AMBOS NOGALES SOIL STABILIZATION THROUGH VEGETATION (ANSSTV)

Final Report

Bureau of Applied Research in Anthropology
University of Arizona
for the
Asociación de Reforestación en Ambos Nogales

January 2006

AMBOS NOGALES SOIL STABILIZATION THROUGH VEGETATION (ANSSTV)
Final Report

Prepared for:

Doug McDaniel
U.S. Environmental Protection Agency
75 Hawthorne Street, AIR-8
San Francisco, CA 94105

Prepared by:
Daniela Diamente
Diane Austin
Bureau of Applied Research in Anthropology
University of Arizona
Tucson, Arizona

With the assistance of:
Joanna Stone
Justin Gaines
Jeremy Slack
Brian Hawkins
Mia Foster
Samantha Herr
Thomas Lance
Wendy Vogt

January 2006

TABLE OF CONTENTS

Acknowledgements

This project would not have been possible without the financial support of the U.S. Environmental Protection Agency and the continuous cooperation and help of many individuals, groups, organizations, and institutions in the states of Sonora, Mexico and Arizona, USA. More specifically, each aspect of this project required the collaboration—one that was often bilingual, binational, inter-generational, and multi-cultural—of numerous people in Ambos Nogales and the surrounding areas. Our sincere thanks go to each and every individual who contributed to the past year and half of community-rooted efforts to stabilize soils, plant and maintain vegetation, develop and extend environmental awareness, and improve overall air quality. We hope that you all see the results of your hard work conveyed through this report.

First and foremost, we thank all members of the Asociación de Reforestación en Ambos Nogales (ARAN). This includes the schools, colonias, organizations, and governmental institutions involved in or supportive of this project. The project would never have been conceived nor carried out without your interest, ideas, perseverance, and commitment to your schools, neighborhoods, workplaces, and community. In addition, a few ARAN members deserve special recognition. We personally thank the following individuals and groups for reaching out beyond their own groups and making this an enjoyable as well as productive experience.

Aurelio Gonzalez, serving as the Treasurer for the Asociación de Profesionales en Seguridad y Ambiente (APSA), readily accommodated the accounting needs of this project, even though they were far more protracted and complicated than anyone anticipated. Thank you for your patience and diligence. Jesús Garcia and the Arizona Sonora Desert Museum provided ongoing assistance and advice. John Swanson and SUMEX were always gracious hosts, providing plentiful food for Mesa Directiva meetings. Michèle Kimpel Guzmán, former Air Outreach Coordinator of the Arizona Department of Environmental Quality Border Team, provided much inspiration and encouragement. Guadalupe Santos de Alcantar, Irma Fragoso of the Instituto Tecnológico de Nogales Crecencio Elenes of Terra Cycle Technologies, Carmina Cervantes and Juan Angulo of Comité TREE, and Virginia Sinohui of the Promotoras Sociales Voluntarias were steadfast in their dedication to the project. To all we owe thanks for your continued leadership, support, and good humor.

Josefina Hinojos and the students of the Ecology Club at the Centro de Estudios Tecnológicos Industrial y de Servicios No. 128 (CETis 128) were always ready and willing to take on new tasks and set a high standard for the rest of us to follow. Likewise, Rosalva Leprón Leon and the students at the Colegio Nacional de Educación Profesional Técnica (CONALEP) kept the rest of us motivated with their enthusiasm, dedication, and outstanding efforts to make their school and Nogales a better place to live and work. Estela-María Díaz and the students of the Health Science Clubs of the Southeast Arizona Area Health Education Center (SEAHEC) inspired us with their willingness to take risks and reach out to others, and were outstanding hosts for our Arizona meetings. Because of each of you, the future is brighter for all of us.

Also, we would like to recognize and show appreciation for the invaluable assistance and patience provided by the administrative staff at the University of Arizona's Bureau of Applied

Research in Anthropology, especially Armando Vargas, Nancy Young, Kevin Oakes, and Maria Rodriguez. Without you, we would still be trying to establish subcontracts, arrange transportation, and get our computers to work.

Executive Summary

The central goal of the Ambos Nogales Soil Stabilization Through Vegetation (ANSSTV) project was to establish a sustainable program for identifying and protecting existing vegetation, as well as promoting effective revegetation efforts to stabilize soils, reduce air pollution, and reestablish communities of native vegetation within Ambos Nogales. The numerous groups and individuals that make up the Asociación de Reforestación en Ambos Nogales (ARAN) continue ongoing work towards this goal, building on the eight objectives fulfilled as part of this project.

A principal aim of this project was to develop the local physical and social infrastructure necessary for achieving its central goal. The project realized the establishment of a central nursery in Nogales, Sonora; development of six satellite school nurseries and composting facilities; preliminary mapping of vegetation in the municipality; coordination of environmental education and public outreach efforts around air quality and erosion control; coordination of maquiladora participation in revegetation planning and efforts; and development of five local neighborhood (greenspace) projects. The project concluded with a formal project assessment and evaluation of the effectiveness of the ARAN partnership infrastructure in completing the tasks listed above.

Beyond the stated project objectives, numerous additional lessons were learned and sustainability objectives achieved. Revegetation as erosion control had advantages and disadvantages in school and colonia settings, both of which provided access to resources and opportunities, as well as unforeseen challenges to the partnership. Awareness and concern that grew out of environmental education efforts in this border community resulted in the participation of at least half a dozen ARAN members in the Arizona-Sonora Air Quality Task Force, a binational policy forum aimed at improving air quality in the region. College and university students played a multifaceted role in the overall partnership, one that included research, information dissemination, project facilitation, and coordination, which proved critical to the success of projects and collaborations. Moreover, the partnership was able to develop relationships with new partners, strengthen the organizational infrastructure of existing partners, and add sources of revenue for other partners, thereby ensuring present and future stability and sustainability.

The results of the project evaluation revealed positive and negative elements of the partnership. The greatest benefits of the partnership included development, availability and dissemination of information resources; leadership development of and assistance provision by UA students; new or improved connectivity within communities and between partners; critical monetary and material resources; the strength and power that come from working together, and community enthusiasm and pride which was derived from the sense of belonging to something larger than one's own projects. The greatest limitations for ARAN partners were time, communication difficulties, and physical obstacles posed by the external environment. Project participants expressed a need for more support from peers and staff within partner organizations, for more residents to become involved in local colonia projects, and for more teachers and parents to become involved in school projects.

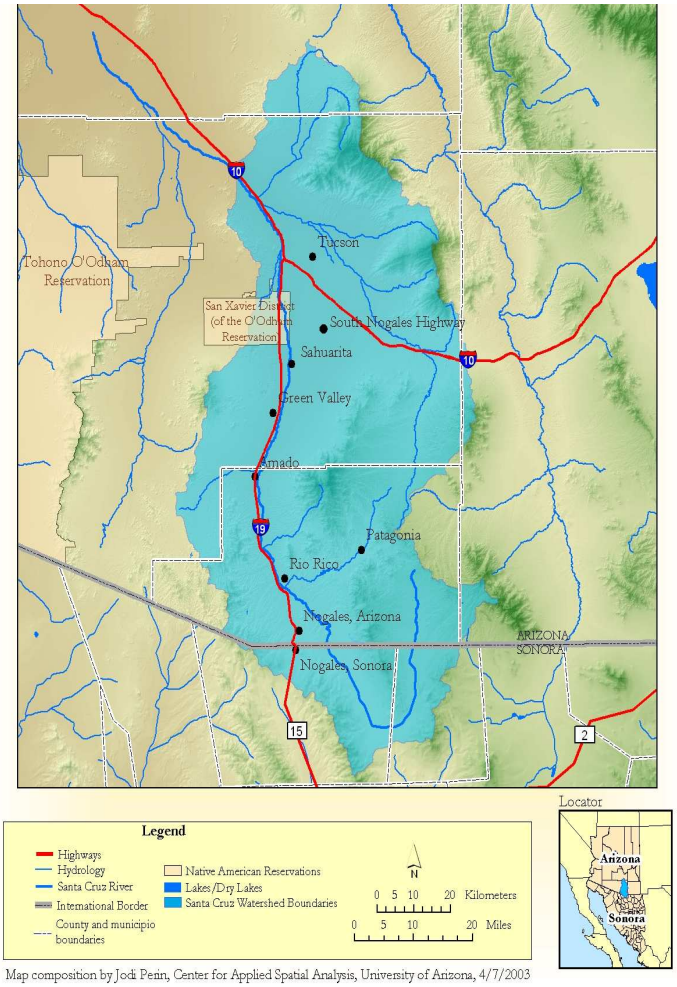
Revegetation is only one part of the larger solution to air quality problems in Ambos Nogales. Control of unchecked urban development as well as broadly conceived efforts directed towards a

watershed level understanding of environmental conditions and influences are needed. This project was initially designed to work towards the Air Quality Task Force's Recommendation for using revegetation as erosion control, and we learned just how closely tied all of these issues are. There is an imperative need for a forum where all the issues relevant to this region (Air, Water, Children's Health, Emergency Relief, and Waste Management) can be addressed, discussed and potentially solved together. This project provided both means and a context in which these relationships, and the associated improved understandings, could be developed. Expanding on existing networks of resource and information flows, and facilitating new relationships among community members oriented towards similar community goals for local environmental improvement, will be the next step.

Introduction

The Ambos Nogales Context

Ambos Nogales is an urban center located within the Santa Cruz watershed on the Arizona (U.S.) – Sonora (Mexico) border. It lies between two major ecological zones, the Madrean Evergreen Woodland and Semi-Desert Grassland and just beyond the Sonoran Desert. It is home to a wide variety of plants and animals. Though the communities of Ambos Nogales are separated politically by local, state, and national boundaries, they are ecologically connected. The name "Nogales" is Spanish for "walnut trees.", and at one time walnut trees grew throughout the area.



Map composition by Jodi Penn, Center for Applied Spatial Analysis, University of Arizona, 4/7/2003

Over 400,000[1] people live in these communities; and because they are linked, the communities of Ambos Nogales share many environmental concerns. First, air flows back and forth through the region, with the prevailing winds from south to north about 25 percent of the time. The Santa Cruz River begins in southern Arizona, makes a 32-mile loop through Sonora, and returns to the United States east of Ambos Nogales, supplying drinking water from its groundwater aquifers to communities along its entire course and providing approximately half the supplies of the sister cities of Nogales, Arizona and Nogales, Sonora. The Nogales Wash, which flows through both cities, is a tributary of the Santa Cruz River.

Many people are concerned about the environment of Ambos Nogales and are working to help others appreciate the local ecology and address environmental problems. One such group—the one responsible for facilitating the projects described in this report—is the Asociación de Reforestación en Ambos Nogales (ARAN).

[1] Population estimates for Nogales, Sonora alone approach 500,000 due to large influxes of transient populations waiting to cross the U.S.-Mexico border, often illegally.

Brief History of ARAN

The Ambos Nogales Revegetation Project began in 2001 with an environmental and social assessment—namely, a pilot project to assess the nature and extent of the de-vegetation and erosion problems in Ambos Nogales. The Arizona Department of Environmental Quality (ADEQ) initiated the assessment as part of a larger binational, government effort to address air quality issues in Ambos Nogales. In May 2001, students from the Bureau of Applied Research in Anthropology (BARA) at the University of Arizona (UA) in Tucson and the Centro de Estudios Tecnológicos Industrial y de Servicios No. 128 (CETis 128; a high school) in Nogales, Sonora, worked together on the Ambos Nogales Revegetation Project (ARNP) and explored the feasibility of community-based solutions. Environmental problems identified by the community included trash, dust, stray dogs, sewage, lack of or invasion into green areas, damaged or unpaved roads, polluted water, and lack of water service. The assessment found that revegetation could reduce erosion, improve the quality of the air, and improve general environmental conditions, and, more importantly, that there was support in Nogales for a revegetation program. It also revealed that a successful revegetation program would require community-wide education as a way to raise general awareness of environmental issues, and fortunately, it was evident that residents and civic leaders in Nogales were eager to support and participate in revegetation projects, especially those focused on native, drought-resistant plants.

Following the assessment, a group of interested individuals from Nogales and Tucson organized three pilot projects. Faculty from CETis 128 and the Bureau of Applied Research in Anthropology at the UA joined with faculty at the Instituto Tecnológico de Nogales (a technical college) and applied for and received funds to begin pilot revegetation projects in Nogales. The partners identified three sites, an elementary school, a secondary school, and a neighborhood in Nogales, Sonora for their first projects. The pilot projects were designed to explore ways to increase the planting and maintenance of native vegetation on hillsides and in local gardens. They also were designed to (1) produce visible action, (2) provide a mechanism for local involvement, and (3) identify challenges and opportunities. A significant goal of this project was the development of institutional relationships and partnerships among border schools and universities in the United States and Mexico. Eventually, new partners joined as the partnership evolved into a loose consortium of groups and individuals and they began holding monthly meetings in order to share information and identify areas of interest. In May 2003, participants adopted a name, for which the acronym is a Spanish word meaning “they plow.”

Currently, the Asociación de Reforestación en Ambos Nogales (ARAN; Ambos Nogales Revegetation Partnership) aims to increase the planting and maintenance of native vegetation and the incorporation of water harvesting principles in order to reduce erosion, increase habitat, and reestablish communities of native vegetation within the communities of Nogales, Arizona and Nogales, Sonora. While improving air and environmental quality are central goals of the partnership, additional goals include fostering attitudes and practices of care for the environment, developing collaborative relationships between institutions, schools, and universities of the Arizona-Sonora border, and encouraging leadership among youth and adult ARAN partners.

The binational partnership includes more than twenty institutions from various sectors– government, academic, business, and non-governmental organizations[2]. Partners develop projects in their neighborhoods and at their school sites and come together to share information and gain assistance. Monthly educational meetings provide information on topics such as native plants, composting, and water harvesting. The partnership organizes member participation in fieldtrips, workshops, academic conferences, and other educational activities on both sides of the border.

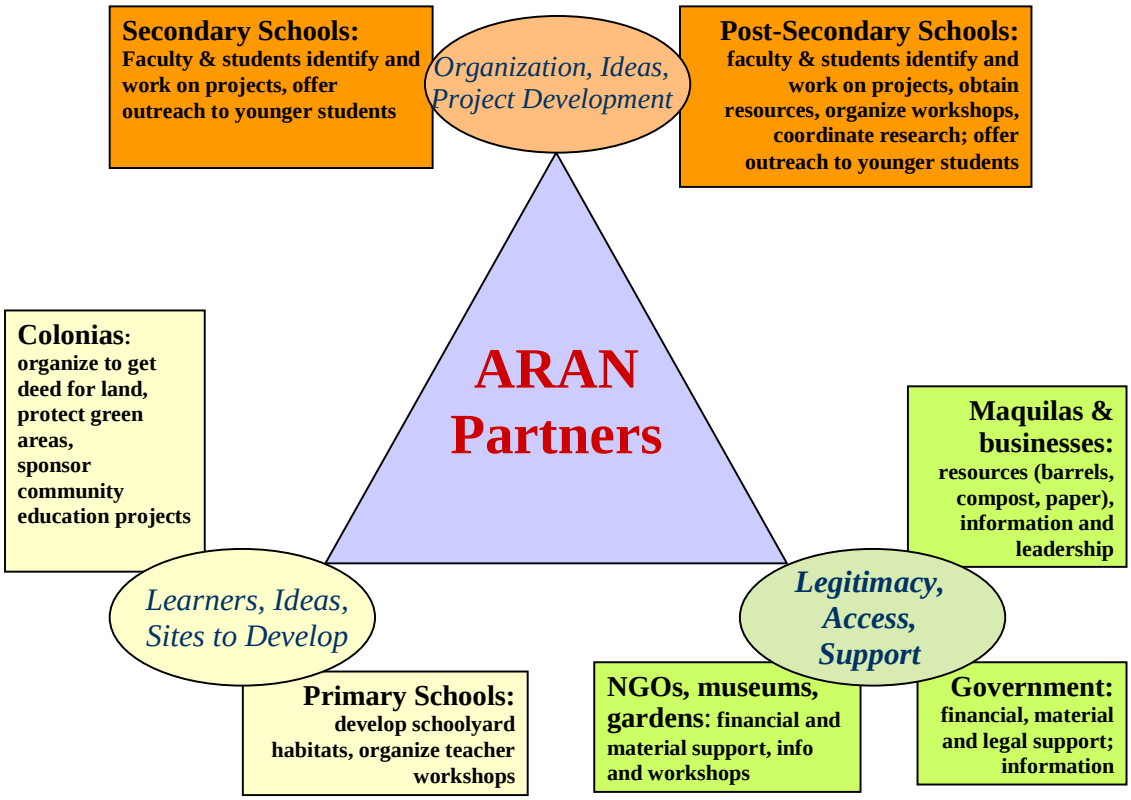


Diagram 1: Structure and Function of ARAN Partners

Review of Goal and Objectives of Project

This is the final report of the project, "Ambos Nogales Soil Stabilization through Vegetation Project" being conducted by ARAN. The central goal of the ANSSTV was to establish a sustainable program for identifying and protecting existing vegetation and promoting effective revegetation efforts to stabilize soils, reduce air pollution, and reestablish communities of native

[2] Members of ARAN with key roles in the ANSSTV project included the Instituto Tecnológico de Nogales; Municipio de Nogales, Sonora; Centro de Estudios Tecnológicos industrial y de servicios N. 128 (CETis 128); Colegio Nacional de Educación Profesional Técnica (CONALEP); Escuela Secundaria General 3; SEAHEC; Nogales High School; AJ Mitchell, Desert Shadows, the Bureau of Applied Research in Anthropology (BARA) at the University of Arizona; Comité Tree; Arizona Department of Environmental Quality (ADEQ); Terra-Cycle Technologies; SUMEX; Otis; Asociación de Profesionales en Seguridad Ambiental (APSA); Arizona Sonora Desert Museum; La Casa de la Misercordia; and Colonias Jardines del Bosque, Villa Sonora and Heroes.

vegetation within Ambos Nogales. The original proposal was submitted by the University of Arizona on behalf of ARAN, which worked collectively through eight objectives, each with distinct outcomes, to achieve this goal. The organizational infrastructure developed at the start of this project proved to be indispensable for both the facilitation and administration of all objectives, and for communication in general.

Project Objectives

Objective 1. Within Nogales, Sonora, establish a centralized nursery and five satellite sites at local schools. Utilize the nurseries for environmental education and training as well as the production of locally adapted plant species, focusing on plants that are effective in soil stabilization. Within Nogales, AZ work with the University of Arizona Cooperative Extension and Nogales High School to coordinate efforts begun under the "2,000 by 2000" program to plant trees within Nogales, Arizona and Santa Cruz County and establish one satellite site at a local elementary school.

Objective 2. Within Nogales, Sonora, establish three satellite composting sites at local schools. Within Nogales, AZ, coordinate with Terra-Cycle Technologies of Rio Rico, Arizona, an organic farm and composting facility, and the City of Nogales, Arizona's green waste program, and establish three satellite sites at local schools. Utilize these facilities for environmental education and training as well as the reduction of solid waste, demonstration of alternatives to burning green waste, and production of compost to enrich local soils.

Objective 3. Use remote sensing and Geographic Information Systems technologies to map green areas and parks, identify areas lacking vegetation, and estimate the effect on airborne particulate matter of protecting existing green areas and revegetating denuded ones.

Objective 4. Implement a coordinated school program through which faculty and students at secondary and post-secondary schools receive sufficient education, training, and experience to develop projects at their school sites and then serve as project leaders in elementary schools, in neighborhoods, and at community facilities. Develop educational materials and workshops for teachers. Use project funds to support experienced university graduate students to help coordinate teams of students working on internships or for social service credit and to identify sources of permanent funds for this purpose.

Objective 5. Expand and coordinate the participation of maquiladoras and other businesses through business organizations such as the Asociación de Profesionales en Seguridad Ambiental and promote their participation in the Arizona-Mexico International Green Organization (AMIGO) program.

Objective 6. Building on a successful pilot project at Colonia Jardines del Bosque, develop a model through which neighborhoods can receive assistance in protecting and developing green areas and neighborhood parks. Implement the model in five neighborhoods (Col. Jardines del Bosque, Col. Villa Sonora, Col. Los Heroes, Col. Solidaridad, Parque Industrial Nuevo Nogales), each with a specific array of needs that require attention, including: (1) protecting existing vegetation; (2) constructing fences and retention walls; (3) leveling areas and adding soil as

necessary; (4) creating pathways and clarifying traffic patterns; and (5) planting of trees and vegetation that will build and stabilize soils.

Objective 7. Assess local knowledge and awareness of local vegetation, composting, and the relationships among vegetation, soil erosion, air quality, and health. Develop and distribute educational materials on locally adapted plants and the ecology of Ambos Nogales; composting and green/organic waste management; and the relationships among vegetation, soil erosion, air quality, and health.

Objective 8. Assess the effectiveness of the nurseries, composting facilities, protection and revegetation efforts, school program, participation of business and industry, neighborhood projects, and distribution of educational materials using (a) baseline documentation of existing site conditions, including measurement of physical attributes such as ground cover and particulate matter where appropriate, (b) interviews with key participants in each of these areas prior to implementation, (c) participant observation during program implementation, and (d) documentation of site conditions six months and one year after implementation.

Development of Organizational Infrastructure

Upon initiation of this project in the fall 2004, more formal structures were introduced to accomplish the goals of the grant. The establishment of this organizational infrastructure proved necessary for carrying out the project objectives and for ensuring the sustainability of the project beyond the life of the grant. This was achieved through the creation of a ten-member Executive Committee (hereafter referred to by its Spanish name: *Mesa Directiva*) and four subcommittees: Nurseries and Composting, Education and Public Outreach, Maquiladoras, and Colonias. The Mesa Directiva met monthly, and each subcommittee met at least once a month, depending on its needs. A collectively designed procedure for submission and approval of proposals encouraged all members to think through plans and find new points of collaboration with each other before engaging in projects. The Secretary of the Mesa Directiva established and maintained a notebook to archive notes from all meetings, copies of all proposals brought before the committee, and other business related to the grant.

