who had completely filled at least one tank was a little less than 7.5 months per tank. The interior dimensions of each tank are approximately 33 in x 32 in x 30in, resulting in a volume of approximately 31,680 cubic inches. Assuming each deposit into the toilet to be approximately 30 cubic inches (including sawdust), the toilet could hold approximately 1,050 deposits. To estimate water saved with each toilet, at an average of 1.6 U.S. gallons per flush (as regulated by the Energy Policy Act of 1992), each complete tank represents a savings of at least 1,680 gallons. On average, each household will fill 1.6 tanks per year, resulting in a per-household savings of 2,688 gallons of water per year per household. With all 35 toilets being used, the savings will be approximately 94,080 gallons of water per year.

The cost of the toilet systems continued to rise throughout the project period, due to increases in the cost of materials, particularly cement and concrete blocks. The cost of materials per bathroom, including tank, walls, roof, and all necessary piping, window, screens, toilet seat

averaged about $200 during the project period. The toilets are most efficiently constructed by a team of two individuals, at least one of whom has considerable experience laying bricks.

Water Harvesting Systems

Monitoring of the water harvesting systems was conducted on an individual basis. All three systems had been completed by the end of October 2008. Nogales' average annual precipitation is 18 inches, with 50 to 60 percent of the annual rainfall usually occurring during the summer monsoon season from July through September (Western Regional Climate Center, www.wrcc.dri.edu/cgi-bin/cliGCStP.pl?az5924). During the project period, however, the city received below-average rainfall.

The two households that received the water harvesting systems also received composting toilets, so they were visited regularly throughout the project period. Problems with the first flush system at one household resulted in brown water; the homeowner therefore reported that she did not use the water to wash her clothes, as she had intended, but instead used it for watering her garden. The second homeowner reported no problems with her system. She used her water for washing and watering plants. The system that was installed at the church was used to supplement water being purchased from the city trucks. The water was pumped into the roof cistern and then used to flush the toilets at the site.

The cost of each water harvesting system varied significantly. The major expenses are the tank, the gutters, the cement base or stand for the bank, and the pipe. Rotoplas water storage tanks were used in all three systems; in two cases the tanks were not purchased by the project. The cost of materials for a system of the type installed at the houses, including purchase of the tank, was approximately $350. The systems were installed by teams of two to three people working over several days; installing the base/stand and the tank requires some experience with construction.

Discussion

This project was focused in Colonia Colinas del Sol, a colonia of approximately 2,000 households located on the eastern edge of Nogales, Sonora that has no access to water or wastewater services and is not programmed to receive those services in the foreseeable future. Between June 2008 and September 2009, 35 composting toilets were constructed within the colonia. At the end of the project period, the Nogales municipal government was constructing an additional 20 toilets, both in Colinas del Sol and in other Nogales colonias.

The project was successful in demonstrating that Nogales residents can and will learn about and accept composting toilets. As the project progressed, even some residents with septic tanks approached project leaders about getting a toilet because it would not require water. Unfortunately, due to the limited resources for the first phase of the project, only those households with pitholes or no options at all were eligible to receive toilets.

The project also demonstrated that rooftop water harvesting is possible in Nogales, though the challenges associated with adding gutters and tanks to irregularly constructed roofs add to the cost and feasibility of widespread adoption of the technology in the colonias. Incorporating

gutters and cisterns into planned housing developments is likely to be more economical and feasible on a large scale.

The project has directly benefited the 35 households that received toilets and the two households and church that gained access to the collected rainwater. It has also helped reduce the flow of raw sewage in the community, and, during the second phase involving the city, provided jobs for colonia residents while educating them about the technologies and their use. The project also sought to extend the technology to other colonias that lack water and wastewater services. It now serves as a demonstration for other Nogales neighborhoods and border communities.