The Asociación de Profesionales en Seguridad Ambiental (APSA), a well-established organization of environmental and safety managers, organized the maquiladora participation and managed the grant funds for all projects on the Sonoran side of the border. This was suggested and then unanimously decided upon at a Mesa Directiva meeting in August 2004 as the best resource for local administration of the project funds. The Secretary of the Mesa Directiva worked closely with the Treasurer of APSA to invoice funds for projects once they had been approved by the Mesa Directiva. The Treasurer took full responsibility for administering the funds, maintaining records, and collecting receipts from ARAN partners. Throughout the process, the Treasurer of APSA and the Secretary of the Mesa Directiva maintained communication and the latter incorporated the financial records into the official notebook.

The committees included representatives from the following organizations and were responsible for ensuring that the specified objectives were met.

Mesa Directiva: Approve proposals for funding; oversee all committees and evaluation
Representatives from: Colonias; Promatoras; Comité TREE/ Instituto Tecnológico de Nogales; Prepatorias; Secundarias; Goverment, Mexican side (Municipio de Nogales); Government, U.S. side (Arizona Department of Environmental Quality); University of Arizona; Asociación de Profesionales en Seguridad Ambiental

Nurseries and Composting: Objectives One, Two, and Three
Representatives from: Terra-Cycle Technologies; Sumex; Asociación de Profesionales en Seguridad Ambiental (APSA); Centro de Estudios Tecnológicos industrial y de servicios N. 128 (CETis 128); Colegio Nacional de Educación Profesional Técnica (CONALEP); Escuela Secundaria General 3; Comité TREE

Education and Public Outreach: Objectives Four and Seven
Representatives from: Instituto Tecnológico de Nogales; Municipio de Nogales, Sonora; Centro de Estudios Tecnológicos industrial y de servicios N. 128 (CETis 128); Colegio Nacional de Educación Profesional Técnica (CONALEP); Escuela Secundaria General 3; Southeast Arizona Area Health Education Center; Arizona Department of Environmental Quality; University of Arizona; Arizona Sonora Desert Museum; Colonia Jardines del Bosque; Comité TREE

Maquiladoras: Objective Five
This committee worked through the Asociación de Profesionales en Seguridad Ambiental (APSA).

Colonias: Objective Six
Representatives from: Colonias Jardines del Bosque, Villa Sonora, Los Heroes, Solidaridad, and Bella Vista; University of Arizona; Municipio de Nogales

The first chapter is organized around the project objectives; much like committees functioned, starting with objectives 1-3 (Nurseries, Compost, and Maps, respectively), then objectives 4 and 7 regarding Education and Outreach, the work done by the Maquiladoras through objective 5, objective 6 for the development of neighborhood projects, and the final objective for the project assessment and evaluation. Next, Chapter Two lays out some of the findings or themes that came out of working on the project objectives in terms of using revegetation as erosion control, working in schools and colonias, facilitating public outreach, and the role of university students in all of this. Because a central objective of this project was to develop physical and social infrastructure for the continuation of a program to protect existing vegetation, promote revegetation, and enhance education and public outreach, Chapter Three explores the evaluation of partnership synergy closely. Beyond the objectives, this report includes a discussion on the challenges of new collaborations as well as successes and lessons learned in Chapter Four. The report ends with a summary, final conclusions and recommendations for both the continued implementation of the program in Ambos Nogales and potential implementation in other border communities.

Chapter One: Review of Project Results

Part One

Objective One: Nurseries
Objective Two: Compost Facilities

Centralized City Nursery
Within Nogales, Sonora, the objective was to establish a centralized nursery through the Municipality for the production of locally adapted plant species, focusing on plants that are effective in soil stabilization. In addition, it was intended to serve for environmental education and training through collaboration with the satellite nurseries developed at schools. Although there were efforts made in the early fall of 2004 to collaborate between the Nursery and Composting Committee and the City of Nogales, Sonora, it was determined that the two entities should work separately, while maintaining communication. Much of this was due to project magnitude and scheduling differences. All partners involved decided at a Mesa Directiva meeting that they were working on very different scales in the design and construction of nurseries and greenhouses, and all agreed that there could be more talk of collaboration once the initial steps had been taken.

Thus, officials of the Municipal government of Nogales, Sonora developed and completed plans for the city nursery. They submitted these to review by the Mesa Directiva and, upon approval, construction took place during the spring and summer so that planting could begin in the early fall of 2005. The large (12 x 36 meters) greenhouse installation holds thousands of plants; is equipped with hanging sprinklers for irrigation, a small tank for collecting rainwater, and electricity for heat lamps in the winter months. At a site visit in late September 2005, the site housed over 10,000 plants that had been transplanted from Santana via coordination with APSA and had begun cultivation of various seedlings of native vegetation. The head of the Municipal nursery, Manuel Mendoza, stated that the goal was to transition into more seedlings produced there at the nursery, as opposed to the relocated plants, which were intended for public use (by colonias, individuals, schools, etc) until the nursery was at suitable production capacity. (See Appendix A for photo documentation of the construction of the City greenhouse and nursery.) Now that the City Nursery has been established, partner schools such as Secundaria General 3, located directly across the street, are looking into pursuing environmental education and training at the site to benefit both the students and the nursery itself.

Satellite School Nurseries & Composting
As mentioned above, the Nursery and Composting Committee addressed Objectives One, and Two, collectively. The first task of all ARAN members involved in establishing nurseries and composting was to participate in workshops and fieldtrips to gather data about nurseries, greenhouses, and composting facilities (See Part Two). Several members researched designs, making visits to schools and nurseries that have greenhouses and composting facilities. Because of Nogales' climate and winter freezes (snow fell in Nogales in November 2004), all members were interested in establishing greenhouses to allow production of plants year round.

The activities of the groups from Nogales, Arizona and Nogales, Sonora developed in parallel with little cross-border group effort. Thus, the Nursery and Composting committee worked

primarily on the Sonoran side, even though information, ideas, and projects were shared regularly across the border through email correspondence, communication via UA student interns, and general ARAN monthly meetings. This report will discuss the results of the first two objectives through the work of all schools and additional ARAN partners involved first, and then move to more specific results at the particular schools in Nogales, Sonora and then in Nogales, Arizona.

Twelve people representing almost all of the groups with members on the committee attended a trip to a tree nursery in early November near the Chirichahua Mountains in southwest Arizona. The trip was a tremendous success in expanding the understanding of committee members and helped them modify their designs to ensure less expensive, more durable, and more productive nurseries and greenhouses. As a result, each group went back to the drawing board to develop new plans for their projects. The trip participants gave a presentation on the experience to the full ARAN membership at its November meeting, requests for nursery and greenhouse supplies were submitted to the Mesa Directiva in December and subsequently approved. The schools on the Sonoran side decided to use specialized planting cells and trays ordered from Stuewe because they use less soil, protect the roots, and facilitate transplanting.

Members of the committee helped partners develop plans for their nurseries and greenhouses. For example, after returning from the winter break in February 2005, students from the CETis 128 Ecology Club participated in workshops on greenhouse construction and worked with staff at the Arizona Sonora Desert Museum and students from the UA to reevaluate their initial greenhouse plans. They developed plans for three different greenhouse models that they began to construct during the second quarter, and then evaluate during the third project quarter. Nursery and greenhouse supplies arrived from Stuewe in January and were distributed to the partners who were developing facilities. In the meantime, Terra-Cycle Technologies developed and implemented workshops on constructing and using pyramid planters at three elementary schools in Nogales, Arizona and developed and implemented a workshop on drip irrigation at a high school in Nogales, Sonora.

The pyramid or tower planters enabled the Arizona schools to more aptly adapt their projects to each school environment, student population (age-appropriate), and community context. Moreover, UA interns and teachers at the participating schools discovered a local nursery that grows and sells native vegetation near several of the schools that was eager to support their projects. They relayed that the schools would have been competing with the nursery had they established production nurseries. As of way of maintaining good working relationships and community support, the schools decided to establish schoolyard habitats that could serve multiple educative functions and better assist the younger students (elementary and middle school levels) and teachers in feeling connected to the learning process and environment. While planting vegetable gardens was not one of the designated objectives of this project, following a community-based approach was, and when it was determined that incorporating vegetable gardens was necessary both to get students and teachers interested in the project (they could eat their results) and as a component of habitats, the projects took that approach. At Desert Shadows, it was the former - last year they had only the planting towers that were all used as a test to see what would work with that school; this year they are expanding to include a desert habitat and garden that incorporates water harvesting. At AJ Mitchell, it was the latter – the teacher wanted

both a native habitat and a cultivated area where the students could grow native crops because both fit into her fourth grade science and social studies curricula.

An example of successful circulation of knowledge beyond the boundaries of ARAN itself was when representatives from the Nursery and Composting Committee and the Education and Public Outreach Committee attended a special session in Santa Fe, New Mexico on soil rehabilitation and the use of compost and vegetation to restore soils and prevent erosion on steep slopes. A follow-up workshop for students, teachers and administrators of CONALEP and CETis was held at the U of A during which participants explored soil structure and examined sandy soil and compost under a scanning electron microscope. [add photo here]. One outcome of that session was the development of a guide to soil restoration by a UA student working on the project (see Appendix B). During July and prior to the summer monsoon rains, ARAN partners held a workshop and seed collection event to gather native seeds that are now being grown in the nurseries and greenhouses. UA students researched alternative soil stabilization and rehabilitation strategies and ARAN partners implemented two pilot projects in the fall after the monsoon rains in both CONALEP and Villa Sonora.

In a second example of collaboration, the CETis 128 greenhouse served as a model for the structure built at AJ Mitchell; some of the students who were involved in constructing the first one helped the teachers and students at the elementary school design and construct theirs. In both cases, the focus was on building structures that were low cost, suited to the environmental and social conditions of the area, and required minimum special skills to construct. Lessons learned during the construction of these two greenhouses were applied in the design and construction of structures at CONALEP.

Similar collaboration has taken place among ARAN members with regard to composting. Schools such as CONALEP that have developed well-functioning compost facilities have prepared presentations, offered workshops, and provided assistance to others who have developed similar systems. In the fall of 2005, CETis 128 Ecology Club members used the composting guide created by CONALEP students to restore composting bins that had been neglected since the previous spring. The pyramid planting towers and composting systems designed and constructed at three Nogales, Arizona schools with the assistance of Terra-Cycle Technologies now serve as models for schools on both sides of the border.

Sonoran Schools

CETis 128:

As one of the initial pilot project sites, students from CETis 128 and their ecology club mentor have been intimately involved in ARAN through projects at their school site, participating in workdays for other groups, and presenting their results in ARAN meetings, professional conferences, and public events. The mentor of the ecology club, a biology teacher by trade, has worked with the school over the years to acquire a permanent club/garden space and permission to grant social service hours for work completed in the club. In addition, she traditionally incorporates ARAN projects into her classroom curriculum. The club is structured so that veteran students, often in their senior year, take on leadership of the club and train younger students. In addition, an intern from the U of A worked with the club on a weekly basis for the past year and a half. The club meets weekly to plan and work on projects at the school.

CETis was the first school to have submitted a proposal to the Mesa Directiva for the development of their greenhouse. Leaders of the club, including the UA intern, visited other greenhouses and met with specialists to put together an appropriate structure. The first greenhouse had been completed by the April ARAN general meeting where everyone could view the hard work that the students put into it. Unfortunately, it did not survive the monsoon rains and wind given its location on the south side of the school. The summer months also presented challenges for the plants started in their nursery and the established composting systems, as student visits were less frequent than anticipated.

Therefore, in the Fall of 2005 the CETis students had their work cut out for them, and set out to reinitiate the composting system, revive the plants in the nursery (70% of which survived), and rebuild their greenhouse. The nursery and composting system are now fully functioning, and CETis has begun partnering with Colonia Jardines del Bosque to supply the colonia with materials and to assist residents with developing their green area. The nursery at CETis has been going strong, with approximately 40 native plants of various types being taken care of within the club grounds. The students dug well-sized holes in the club area for transplanting the plants that were ready, and filled them using a mixture of their compost and a store bought plant growth solution. There was a wave of freezing temperatures in late November, and students are monitoring their plants to see which ones will survive the sudden extreme temperatures.

The composting at CETis is looking better than ever. The students reinitiated the system with the cafeterias in collecting their organic trash and are using it in the compost. The compost now has proper layers of dry and wet materials, and is being tended to (watered and mixed) on a weekly basis. A subgroup of students from the Ecology Club have developed a puppet show (see Part Two) and in the fall created a special show about composting, featuring their star character Bordi Ecoyote. [add photo here] The compost is also being put to use in the transplantations going on around the club area.

Ecology club members redesigned the greenhouse to withstand stronger winds and relocated it to an area more protected by the school walls. However, the second greenhouse at CETis is still awaiting completion. By late November, the full structure and 2 out of 3 walls of plastic were put up, making it essentially 80 percent complete. However, the group continues to struggle with the winds that blow across the school site and to seek ways of protecting their structure.

CONALEP:
The students at CONALEP participate in the ecology club as a way of completing their social service hours, as do those at CETis. The leader of this group is an administrator. The group meets as needed to discuss and plan projects, but for the most part students work in smaller groups with specific duties. For example, this past year there was a group of students assigned to work on compost, another for the desert garden, yet another for the nursery, and so on. Each group worked according to class and work schedules: some in the morning, others in the afternoon, and on different days of the week.

The CONALEP Nursery provides plants for the various areas developed and maintained throughout school grounds, and extends this service to Colonia Villa Sonora (see colonias

section). Their composting system has proven to be so successful that other partners use it as an example of productive compost. Partners at the Instituto Tecnológico de Nogales (ITN) recently acquired compost from CONALEP to use in office and home plants.

At the ARAN general meeting in May 2005, Jesus Garcia of the Arizona Sonora Desert Museum presented a hands-on workshop on erosion control structures, *trincheras*, which included a classroom presentation and then practicum on the school hillside. The process involves building barriers with rocks along erosion streams to both prevent erosion and support the growth of native vegetation where water is contained. This has been one of the most successful endeavors and now serves as an exemplary project—everyone can see direct results with small plants, ground cover and even wildflowers sprouting around the areas where erosion had been controlled and water is being captured.

Throughout the fall of 2005, CONALEP collaborated with City High School, a charter school in Tucson, Arizona after the latter attended the ARAN Retreat. Students from both schools and UA interns worked together to build the greenhouse at CONALEP. As a result, students at CONALEP assembled a step-by-step guide on building a greenhouse to give to another school in Nogales, Sonora that is also interested in building a greenhouse on their campus. The greenhouse was completed just in time to house the nursery plants during the cold winter months.

One UA intern working closely with CONALEP over the past year wrote:

> *The project at CONALEP can only be described as a phenomenal success. The amount of enthusiasm and effort that has been expended on this site shows just how vital projects of this nature are in raising consciousness and inspiring people to care and work on their own to further the goals of environmental sustainability. The simple fact that this is the fastest growing social service project at the school echoes this fact. Demand for work at the school has outstripped the ability of administrators and interns to accommodate everyone. In the past year this school went from barely participating to the most active site involving 5 interns, and over 50 students.*
>
> *Why? In the simplest terms possible, pride. The students have seen that people from somewhere else care about their town and their school and most importantly, them. This is inspiration at its core and has catapulted the project into something that simply cannot be stopped. The students will not stop working on beautifying their campus and creating the sense of pride and accomplishment that they can see and relive everyday as part of their academic experience.*

In a recent visit, the new state director for all the CONALEPs in Sonora recognized the mentor relationship developed between students from University of Arizona and the CONALEP Nogales. He decided that the Nogales CONALEP should be the model for all the state schools. This came as well deserved recognition not only for all the work CONALEP has done over the past year, but also for the positive impact it is having.

Secundaria General 3:
Work at Secundaria General 3 began through the Nursery and Composting committee at the start of this project period, but due to another project that had been planned for the school site having run into difficulties, the composting and nursery projects were underdeveloped in the 2004-2005 school year and did not really take off until fall 2005.

During the fall of 2005, students built six composting bins, using wood donated from the maquiladora Sumex, an active participant in APSA and ARAN. They plan on constructing a total of 12 bins. At the ARAN general meeting in November 2005, students from Sec #3 presented their plans, including a hand drawn map of the school to illustrate where the bins were to be located, as well as the future area of the nursery. They also used some photos and a PowerPoint presentation to illustrate their future plans that include reinforcing the eroding hillside of the school and initiating a recycling program for the school.

Arizona Schools
AJ Mitchell:
The site at AJ Mitchell was predetermined as it has been involved with ARAN for the past 3 years. It is an enclosed garden area surrounded by a chain link fence at the school.

In April 2005, Crecencio Elenes (ARAN partner), from Terra Cycle Technologies, went to AJ Mitchell to build two planter towers with students. The planter tower concept was developed as an alternative to either ground gardens or raised beds because of their minimal weed problems and increased surface area for planting and maintenance needs, both central for elementary school projects. [add photo here]. During this time, Crecencio also taught the teachers maintenance and repair techniques for the towers. Problems with cracking and deterioration of the wood after six months in the harsh desert environment led to experimentation with wood sealer (See Desert Shadows). The only problem the towers experienced, due to the irrigation set up, was that one tower received more water than the other. Problems with the drip irrigation system led to a decision to replace it with separate hoses for the towers and one garden plot. Since the lead teacher has experience with gardening, she was able to fix small problems that arose.

AJ Mitchell also continued developing regular garden plots and a native plant habitat. The sunflowers, tomatoes, cucumbers, pumpkins and gourds planted in the garden plots did very well. One of the pumpkins won first prize in the county fair and one gourd took best in the show. The drip irrigation system worked very well in the one plot, while the garden plot on the other side of site (regular bed) still suffered from invasive Bermuda grass. The grass had overgrown and killed the native plants the students planted there, and only a few of the vegetable plants were producing and poorly at that. The AJ Mitchell teacher and several club students worked with a UA intern to cover the area with two large, black tarps to burn the Bermuda grass and rid the area of it.

On June 24, UA interns and students from CETis went to AJ Mitchell to help build their greenhouse. The teacher had ordered a PVC structure on-line, which came in pieces that had to be cut and glued together according to the blueprints. The plan was that once the frame was built, the next step would be to enclose it with industrial plastic. The structure was mostly destroyed

during the summer monsoons, but was reconstructed again in the fall based on lessons learned from the first experience.

Desert Shadows:
The original site selected by the Desert Shadows teachers was on the south side of the school next to the playing fields. It was a large, barren lot with an abundance of weeds and scattered patches of native grasses. The soil of the original site was very poor and needed to be conditioned before any planting could take place. The use of this lot had been approved by the Nogales Unified School District, but school officials decided to develop the site for an agriculture program. The Desert Shadows teachers working on the project collaborated with the neighboring elementary school, Bracker, to develop a joint-use site. The Bracker administration was excited and fully supported using their site. The site had six raised beds that had been out of use for several years. The bed frames were weathered and warped, and covered with weeds and native grasses. Repeated attempts to coordinate student schedules between the two schools eventually failed and the Desert Shadows teachers identified another location on their own campus to begin work.

At the end of March, Crecencio Elenes went to the school and held a workday and constructed a planter tower. During this time, he also taught the teachers maintenance and repair techniques for the towers. Desert Shadows experienced the same rapid weathering of the wood and irrigation blow out, faucet leaks, and lack of maintenance follow up, visibly demonstrated by the invasion of weeds. Using what has been learned from their experiences in the fall of 2005 they disassembled and rebuilt the tower planters, making improvements such as sealing the wood and using soaker hoses instead of the drip irrigation system that was found to have imperfections. Now, with three teachers involved and enthusiastic about the project, they expanded the site to include four more plots so that teachers will eventually be able to take entire classes out at one time to work together. They developed new raised garden beds: one rectangle, one octagon, and two triangles. The rectangular plot was developed for growing native vegetation and the octagon plot for growing high water use native vegetation utilizing water-harvesting techniques. To accomplish all this hard work, they held a family workday in which parents, students, the three teachers, and the two interns attended. Next semester these garden beds will be used in science lessons about plants, soil, and sustainable methods.

UA interns developed composting and recycling workshops for the students of Desert Shadows and AJ Mitchell. An overview of the topics covered were composting materials, compost pile ecology, composting methods and composting structures. The workshops went very well as demonstrated by active student engagement with the activities. The activity the students enjoyed the most was the sorting activity of compost materials and the “life-cycle” of compost demonstration. The next step with the students (after the workshops) was to build composting bins using recycled pallets from Terra Cycle Technologies. During workdays, the sites were cleaned up and two composting bins built, a single bin system at the Desert Shadows site and a two-bin system at the Bracker site. Over the course of the year, project work proceeded at both Bracker and at Desert Shadows.

In her reflection, one UA intern working with this school stated, “Despite the huge demands on their time and energy from the huge class sizes (usually around 35-47 kids), Desert Shadows has managed to come quite a way this semester.”

Welty:
There were a number of delays in the partnership with Welty largely due to the pressures placed on schools and teachers under the No Child Left Behind Act and other programs, such as the Reading First and new science initiative in effect at Welty. These programs are overwhelming teachers and schools, and making it difficult for them to innovate. Rather than rushing into a program that would only add to frustrations teachers were already experiencing, Welty projects were postponed until the fall of 2005 when an appropriate venue (the student council) could be identified to begin the effort.

As of the Fall 2005, contact with Welty had been reestablished and the student council had begun their project with a planting tower with the assistance of Crecencio Elenes and cared for by the students.

Objective Three: Map Green Areas

The objective of this activity was to create a Geographic Information Systems (or similar) database that could be used to map green areas and parks, identify areas lacking vegetation, and estimate the effect on airborne particulate matter of protecting existing green areas and revegetating denuded ones. The Nogales, Sonora Municipio took responsibility for this task and produced a series of paper maps of 55 green areas in Nogales (see Appendix C). Because those maps do not allow the estimation of the area of land designated as green areas, vegetation cover in those areas, or the potential for improvements through revegetation, a new project is being developed between the UA and CETis 128. The project will involve building local capacity for using GIS and related tools as well as mapping local green areas and evaluating their status.

Part Two

Objective Four: Coordinate School Program
Objective Seven: Develop Public Outreach

The education and public outreach component of the Ambos Nogales Soil Stabilization Through Vegetation project is one of its most significant and enduring contributions. Prior to the project, the Asociación de Reforestación en Ambos Nogales (ARAN) was a loose knit collaboration of governmental, educational, business, and citizens’ groups maintained by a core group of individuals representing various schools, neighborhood organizations, maquiladoras, and government agencies. Because much of the activity of ARAN was carried out by schools, turnover was high as each group of students moved on and was replaced by a new group. The educational and outreach objectives of this project (objectives 4 and 7 in the original proposal) were to: (1) implement a coordinated school program through which faculty and students at secondary and post-secondary schools receive sufficient education, training, and experience to develop projects at their school sites and then serve as project leaders in elementary schools, in neighborhoods, and at community facilities; (2) develop educational materials and workshops for

teachers; (3) assess local knowledge and awareness of local vegetation, composting, and the relationships among vegetation, soil erosion, air quality, and health; and (4) develop and distribute educational materials on locally adapted plants and the ecology of Ambos Nogales, composting and green/organic waste management, and the relationships among vegetation, soil erosion, air quality, and health. Though the education and public outreach objectives were initially framed as distinct, as the Mesa Directiva and committees were organized, the commonalities between the two were recognized and the tasks associated with them integrated.

The initial work under this objective aimed at creating a structure though which education, training, and outreach would occur, and at gathering information about current environmental knowledge and awareness. The Education and Public Outreach Committee established regular meetings and set priorities for the grant period. Activities of this committee were focused in three areas: (1) assessing knowledge and awareness of high school aged youth as a proxy for the general public; (2) developing a list of priority topics for workshops and training programs and soliciting proposals from groups who can provide those topics; and (3) arranging opportunities for students of all ages to participate in local and regional meetings, workshops, and conferences where they could both learn and build confidence and skills through sharing what they have learned in their projects. Committee members also used their meetings to define general boundaries for ARAN, deciding for example that air quality and its connection to erosion, dust, and asthma was directly relevant to the group's mission while water quality, though important, required expertise and focus beyond the scope of the group. Education and outreach activities are presented here in two categories: those designed for ARAN members and those designed for the general public beyond ARAN.

Activities for ARAN Members

Monthly ARAN meetings were identified as a key mechanism for promoting education and outreach among members and, due to the high participation of school groups, for coordinating education and training efforts to that population. A meeting schedule was established and the Education and Public Outreach Committee identified topics for each month. Each meeting was designed to focus on a particular theme and include an informational presentation on that theme. Then ARAN member groups took turns presenting their projects and plans and sharing challenges and concerns that served as the basis for discussion among members.

Priority topics for educational programs include rehabilitating soils and composting, installing drip irrigation and water harvesting systems, constructing nurseries and greenhouses, schoolyard habitats and gardens, air quality and asthma, and using puppets to educate young students. The Committee determined that the location of meetings would rotate among partners so that every group had the opportunity to host the meeting and show others the status of their projects. The pattern of monthly meetings is now well established and will continue into the future beyond the grant period. In addition to providing a forum for addressing topics such as native vegetation, invasive species, water harvesting, and erosion control, meetings serve as venues for cross-fertilization of ideas and increase accountability of members to one another.

Another venue for increasing information sharing and interaction among ARAN members, especially participating schools, is the annual ARAN retreat, which is held each fall. The retreat was established several years ago, but during the grant period it was restructured so that each

partner organization took responsibility for developing and presenting a workshop for other members. The retreat was moved to September to serve as a catalyst for the various partners and as a means of introducing new members to ARAN. In both 2004 and 2005, approximately 100 people participated in the retreat.

Another key component of the education and outreach program was the development of hands-on workshops aimed at specific ARAN members and their needs. These workshops were also opened to members from other ARAN groups to facilitate knowledge transmission. For example, CONALEP hosted a workshop on the construction of passive water harvesting structures to manage rainwater runoff, prevent erosion, and provide water for vegetation and groundcover to address severe hillslope erosion at their site. CONALEP members who participated got a head start on installing *trincheras* on their site, while representatives from several other groups who faced similar problems gained information and hands-on experience to take back to their groups. Building on that workshop, a summer 2005 workshop on trail building was developed to help residents of Colonia Villa Sonora utilize both trenches and trails to control erosion within their green area. Students from CETis 128, CONALEP, and A.J. Mitchell Elementary School visited the Desert Survivors nursery in Tucson to learn how to establish and maintain a nursery in the arid southwest. In conjunction with their participation in the Meeting on the Border Environment in Rosarito, B.C., ARAN members visited Ecoparque in Tijuana in May to learn about using graywater to revegetate steep urban hillsides to prevent erosion and provide habitat for plants and urban wildlife, Additional specialized workshops were provided by staff of the Arizona Sonora Desert Museum, Terra-Cycle Technologies, Native Seeds/SEARCH, and the U.S. National Park Service. These events were all highly successful and allowed ARAN members to make significant leaps in understanding and progress on their projects.

Students from the Southeast Arizona Area Health Education Center (SEAHEC) Health Careers Club at Nogales High School were trained in the Open Airways curriculum and have begun delivering the six-session curriculum to upper elementary students and their parents in Nogales, Arizona. Students at CETis 128 developed puppet shows about maintaining a clean environment, air quality, and composting. CETis 128 members also presented their puppet show at the annual retreats and worked with UA students and members of the SEAHEC Health Careers program to develop a workshop to teach others how to use puppets in education and outreach. SEAHEC members at Nogales High School developed puppet shows on asthma and air quality and on maintaining a clean environment.

Written materials were developed by ARAN members in order to enhance information sharing. These include information sheets on composting, planting cycles, and tree care as well as longer guides on composting and the development of greenhouses (see Appendices D to F). These written materials are important supplements to the information received in meetings and workshops and help reach members who do not participate in those specific events.

Important educational opportunities were also available via workshops and conferences organized by other groups and held throughout the region on topics of interest to ARAN members. The Education and Public Outreach Committee developed an application form for representatives of any of the participating groups who identified workshops or conferences they wanted to attend to gain knowledge relevant to their projects or programs. In exchange for

receiving support for their participation in such events (which ranged from paying for travel to providing translation services for members attending monolingual conferences), members were encouraged to share what they learned by making presentations at the monthly ARAN meetings. ARAN members participated in the 2004 Environmental Justice Symposium in Tucson, the 2004 Sonora-Arizona Environmental Conference in Magdalena, the 2004 Arizona Association for Environmental Educators conference in Tucson, the 2005 Border 2012 National Coordinators Meeting (co-hosted by EPA and SEMARNAT), the 80th Annual Meeting of the American Association for the Advancement of Science Southwestern and Rocky Mountain Division (SWARM), the 2005 Water Resources Research Center workshop on Riparian Restoration in Tucson, the 64th Annual Meeting of the Society for Applied Anthropology in Santa Fe, Project WET's 2005 Healthy Water, Healthy People workshop, the 2005 Border Ecological Symposium in Tucson, the 2005 Border Environmental Conference in Rosarito, B.C., the 2005 North American Association for Environmental Educators conference in Albuquerque, NM, and the 2005 Encuentro Nacional de Centros de Recreación y Cultural Ambiental in Tecate, B.C. Participation in these events stimulated some specific changes in the function of ARAN; for example, the idea for an annual retreat originated when high school students attended their first binational conference and decided they could do something similar at home.

Activities for People and Groups Outside of ARAN

This project was also designed to reach educators, students, and members of the general public outside of ARAN. A first step in the process was to gather information about the knowledge and awareness of residents of Ambos Nogales. Two data collection efforts were undertaken.

Survey of High School Students:

The objective of the first effort was to gather information regarding: (1) existing knowledge, beliefs, and attitudes among the target student population and (2) community structure and communication channels (see Appendix G). This information could then provide the framework for developing effective and appropriate environmental health messages pertaining to air quality. The data collection proceeded in two phases. First, preliminary data to aid in survey construction was acquired from three focus groups conducted with students from Ambos Nogales attending an Environmental Health Summer Research Camp in Nogales, AZ. Seventeen students took part in the focus groups, two of which were conducted in Spanish and the third in English. In each of the two Spanish sessions, 6 students participated. Five students took part in the English session. The age range of the students was 13-16. Next, information from the focus groups was incorporated into a comprehensive survey aimed at determining: (1) perceived sources of air pollution in Ambos Nogales, (2) concerns about air quality, (3) perceptions about self-efficacy (as well as perceptions about efficacy at the local-level & national-level), (4) sources of information about air quality and the credibility of sources, (5) knowledge about air pollution and comprehension of health risks associated with air pollution, (6) willingness and involvement in air quality actions, and (7) demographics. The survey was implemented at two high schools, one in Nogales, AZ and the other in Nogales, Sonora. Once informed consent was obtained, data were collected during regularly scheduled class time in pre-approved class periods. After appropriate consent was obtained at all levels, a total of 305 students took part in this survey. Specifically, 140 students from Nogales High School in Arizona and 165 students from Colegio de Estudios Cientificos y Tecnológicos del Estado de Sonora (CECYTES) in Nogales, Sonora participated. On average, U.S. participants were 15.1 years of age. Among these students, 64%

were female and 34% were male, with 2% providing no information on their biological sex. The average age of participants in Sonora was 16.6. Forty-one percent of these students were female, 58% were male, and 1% did not report their biological sex.

When asked to list their top *three* environmental concerns (if any), 44% of U.S. students named air quality, 29% reported water quality, and 20% noted litter. Among Mexican students, 44% reported litter in their top three concerns, 37% named water quality, and 30% identified air quality. In terms of the magnitude of these students' attitudes and perceptions, Mexican students were significantly more likely to rate air quality as a serious environmental problem in Nogales and reported higher levels of concern about air pollution, than their U.S. counterparts. Students also differed in their identification of sources responsible for local air pollution. Those in the U.S. identified diesel truck emissions as the source most accountable for air pollution in Nogales, while those in Mexico held large industries most culpable. In addition, Mexican students were significantly more likely than U.S. students to identify unpaved roads, local burning, and denuded land to be contributors to air pollution. When asked about the origin of local pollutants, students in the U.S. were significantly more likely than those in Mexico to name Nogales, Sonora. Participants in both the U.S. and Mexico placed the greatest responsibility for improving local air quality on the local government in Sonora.

Students from both Mexico and the U.S. recognized the dangers of air pollution to the environment; however, participants in Mexico were significantly more likely to appreciate the direct influence of air quality on their personal lives and health. On average, Mexican students report being exposed to more messages about air quality than U.S. students. Mexican participants identified television, radio, and newspapers, in that order, as the top media information sources about air quality. U.S. students ranked newspapers first, then television and finally the Internet as their primary media sources. For both groups, the primary interpersonal sources of air quality information were teachers and family members. Among students in the U.S., local and state public health officials were identified as the most credible sources of information, whereas, for Mexican students family members and teachers were deemed most trustworthy.

Overall, students from both the U.S. and Mexico reported that they were uninformed about air quality and were dissatisfied with their level of knowledge on this topic. In general, they expressed minimal understanding about ways to improve air quality and the steps they could take to minimize the health risks associated with air pollution. Finally, although significantly stronger among the Mexican students, participants in both the U.S. and Mexico revealed: (a) interest in learning more about local air quality; (b) willingness to make changes in their daily lives to improve air quality, including planting and maintaining native plants; (c) willingness to talk with friends and family about air quality issues; and (d) willingness to ask friends and family to take actions to improve air quality. The results of the survey are being used to develop environmental messages that make it possible for residents in both Nogales, Arizona and Nogales, Sonora to learn more about air quality issues, take meaningful steps to improve air quality, and share their knowledge with others.

Promotoras Survey in the Colonias:
As part of the second effort, the leaders of Promotoras Sociales Voluntarias began working with students from the University of Arizona, Comité TREE, and the SEAHEC Health Science Club

at Nogales High School to develop a structure for collaboration. The group developed a household assessment of triggers for asthma and respiratory disorders and used this information, along with what was gathered in the first effort, to design outreach materials (see Appendix H**).**

Activities for Schools:
Several specific activities were developed to meet the needs of schools. First, teacher workshops were designed for both Nogales, Sonora and Nogales, Arizona. Due to the preference among school officials for workshops at the beginning of the school year, the workshops were scheduled for the start of the 2005-2006 academic year. In August, Punto Verde Consultores of Nuevo Leon offered a two and a half day workshop, hosted by CONALEP and aimed primarily at high school teachers in Nogales, Sonora (see Appendix I). Staff from the Arizona Sonora Desert Museum designed a workshop for Nogales, Arizona teachers, but a change of top administrators in the district meant that the workshop was changed to an informational session, which was hosted by Desert Shadows Middle School, and postponed to the spring of 2006. The Desert Museum staff also produced teacher resource kits, one for Nogales and Rio Rico, Arizona and the other for Nogales, Sonora. The Arizona resource kit was presented at the fall information session (see Appendix J for outline of materials in the kit). One outcome of the workshop at CONALEP is the development of a long-term partnership between CONALEP and Punto Verde to ensure the continuation of environmental education programs in teacher preparation and enrichment. The workshop at Desert Shadows brought together several new schools with interest in developing schoolyard habitats and educational programs. A UA intern researched elements of successful schoolyard habitats and prepared a summary report for schools in both Arizona and Sonora (see Appendix K).

Several programs were aimed at school students. Comité TREE developed a desert gardening program that members implemented in *primarias, secundarias,* and *preparatorias* in Nogales, Sonora and sponsored a gardening contest for schools at all levels in the spring. Students at CETis 128 and Nogales High School developed puppet shows about maintaining a clean environment, air quality, and composting. The CETis 128 students took their shows to primary schools in Nogales, Sonora.

In a related effort, members of the Asociación de Profesionales en Seguirdad Ambiental (APSA) developed an adopt-a-school program with a specific agenda of monthly environmental activities. ARAN member schools are working with APSA to test and enhance that program.

Activities for the General Public:
Based on results of the assessments and expressed needs of others in the community, this project spurred development of outreach activities on revegetation, erosion management, air quality, and health impacts. ARAN members participated in a number of public forums, community fairs, and related events to share information with members of the general public. In the fall of 2004, Sonoran partners from the Instituto Tecnológico de Nogales and the Colonias Committee participated in workshops hosted by the Comisión Nacional Forestal (CONAFOR), where they were introduced to the use of games to teach environmental education concepts. They acquired a complete set of games for Nogales, Sonora and shared those games in various settings, including a binational outreach summer camp for youth held during the summer of 2005. In both 2004 and 2005, CETis 128 and Nogales High School students presented their puppet shows at community

health fairs and the Fiesta de Tumacacori, held the first weekend of December. ARAN partners also participated in the Native Seeds/SEARCH San Juan festival in Patagonia, AZ in 2005. ARAN members from schools, colonias, maquiladoras, and the municipal government participated in a tree distribution campaign in Nogales, Sonora in the spring of 2005.

Project participants also targeted specific populations. For example, the Promotoras Sociales Voluntarias developed fliers on preventing asthma triggers for distribution in colonias in Nogales, Sonora (see Appendix L).

Participation in conferences and workshops hosted by other groups served an important outreach function as well. Students, teachers, and community leaders prepared posters and presentations for conferences such as the Environmental Justice Symposium, University of Arizona Undergraduate Biology Research Conference, SWARM conference, and Border Environmental Conference (see *Activities for ARAN Members,* above). ARAN members participated in several events with the express goal of sharing information about environmental health issues on the border. These included the 2005 Health Careers Club statewide conference in Tucson, the 2005 Healthy Schools Index workshops in Nogales and Rio Rico, Arizona, and the 2005 Information for Action Conference for exchanging information on key border health issues. Participation in conferences and workshops, as members of ARAN, helped attendees develop bonds and opened up additional avenues for information sharing. For example, 26 representatives from CONALEP, UA, ITN, Nogales High School, SEAHEC, Secundaria General 3, APSA, Promotoras Sociales Voluntarias, and CETis 128 attended the 2005 Border Environmental Conference and trip to Ecoparque together. They presented posters on their projects and participated in workgroups on reducing contamination, developing environmentally beneficial strategies for urban areas, and managing and protecting water resources.

Another important outcome of the public education and outreach activities was the opportunity for developing contacts with other groups and combining efforts to achieve greater results. For example, project participants, with support from the Arizona Department of Health Sciences, helped to plan and develop a summer youth environmental health research camp and an outreach workshop on the environment and asthma in Ambos Nogales, both of which were held at SEAHEC in June and July, respectively. Participants also obtained funding for additional workshops and participation in conferences from individual fundraisers, small community grant programs, and school-based sponsorship programs.

In June, ARAN was featured in the first edition of the Border-Wide EE Coalition Bulletin, *Senderos* (http://www.eecc.net/ARANeng.htm). A UA student intern developed a web site that allows ARAN partners to add their own information on their activities as it is generated (nogales.bara.arizona.edu).

Part Three

Objective Five: Coordinate Maquiladora Participation

The Asociación de Profesionales en Seguridad Ambiental (APSA), a well-established organization of environmental and safety managers, organized the maquiladora participation and

managed the grant funds for all projects on the Sonoran side of the border. (See Introduction, "Development of Organizational Infrastructure") Through both projects, APSA exhibited its professional capacity for and enduring commitment to assisting the communities of Ambos Nogales.

As a central figure in environmental conservation and restoration efforts in Ambos Nogales, APSA took on key leadership roles and participated in many facets of this project. First, APSA was a key participant in several local events, including revegetation at a new community health facility and a tree giveaway organized by the Municipal Government of Nogales, Sonora for Earth Day in April. APSA members participated in the May 14 visit to Ecoparque and established relationships with the park managers so they could receive technical assistance as they developed their projects. Members of APSA, Promotoras Sociales Voluntarias, and Comité TREE all collaborated in the design of a project to revegetate a steep hillside below the APSA nursery, applying knowledge and techniques learned at Ecoparque. This has become the central focus of APSA's continuation of this project as they work to develop their tree nursery and support the development of a green area in Colonia Colosio directly below the site. Hence, APSA received funding through this grant only in so far as it aided them in establishing their nursery site as the Parque Industrial Nuevo Nogales, which the Mesa Directiva collectively recognized as the development of a neighborhood project (see objective six).

APSA began construction on a nursery on land that they acquired under a long-term lease and supported with gray water from nearby maquiladoras. . The site was initially designated to be a green area onto which all the oaks were transplanted that were removed from the Colonia Casa Blanca, a high-end housing development located to the east of the site. The oaks did not survive, and the area was graded to serve as an alternative road when the city was paving the main dirt road passing through this area. APSA project leaders completed plans for the nursery that will be developed on the land, and used this grant to initiate that process through demarcating the land with a fence and sign and then maintaining the site. APSA installed a chain-linked fence to surround the site area and planted bushes and trees inside. The fence prohibited people and cars from passing through the area, as was the intention. [add photo of sign]

It is important to note here the particular location of the Parque Industrial Nuevo Nogales. The road leading up to this area overlooking Colonia Colosio, one of the newest and poorest areas in all of Nogales, is a steep, bumpy, and incredibly dusty gravel/mud path, and yet one of the most heavily traveled routes in the area. Dust kicked up by motorized traffic on the road covers everything, such as the cars in a junkyard alongside the road, making them all seem the color brown. This road is the source of much consternation among members of the Border 2012 Air Quality Task Force. The Municipio of Nogales, Sonora applied for funds from the NADBank (North American Development Bank, created as part of the North American Free Trade Agreement) to pave roads as part of its air quality improvements. Paving the road by this site is a high priority for community members and ARAN partners.

Future plans for the use of the APSA nursery include benefits for the entire community, with a strong focus on incorporating schools for educational and maintenance purposes. In addition, a couple of maquilas, such as Otis, developed nurseries on their sites and made plants available to

neighborhoods and schools. The members of Comité TREE utilized this nursery to outfit its revegetation work at the Casa de la Misercordia, (See Appendix M).

Part Four

Objective Six: Develop Neighborhood Projects

Several residents of the colonias involved in this project had been members of ARAN for some time, or at least familiar with the work that ARAN did. Since the initial pilot project in Colonia Jardines del Bosque, which sparked the formation of ARAN, there has been interest from various colonias in getting involved with ARAN. Primarily, colonias perceive ARAN to be an extraordinary resource for getting assistance (i.e. labor, financial, organizational) in developing their green areas. ARAN members determined that every colonia should proceed through the same process to become involved in the group. Therefore, the first objective of this grant regarding work in colonias was the establishment of "ground rules" for colonias' participation in ARAN as a way of facilitating their understanding and incorporation.

The colonias committee developed a manual for colonias wishing to participate in revegetation projects. (See Appendix N). The manual includes information on what ARAN is, who is involved, and how to become involved. Additionally, the manual provides information on the steps involved in forming a committee within a colonia, interacting with the municipal government (Department of Urban Development and Ecology), and soliciting funds for projects. The manual was finalized at the Mesa Directiva meeting in March, where representatives from all ten sectors helped review and edit the manual. It was decided at that time that this would serve as the standard document for all colonias involved in this project, and other colonias interesting in getting involved in the future.

With the exception of the Parque Industrial Nuevo Nogales, which was managed by APSA, the colonias committee represented all colonias and consisted of members from Jardines del Bosque (representative of committee), Villa Sonora, Heroes, and Solidaridad. UA interns assisted members of the colonias in organizing a tour of all green area sites within these four colonias in the fall of 2004 and initiating planning of individual projects. Residents from Colonias Jardines del Bosque and Villa Sonora presented proposals to the Mesa Directiva that they had put together based on the needs of their green areas. Each was modified as needed, and approved. Both Colonias Heroes and Solidaridad had worked with engineers from the municipal government of Nogales, Sonora to draw up plans for their green areas. The Mesa Directiva determined that each proposal needed to incorporate erosion control through revegetation and more resident participation before they could be approved. While residents from Heroes were successful in making changes in the proposal and participating in the process, this did not happen in Solidaridad, as was evident at a site visit by the Mesa Directiva in late August 2005. At that time, the Casa de la Misercordia, with the assistance of Comité TREE, presented a proposal for more support of the revegetation, water-harvesting, and community development projects at their site in Colonia Bella Vista. The Mesa Directiva determined that their projects complied with the guidelines outlined in the Colonias Manual and therefore approved their request.

Additionally, the colonias committee worked to facilitate coordination between school groups and neighborhoods. For example, in addition to the projects they are doing on their school

grounds, students from CONALEP go to Colonia Villa Sonora once a month to help residents enhance and protect their neighborhood green area; in turn, neighborhood residents collect their organic waste in a couple of central locations for the students to use in their composting program. Students from CETis 128 are raising plants that will be used in a revegetation project at a nearby orphanage. They also held workdays in Colonias Jardines del Bosque and Villa Sonora.