The project period was sufficient for designing, constructing, and monitoring the composting toilets in the pilot phase, but it was not long enough to foster and monitor more widespread adoption of the technology within the target colonia or elsewhere in Nogales and beyond. The involvement of the city helped move the project to a second phase, during which workers from the community helped construct the toilets. The success of this phase depended on the positive outcomes of the first phase where many households had not only accepted but had begun promoting the technology. The involvement of local workers also helped to develop a sense of community ownership of the project, but that phase was too brief to foster the formation of durable groups of residents who could continue building toilets after the city engineer left.

What is now needed is a mechanism to transition the composting toilets initiative to a new level. For example, it may be possible to shift to constructing only the toilet tanks while families take on the responsibility for constructing the rest of the bathroom, enabling project and community leaders to extend the technology to a greater number of households. Project participants also want to experiment with various recycled materials to lower cost of construction and to try new designs. Ongoing and high demand for the toilets indicates the potential for success of such efforts.

Due to continued interest in the project and the toilets, project leaders will work with residents and leaders of Colinas del Sol throughout 2010 to develop plans for extending the project. Specific issues to be addressed include designing toilets of different sizes to accommodate households with more members, identifying more effective methods of insect control, such as traps, and ensuring the availability of sufficient sawdust or other carbonaceous materials as the project expands. The project leaders will also work with residents and community leaders to identify additional options for the disposal of the compost end product.

In addition to addressing the immediate needs of colonia residents, the project provided the opportunity to raise consciousness of the link between human waste, contamination of the water supply, and health. As the technology is extended to other neighborhoods and communities, outreach opportunities will also grow.

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Appendices

Appendix 1. Household Assessment

Appendix 2. Slide Presentation

Appendix 3. Household Monitoring Form

Appendix 1: Household Assessment

Construcción de Sanitarios Composteros y Recolección de Agua Pluvial: Alternativas para la Recolección y Protección del Agua en Nogales, Sonora

Estamos aquí visitándoles por su interés en ser parte del estudio de los baños ecológicos/de composta. ¿Todavía está interesado usted en un baño ecológico? (Ahora, en un mes, el próximo otoño) ¿Usted todavía está de acuerdo con que nosotros (los estudiantes) vengamos a su casa para hacerles entrevistas y visitas en su casa? sí no
Días, horas:
Su participación en este proceso es completamente voluntaria y a cualquier momento puede retirarse del proceso.

Fecha:
Nombre del encuestador(a):

Nombre del participante:
Dirección de la casa:

CONSTRUCCIÓN:----------
¿Qué tipo de baño está usando hoy?

Durante los 4 días de construcción, ¿quién va estar en casa, nombres y los días mejores para ellos?

¿Pueden ustedes mismos hacer las preparaciones preeliminarias?

¿Su aportación puede ser especia o económica? Será 2000 pesos. (show the list)

Necesitamos un mitad de su aportación antes de empezar. ¿Cuando se puede conseguir su aportación?

¿Con qué material van a construir los muros / las paredes?

¿Quién en la familia va a mantener el baño?

SITIO:----------
¿Dónde pondría el baño ecológico? (space required 7'x5' in feet, 2x2 in meters)

Tamaño del espacio:
Tamaño de la propiedad:

¿Es la única opción ponerlo sobre un hoyo abierto? sí no
¿Se puede llenar el hoyo? sí no
si se puede, con que? _____
Durante los 4 días de construcción, ¿qué se usara?

Fotos (log en la otra página) sí no

Comentarios del encuestador(a):

	Nombre	Edad	¿Trabaja?	¿Estudia?
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				

INFORMACIÓN ADICIONAL:----------
¿Es **propia** o **rentada** el terreno / la casa?

¿De qué material está construida la casa?