The colonias committee also worked with University of Arizona students to help residents in two colonias, Jardines del Bosque and Bella Vista (through the Casa de la Misericordia community center), set up ecology clubs for students 10-14 years of age. At the ARAN general meeting in November 2005, seven youth members of the Jardines del Bosque ecology club presented their goals and objectives to the entire group. UA interns continue to visit colonias regularly to assist with work in the green areas.

Villa Sonora

A few key women within the Colonia Villa Sonora, along with numerous volunteers, have ensured the success of their green area project through their perseverance, resourcefulness, and willingness to participate and learn within ARAN. While the municipal government of Nogales, Sonora, delineates official green areas, there are often encroachments on these areas. As is the case in most colonias, this colonia struggled to maintain the boundaries of their green area from intentional and unimpeded illegal invasions. They repeatedly filed official complaints with the municipal government to document the invasions, and ended up losing a small portion, but were successful in saving their green area overall. On one occasion, they were able to get stolen agaves returned to the green area when a representative from the municipal government followed through with enforcement of their complaint.

Colonia Villa Sonora also had success in mobilizing people to collaborate in restoration and maintenance efforts. They held workdays every Saturday morning to establish consistency. This provided two benefits: 1) realistic weekly progress could be made, and 2) others could see that people worked and cared for the green area. In addition, it provided a time that was convenient to the colonia members and volunteers, such as UA interns and local students. Throughout the year, those of Villa Sonora made considerable progress in revegetating and maintaining existing vegetation in the green area, installing a drip irrigation system, establishing compost bins for the colonia, and preventing erosion in selected areas. Much of this work was made possible by hours of volunteer work, especially by the students from CONALEP that worked in Villa Sonora one day every month. Volunteers from the U.S. National Park Service facilitated trails workshops to establish walking trails through the green area, involving the women of Villa Sonora and volunteers from the UA, CONALEP, and the Mexican National Army. Previous man-made trails through the eroding hillside adjacent to the green area posed threats to its sustainability, and therefore these trails were designed to give residents a clear, safe, and pleasant route to pass through the green area without causing further erosion. The trails workshops incorporated the concept of "*trincheras*" and other water harvesting mechanisms for maximizing irrigation of ground cover and native vegetation and minimizing soil erosion.

Jardines del Bosque

The green area in Colonia Jardines del Bosque, since established through previous pilot projects, expanded in new directions and responded to lessons learned over the year. Residents continued

to monitor existing vegetation and installed a water fountain to provide an alternative to outside interference with the drip irrigation system—a challenge they confronted and peacefully resolved. Numerous volunteers collaborated with Jardines del Bosque such as the Arizona Sonora Desert Museum to plan out native ground cover vegetation, and a local engineer who drew up plans for their new retaining wall. Additionally, students from ITN, CETis, and the UA contributed many hours of social service through working with the residents to maintain and improve the green area.

One of the greatest successes for Jardines del Bosque was the establishment of a youth ecology club as residents recognized the need to involve more of those people who use the green area. The Jardines del Bosque Ecology club meets once a week in the green area at the colonia. As their first objective, they set out to understand the basic concepts of revegetation for controlling erosion and improving air quality. The group presented at the ARAN general meeting in November 2005. They plan on making plaques with the scientific and common names for each of the trees, painting their trunks white for anti-bug purposes, as well as initiating a recycling program with the wealth of recyclables they have in the colonia.

Colonia Héroes
Representatives from Colonia Heroes first attended a Mesa Directiva meeting in November 2004 to present a proposal drawn up by engineers working for the municipal government of Nogales, Sonora. The representative from the Colonias Committee agreed to work more closely with them to establish a plan that would fit into the objectives of the overall project and to help orient them to ARAN. While the incorporation of these residents in the Colonias committee assisted them in learning more about revegetation and forming a group of concerned residents as was established in the guidelines of the colonias manual, there were a number of delays in progress for the physical infrastructure because the original plans did not accommodate changes requested by the Mesa Directiva. Residents organized themselves to complete maintenance workdays in the green area without funding, and eventually sought out a separate engineer to design something they wanted for the area with a much better project and use of run-off water and erosion control. In addition, they were able to get involved in the Mexican Federal assistance program for neighborhoods, PASOS. The money used for this project served as seed money to get a dollar-for-dollar match from PASOS, as well as raise funds within the colonia to initiate a larger-scale project for revegetating and maintaining their green area. (See Appendix O for final plans).

Casa de la Misercordia / Colonia Bella Vista
Much of the work completed at the Casa de la Misercordia, a community center in Colonia Bella Vista, was made possible by students from the UA and the Instituto Tecnológico de Nogales (ITN) participating in their ecology club, Comité TREE, to complete social service hours. After determining lack of protection for trees to be a great weakness, participants constructed 24 structures to protect trees recently planted with wood donated in-kind from a private individual.

In addition, students collaborated with the Casa to complete the water harvesting system that had been unfinished due to insufficient funds. As a community center that provides meals for youth, education opportunities to the community, and an orphanage, one its greatest priorities was securing enough water throughout the year. The system now installed collected 10,000 liters of water during the rains of July alone. Within Colonia Bella Vista, the water harvesting system that

was completed at the community center is helping to divert water that had been causing significant erosion problems on the hillside below the center. Both projects serve as educational models for residents of the colonia.

Parque Industrial Nuevo Nogales / Colonia Colosio
Students from ITN Comité TREE developed a partnership with the Promotoras Sociales Voluntarias to work in Colonia Colosio, one of the marginal colonias in Nogales, Sonora, on the issue of air quality and asthma. The students began visiting residents to learn more about the community and residents' experiences and developed an informational brochure reviewed by the Education and Public Outreach Committee. The nursery being developed by APSA is located immediately adjacent to Colonia Colosio, and the APSA members agreed to work with Comité TREE and the promotoras to help stabilize a steep slope leading down to the colonia and to develop a neighborhood green area at the base of the slope (as mentioned above, see part three). Students from Comité TREE are working with Promotoras Sociales Voluntarias to gather data and design outreach projects for residents of Colonia Colosio (as mentioned above, see part two).

Part Five

Objective Eight: Project Assessment and Evaluation

Faculty and students from the Bureau of Applied Research in Anthropology at the University of Arizona facilitated the evaluation process. First, they visited the sites where nurseries, habitats, and green areas were planned and conducted initial site assessments. Second, they adopted and implemented a mechanism for evaluating the social infrastructure established through the Ambos Nogales Soil Stabilization Project, based upon the model of Partnership Synergy to evaluate the ARAN partnership based on a modified set of "Determinants of Partnership Synergy."[3] Sources of data include university students' field notes from participant observation, formal interviews with project partners, initial site assessments and other documents generated by the partnership such as proposals, brochures, and emails. The seven-step process of evaluation developed has had an ongoing and positive result in itself. For example, through re-reading field notes and interviewing partners, the university team has been able to follow up on "unfinished business" and address issues that had been missed or passed over for any given reason, including lack of time. Moreover, it offered all group leaders an opportunity to discuss ARAN and their own presence, and has established a more formal structure for reflection at a group level with more retrospection.

Below is the model upon which the research methodology was based:

I. Model

Our evaluation of the ARAN partnership is based upon the model of Partnership Synergy. Our goal is to use a modified set of "Determinants of Partnership Synergy" to evaluate notes from participant observation and formal and informal interviews with partners. We will code notes to look for four of the five determinants. We will use summary coding, in which we will read the entire set of notes and then record at the bottom of the notes the determinants that we identify in

[3] Developed by Roz Lasker, Elisa Weiss, and Rebecca Miller (Partnership Synergy: A Practical Framework for Studying and Strengthening the Collaborative Advantage, 2001, *The Milbank Quarterly*, 79(2):179.).

those notes (*RES – money; or *RAP – respect), with a sentence or two summarizing the relevant text related to those determinants.

1. *RES – Resources Available to the Partnership: Participant Observation and Interviews
    a. Money
    b. Space, equipment, goods
    c. Skills and experience, including language skills
    d. Information
    e. Connection to people, organizations, and groups
    f. Endorsements
    g. Convening power
    h. Permits/permission
    i. Time
2. *RAP – Relationships Among Partners: Participant Observation and Interviews
    a. Trust
    b. Respect
    c. Conflict resolution
    d. Power differentials
    e. Access to other partners
    f. Communication
3. *PC – Partnership Characteristics: Participant Observation and Interviews
    a. Leadership
    b. Administration and management
    c. Governance
    d. Efficiency
    e. Complementarity
    f. Equity
4. *EE – External Environment: Participant Observation and Interviews
    a. Community characteristics
    b. Public and organizational policies

We will evaluate the fifth determinant, Partner Characteristics, by seeking information about changes over time in the two factors, heterogeneity of the partner organizations and their level of involvement in the partnership, through interviews.

II. Process

We will follow a seven step process:

1. Assign groups/activities to researchers
2. Read through notes, identify determinants, mark determinants, revise list of determinants as necessary, etc. Keep in mind the following four big questions:
    a. What do groups/individuals contribute to the partnership?
    b. What do they get out of it?
    c. What is the role of the university? (Pull out information on UA students' roles...what are we missing and how can we improve on that?)
    d. How do these notes reflect on partnership-synergy? (Is the partnership working and why? And what are the greater impacts?)
3. Create separate Word files for the groups/partners/questions and paste list of determinants and explanations (from coding) and reflections and questions that arise. If determinants involve more than one group/partner, copy into all relevant Word files.
4. Exchange Word files among team and write in more reflections and questions that arise
5. Develop interview protocol, pilot test protocol, revise as necessary, etc.

6. Conduct two rounds of interviews
    a. Identify people to be interviewed
    b. Assign interviewers to interviewees
7. Transcribe and analyze interview notes using same determinant process above

Active participants from the Nursery, Education, and Colonias committees, along with the UA faculty and students conducting the evaluation, attended a series of events at the Society for Applied Anthropology meetings in Santa Fe, New Mexico in April 2005, including a session devoted to evaluating community partnerships. This was the first time that ARAN members outside of the UA team got a closer look at the evaluation process itself, and had the opportunity to hear from other scholars and community members across the country about the value of internal evaluation. Those who attended shared what they learned in Santa Fe at the following Mesa Directiva meeting. Since then, possibly as a result, there were several requests from various partners/leaders within ARAN for continual, consistent evaluation of projects within ARAN as a way of both keeping with the organization's mission and circulating information so that everyone knows more of what others are doing. Thus, ongoing evaluation became an objective of Mesa Directiva meetings.

The general themes that emerged through the evaluation of the ANSSTV make up the next chapters of this report, with recommendations and suggestions for implementation in other border communities in the final concluding chapter.

Chapter Two: Discussion of General Themes

Several themes emerged during the evaluation, and these warrant special mention. These are organized in this chapter into five sections: (1) revegetation as erosion control; (2) revegetation in schools; (3) revegetation in colonias; (4) approaching environmental education in border communities; and (5) the role of college and university students.

Revegetation as Erosion Control

A central goal of the Ambos Nogales Soil Stabilization Through Vegetation (ANSSTV) project was to explore the use of vegetation as a mechanism for controlling erosion and the dust and particulate matter resulting from the entrainment of the products of erosion into the air. Revegetation of denuded areas, especially those in neighborhoods and schools, offers numerous environmental benefits, including protection of soil cover and prevention or at least reduction of erosion. Revegetation is generally cost effective and offers an opportunity for many people to get involved in environmental protection efforts through active learning. Yet, because the links between revegetation, erosion control, and air quality are not always obvious, participation in revegetation projects does not ensure understanding of the links. Even more important, participation in revegetation projects in one area does not ensure efforts to prevent erosion in others. For example, during the project period, while participants were busy working to find ways to stabilize sandy soils, plant and maintain vegetation, and install both passive and active water harvesting systems to manage surface runoff and reduce erosion in some sites, new developments were being started across Nogales, Sonora. In many cases, these began with the cutting of vegetated slopes, creating in some cases almost completely vertical and denuded slopes that began eroding after the first rain event. Clearly, revegetation is an important tool in the suite of alternatives for preventing and managing soil erosion, but it cannot solve the serious problems created by unmanaged development and the associated denuding of hillsides.

Revegetation in Schools

Schools make available a number of resources to the ARAN partnership and revegetation efforts. These include meeting spaces, goods and equipment, labor (students), information, skills, and connections to other people, groups, or organizations. For example, many students are bilingual and can provide translation or facilitate communication among partners. Some schools, such as CONALEP, have had success soliciting goods and equipment from nearby maquiladoras, restaurants, and other schools. Most consistently, though, schools provide a venue at which students (and others in the community) can learn and work on the land surrounding the school. The time and energy students dedicate to revegetation efforts, either for classes, clubs, or social service hours, and the time, experience, and leadership that teachers give exceeds anything that could be bought with project funds. On top of that, the commitment and dedication of school partners keeps the projects and the partnership going.

There are also numerous challenges to working with schools, though, some of which vary from one side of the border to the other. In all schools, bureaucratic procedures can slow down efforts to get projects off the ground; in this project, though, bureaucratic barriers were higher on the Arizona than Sonoran side of the border. In the post-9/11 era in the United States, restrictions on

who can visit school campuses and what can be done there have increased. In addition, Arizona teachers acknowledged the constraints placed on them and their students, and challenges to curriculum innovation and cross-border collaborations due to State standards, emphasis on test scores, and similar measures. During the past year, partners worked through situations where teachers were unable or unwilling to deviate from standard curriculum and/or school schedules to cross the border with students, invite Mexican students/partners to their schools, or participate in educational activities/conferences themselves.

Mexican teachers and students face their own challenges, as well. While most schools have been gracious in allowing students to partake in environmental activities during school hours and have incorporated them into either curricular or extra-curricular programs, many students work and cannot get permission to leave for extended periods to participate in project-related activities. Since passports are needed for entry into the United States, numerous students with limited resources have been restricted to participating in events that take place on the Sonoran side of the border.

Teachers on both sides of the border face large classes –for example, finding more than 40 students in a class is not uncommon in middle and secundaria schools in Ambos Nogales. In addition, unless they earned their degrees in the natural sciences or agronomy, their educational preparation generally did not include much information or training in environmental studies, especially soil science and botany. Thus, many teachers require educational opportunities in the basic principles of ecology and environmental science. Many also need assistance in alternative modes of teaching that reach beyond the classroom and standard didactic approaches. At the participating schools, administrators on both sides of the border were supportive of environmental education efforts; it was more challenging to engage administrators elsewhere.

Two of the key school partners in ARAN—namely, CONALEP and CETis—work on the revegetation projects under very different circumstances and organizational structures. To begin, CONALEP was established as a high school designed for technical studies, while CETis was established as a college prep high school. Though each supports a holistic curriculum and there are efforts to standardize all high school education in Sonora, differences remain. More importantly, the ways in which students, teachers and administrators have become involved in ARAN differs from school to school. The leader at CETis is a science teacher who also leads the ecology club. She had been able to incorporate students from her classes, as well as the school ecology club, into projects. While some of the students earn social service credit for their participation in revegetation projects, others are expected to do so as part of their regular education. At CONALEP, the leader for the ecology club is an administrator who heads up the social service program and has established the revegetation program as a social service option for students on the campus. Her work with the club is in addition to her regular duties.

Many border schools have faced budget cuts in recent years, and both teachers and administrators are finding themselves with more work, either more classes to teach or more tasks to undertake. For example, one of the high school administrators was recently assigned an entirely new department, in addition to the one she already led. Training for the new position took her to Hermosillo for four weekend trainings in the fall of 2005, leading to her absence from school almost every other week. In all schools, because of the need for school personnel to be

present at every activity involving students, it is critical that multiple personnel are able and willing to work with the projects if they are going to continue. In the case of the high school administrator, when she could not attend a workshop or weekend fieldtrip, two other administrators took the students from that school; that event was the first major activity in which the students have participated where the administrator who began the program was not present. The same situation exists at other schools, and active teachers, in particular, have struggled to find colleagues to help share the responsibilities of their revegetation and ecology programs. A critical function of ARAN has been the support that partners at other schools and institutions provide to its members. Nevertheless, without increased support at each partner organization it is difficult for the programs to continue and be prioritized among all other demands year after year.

Student turnover is a necessary component of any projects that involve schools and must be planned for. All participating schools have developed innovative mechanisms to insure the transfer of knowledge from one year and group to the next. ARAN partners sought and received funding from the Arizona Department of Health Sciences to develop a summer research camp designed for the end of the spring semester to orient club members who will take over as leaders the following year. In addition, the ARAN fall retreat provides an opportunity for new students to become oriented to the goals of ARAN and the knowledge and skills they will need to be successful in their projects.

Revegetation in Colonias

Colonias provide a different set of resources, opportunities, and challenges for revegetation projects and the ARAN partnership. A wide variety of people with differing skills and interests reside in the colonias, and a critical aspect of successful colonia projects is ensuring that people know about projects and helping those who are interested find ways to contribute. There were two types of colonia projects involved: continuing and new. The continuing projects were those conducted in Colonias Jardines del Bosque and Villa Sonora where green areas had been established for a few years. The key to these projects was sustaining and growing motivation within the colonias through projects that addressed real community concerns. For example, in Jardines del Bosque, residents were able to start a youth ecology club, resolve the water issue, and plan for a new retaining wall—all of which were challenges that arose through the process of working in the green area over the last couple years. Similarly, the residents of Villa Sonora decided to establish trails through workshops to resolve a real concern for the area and encourage more residents to be involved. Residents from both of these colonias made a visit to the Arizona Sonora Desert Museum in early December 2005 to inspire new ideas and creative ways to incorporate native vegetation and water harvesting into their ongoing plans. On the other hand, the magnitude of the projects in Colonia Heroes and Parque Industrial Nuevo Nogales was much greater because they were new projects. This grant served to attract other resources as seed money to begin projects. For residents of Heroes, they used this money to qualify for a Federal program to establish their green area from scratch. For APSA, they used this money to secure their land for the future nursery by putting up the fence. In both cases, these steps were necessary to show commitment for gaining further support.

One of the greatest lessons in working with colonias is that community development proceeds at its own pace, regardless of efforts to force change to happen faster. Unlike schools, which are

designed to operate according to schedules and to have people present at specified times, colonias are comprised of loose associations of people who are engaged in multiple activities spread over wide geographic areas. Even getting people together at the same place and time can be challenging. The result of early failures to recognize and adapt to this reality has been continual delays in physical/infrastructure progress. At the same time, because of the persistence of the partners in trying to understand and meet each other's needs and goals, the result was also consistent growth in human relations and progress in communications. The limitations encountered ranged from political/power differentials to disconnected phones and personal/family affairs that limited communication and the availability of key players.

Initially, UA graduate students were assigned to work with the colonias committee, which was made up of representatives from four different colonias. One of the challenges was to find a mechanism to overcome some of the inevitable obstacles that groups of people face who do not have a custom of coming together. Here is an excerpt from an intern's field notes (01-31-05) following a progress report meeting on the colonias:

> *[We] spoke about our frustrations with the project, and the difference between working with the colonias and working with school groups, or organizations which have more regular meetings. [many participants in colonias are women with families, jobs, and other obligations] and considering the various circumstances with each person last semester (family illness, death, religion, other obligations…) our planned group meetings were few and far between. While we did have some successful days, more often than not [we] would show up and find out the meeting was cancelled. When we did meet, we talked about proposals, but never received anything in writing that would be taken to the Mesa Directiva. Taking all this into consideration, […] suggested that we move away from colonia committee meetings and focus more on each individual colonia.*

To improve communications and increase each colonia partner's access to resources, UA interns and graduate students were assigned to work with individual colonias as their projects were accepted by the Mesa Directiva. Making progress within the colonias required the important and long-term process of leadership development. For the most part, women with families, jobs, and homes to care for were the key players in the development of neighborhood projects. One woman accepted the Colonias Committee as her duty from the start of the grant period and often had to bring along her two youngest children to committee meetings. As the representative of the colonias, she served on the Mesa Directiva as well as the Education and Outreach Committee and helped get an ecology club started in her colonia. In the past, this woman had been responsible for cooking food for others during workdays while men in the colonia led meetings and directed projects. Other women, too, took on leadership roles in organizing groups of neighbors to come together to develop plans, plant vegetation, and clean their green areas. One woman notes in an interview (04-01-05) how she came to take on greater responsibility:

> *Residente de Colonia: Bueno, en principio simplemente observabamos y trabajabamos lo que se necesitaba. Estabamos siguiendo lo que se nos estaba proponiendo. Ahora el cambio, lo que ha estado cambiando en mi es que ya soy una parte integral, estoy trabajando activamente dentro de la agrupación de ARAN.*
>
> *Entrevistador: Y si puedes hablar un poco de como te sientes en este papel, ahora que estás mas involucrada, mas integral en ARAN?*

Residente de Colonia: Siento mucho compromiso porque ahorita depende de mi actitud y de la forma como me vaya desarrollando en que otra gente se vaya interesando trabajar en las colonias. Es mucho responsabilidad porque...eso está diciendo que crezca mi manera de percibir mi alrededor, de la forma, el ambiente es responsabilidad porque lo que yo soy absorbiendo hay que transmitirlo a los niños...Y me siento a gusto poder trabajar, servirle a la comunidad.

TRANSLATION:
Colonia Resident: Well, in the beginning we simply observed and worked towards what was necessary. We were following up with what was being proposed to us. Now the change, that which has been changing in me is that I am an integral part, I am actively working within the group of ARAN.

Interviewer: Can you talk a little about how you feel en this role, now that you are more involved, more integral to ARAN?

Colonia Resident: I feel a lot of commitment because right now things depend on my attitude and on how I am developing given that other people are getting interested in working in the colonies. It is a lot of responsibility because. ..this is saying that my way of perceiving my surroundings should grow , in form, the environment is a responsibility because what I am absorbing I have to transmit to the children. ..And it feels good to be able to work, to serve the community.

One of the greatest challenges of working in colonias has been the recruitment of residents to help out in the green areas. Even in the most stable colonia, only a select few women commit themselves to working in their area weekly. To address this challenge, one school extended its program to involve students to work in a colonia one week per month; the other three weeks a month are still devoted to projects on the school campus. Thus, the students of CONALEP began making monthly visits to Colonia Villa Sonora in the early fall of 2004. The students and administrators found both satisfaction and inspiration in reaching out to this colonia, and thereby started a sustainable trend of partnerships among high schools and colonias on a regular basis. In the past, ARAN members, including schools, have participated in workdays in colonias and other sites as a way of lending a hand. And yet, it was not until 2004 that high schools started to see assisting colonias as part of their regular duties. In an interview, one ARAN partner commented on just how critical her colonia's involvement in the partnership has been in progressing in their green area:

Si no hubiera sido por el grupo de ARAN, pues muchas cosas tampoco haríamos. Estamos programando más con el grupo.

TRANSLATION:
If it had not been for the group of ARAN, there are many things we would not have done. We are planning more with the group.

For the colonias, the modest amount of money allocated for their projects was sufficient to accomplish a great deal because they could and did rely on a significant amount of volunteer labor, without which their projects would have been much more onerous, if possible at all.

Approaching Environmental Education in Border Communities

One objective of this project was to identify local groups that could incorporate education and outreach about air quality, erosion, vegetation, and health impacts into existing programs. As indicated by the survey of high school students, people are not unaware of air quality concerns but lack information needed to take steps toward improving poor air quality; students on both sides of the border identified local government as the key actor in addressing air quality. Local governments do play an important role, and issues such as management of development to reduce hill slope cutting, erosion, and subsequent dust require serious attention. Where possible, ARAN members tried to encourage and promote government actions for environmental improvement. For example, ARAN partners worked together to support the tree giveaway sponsored by the Nogales, Sonora municipal government and the Asociación de Profesionales en Seguridad Ambiental.

However, this project also aimed to reach individuals through groups such as health promoters. This effort was more successful in Nogales, Arizona, where these issues could be included in the activities of the Health Careers Club program and information disseminated via the students than in Nogales, Sonora where competing health concerns made it difficult for groups to take on the additional challenges of public education on these issues. While public fairs, newspaper and radio announcements, and local events raise initial consciousness of the problems, they are clearly insufficient for giving people the tools they need to take positive action. Participation in the ongoing activities of the ARAN groups, confronted with regular conversations about the purpose of their actions, is one concrete step that proved effective in raising awareness and knowledge of what was needed to address the problems. The participation of at least half a dozen ARAN members in the Arizona-Sonora Air Quality Task Force, growing out of this awareness and concern, is a direct positive result of this project.

The most effective approach for learning and at the same time getting work done in both schools and in the colonias was the incorporation of hands-on workshops. For example, a hands-on workshop on water harvesting techniques was held at CONALEP and served to begin what became a much larger project of erosion control on the school campus. Similarly, a hands-on workshop on the construction of trails on steep slopes at Colonia Villa Sonora resulted in the establishment of a safe trail up a slope within the colonia's green area. These hands-on workshops took place during ARAN general meetings and at special times and places, according to the needs of the participants and workshop hosts.

The mechanisms and formats devised for educating ARAN members were better suited to some partners than others. Monthly meetings, for example, were better attended by schools and colonia representatives. Participation by government and business members, key targets for education and outreach, dwindled considerably as the grant period progressed. Both the time required for attendance, usually during a weekday afternoon, and the clear focus on education, kept some members from attending. Some individuals argued, for example, that they did not have time to listen to school children present their projects. Unfortunately, as representatives from these sectors withdrew from this venue it became increasingly difficult to reach those members with information and undermined the value of the meetings as places of interaction and exchange. Even among the groups that participated regularly, the rotation of members to give as many

students as possible the opportunity to come to an ARAN meeting (most school groups have as many as 20 to 40 members and would send only a portion of their members to each ARAN meeting) meant that only the group leaders were consistently getting information and building on their knowledge. In some groups the leaders established specific mechanisms for the information from the ARAN meetings to be shared back to all their members, but in other groups information transfer beyond the meetings within the groups was minimal. To address this gap, some ARAN members requested that groups making presentations at ARAN meetings provide written information that can be shared within the various groups after the meeting. The group has been only somewhat successful in obtaining such materials but will continue to push for them to expand the collection of materials available to ARAN members.

In addition to monthly meetings, other activities and events were established to bring members together and increase the flow of information. The fall retreat is an all day event and, like the monthly meetings, was attended primarily by students and teachers. While this is an important audience to reach, it is necessary to determine if there is another venue that would be attractive to ARAN members from other sectors. One mechanism to try to address the inconsistency of participation and information exchange was for the University of Arizona interns to maintain weekly meetings among themselves to share information and help increase the flow of information. Still, a key concern is that among some groups few of the members have a good sense of what their project is designed to achieve or how they fit into a larger structure; this appears especially prevalent within some groups whose student members are working on projects to fulfill their requirements for a class or for social service. While they learn through the activities in which they participate, their main objective is completing their 480 hours of social service.

Working in a binational context also poses significant challenges. To accommodate individuals who cannot cross the border, a rotating schedule was established where two meetings would be held on the Sonoran side and a third on the Arizona side. This helped bring members to ARAN meetings but contributed to the discontinuity among attendees. All meetings were attended by at least some participants who could provide translation (while we experimented with simultaneous translation we found that managing the equipment was sometimes more trouble than it was worth and individual members would instead provide translation for those who did not understand the language in which a presentation was being given). The language barriers were more significant for ARAN members participating in workshops and conferences offered by others. Even at external events that were designed to attract binational participation, often inadequate preparations had been made for allowing full participation by monolingual participants; on numerous occasions bilingual ARAN members found themselves providing translation services, without compensation, for the event at which ARAN members were intending only to act as attendees.

Participation in conferences provided a variety of benefits but also presented special challenges. Despite their intent, many conference organizers who are attempting to encourage binational or cross-border collaboration end up providing only limited opportunities due to monolingual sessions and presentations, an imbalance in the number of participants from one side of the border or the other, and lack of opportunities for attendees to interact with one another. ARAN members face an ongoing challenge in seeking new opportunities to learn and to provide forums

for partners, especially youth, to participate. The most effective venues were those where ARAN members could share what they were doing, demonstrate their leadership abilities, and network with like-minded individuals and groups working on similar issues.

The Role of College and University Students

Interns from the University of Arizona play a central role in ARAN, and did so in this project as well. Responding to the needs of their particular partners, they help to plan, coordinate, facilitate, network, lead, and participate within groups. They help set up for and clean up after activities, document the progress of the projects, and often provide manual labor and transportation. Students from the Instituto Tecnológico de Nogales, through the campus organization Comité TREE, work within colonias to help revegetation and environmental education efforts.

Students from both UA and ITN also serve as inspiration for and share their college experiences with younger students. They are called upon for friendship or to play the role of an older sibling, especially with high school and middle school students. Also, when teachers are overwhelmed by their heavy workload and oversized classes, interns provide more individual attention and encouragement to students. One of the most important functions performed by UA interns is that of communication – these students help link partners, identify places where one group can learn from another, and facilitate information sharing among partners.

One UA intern frequently reflected on his role within a school ecology club in his field notes. He mentioned serving as an "assistant," helping the club to do things they wanted to do and being a "pillar of support." Although he admitted his role as somewhat of an advisor, he also noted that he did not feel there was much on which he could provide advice since he felt he had the same general level of knowledge as the students. Nevertheless, he recognized his role as a resource, "they do need someone who can connect them to things they can't reach, and that is the majority of what I have been doing."

One role played by UA faculty and students is to help with grant writing—for individual partners, groups of partners, or the whole partnership. Many individual groups secure much of their own funding and material support from their networks, but funds for special events and activities, such as the summer youth environmental health research camp or field trips, often come from grants. Learning to write funding proposals, even for small amounts of money, is an important skill for students and other ARAN members to attain, so faculty and experienced graduate students are available to support these efforts.

Within the revegetation project and ARAN, there is a tension between the desire to increase decentralization to foster greater independence and give more people opportunities to serve as leaders and the desire to have everyone moving in the same direction. Both the individual UA interns and the UA participants as a group struggle to allow each partner sufficient autonomy while at the same time providing leadership as needed.

Participation of the UA and ITN also helps, at times, to increase the attention paid to partners and their needs. On one occasion, for example, two colonia representatives happened upon a UA graduate student at the Municipio building in downtown Nogales, Sonora. The student was able

to assure that a city official spoke with the women, simply because she insisted, and thus attend to their complaint regarding plants that had been stolen from the green area. At the meeting at the colonia the following Saturday, the women commented on how the student's presence when they went to the city helped them get the forms filled out and get the attention of the city, which made a huge difference. The following day someone from the city came out, found the plants in one of the neighbors' yards, and made the man go replant them in the green area. This sort of networking and mutual support (even if serendipitous, as in this case), increasing the power of individual members through their association with the group, was recognized by many participants as a strength of ARAN.

Chapter Three: A Look at Partnership Synergy

> "The critical issue for partnerships seeking to achieve high levels of synergy is not the size or diversity of the partnership, per se, but whether the mix of partners and the way they participate are optimal for defining and achieving the partnership's goals" (Roz Lasker, Elisa Weiss, and Rebecca Miller. 2001. Partnership Synergy: A Practical Framework for Studying and Strengthening the Collaborative Advantage, *The Milbank Quarterly*, 79(2), p. 190-191).

The ANSSTV project was designed to strengthen the social as well as the physical infrastructure necessary for developing and maintaining revegetation projects and programs. The focus of this effort was ARAN, the Asociación de Reforestación en Ambos Nogales. From the standpoint of the UA (BARA), the evaluation piece of this project provided a unique and indispensable opportunity to use research as a way of examining how partnership functioning influences partnership effectiveness. For all of ARAN, with BARA and the UA interns included, it also provides an opportunity to apply what was learned from the evaluation research to improving the partnership. While partnership collaboration has been the subject of much study in various disciplines, this study is exceptional because the ARAN partnership spans more than 100 miles, crosses national borders, and involves two languages, all of which present logistical, theoretical, and communicative challenges. And yet, a number of determinants were revealed that point to how the combined efforts of many help to create partnership synergy. Here this report will provide some specific examples of those determinants.

First, to clarify, the methodological approach used in this evaluation was drawn from the work of Roz Lasker, Elisa Weiss, and Rebecca Miller (Partnership Synergy: A Practical Framework for Studying and Strengthening the Collaborative Advantage, 2001, *The Milbank Quarterly*, 79(2):179.). Those authors identified *synergy* as the "proximal outcome of partnership functioning that gives collaboration its unique advantage" (p. 183). As many have defined it, synergy refers to combined efforts being greater than the individual parts, or "the power to combine the perspectives, resources, and skills of a group of people and organizations" (p. 183). This evaluation specifically set out to observe the thinking and actions that result from the ARAN collaboration as products of the people and organizations that make up the partnership, as well as the relationship that it has with the wider Ambos Nogales community.

As explained in Chapter One, the evaluation process used the method of reviewing and coding field notes to highlight the determinants of partnership synergy. These included resources available to the partnership (i.e. money, information, time), relationships among partners (i.e. trust, respect, communication), partnership characteristics (i.e. leadership, governance, equity), and the external environment (i.e. community characteristics, public and organizational policies). Every time a UA intern, graduate student, or faculty member participated in an ARAN activity, whether that was a workday at a school site or a professional conference at which ARAN members were present or participating, s/he wrote up field notes to document the experience. This is part of the training in participant observation as an anthropological method that UA students receive, as well as a way of documenting the numerous happenings of the partnership. All notes were reviewed and coded for determinants; some also provided a holistic view of ARAN.

For example, the ARAN general meetings were a great place to look for partnership synergy. They are one of the few times that representatives from many of the groups join together, providing *access to other partners*; and they are also a place where decisions are made about future activities, demonstrating *efficiency*. Some of the themes that came out were 1) the level of *respect* that is shared for each group through the way everyone contributes and *communicates* after a presentation to offer advice, help, and encouragement; 2) *complementarity* in the different roles that different members play (i.e. there are school groups that are directly involved in projects, and then 'supporters' that offer *expertise* and *endorsements*); and 3) the consensus that is shared about what ARAN's mission is, which from time to time is clearly articulated by various members. Moreover, partners benefit in various ways, ranging from the joy of seeing their students present to receiving recognition for hard work to being part of something more rewarding than everyday jobs or lives—a way to participate in and give back to one's community. Over the past year and a half, the ARAN general meetings have become one of the most successful elements of the partnership through making resources available, enhancing relationships among partners, and strengthening partnership characteristics, all in light of ARAN's goals.

Partner Characteristics

In addition to documenting the regular activities of ARAN, the UA team conducted interviews during the spring and summer of 2005 with a total of 12 "leaders" of ARAN, four of whom were from the Arizona side and 8 from the Sonoran side. This included leaders of clubs, school/class projects, organizations, and governmental institutions—all of whom had been associated with ARAN for more than two years. The interviews were part of the evaluation process and specifically served as a tool for examining "Partner Characteristics," providing information about changes over time in the two factors: heterogeneity of the partner organizations and their level of involvement in the partnership. (See Appendix P for the interview protocol in Spanish and English). Main topics also discussed in the interviews include how people/groups view ARAN and its function, how the EPA grant impacted ARAN, and what participants see as the future of ARAN. Each topic provided insight into the evaluation of partner characteristics and contributed to the overall analysis of partnership synergy.

Various sectors represented in ARAN have remained the same over the years, for the most part, even though there is some fluctuation in individuals' or groups' level of involvement. From one year to the next, the students are the partners who change the most. Even so, students who were involved through one school program have found new mechanisms for involvement at a different school. For example, one student who began as the ecology club president at the CETis 128 preparatory school became the president of Comité TREE, having taken on a new role as a university student at ITN. Some partners expressed changes in their own level of involvement or that of others, and yet pointed to the overall consistency and growth of ARAN over time, even when funding had not been available.

In terms of heterogeneity, partners on both sides of the border expressed a need for more work in the United States. For reasons ranging from lack of interest to bureaucracy on the U.S. side, it has been more difficult to get partners as deeply involved in ARAN as their Mexican

counterparts have been. This resulted in an uneven mix of partners across the border. While this project helped to balance out the number of partners on each side, interviewees still noted a lack of connection between Arizona and Sonora partners, as well as among schools on the same side of the border, in terms of themes, communication, interactions, and collaborations. One indication of the imbalance came out clearly in the interviews. For several U.S. partners ARAN = "they"; for Mexican partners ARAN = "we." This was directly correlated to the level of involvement with *all* of ARAN (e.g., attending general meetings regularly), and not necessarily to the amount of work actually completed at a single partner site. In response, numerous partners expressed the need and desire to have at least one event/activity annually for ALL ARAN members and a calendar of events of all partners as a way of maintaining communication and group solidarity.

Through participant observation, we have been able to document the ebb and flow of certain partners as they fall in and out of higher levels of involvement. There are numerous personal, occupational, and circumstantial factors that play into just how involved individual partners can be within ARAN at any given time. As discussed in Chapter Two, teachers at schools are dependent upon the material they are required to teach and whether or not they can have access to students to participate in ARAN. One teacher stated,

> *El problema es que en ese periodo me tocó impartir una materia que no puedo utilizar a los alumnos directamente entonces siento que se ha limitado por la materia. Y en cambio ya en los próximos semestres ya va a ser materia accesible, va a ser biología y ecología. Entonces va a ser lo mismo. Puedo incluir cualquier tema dentro de la materia y los muchachos tienen la participación.*
>
> *TRANSLATION:*
> *The problem is that in that period I was asked to give [teach] a subject such that I can't utilize the students directly and therefore I feel that they have been limited by it. And on the other hand, there are going to be more accessible subjects for the next semesters, which will be biology and ecology. So it will be the same. I can include whatever theme inside of the subject matter and the students participate.*

Furthermore, over the course of one year, circumstances in partners' lives alter their level of involvement, whether they are family obligations, personal health, or increased workload. The aspect that points most clearly to synergy is how others fill in gaps or simply step up their involvement when others must back away. The Mesa Directiva allowed for this fluctuation more in that that body is composed of representatives of each sector rather than particular individuals. For almost every sector, there was some variation on who attended the meetings. The Mesa Directiva also took advantage of the "majority" rule it set out for itself from the start. At least six sectors had to be represented at any meeting in order for a vote to be taken on issues or proposals. This rule incorporated the flexibility necessary in establishing a sustainable governing board without over dependence on particular individuals.

Resources

As mentioned earlier, there are not only a number of resources that partners bring to the partnership, but also a number of resources that the partnership makes available unto itself. Throughout the evaluation process, there were numerous examples found of each and every resource listed in the model, from money to information to convening power. Some resources serve as direct benefits to partners, such as information, endorsements, and space, equipment, and goods. Classrooms, offices, and homes were used for committee meetings; partners learned a great deal while building important social infrastructure in their community. Networking through existing partners was a key way to learn about others and what has been going on and to find potential new partners. However, other resources proved restrictive, such as permits, skills and experience, and time. Many Mexican students do not have adequate resources to attain a Visa to travel to meetings, activities and field trips in the United States. Even though the border is a bilingual environment, language presented a challenge in many situations, even when translation was available. One interviewee discussed her frustrations with not being able to communicate on a personal level with other partners because of language barriers. Here we discuss two resources in greater detail to show their complexity.

Money
Interviews and participant observation revealed both positive and negative impacts (and perceptions of impact) that the grant money had on ARAN as a partnership. Leaders of groups referred to expanded opportunities for learning, personal growth through participating in the grant proposal experience, and being able to get a lot accomplished. It also served as the stimulus for the development of the Mesa Directiva as a democratic governing board. The board convened to make decisions specifically related to the use of money for projects that coincided with objectives set out in the grant. With this resource available to the partnership, individuals and groups benefited on many levels.

However, there were perceptions of the money's impact that framed it as a negative resource, and as working against partnership synergy. When grant funds arrived behind schedule, people were limited in what they could do since many partners participated in writing the proposal and planning activities according to the anticipated timeline. In interviews and ARAN related committee meetings or activities, some partners expressed concern that the money had attracted people who were only interested in money and not the overall, long-term goals of ARAN. Others worried about the disintegration of the partnership at times, stating that too much was going on and it was too difficult to participate or know about all of it. Without financial resources, ARAN as a whole could only host and support a limited number of activities in the past. Others attributed too much diversity in projects and a loss of focus to the new money that became available through the grant.

Some expressed an interest in returning to how ARAN 'used to' work with less money, and even suggested that ARAN accomplished more with little money. Others recognized as important the need for a balance between using and benefiting from grant resources and also not becoming dependent on them. Individual partners did acquire their own resources on many occasions, as was mentioned above, to participate in events with ARAN. While several members of ARAN intend to keep doing this, the majority of representatives want to continue the Mesa Directiva

into the New Year as a way of keeping "business" out of ARAN general meetings and monitoring the progress of ARAN as a partnership.

The EPA grant was the largest amount of money that ARAN had managed to date, and consequently many people specifically discussed the issue of money. Several participants talked about the ample array of resources that this grant made available to individual partners, besides money.

> *Interviewer: What about other changes that have come with the EPA grant besides money?*
>
> *Leader: Well, more training, more opportunities to travel, more, all of a sudden because of the EPA money there's been more contacts with more organizations or other people that we weren't in contact [with] before. So that has expanded the knowledge and the possibilities to learn even more.*

Time

Within a partnership the issue of adjusting schedules and accommodation is critical. Variance in school schedules across the border, and across grade levels, has caused time conflicts for many students. The SEAHEC students from Nogales High School could not participate in one ARAN general meeting because they had final exams at that time. Moreover, ARAN is extra for the majority of participants; and people feel great time limitations. As several partners mentioned, though, UA interns help out a lot in planning, organizing, and facilitating meetings and projects. Teachers have constraints of classes they are assigned to teach and often have to fit ecology in when they can. One teacher stated in his interview, "Antes de pertenecer a ARAN, yo tenía mucho tiempo libre." (*TRANSLATION: Before belonging to ARAN, I had much free time.)* While he went on to talk about the many benefits he receives from ARAN, his statement is a reality for many partners. Too many meetings can be a drain on time/energy. Some partners expressed the need for greater efficiency and for more consistent self-evaluation of projects within ARAN to make sure that participants stay on track with their goals.

One interviewee reflected on the issue of time, and just how much working within a partnership saves time and accomplishes much more:

> *Si empezamos a romper con esos paradigmos de individualismo, de apoyarnos, de trabajar mas en equipo, de darnos un poco de tiempo para ayudar a los que verdaderamente lo requiere en determinado tiempo, yo creo que eso nos va a dar el solidez y el fortalecimiento como grupo informal…Entonces, el reto alli esta para todo nosotros y ya depende de nosotros si queremos tomar esa responsabilidad y llevarla a cabo. Porque es mucho, mucho trabajo, muchas horas que tenemos que invertir y que tenemos que estar concientes de eso.*
>
> *TRANSLATION:*
> *If we begin to break with these individualistic paradigms, by helping each other, by working more in the group, if we give a little of our time to help those that really require at a certain time, I believe that that is going to give to us the soundness and the*

strengthening as an informal group… Then, the challenge is for all of us and already it depends on whether we will take that responsibility and carry it out. Because it is a lot of, a lot of work, we will have to invest many hours and we have to be conscious of that.

External Environment

There is no doubt that border communities present a unique set of characteristics, and integrated and disparate public policies further add to complexity within the region. One partner described the external environment well by stating,

> *Well, I think ARAN is a very interesting organization because, first of all, it's tackling border issues. And dealing with the population that lives on the border, and given that the border population is a unique population altogether… and then you have the whole border friction, tensions, that you have. So that's a unique situation that's there.*

As complex as it is, there are certainly aspects of the external environment of Ambos Nogales that contribute to and others that take away from overall partnership synergy. An intern working with Nogales High School students and referring to the cross-border environment stated, "The partnership [has been] successful in getting the students more aware of the community and their Mexican neighbors. The students have successfully learned about community services available to them, too." However, increased school security and also border security have made it more difficult for members of one group to work with another. At times ARAN partners have encountered huge bureaucratic challenges when trying to arrange activities while at others they have eased through the system.

Some of the greatest challenges for partnership synergy involve the hindrances to Arizona schools' participation in ARAN. With various levels of restrictions and responsibilities laid on Arizona schools, teachers, and students, ranging from the Federal "No Child Left Behind Act" to larger class sizes, it is becoming increasingly difficult for them to collaborate with others. Teachers are obligated to align curricula with Arizona State Standards and students are pressured to score well on state-mandated standardized tests. The large class sizes create more work for the teachers so they cannot take on as much responsibility or focus as much on ARAN projects. In addition, dealing with administration at schools caused time delays and limitations when officials did not see eye-to-eye with the teachers.