Comentarios adicionales (Detalles acerca de la casa y observaciones)

FOTOS:----------

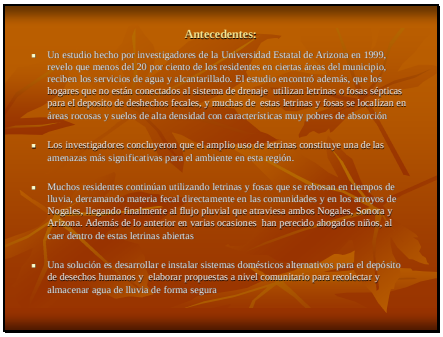
No. de foto	Dirección	Descripción

DIBUJO:----------

Appendix 2. Slide Presentation

Slide 1

Slide 2



Slide 3

Slide 4

Financiamiento

Frontera 2012

8 de Noviembre 2007

Slide 5

Miembros del Consejo Consultivo

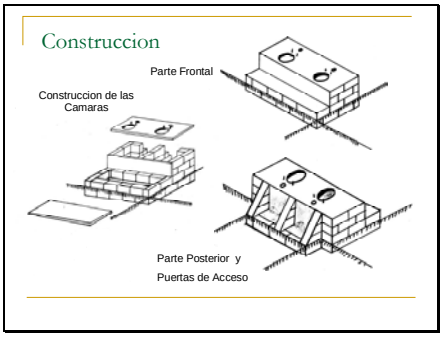
- *Representantes de la Colonia*
  AVES
- *Representante de la Administración Municipal*
  Desarrollo Urbano
- *Gobierno de Arizona*
  ADEQ
- *Industria/Negocios*
  AEGA
- Organización Civil
  Frente Cívico Municipal
- Académicos
  Instituto Tecnologico, CONALEP y U of A

Slide 6

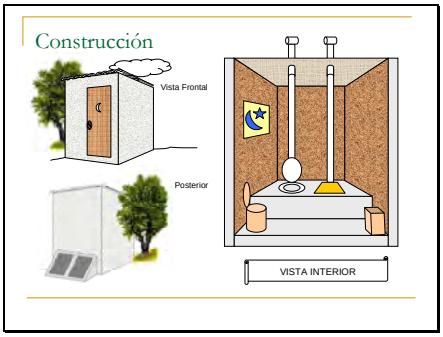
Baños de Composta

- Que es Composta?
  Composta es la descomposición biológica aeróbica (que usa oxigeno) controlada, de materia sólida orgánica para producir un acondicionador del suelo. Debido a que requiere oxigeno, no debe contener agua (saturado).
- El énfasis es en el "CONTROL" esto lo separa de la descomposición sin control que ocurre en el ambiente natural
- En un baño de composta, el objeto es transformar residuos potencialmente dañinos, presentes en la mayor parte del excremento humano, en materia estable oxigenada.
- Los principales microorganismos responsables de la descomposición son las bacterias y hongos. Sin embargo, algas, virus, líquenes y otros, son organismos que se encuentran presentes en el proceso de composta. Otros animales del suelo también contribuyen degradando los desechos consumiendo bacteria y ayudando a la oxigenación.
- Algunas recomendaciones de manejo son:
  - Utilizar un asiento para retrete sellado con empaque
  - Colocar malla mosquitera en las aberturas del respirador
  - Sellar bien las ranuras del tanque
  - Aplicar insecticidas amistosos con el ambiente.
  - Evite depositar desechos de la cocina en los tanques.

Slide 7



Slide 8



Slide 9

Reglas de Uso

- No Deposite los papeles dentro del Tanque
- Poner Aserrin despues de usarlo.
- Cerrar la tapa al terminar.
- Utilizar trampas para moscas dentro del baño
- Sacar la Composta solo despues de un año

Appendix 3. Household Monitoring Form

Updated Survey – Phase 1 Data entered _____

Number of this visit (1st, 2nd, etc.) _____

Construcción de Sanitarios Composteros y Recolección de Agua Pluvial: Alternativas para la Recolección y Protección del Agua en Nogales, Sonora

[Recuerde al participante que queremos aprender sobre sus experiencias para mejorar los sanitarios, si es necesario.]