Relationships among Partners

> It has been noted that the most time-consuming and overwhelming challenge for partnerships is the building of relationships.
>
> (Lasker, Weiss, and Miller,2001, p. 192)

During an impromptu meeting of a few ARAN leaders taking a break from the ARAN Retreat, a teacher from one school grabbed a chip from the hand of another partner (from a different school) just as she was about to eat it. They smiled, laughed a little, and went on with the conversation of the group. More overt acts of trust and respect emerge in meetings when

everyone acknowledges the challenges and successes of each partner, or when individual partners comment on others' considerable contributions to the partnership.

The Environmental Justice Symposium held in Tucson in September of 2004 served many purposes, one of them being developing relationships among partners. The leaders of ARAN participated in a panel discussion about community-based environmental partnerships, and approximately 40 students from partner organizations attended the session. Each leader presented her/his group's role within ARAN, and also made reference to the value of being part of the larger partnership. Several of the presenters commented on how wonderful it was to have all of the ARAN groups together in one place, and communicated to the audience how much respect all of ARAN members have for each other and how much they enjoy working together. Although there were only a few attendees not associated with ARAN, the event served an important purpose in giving newer students a chance to become acquainted with what ARAN does and to start to meet each other. Furthermore, it was an opportunity for groups to share what they had been doing with one another.

At conferences and multiple-day events, some partners offered up their homes for other partners who needed a place to stay. One family invited a group of UA interns to stay in their home for the ARAN Retreat 2005, even though the family members were out of town that weekend. This illustrates high levels of trust among partners, also allowing partners to further develop personal relationships. One partner on the U.S. side recalled one of these occasions as her most memorable experience within ARAN:

> *Leader: Last year when they had, in the fall, the retreat or whatever, and everybody stayed at my house and everything that was my most memorable experience.*
>
> *Interviewer: So you want more slumber parties?*
>
> *Leader: Yeah, I like the slumber parties [laughing] I like the social part too. It's fun.*

Although monthly meetings held by each committee stretched partners' time thin on occasion, they were critical for communication, access to other partners, and conflict resolution. For example, one of the first Education and Outreach committee meetings in September of 2004 resulted in an interesting discussion and a number of disagreements on the limits of the themes that would be addressed by ARAN partners during the period of this project. The idea was that schools, colonias, and others would be going to that committee to present proposals for education-related activities. The group decided that there should be some boundaries because education related to water quality, for example, did not fit into this project. Some wanted a few general themes to guide the committee, while others urged for a longer, more specific list of themes. The committee members discussed the issue, made a long list of themes, prioritized them as a group, and then circulated the results via email to gain feedback. By the second Education and Outreach committee meeting, the committee members reached an agreement on the limits they could set for the education and public outreach proposals that would come their way over the course of the project.

Communication was not always as effective as it could have been. There were incidences when miscommunication among colonia partners led to cancelled meetings, or misunderstandings

among interns and other partners resulted in missed opportunities or frustrations. The frequent use of the phone and email as a way to get messages out to partners proved effective only for some partners and some of the time. Some partners' phones were turned off for short periods due to unpaid bills; internet access would fail at schools; and different holidays in Mexico and the United States would conflict with partners' plans.

Dealing with power differentials is inevitable in the case of multi-sectored partnerships, and ARAN was certainly not an exception. There were situations where older students chose not to partake in activities with younger students, or more politically slanted situations where certain partners challenged or felt threatened by the participation of the municipal government of Nogales, Sonora. The partnership did suffer from some individual cases of mistrust and miscommunication, all primarily linked to the involvement of the governmental sector in ARAN. Regardless of individuals involved, some long-time partners of ARAN did not want to involve governmental entities in what they viewed as "civil" projects of ARAN. Partners often referred to the instability and unreliability of government within Mexico given the probability of complete over-turns every three years. The Nursery and Composting committee worked around this by maintaining loose communication with the municipal government, and the Mesa Directiva worked collaboratively to balance power differentials in its governance. The participation of the University of Arizona also presented a power imbalance. Some partners within ARAN and particularly those outside of ARAN tended to view the UA as the head of the partnership. This will be discussed further under partnership characteristics and the future of ARAN, below.

Partnership Characteristics

For the first time in ARAN, this project introduced a formal organizational structure—committees provided an opportunity for individuals other than the initial group organizers to step into leadership roles. This was especially true in the case of the Colonias committee. Something worth mentioning here is that there were more females in leadership roles for this project within ARAN than males, on both sides of the border. The interviews conducted with these twelve leaders revealed a lot about how participants view ARAN. It is interesting to note that everyone wanted to maintain ARAN and keep their own separate groups participating – whether more or less depended on the semester, the group, and the timing. For example, partners at ITN work hard to incorporate ARAN projects, events, and activities into their courses, even when it may seem like a stretch to other partners.

When asked what benefits they receive from their participation in ARAN, many partners discussed efficiency, complementarity, and equity as results of the collaborative nature of ARAN. One interviewee responded:

> *Yo tomaría lo de trabajar en grupos porque antiguamente tu decías que yo voy a trabajar y voy a ayudar el medio ambiente. Voy a plantar, voy a cuidar este. Pero como tu es que hay mucha gente que es interesada pero mucha gente no. Pero entonces, estás viendo que no estás sola, y eso es muy positivo. ¿Que otro beneficio? Pues que nos apoyamos con nuestras limitaciones de horarios y todo, pero en general nos estamos apoyando unos a otros.*
>
> *TRANSLATION:*

I would take it to be the work in groups because in the past you would say that I am going to work and I am going to help the environment. I am going to plant; I am going to take care of this. But just like you there are many people that are interested but many people that are not. But then, you are seeing that you are not alone, and that is very positive. What another benefit? Well that we support each other with our limitations of schedules and all, but in general we are supporting each other.

Others discussed the personal attributes and knowledge they gain from participating in ARAN:

Ahorita ya tengo confianza, ya puedo opinar, ya conozco, porque al primero no sabía nada de ecología. Nada. Nada. Absolutamente. Me gustaba, sí me gustaba, pero no tenía conocimiento. Quería hacer cosas, pero no sabía como. Ahorita, ya hay gente que me ayuda, yo he aprendido, he buscado en Internet, he leído, entonces, ya, ya puedo de este...

TRANSLATION:
Right now I am confident, I can be opinionated, I know, because at first I knew nothing about ecology. Nothing. Nothing. Absolutely. I liked it, yes I liked it, but I did not have knowledge. I wanted to do things, but I did not know how. Right now, already there are people who help me, I have learned, I have searched on the Internet, I have read, therefore, now I can do this.

At the ARAN Retreat 2004, the participants from CETis 128 suggested that those from CONALEP develop a logo for their ecology club, and even offered ideas. Each group was able to present at the end of the day, and each received equal recognition for the work put into planning out their projects for the year.

Equity among partners is an important characteristic and one that is achieved through continued negotiation. Equity does not necessarily mean equal with everyone doing the same thing. Money, of course, presents challenges for maintaining equity. Some partners expressed satisfaction that the university would handle the grant writing, money raising money, etc. Others supported the goal of increased capacity development within the individual groups.

When asked what ARAN is and what its main goals are, there was a general consensus among all interviewees that ARAN is a grouping of people from different backgrounds who come together with the main goal of improving environmental quality in Ambos Nogales. One leader who has been with ARAN since the beginning eloquently stated:

Bueno, ARAN es una agrupacion de personas de los diferentes ambitos y la meta que persigue es cuidar su medio ambiente, protegerlo y retribuirle a la naturaleza lo que hemos sido quitandole poco a poco.

TRANSLATION:
Well, ARAN is a group of people of different ambitions and the goal that persists is to care for the environment, protect it and to pay back to nature that which we have been taking little by little.

Moreover, leaders of ARAN view ARAN as an educational or learning experience in itself, and not only for the students involved. Interviewees referred to practical, technical, and personal knowledge gained through their participation in ARAN. Some mentioned the benefits of social

networking or exposure to new ideas, projects, and even alternate worldviews of individuals. Numerous leaders referenced resources available *to* the partnership as also being ones that are provided *through* the partnership, such as skills and experience, information, connection to others, and convening power. A member of ARAN and representative of ADEQ stated,

> *…one of the greatest values of ARAN is the way that it creates and establishes and promotes and builds and fosters and strengthens partnerships among many different entities within the community so that there is sustainability…whatever kind of challenge that comes around, the strength of that partnership is so broad and so robust that it survives all of those challenges and moves on always to bigger and better things…*

Several ARAN partners, including UA interns in their reflections on working with partners, referred to the motivation derived from knowing that someone else cares about the environment in their community and what they are doing to maintain and improve it. Simply, access to the larger network of ARAN and feeling like part of something bigger are sufficient to keep people inspired. Within this spirit of synergy, one teacher commented on the specific advantages of working as a group:

> *Pues, ARAN me ha dado la oportunidad de trabajar en algo que yo quería hace mucho tiempo. Para que te des una idea, yo tengo veinte años de servicio como maestro. Los últimos casi once años ya, esos últimos años trabajando en secundaria. Y siempre con esa idea de hacer algo diferente a lo que se hace en el trabajo. Y anduve en diferentes organizaciones, en la CNC y grupos políticos, pero siempre está allí el, el egoísmo, la avaricia, el conseguir cosas para los que están allí, ¿no? Personales. Y pues, no, no era suficiente. Y aquí, ya trabajas con alumnos, con gentes, y en algo que nos va a beneficiar a todos. Si es cansado, nos cansamos y nos enfadamos... pero, es pasajero esto. Después vuelve el nosotros, o el mío vuelve a ese deseo de seguir adelante. ¿Verdad?*
>
> *TRANSLATION:*
> *Well, ARAN has given me the opportunity to work on something that I have wanted to do for a long time. To give you an idea, I have been a teacher for twenty years. The last almost eleven years, those last years working in a secondary school. And always with the idea of doing something different in my work. And I was in different organizations, in the CNC and political groups, but always it was there the, the selfishness, the avarice, to obtain things for the ones that are there, no? Personal. And therefore, it was not, was not sufficient. And here, we work with students, with people, and in something that is going to benefit us all. Yes, it is tiring, we tire and we get annoyed... but, that is temporary. Later it returns to us, or it returns to me, that desire to continue ahead. Right?*

Finally, an intern from the UA reflecting on ARAN as a whole after his first encounter with the group during the 2005 Retreat stated:

> *My first reflection is something that really hit me half way through the day…it is simply that, especially for the students, ARAN is a fairly amazing organization. When I was growing up the kind of interactions that the students were having was a unique*

opportunity that I have neither heard of nor seen before. This includes middle school and high school students mixing together as well as the introduction of college students; adults independent of the schools like the women from the colonias; the unique opportunity to bring students from Arizona that made this an international meeting…exposure to all sorts of issues that effect the lives of the participants and the actual planning and implementation of methods to alleviate these problems…This retreat and organization is not like anything that I have experienced before. The opportunities that this affords the interns at BARA to be involved in communities in a foreign country and to help change in a positive way the communities we are involved in is a privilege and a responsibility.

When asked to reflect on the future direction of ARAN, many interviewees talked about the need for growth of ARAN within itself, rather than expansion. They highlighted the need to strengthen the existing partners by gaining more teacher participation within schools, more involvement across the staff in organizations, and more neighbors participating within colonias. Though a few did express interest in expanding ARAN to include new partners, they too acknowledged the need for internal development first. Many partners expressed a desire for more leadership/direction from the UA, identifying the UA as the central figure (i.e. "glue") of ARAN, and even suggesting that without the university ARAN would not exist as it does now. Some partners expressed interest in hierarchical organization, including elections to establish a more formal leadership structure, especially to handle growth. And yet, several partners emphasized the effective "train-the-trainer" model used throughout the partnership and saw this as the future of ARAN.

Some partners expressed the need for more recognition of ARAN on a larger socio-political scale; while others conveyed how they used ARAN as leverage already:

Yo siento que hemos crecido. Ahora ¿podemos hacer mucho mas? Si podemos hacer mucho mas pero tambien como te comentaba hace rato quizás ya las gentes que tenemos mucho tiempo estamos en los limites de lo que podemos participar, pero todavía no se sabe.

TRANSLATION: I feel that we have grown. Now, can we do much more? Yes we can do much more but also as I just commented to you perhaps already with the people that we often have we are at the limit of how much we can participate, but still no one knows.

Chapter Four: Summary and Conclusions

Successes and Lessons Learned

The ANSSTV project had numerous successes, and many lessons were learned throughout the endeavor, at individual, group, and partnership levels. The project accomplished much—building and maintaining physical and social infrastructure within Ambos Nogales. This project proved more than ever before just how vital both of these elements are to success and sustainability in revegetation projects and programs. Without too much redundancy, we would like to emphasize a few key lessons learned that led to successes.

Time and schedule restrictions were the greatest challenge for many partners. The structure of the partner group, whether organized as a club, class, or committee, affected the extent to which these barriers could be overcome. Some benefits of the "class" organization include a set time dedicated to the project, complementary curricula, and maximization of student labor and teacher time. On the other hand, some benefits of the "club" organization include youth leadership development, flexible curricula, and maximization of social service hours and outside activities. For example, projects at Desert Shadows Middle School are being incorporated into classroom curricula so teachers can take full classes out to the native garden at one time. In contrast, ARAN involvement at Nogales High School is limited to participation of members of the SEAHEC Health Careers Club; during the project cycle, the students and leader reorganized their Health Career Club around ARAN activities, research agendas, and meetings.

Despite the benefits of working together, partners are busy maintaining their individual groups and onsite projects, and the addition of partnership-level meetings and activities has proven challenging. While the Mesa Directiva and the Education and Public Outreach committees determined their meetings to be worthwhile enough to continue beyond the term of the grant, committees for nurseries and colonias discovered that more could be accomplished without trying to organize additional meetings. In this way, each partner or groups of partners within ARAN worked to find the most effective use of time and combination of schedules through an appropriate organizational structure.

Definitions of success may differ based on what an organization wants to get out of an encounter. In the case of the Binational Health Fair, for example, regardless of the number of participants, for the students to have shared their puppet skits in public appeared to be enough for success at that time. However, in trying also to fulfill grant objectives, partners discovered both the pressure and satisfaction associated with having a tangible goal with deadlines that needed to be met. Deadlines were determined collectively, determined by and in response to the needs of partners rather than the specifics of the grant. While some of the deadlines slid as partners faced unexpected hurdles, they provided necessary structure. The Mesa Directiva requested and received a "no-cost time extension" due to circumstances encountered by partners in getting materials, permissions, and other resources to carry out their projects. The flexibility of the funding agency was central to the success of the project.

Collaborations that worked especially well were those established between schools and colonias. Countless hours of volunteer work—by colonia residents and university and high school students

with guidance from specialists from the Arizona Sonora Desert Museum and U.S. National Park Service—ensured that many of the Villa Sonora neighbors' goals were accomplished. Moreover, the help they received motivated this group, like others, to become more integrated into the overall ARAN partnership through monthly meetings and retreats. Partners remarked that they felt like part of something bigger, and that often this was the motivation they needed or used to motivate others.

Challenges of New Collaborations

One goal of the ANSSTV was to increase the reach of the project beyond the initial partners involved in ARAN. At the start of the project period, the Nursery and Composting Committee made repeated attempts to include other schools in the process, though with little success. After a few months, committee members made a conscious decision to develop their own projects first and postpone pursuing new collaborations until later. Partners learned how difficult it was to "show" others what ARAN was about or get them to come to an ARAN general meeting without tangible results. In the cases where new groups attended meetings or the retreat, they left inspired to get their group involved more in ARAN. For example, both Secundaria No.1 and CECYTIS attended the 2005 Retreat and were interested in collaborating with ARAN partners to begin development of their own groups and projects. Teachers from both schools participated in the workshop for Nogales, Sonora teachers held at CONALEP and left with specific ideas about how to implement projects at their schools. In general, new collaborations will not require as much work if the new group is inspired and motivated to participate. Here, ARAN serves as a catalyst for research and project ideas.

Nevertheless, the reality of new collaborations is that community development, or essentially the building of relationships, takes time and proceeds at its own pace. Helping new collaborations take off required a lot of invested time and energy from existent partners to bring the new groups up to speed. Some new groups struggled with how ARAN in general could be of use to them, and vice versa, and more specifically with how to "utilize" help from college and university students. At times ARAN partners expressed frustrations with the difficulties involved in motivating and educating new partners, and even found a lack of enthusiasm on the part of students or maybe a lack of incentive to be involved. Much of this was attributed to the failure of ARAN members to convey – and new partners to grasp—the "big picture." Rather than tapping into resources students may have to offer, new groups run the risk of seeing them more as secretaries or another 'teacher' to keep them on task. The most successful new collaborations came about as new groups understood more of what ARAN is, how it functions, and how their group could best fit into the partnership.

Recommendations for Continued Development of ARAN

Despite the immeasurable advances in social networking, there is an imperative need to improve communication within all of ARAN. Prior to this project, UA interns were assigned "phone" partners and required to check in with them weekly. This became extremely time consuming and expensive, and with wider use of the Internet, the partnership moved to email as the primary means of communication. However, both phone and email medians proved ineffective for some partners during this project and only reached a select few within groups. A couple solutions that

have come out of group discussions include returning to a “phone” system, but extending it to create a phone tree so that other members are responsible for calling besides UA interns. Without funding to cover these costs, however, the onus would be on each individual—a stipulation that cannot be met by everyone, nor should that be expected. Some UA interns this year found that obtaining the email addresses of students in school groups was effective in communicating and did not put sole reliance on group leaders or teachers. Yet, still some groups suggested developing bulletin boards that could be created by group participants as a way of communicating within groups and gaining pertinent information about ARAN in general and upcoming events. An ARAN poster could be developed with general information about the partnership, presented in a professional manner and posted at each partner site. This could be one way of providing the “big picture” for educational and motivational ends.

ARAN members have identified a wide range of resources that can support the long-term goals of the project and the partnership. By participating in local and regional events, ARAN members have come in contact with many others who share their interests and goals and have offered resources to the partnership. Each monthly ARAN meeting has a specific educational focus as well as offering the opportunity for project participants to share progress on their projects. However, there is a need to ensure an effective transfer of information beyond the meetings. To address the information gap, this year members of the Mesa Directiva requested that groups making presentations provide written information that can be shared within the various groups after the meeting. It will take some time to establish this system as the norm, but ARAN members have requested this and will push to expand the collection of materials available for the partnership.

As stated earlier, revegetation is an important tool in the suite of alternatives for preventing and managing soil erosion, but it cannot solve the serious problems created by unmanaged development. There is a need to think on a grander scale, and take more of a watershed approach. While many leaders recognize the “big picture” regarding air quality, soil stabilization, native vegetation and water management, they also acknowledge that there is definitely a need to bring this to the forefront for all of the partnership.

In terms of the growth of ARAN, there is a need to increase support at each partner organization because it is difficult for the programs to continue and be prioritized among all other demands year after year. Moreover, there is also a need for more educational opportunities for those in government departments, since few took advantage of those available throughout this project period. While there will be strengths and weaknesses in any partnership, the more internal strength and growth that ARAN fosters, the more sustainable the partnership will be. Many partners recognize that ARAN is now in a position to not only learn from others, but also to share with other groups. As one ARAN leader stated in her interview:

> *The story of ARAN needs to be told to other border regions.*

Suggestions for Implementation in Other Border Communities

The most important suggestion for implementation of similar sustainable revegetation for erosion control projects and programs in other border communities is to start small. Projects should be

piloted, without grants or money first. It is crucial to build rapport, establishing relationships based on trust, and developing social networks that will not end with the closing of a project period, or when money runs out.

Also, it is vital to involve people and groups from various sectors through collaborative activities, including fundraising activities such as a *carne asada*, or clean-up days that allow time for work, play, and business. In this way, people can get to know one another, learn what resources each partner makes available, share ideas, and discover commonalities, all while working together on a single goal.

Each sector requires a different structure and approach for involvement. Try to engage teachers and students through activities that can be incorporated into classroom curricula, social service requirements, and/or extracurricular clubs. Partners will need help finding how they best fit into the partnership, and what they can get out and contribute to the partnership. This will not only vary from one sector to another, but this will also change over time from one year to the next or from one project to another.

Be ready to flex and write proposals to allow for that—building the Mesa Directiva helped build flexibility into ARAN, even as it provide additional structure. Without the Mesa Directiva to make some difficult and important decisions, individual partners would have risked damaging relationships. It was very important to everyone involved that the Mesa Directiva was not arbitrary. The members used a listserve to communicate within the Mesa Directiva, and also retained email messages for documentation. This allowed for transparency, which is something critical to a long-term, multisectoral partnership. It was vital that members knew of, understood, and participated in all decisions made.

Set timelines in everyone's minds, but then be flexible. Due to the active participation of the schools, this project was extended through the fall semester of 2005 rather than ending in October. The Mesa Directiva meetings were used as reminders of upcoming deadlines (e.g., quarterly reports), but then it was ultimately up to the members of the Mesa to enforce those deadlines. Due to summer hardships—plan on them—among other factors mentioned earlier, projects got behind schedule. The "no-cost time extension" ensured that partners didn't have to spend in advance of doing projects without being sure of their highest priorities. Therefore, the focus of this project and recommendation for implementation in other border communities are one in the same: Build partnerships, not just projects.

Acronyms

ADEQ: Arizona Department of Environmental Quality

AMIGO: Arizona-Mexico International Green Organization

APSA: Asociación de Profesionales en Seguridad y Ambiente

ARAN: Asociación de Reforestación en Ambos Nogales

ANRP: Ambos Nogales Revegetation Partnership

BARA: Bureau of Applied Research in Anthropology

CETis: Centro de Estudios Tecnológicos Industrial y de Servicios

CONALEP: Colegio Nacional de Educación Profesional Técnica

ITN: Instituto Tecnológico de Nogales

SEAHEC: Southeast Arizona Area Health Education Center

SWARM: Southwest and Rocky Mountain Division of the American Association for the Advancement of Science

UA: University of Arizona

APPENDICES

APPENDIX A
PHOTOS OF THE CITY GREENHOUSE AND NURSERY

City Greenhouse

City Nursery

APPENDIX B
SOILS REPORT

Preventing Soil Erosion in Nogales, Sonora

Information compiled by Wendy Vogt
Fall 2005

One of the largest problems facing the residents in Nogales, Sonora is soil erosion. The city has grown rapidly in recent decades, and many structures are built close together upon steep hillsides. Significant amounts of vehicular and foot traffic, monsoon rains, and a lack of vegetation also contribute to soil erosion. This report summarizes research on addressing soil erosion in the region and provides links to more information. Most of the work on soil restoration in Southern Arizona focuses on lands affected by fires or drought, not urbanization. Nevertheless, several techniques are outlined below; however, each unique site and circumstance in Nogales will require a specialized plan.

This report is intended to demonstrate the options available for soil erosion control and native plant restoration in Nogales, Sonora and offer suggestions for how to proceed in this unique environment. From discussions with scholars and officials and through internet research, it is clear that there is no universally agreed upon way to prevent soil erosion and encourage or support vegetation. However nearly everyone agrees that an increase in vegetation will help reduce erosion. One of the major emerging issues is the need to understand the specific nutrient composition of existing soils and amend them to ensure proper amounts of nutrients and organic materials for optimal plant growth. Some methods do not require amending the soil, but instead alter the landscape by installing features such as water culverts or silt fences to help prevent further erosion. Finally, commercial products, such as straw blankets, mats, and mulches may be placed directly on a site to promote plant revegetation. A site evaluation, time, money, final goals, and available workers will determine the need to amend soils, alter the landscape, and/or promote plant re-vegetation.

In Nogales today, stacking car tires is the most common method of controlling hillside erosion. While it certainly works in many situations, it is not a long term solution, nor does it facilitate plant restoration. Because many people would like to see their green areas in neighborhoods and schools have viable vegetation, including food crops, native plants and trees, it is important to seek alternatives which can both prevent erosion and simultaneously support plant communities.

Identifying the Problem

Once the decision has been made address soil erosion on a hillside and/or promote plant growth, it is important to identify the possible problems. An in depth site evaluation looks at structural and landscaping issues (slope, area, elevation, plant cover), climate (temperatures, rainfall, monsoons), water resources (irrigation) as well as soil characteristics and composition. No matter the location, a careful consideration of each of these points will be necessary for

determining how the site might be physically altered, what types of features will be bought or installed, if the soil will be amended, and what plants will be chosen. For areas that will be revegetated, understanding the soil composition will aid in choosing the right plants, as well as making the proper amendments to the soil.

Begin with the Soil

Soils are mixtures of living, organic and mineral matter that are important in ensuring plant survival. Living organisms such as insects, fungi, and bacteria help break down organic matter to make it available to plants. Organic matter in soils offers nutrients and moisture to plants. Soil texture affects moisture retention and nutrient exchange. The pH levels in soils also affect how much plants can absorb nutrients. When soils are compacted, it is difficult for plant roots to penetrate and grow. Plowing may help reduce soil compaction. It is often recommended that soil samples be sent to a laboratory to get in depth reports on the soil characteristics and composition. However, a few steps that can be taken by anyone to begin understanding soil texture, pH levels, organic matter and compaction, are outlined in Appendix 1.

Taking Soil Samples for a Lab

Experts, such as specialists from the National Park Service, recommend having professional soil scientists help evaluate project sites and soils. Before sending soils to a lab, consult the lab beforehand to get specific instructions. Collect soil samples with a cylindrical soil probe, at a depth of around 20 centimeters. Try to take composite samples (minimum of three cores from a single area) in order to determine soil variability. Place soil in a plastic bag at the site, label, and keep cool during transport. Most labs need the soil to be air-dried (do this by spreading the soil into a thin layer on butcher paper), however plant-available nitrogen tests and tests of microbes present in the soil require fresh samples.

Organic Solutions

It is often recommended to amend soils that are lacking in nutrients and organic materials. Topsoil, organic fertilizers, peat, and lime are soil amendments which may replenish lost nutrients that are needed to support plant communities. However, before adding amendments, it is suggested to test the typical nutrient levels of undisturbed soil from the same area. The living components of topsoil, such as microbes and invertebrate animals, help to cycle nutrients, maintain soil structure and aerate the soil. A seeded compost mixture or tea will replenish the missing mineral and biological elements, such as calcium and/or fungi, and preparation of such a mixture requires understanding the chemical makeup and organisms present in soil. It is also important to determine what types of plants are desired on a site, because then the compost can include the amounts of mineral and biological components necessary for those types of plants. Aerating the soil helps aerobic bacteria thrive.

Before applying topsoils or composts, it is important to check for weeds or weed seeds. If topsoil is not an option, organic matter such as compost or sewage sludge may also help release nutrients in existing soil and help retain soil moisture and structure. Commercial fast-release fertilizers are not recommended to amend the soil. If the soil pH needs to be altered for a specific plant community, copper sulfate, elemental sulfur, peat, pine bark and pine needles can help reduce the pH and increase acidity while lime can help raise the pH and decrease acidity. For more soil information, visit http://soils.usda.gov/.

Hydroseeding

The processes known as hydroseeding or hydromulching, where specially designed mixtures made with mulch, water, seeds, and sometimes fertilizer are sprayed onto hillsides through special hydromulching machines, are used quite extensively.

Loren Morris, author of "The Secret Life of Soil," supports the idea of soil analysis before hydroseeding. Morris outlines 8 steps to creating healthy soils and plant restoration:

1. Site Evaluation: A proper site evaluation will consider:
    1) Weather conditions
    2) Elevation and Slope
    3) Sunlight

These conditions all need to be considered to develop a plan to revegetate and stabilize the site.

2. Soil Analysis: A soil analysis will help provide information on the soil's deficiencies and imbalances so that the proper soil amendments (microorganisms and nutrients) can be chosen.

3. Soil Microorganisms: Soils are often sterile, which means that they have little or no micro-flora or mycorrhizae present, both of which are important to stimulate fungus and plant growth. To increase mycorrhizae fungus growth, a bio-stimulant and organic soil amendment can provide the necessary soil enzymes, humic acid, and cytokinins (a plant hormone that regulates cell division). The application rates and quantities will vary with the product being used and the conditions of the site.

4. Nutrient Balance: During the hydroseeding phase, add a product high in organic content to ensure the long-term release of nitrogen, potassium, phosphorous and calcium. Synthetic fertilizers are not recommended because they may harm soil organisms needed by native plants.

5. Soil Stabilization: When hydroseeding on steep hills, a soil stabilizer (tackifier) may be needed to bind the seed and soil amendments.

6. Seed: Native species should be applied to the soil.

7. Application: On steep slopes, the recommended method for applying seed, organic amendments, composted much and soil stabilizer is one-step hydroseeding.

8. Moisture: Choose plants that will receive the proper amount of moisture on the site. See appendix 4 for full article
http://www.soilerosiononline.com/html/mar05/secretlifemar05.html

Proponents of soil amendments argue that an understanding of the soils will contribute to a better chance of survival for plant communities. There is some debate, however, as to how important the actual nutrient makeup of the soil is to the success of amending soil.

Custom Made Compost is Best

One company that promotes the production of custom made compost tailored to the specific needs of a site is Soil Dynamics. Soil Dynamics was founded by Hendrikus Schraven and is a Dutch based company, but operates all over the world. The research group seeks to restore landscapes with custom made organic compost topsoils which are blown onto eroding hillsides. Soil Dynamics' topsoils are rich in microbial activity which facilitate healthy plant growth, increase soil percability, and reduce runoff. Soil Dynamics argues that living soil mixtures are better able to adhere to steep slopes than mulches and withstand "the rigors of nature" to ensure revegetation without requiring structural solutions such as retention walls or geo-textiles. Visit www.soildynamics.com for more information.

Compost is Compost

University of Arizona soil scientist Dr. Thomas Thompson expressed skepticism of the need to analyze soil composition in advance and create custom made compost, and that good quality compost (fine dark brown material) should be sufficient (Interview conducted by author, May 2005). Thompson argues that all composts have fairly similar properties and no matter the original nutrient composition, in a few months the microbial population will stabilize. He says that you must increase organic matter to increase microbes. He suggests mulch or terracing would as the most effective method of preventing erosion.

Focus on the Environment

Despite the attraction of alternatives require only living soil mixtures, structural adjustments may be required as well, especially in steep, highly eroded hillsides. Two processes must be controlled in order to control erosion:

1) Detachment - detachment is the process of soil particles separating, and is caused by anything that crushes aggregates, such as foot traffic, grazing, or rain. To

prevent detachment, cover the soil with anything that will prevent disturbance. Mulches, wood chips, or compost will work in preventing detachment. Mulching with weed-free stray or hay that contains native seeds may minimize erosion.

2) Transport - transport is the movement of particles caused by rain. To control transport, it is necessary to control the velocity of water flows. Terracing is quite effective for this purpose. Structural adjustments may be made to steep slopes to regrade them and make them rough and uneven, even concave at the surface, rather than smooth. This will also better support a diverse ecological community. For example, terracing has worked to prevent erosion in Colonia Jardines del Bosque.

For slopes that cannot be easily regarded on terraced, physical barriers such as silt fences or straw bales may be used. There are also many types of natural biodegradable mats and textiles available that can be placed on bare soil. With the environment stabilized, good compost can help to amend the soil and ensure plant growth. Temporary cover crops, such as barley or cultivated oats, may also be quickly seeded and established on a site, while native plants are beginning to establish themselves (http://www.nps.gov/plants/restore/pubs/intronatplant/planning.htm).

For more information and examples on commercial products being developed to prevent erosion, see Appendix 3.

Native vs. non-Native Plants

There is some debate as to whether it is important to plant native plants when re-vegetating hillsides. In general, it is argued that native plants have a better chance of survival in their places of origin, and will not interfere with existing plant communities. Non-native plants (exotic or non-indigenous) often displace native plants and disrupt natural habitats for plant and animal communities. For example, sod forming grasses such as Bermuda or buffalo grass are common for erosion control, but they can significantly disrupt native habitats. Still, non-native plants may be necessary when the goal is to prevent soil erosion.

Curly mesquite is a native grass that may be helpful for erosion control, especially if planted in rows. Rows or belts of plants would act as a nice wall to prevent erosion and act as terraces, without necessarily moving the soil. Trying to increase plant growth is a slow process, not guaranteed to work, and may require irrigation. For a list of grasses (not all native) see the article on erosion after wildfires in Appendix 2. For further discussion of native plants in Ambos Nogales, see Guide to Native Vegetation of Ambos Nogales.

Conclusions

While there are certainly many techniques for preventing soil erosion, the general principle of understanding soil composition and making appropriate amendments to not

only solve, but prevent, erosion problems in the future is convincing. A retaining wall or a culvert may be a quick solution, and in some cases may be necessary to prevent further damage, but these will not solve erosion problems in a natural and long-term way. Amending soil and carefully choosing vegetation which will not only benefit soil structure but improve air quality seems to be the only long-term solution and one to strive for. The next steps are:

1**)** Decide if lab work is desired or soil evaluation should be done at a more basic level

The information for a soil lab in Mexico is

Laboratories Soil Foodweb de Mexico, SA de CV.

Carretera Culican El Dorado
#3016 Sur Campo el Diez.
Culican Sinaloa
Mexico C.P. 80300
Ph. 011-52-667-760-6038
Cell 011-52-667-996-9749
FAX 011-52-667-760-6038
soilfoodwebmexico@myway.com

2**)** Determine what types of plants are desired and will flourish on the site. It may be useful to refer to the grasses chart in Appendix 2 or to the Guide to Native Vegetation of Ambos Nogales written in 2002.

3**)** Decide what amendments would be needed to make to the soil nutritious for the plants.

4) Purchase or create a proper compost or topsoil mixture with desired seeds.

5) Carefully plan an appropriate time and method (renting a blowing machine or applying by hand) to apply the compost so that it does not wash away.

Average Nogales, AZ Precipitation in inches:
Over 4 inches
July & August
Between 1-2 inches
September-October & December-March
Less than 1 inch
November & April-June

6) Take appropriate measures to ensure the plants have what they need to be viable (water, shade, sunlight, temperature etc…).

A thorough site evaluation and prevention plan that begins with understanding the soil composition and planting from seeds will not necessarily yield immediate results but will encourage long term and viable plant restoration. Furthermore, these methods can be combined. In addition to soil testing and amending, altering the environment or landscape by creating terraces or plant walls with native plants can help further prevent erosion. With resources such as a central composting facility in Nogales, Son. and satellite composting centers in the schools, it may be possible to at least start developing

and applying locally produced compost or compost teas, perhaps with added seeds and nutrients, on Nogales eroding hillsides.

Appendix 1: Understanding our Soil outside the Laboratory:

There are ways to understand soil without going to a laboratory. Here are a few activities that can be done in schools or on workdays to better understand local soil (this information is taken directly from the website http://www.nps.gov/plants/restore/pubs/intronatplant/planning.htm):

Soil Texture

Soil texture is important because it influences both water availability and nutrient availability. For a rough idea of the texture, moisten the soil a little and then feel the texture by rubbing and rolling some of it between fingers. Is it very sandy and not able to stick together much or is it mostly fine material that can be molded like clay? Clay-dominated soils will also tend to stain skin whereas sandy or silty soils will rub off more easily. Soils that are very sandy tend to be drier because they allow water to drain quickly. Clay-dominated soils are often associated with wetlands because of their poor drainage.

Soil pH

The soil pH has a major effect on nutrient availability. Test the soil pH using the following steps:

1. Use a 2 mm sieve to remove all soil particles greater than 2 mm.
2. Mix approximately 20 to 25 grams of the sieved soil with a 1:1 or 2:1 ratio of water to soil to make the soil into a wet paste. Add just enough water to saturate the soil (when forming a depression in the sample, water just begins to move into the hole and puddle).
3. Let the paste sit for half an hour to equilibrate.
4. Stir the paste again.
5. Measure the pH of the paste with a pH meter or pH paper.

Make sure a several different samples from different places at the site are tested to be sure of accuracy and that the pH does not vary throughout the site. The range of pH values is from 0 to 12. The classification of the pH of soils is:

pH	Classification
< 5	strongly acid soils
5 - 6.5	moderately acid soils
7	neutral soils
7 - 8.5	alkaline soils
8.5	or higher strongly alkaline soils

Knowing the pH will help guide plant selection as certain plants prefer more acid soil conditions and others prefer more alkaline soil conditions. If the site has elevated concentrations of heavy metals, it will be necessary to keep the soil pH greater than seven for the restoration program to be successful. This can be accomplished through limestone application.

Electrical Conductivity

Salt concentration of the soil is measured using a conductivity meter. These are similar to pH meters and are easily used. Generally, an electrical conductivity measurement of greater than 2 deciSiemans per meter is an indication of a potential salt problem.

Organic Matter

Organic matter is typically defined as a combination of recognizable organic material (roots, insects, etc.) and decayed organic material that is no longer recognizable (humus) in the soil. The terms "duff" and "litter" are also used in some literature and by some resource managers. There are a number of beneficial effects of organic matter in the soil, including increased water holding capacity and increased nutrient exchange.

There are a few field methods for detecting organic matter which do not require an intricate setup. However, these do not produce accurate assessments or estimates. They include:

1. Visual assessment - dark color of soil
2. Floating - floating off organic matter by shaking a soil sample in a jar of water

Soil organic matter can be estimates using a muffle furnace that can heat soil to very high temperatures. Follow these steps to determine the soil organic matter content:

1. Use a 2 mm sieve to remove all soil particles greater than 2 mm.
2. Dry the soil sample at 105℃ overnight.
3. Weigh the sample and record its weight. This is the initial dry weight.
4. Burn the sample in the muffle furnace at 450℃ f or four and a half hours.
5. Weigh the sample and record its weight again. This is its final weight.
6. Calculate the percentage of organic matter in the soil using the following equation:

$$\frac{\text{(Initial dry weight - Final weight)}}{\text{Initial dry weight}} \times 100 = \%\ \text{organic matter}$$

The typical range of organic matter percentages ranges from trace amounts in sandy desert soil to up to 20 or 30 percent in some forest soils. Organic soils with greater than 30 percent organic matter, such as peat, are mainly found in wetlands or former wetlands.

The estimation of percent organic matter can sometimes be an indicator of nutrient availability in the soil. However, having a professional soil lab test the soil for available nutrients will be a more accurate determination. This information can be used to check if appropriate nutrient amounts are available for the desired plant community. It is also important to find out what the organic matter content is in nearby soils that have not been disturbed. This can be done by consulting the local NRCS office or the soils testing lab of the state's land grant university. These places would also be a good place to ask about sources of organic matter should the site require additional material. If the soil has lower total organic matter than comparable nearby soils, adding organic matter to the soil will improve the chances for success in plant restoration.

Soil Compaction

Another soil characteristic to consider is soil compaction, especially if the site has previously been subjected to a lot of heavy traffic (vehicular, livestock, bicycle, foot). Compacted soil can make it difficult for plant roots to penetrate, thus decreasing their ability to grow and survive. Just trying to dig in the soil gives a rough idea of the compacted level. Soils with higher clay contents tend to become compacted much more easily than soils with high sand and silt contents. However, a more quantitative way to evaluate soil compaction is to measure the bulk density of the soil. There are bulk density soil samplers, also called core soil samplers, available through forestry supply catalogs (***Appendix A***) that can be used to collect a known volume of soil. However, as long as a known volume of soil is collected it need not involve a bulk density sampler. One alternative to a bulk density sampler is to collect a sample, then place a waterproof plastic bag in the hole left by collection, fill the bag with water until the level is at the same level as the soil surface with the bag pressed against the sides of the hole, and the water is poured into a graduated cylinder to measure its volume. The soil sample should then undergo the following steps.

1. Carefully collect a soil sample of a known volume.
2. Dry the soil in a 105℃ oven to remove any moist ure.
3. Weigh the dried soil sample.
4. Use the following equation to calculate bulk density: dried soil weight / known original volume of sample = bulk density

The point at which the soil becomes compacted enough to impact root growth is a bulk density of 1.6 Mg/m^3. If bulk density is too high, a good way to decrease it and improve the growth environment for plants is to incorporate organic matter into the soil. Addition of manure, composts or municipal biosolids will improve soil aggregation and decrease bulk density, but may also add significantly to problems with invasive plants. For more information on the use of these types of amendments see the separate paper on ***Using Biosolids for Reclamation and Remediation of Disturbed Soils***.

Other Resources

Another good way to get more information about the soils at the site is to find the Soil Survey reports for the area. These can often be obtained through the local NRCS office, cooperative extension offices, libraries or city or county planning departments. Maps in the soil survey can cover the classification of the site soils and usually will include a detailed description of the characteristics of that soil.

We have two copies of the Soil Survey for Santa Cruz and parts of Cochise and Pima Counties in the intern office. An activity that may be useful for students is to look up and read the types of soils present in Nogales: Rn Ge & LcF.

Appendix 2: Article on Preventing Erosion after Wildfires

Soil Erosion Control after Wildfire
Cooperative Extension, College of Agriculture & Life Sciences, The University of Arizona
Issued by
Alix Rogstad, ***Fire Education Specialist***

Article copied from the website http://cals.arizona.edu/pubs/natresources/az1293/.

Introduction

The potential for severe soil erosion exists after a wildfire because as a fire burns it destroys plant material and the litter layer. Shrubs, forbs, grasses, trees, and the litter layer break up the intensity of severe rainstorms. Plant roots stabilize the soil, and stems and leaves slow the water to give it time to percolate into the soil profile. Fire can destroy this soil protection. There are several steps to take to reduce the amount of soil erosion. A landowner, using common household tools and materials, can accomplish most of these methods in the aftermath of a wildfire. More specific information on how to implement the soil erosion control techniques that follow can be found by accessing the electronic links found in the NRCS Fire Recovery Tips section at the end of this document.

Hydrophobic Soils

In severe, slow-moving fires, the combustion of vegetative materials creates a gas that penetrates the soil profile. As the soil cools, this gas condenses and forms a waxy coating. This causes the soil to repel water – a phenomena called hydrophobicity. This hydrophobic condition increases the rate of water runoff. Percolation of water into the soil profile is reduced, making it difficult for seeds to germinate and for the roots of surviving plants to obtain moisture.

After a severe fire, soil erosion can cause adverse effects on many ecosystems.

Hydrophobic soils do not form in every instance. Factors contributing to their formation are: a thick layer of litter before the fire; a severe slow-moving surface and crown fire; and coarse textured soils such as sand or decomposed granite. (Finely textured soils such as clay are less prone to hydrophobicity.)

The hydrophobic layer can vary in thickness. There is a simple test to determine if this water repellant layer is present:

1. Place a drop of water on the exposed soil surface and wait a few moments. If the water beads up and does not penetrate the soil then it's hydrophobic.
2. Repeat this test several times, and each time remove a one-inch thick layer of the soil profile. Breaking this water repellant layer is essential for successful reestablishment of plants.

A simple test can determine whether a water repellent layer is present

In addition, freezing and thawing, and animal activity will help break up the hydrophobic layer.

A positive initial step after a wildfire is to reseed grass in the affected area.

Erosion Control Techniques

The first step after a wildfire is reseeding grass in the severely burned areas. Remember many plants can recover after fire depending on the severity of the burn. It is important to leave existing vegetation if the plants do not threaten personal safety or property (hazardous trees in danger of falling should be identified first).

A "Cyclone" seeder works well to broadcast grass seed.

Seed can be purchased in Arizona. Obtain certified seed — this guarantees the variety, that it was tested under field conditions, that it is recommended for the state, and that it is certified weed free to prevent the introduction of noxious and invasive weeds.