1. ID # _____ 2. Fecha: _____ 3. Nombre de Encuestador(a): _____

4 Nombre de Residente: _____ 5. Sector: _____

6. Dirección de Casa: _____7. Fecha que se concluyó la construcción_____

8. Cuantas personas viven en la casa_____ 9. Fecha que han cambiado de lado _____

OBSERVACIONES HECHAS POR EL/LA INVESTIGADOR(A)----------

10. Problemas (marque todo lo que corresponda):

Nunca La puerta de atrás no está sellada Las paredes están rajadas El tanque está rajado

El tanque gotea El sello de la tapa está dañada La puerta del baño no cierra Otro

_____

11. El tanque en uso al tiempo de la visita (viendo al sanitario por dentro) (marque uno):

Izquierdo Derecho

12. Estado de la tapadera siendo usada (marque uno): Abierta Cerrada

a. Estado de la cobertura sobre el tanque no siendo usado (marque uno):

Completamente sellada Parcialmente sellada Abierta

b. Número de tubos de respiración en el tanque siendo usado (marque uno):1 2 3

13. Uso del sanitario (marque uno): <1/4 lleno 1/4 a 1/2 lleno 1/2 a 3/4 lleno >3/4 lleno

Comentarios:

14. Insectos visibles (marque todo lo que corresponda):

Para cada tipo, escriba el nombre del insecto y ponga una X debajo de todas las que apliquen:

Tipo de insecto	Dentro del sanitario	Dentro del baño pero no dentro del sanitario	Inmediatamente afuera del baño

15. Papel del baño (marque todo lo que corresponda):

En la basura En el sanitario Sobre el piso

16. Aserrín (marque todo lo que corresponda):

En Recipiente Sobre el piso No hay

17. El recipiente de aserrín esta (marque uno): vacío - mitad +mitad lleno

18. Estado del baño:

a. Mega limpio Medio limpio Sucio

b. Huele No huele

PREGUNTAS----------

19. Su contribución fue **económica** o **en material** o **ambos**? (marque uno)
    Si económica: Ha hecho algún pago esta semana/mes? Cuantos?
    Si material: Cual fue su aportación?

20. a. ¿Qué tan seguido fue usado el sanitario la semana pasada? (marque uno)
    Diariamente Una o dos veces Nunca
    [Si la respuesta es NUNCA, vaya a 20b y parada. Por otra parte vaya a 21.]

    b. Si el sanitario no está siendo usado, ¿por qué no?

21.a. ¿Cuáles son los pasos para usar el sanitario que son los más difíciles para recordar? (Nombra cada paso y que son difíciles para recordar.)

21.b. Dígame sobre su experiencia con el sanitario. ¿Está contento / satisfecho?

22. ¿Tiene alguno problema con el baño?
    a. si no
    b. [*Si existen problemas*]: Describe su problema.

23. ¿Cuánto aserrín usó durante la semana pasada en medida de bolsa tamaño normal?

24. ¿De dónde consiguió el aserrín?

25. ¿Cómo limpia el sanitario?

26.a. ¿Ha visto pruebas de insectos dentro del sanitario en la semana pasada?
    b. ¿Qué tan seguido?

27.a. ¿Está usando insecticida? b. ¿Qué tipo?

28.a. ¿Le están echando algo más que excremento? b. ¿Qué?
    c. ¿Qué tan seguido?

29. Estamos interesado si otros están aprendiendo de estos sanitarios.
    a. ¿Ha usado este sanitario alguien que no vive en la casa? Si No

    b. ¿Quién?

    c. ¿Cuáles fueron sus reacciones?

    d. ¿Si ocurrieron problemas, qué tipos?

30.a. ¿Alguien que no vive en su casa ha venido nada mas para ver el sanitario durante la semana pasada?
    b. ¿Cuáles fueron sus reacciones?

31.a. ¿Ve usted alguna razón para no continuar usando el sanitario? b. ¿Cuáles son esas razones?