Recommended Grasses

Scientific Name	Common Name	Seeding Rate (lbs/acre)	Water Needs	Cool/Warm Season	Sun/ Shade	Mature Height (feet)	Elevation (1000') 3 4 5 6 7 8 9
Agropyron smithii	western wheatgrass	10	11 - 17"	Cool	S	1-2, S	N Y Y Y Y N N
Bouteloua curtipendula	sideoats grama	3-4	12 - 16"	Warm	S	2-3, B	Y Y Y Y Y N N
Bouteloua gracilis	blue grama	3-4	12 - 16"	Warm	S	1, S	Y Y Y Y Y Y N
Buchloe dactyloides	buffalograss	4-8	VL-L	Warm	S	1, S	Y Y Y N N N N
Festuca arizonica	Arizona fescue	3	VL-L	Cool	S-PS	2-3, B	N N N N Y Y Y
Hilaria jamesii	galleta grass	3-4	9-12"	Warm	S	1-2, B	N N Y Y Y N N
Leptochloa dubia	green sprangletop	6	L	Warm	S	1-2, B	Y Y Y Y Y N N
Koeleria macrantha	Junegrass	1-2	VL-L	Cool	S-PS	1-2, B	N Y Y Y Y Y Y
Muhlenbergia rigens	deergrass	2	L-M	Warm	S	2-5, B	Y Y Y Y Y N N
Muhlenbergia wrightii	spike muhly	2	12 - 16"	Warm	S	1-2, B	Y Y Y Y Y Y Y
Poa fendleriana	muttongrass	1-2	VL-L	Cool	PS	1-2, B	N N Y Y Y Y Y
Elymus elymoides	bottlebrush squirreltail	8-10	VL-L	Cool	S-PS	1-2, B	N Y Y Y Y N N
Sporobolus cryptandrus	sand dropseed	2	VL-L	Warm	S	2-3, B	Y Y Y Y Y N N
Stipa comata	needle-and-thread	8	VL-L		S	1-2, B	Y Y Y ? N N N
Stipa hymenoides	Indian ricegrass	5	9 - 13"	Cool	S	1-2, B	N Y Y Y Y N N

Sun/Shade: S = full sun, PS = partial sun, Sh = shade
Mature Height: feet, B = bunchgrass, S = sod forming
Water Needs: VL = very low, L = low, M = moderate, H = high
Elevation in 1000': Y = yes, N = not recommended, ? = unknown or doubtful

Seeding Tips for Hand Planting

1. Roughen the soil surface to provide a better seedbed by breaking through the hydrophobic layer. A steel rake works well for this, or, depending on the slope, a small tractor drawn harrow could be used.
2. Broadcast the seed (a “Cyclone” seeder works well). Seeding rate depends upon the variety of seed sown (see chart above).
3. Rake or harrow in 1/4 inch to 3/4 inch deep.
4. If the area is small enough, roll or tamp the seed down to ensure good soil/seed contact.
5. Spread certified, weed-free hay straw. If the area is small, crimp the hay into the soil with a shovel. (This will help keep both soil and seed in place during wind and rain.)
6. Control weeds as needed by cutting off the flower before it can seed.
7. Do not use herbicides for broadleaf weed control until after the grass has germinated and developed five leaves.

Weed Control

Weeds are among the first plants to recolonize after a fire. In many instances they are not a problem. However, if the weeds are listed as noxious, they must be controlled. Noxious weeds displace native plants and decrease wildlife habitat, plant productivity, and diversity. They can spread downstream or into agricultural areas, resulting in high control costs. Control of noxious weeds is best accomplished through an integrated plant management system that includes chemical, biological, mechanical, and cultural controls.

Spread straw over seeded area to prevent erosion

Straw provides a protective cover over seeded areas to reduce erosion and create a suitable environment for revegetation and seed germination. If possible, the straw should be crimped into the soil, covered with plastic netting or sprayed with a tacking agent. If you can only broadcast the straw, do so; it’s better to have some coverage than none at all. The straw should cover the entire reseeded section and extend into the undamaged area to prevent wind and water damage. Care must be taken to insure that you use only certified weed-free hay straw to avoid spreading noxious weeds. (Contact the State Department of Agriculture for a listing of Certified Weed Free Hay growers.)

Straw should be applied to a uniform depth of two to three inches. When applied at the proper density, 20 to 40 percent of the soil surface is visible. One typical square bale will cover about 800 square feet. (Figure 1.)

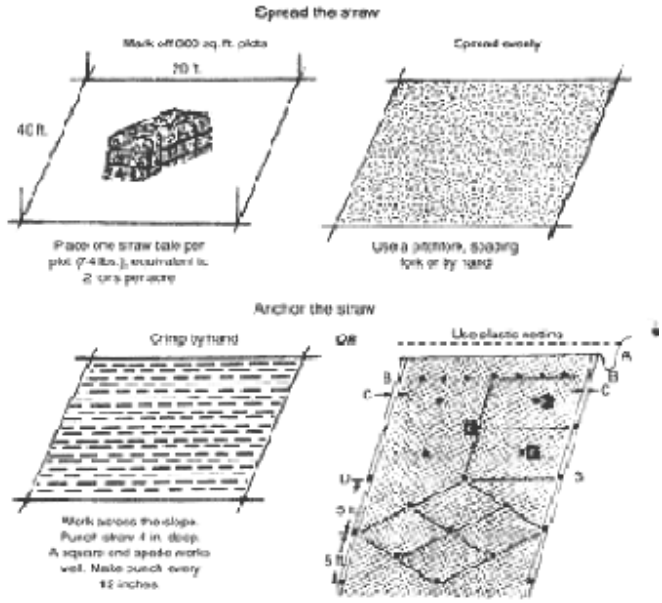


Figure 1 *Application of straw to prevent erosion control (graphic courtesy of Natural Resources Conservation Service).*

Contour Log Terraces

Log terraces provide a barrier to runoff from heavy rainstorms. Dead trees are felled, limbed, and placed on the contour perpendicular to the direction of the slope. Logs are placed in an alternating fashion (Figure 2.) so the runoff no longer has a straight down slope path to follow. The water is forced to meander back and forth between logs, reducing the velocity of the runoff, and giving water time to percolate into the soil. Felling of trees can be dangerous and is best done by a professional logger or arborist.

Felling of trees to form log terraces.

Logs should be 6 to 8 inches in diameter (smaller logs can be used) and 10 to 30 feet long. The logs should be bedded into the soil for the entire log length and backfilled with soil so water cannot run underneath; backfill should be tamped down. Secure the logs from rolling by driving stakes on the downhill side. It is best to begin work at the top of the slope and work down. (It is easier to see how the water might flow by looking down on an area to better visualize the alternating spacing of the logs.

Figure 2. *Contour Log Terrace. These barriers are an effective, first-year treatment for hydrophobic soils, low ground cover density, and severely burned areas (graphic courtesy of Natural Resources Conservation Service).*

Straw Wattles

Straw wattles are long tubes of plastic netting packed with excelsior, straw, or other material. Wattles are used in a similar fashion to log terraces. The wattle is flexible enough to bend to the contour of the slope. Wattles must be purchased from an erosion control material supplier.

Straw wattles are used in a similar fashion to log terraces

Silt Fences

Silt fences are made of woven wire and a fabric filter cloth. The cloth traps sediment from runoff. These should be used in areas where runoff is more dispersed over a broad flat area. Silt fences are not suitable for concentrated flows occurring in small rills or gullies. Silt fences are made from materials available at hardware stores, lumberyards, and nurseries. (Figure 3.)

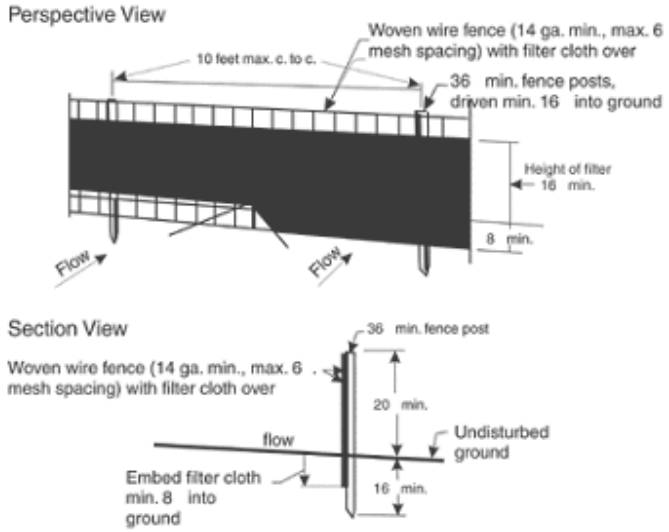


Figure 3. Silt fences are suitable for areas where runoff is in the form of “sheet flow” (graphic courtesy of Natural Resources Conservation Service).

Straw Bale Check Dam

Straw bales placed in small drainages act as a dam – collecting sediments from upslope and slowing the velocity of water traveling down the slope. Bales are carefully placed in rows with overlapping joints, much as one might build a brick wall. Some excavation is necessary to ensure bales butt up tightly against one another forming a good seal. Two rows (or walls) of bales are necessary and should be imbedded below the ground line at least six inches or held in place by stakes or rebar driven into the soil. Again, make sure the straw bales that are purchased for use are certified as weed free. (Figure 4.)

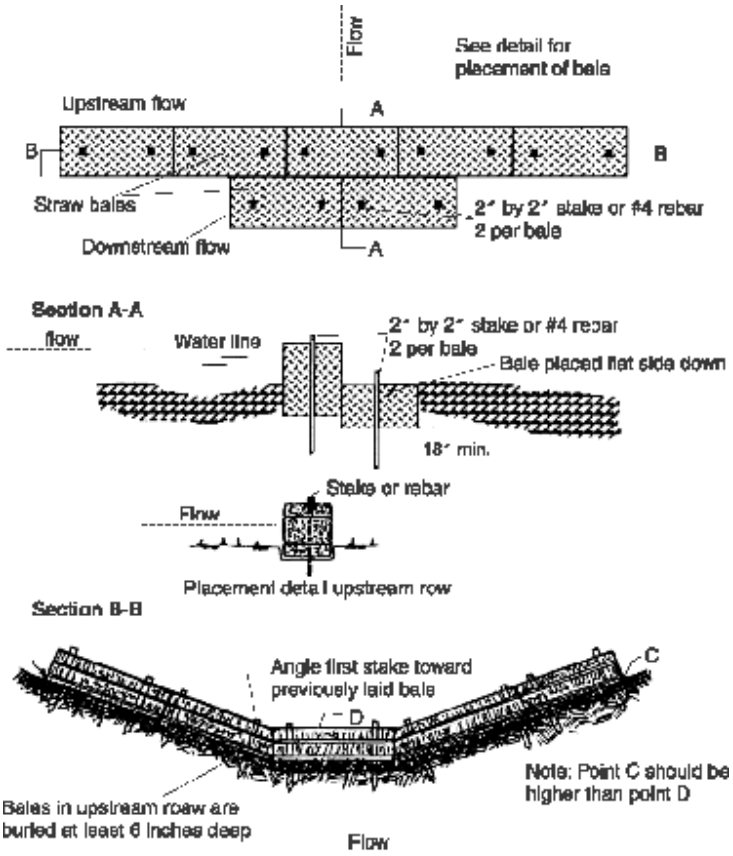


Figure 4. *Straw bale check dam: diagram for construction and placement*

Water Bars and Culverts

Bare ground and hydrophobic soils left after a fire increase water runoff. This requires intervention to channel water off of the burned area and release it to the streams below. The two most common structures to do this are culverts and water bars. Determining the type of drainage practice to use depends on the soil, type of road use, slope, speed of vehicles, season of use, and amount of use.

Culverts

It is best to engage a professional engineer to assist with the design and construction of culverts. These professionals are able to determine the size of the drainage area and the amount of runoff for rainfall events of varying intensity that require culverts. Once sized, culverts must be installed

properly at the correct locations. Installing more culverts than previously existed before the fire may be required. The inlet sides must be regularly maintained to prevent sediment and trash from plugging the pipe. It is common practice to armor the ground at the outlet end with rock riprap in order to dissipate the energy of the discharged water and to spread it over the slope below. The inlet side can have a drop inlet so as to allow sediment to settle out before water enters the pipe. Armoring the inlet side with rock will also prevent water from scouring under and around the pipe and flowing under the road.

To be effective, culverts must be installed properly and at proper locations.

Water Bars

Water bars are berms of soil or bedded logs that channel water off roads and trails to avoid the creation of gullies. Water bars are angled down the slope to the outlet side. These bars can divert water to a vegetated slope below or redirect it to a channel that will take it to a culvert. On-site soils and the road grade will dictate spacing. (Figure 5.)

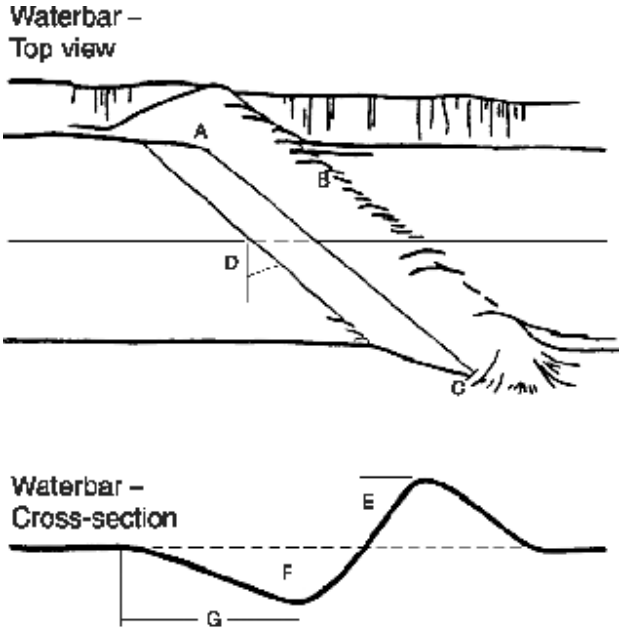


Figure 5. *Waterbar construction for forest or ranch roads with little or no traffic. Specifications are average and may be adjusted to conditions.*

A. Bank tie-in point; cut 6 inches to 1 foot into the roadbed.
B. Cross drain berm height 1 to 2 feet above the roadbed.
C. Drain outlet cut 8 inches to 16 inches into the roadbed.
D. Angle drain 30 to 45 degrees downgrade with road centerline.
E. Up to 2 feet in height.
F. Depth to 18 inches.
G. 3 to 4 feet.

Appendix 3: Examples of other Commercial Options: Blankets, Mulches and Straw Wattles

Vegetation enhancing mats and blankets

SI Geosolutions, www.fixsoil.com:

Geosolutions offers vegetation enhancing mats and blankets, both short and long term solutions to help vegetation become established.

Reinforcement is the only way vegetated channels and slopes can stand up to storm water. And Landlok TRMs with advanced X3 fiber technology give you two key advantages over traditional hard armor products like rock riprap and concrete. First, their unique fiber shape and 3-D pattern create a thick matrix of voids that trap seed, soil and water in place for quicker, thicker vegetation growth. Then they provide additional reinforcement that doubles your vegetation's natural erosion protection abilities. Unlike ECBs, these flexible, three-dimensional reinforcement systems remain a permanent part of your application, anchoring mature plants to the soil for superior, long-term erosion resistance.

LIMITATIONS

Landlok TRMs are not recommended for the following applications:

- Continuous flow channels
- Unfertile soils
- Unvegetated applications
- Severe slopes
- Critical structures, where higher factors of safety are required

Mulches (http://www.hydrograsstech.com/Portal/Page.aspx?p=368)

In response to today's standards for environmental management and soil stabilization, site managers are seeking safe, non-toxic, effective products that are economical.

GeoMatrix is a premium wood mulch that is customized to a site's specific soil composition. Soil samples collected from a site are analyzed in our laboratory to determine their electromagnetic and chemical profiles. Once the profiles are determined, a proprietary blend of additives, selected to complement the soil's composition are combined with the GeoMatrix base to create a customized product that is durable and can provide maximum soil stabilization.

Testing the soil from the application site and tailoring the blend to complement it is a radical yet logical approach that stands in contrast to off-the-shelf, one-size-fits-all, pre-mixed products that are so prevalent in the erosion control marketplace. Innovative, long lasting, and economical

GeoMatrix is acknowledged by industry experts as being the NEXT GENERATION of effective erosion control.

Our Premium Wood Mulch + Organic Bonding Agents sprays on like a mulch, but dries to form a porous, breathable, and water insoluble mat that bonds firmly with the soil, prevents erosion, and saves time and money. Easy to mix, easy to apply, no cavitation, no tenting or rilling, no staples or stakes, does not hurt wildlife or fish.

GeoMatrix II combines the low cost and ease of application of hydroseeding, the protection of a blanket, and the advantages of a mulch. GeoMatrix II consists of premium Northern Softwood fibers, a natural guar gum tackifier, and a proprietary crosslinking agent. Our mat protects seeds and enhances germination then decomposes over time into carbon dioxide and organic matter to further aid in plant development.

Straw Wattle (http://www.ssseeds.com/ecb/product_sid.html):

We encourage you to order our Greenfix America® Straw Wattle Slope Interruption Devices (SID) for your next job.

SIDs are manufactured from straw wrapped in tubular black plastic netting. These rolls are approximately 8 inches in diameter by 20 to 25 feet long, and are staked in place along the contour of newly constructed or disturbed slopes. The SIDs reduce soil creep and sheet and rill erosion until permanent vegetation gets established.

They are a relatively low-cost solution to erosion problems, can replace silt fences or straw bales, and store moisture for vegetation planted immediately upslope.
The plastic netting eventually photodegrades, eliminating the need for retrieval of materials after the straw has broken down. The straw becomes incorporated into the soil with time, adding organic material and retaining moisture for vegetation.
Straw wattles last an average of one to two years, an important factor when planning your job. For more information, call (805) 684-0436 or go to http://www.ssseeds.com/ecb/product_sid.html.

Appendix 4: Article on Soil and Hydroseeding

SOIL EROSION & HYDROSEEDING
The Secret Life of Soil
by Loren Morris
3/04/05
http://www.soilerosiononline.com/html/mar05/secretlifemar05.html

Typical construction begins with the earthwork. The ground surface is scraped, picked up and the dirt placed where an embankment might be needed. Rarely is the topsoil from a large earth moving construction project saved and replaced. What is left after construction to grow vegetation in has never been exposed to air or light and has little or no nutrient value. Stripped of this valuable top layer, which contains many essential nutrients, the sterile soil left behind is not able to sustain plant life. Construction, mining and land reclamation sites, landfills, and hillsides are all harsh environments in which to grow and maintain plant life. According to the U.S. Department of Agriculture, we lose more than two billion tons of topsoil each year to erosion. This thin layer of topsoil, common to the earth's crust, is rich in bacterial biomass and mycorrhizae (fungal growths on the roots of plants that make soil nutrients available to plants.) Nutrient cycling, and the sustainability of plant growth, is in a large part controlled by a bacterial biomass that includes these root algae.

The loss of this bacterial biomass and the loss of certain nitrogen fixers during construction makes it difficult to reestablish vegetation on the exposed subsoil. For this reason, cut and fill slopes exposed during construction will usually not fully revegetate and thus remain sparsely populated. What you add or don't add to the soil in terms of fertilizers or amendments can determine the success or failure of the project. So how do we know what to add to the soil to promote the strong plant root systems that keep the soil where it belongs? The goal is to first assess your soil with a soil test. This will identify mineral deficiencies and provide the necessary answers to what type of soil you are working with. A standard soil test will include determinations of soil pH, salinity, sodium content, boron hazard, lime content, organic matter and soil texture. Your soil test will also include the available nutrient levels, with the lab suggesting either organic/or chemical soil amendments. The applicator will then be able to choose the right soil amendment and dosage to fit your soil situation. Soil assessment will always be site specific, as there is not a site or soil that is created equal. If a soil deficiency is found, then that deficiency must be corrected for the soil to function and help establish vegetation. A functioning soil is a widespread ecosystem that consists of rock, minerals, mycorrhizae, nematodes, protozoa, arthropods and earthworms all interacting, and each providing a vital function for healthy soil. When your soil has this type of balance, fence posts will sprout.

A functioning soil will have these attributes:
- It must help retain nutrients
- Be able to transport the retained nutrients to the plant
- Produce hormones that help plants grow
- Decompose organic matter into humus
- Protect the roots from disease
- Act as a glue to hold soil particles together
- Will remain stable on steep slopes without mechanical aids
- Will not erode from rainfall
- Filter out pollutants

There are two broad categories of soil amendments: organic and inorganic. Organic amendments are any materials that have ever been alive either as a plant or an animal. Nutrients from organics are not immediately available to the plant. Soil microorganisms are needed to

change nutrients, through bacterial action, into forms the plant can use. Organics will provide a steady supply of nutrients over a fairly long time. Organics are primarily a source of nitrogen and trace elements, but some will provide some phosphates and potash. Organic amendments include sphagnum peat, wood chips, grass clippings, straw, compost, manure, biosolids, sawdust, and wood ash. Organic amendments increase soil organic matter content and offer many benefits. Organic matter improves soil aeration, and water infiltration, as well as the soils water and nutrient holding capacity. Inorganic amendments are either mined or man-made materials. They include vermiculite, perlite, rubber chunks, pea gravel and sand.

Quick Facts…

Soil amendments improve the physical properties of soils.
Amendments are mixed into the soil. Mulches are placed on the soil surface.
Soil amendments increase water and nutrient holding capacity and improve aeration and water infiltration.
Soil microbiology controls over 80% of all soil chemistry
Wood products can tie up nitrogen in the soil
Do not add sand to clay soils, it creates a soil structure similar to concrete.

Without the use of some type of soil amendment, projects with topsoil deficiencies will continue to fail, and will continue to cost states and municipalities monies that might be better spent on other fiscal projects. Advances in soil research and technology have led to the development of organic soil amendments that will stimulate soil microorganism growth, such as mycorrhiza and other beneficial bacterias. The surface medium on many of these disturbed sites are void of topsoil and is made up of decomposed granite in uneven particle sizes. This substrate has a low moisture holding content, is very erosive, and shows extreme prejudice towards plant life. The use of soil amendments for revegetation purposes has greatly increased the chances for establishment of the native vegetation on these difficult sites.

Research has concluded that there are eight key factors to consider on your revegetation project to ensure success:

1. Site Evaluation
2. Soil Testing
3. Soil Microorganisms
4. Nutrient Balance
5. Soil Stabilization
6. Seed Species Selection
7. Application and Monitoring
8. Moisture

1...Site Evaluation

A thorough study of the areas weather conditions, the project's elevation, slope if any, as well as the suns directional aspect must all be weighed to develop a successful plan to revegetate and stabilize your site.

2...Soil Analysis

Evaluating the soil will provide information on any deficiencies and imbalances, allowing you to choose the proper soil amendment and dosage to fit the soil situation.

3...Soil Microorganisms

If the soil is sterile, as is the case much of the time, it will have little if any micro-flora or mycorrhizae present. For any sustainable plant growth, it is vital to the projects success to stimulate the mycorrhizae fungus growth. This can be accomplished with a bio-stimulant and organic soil amendment that can provide soil enzymes, humic acid, and cytokinins, a plant hormone that regulates cell division, thus stimulating mycorrhizae growth and giving the plants

the added boost to establish themselves. The application rates will be site specific and vary greater with the product being used and can range from mere ounces to gallons per acre.

4...Nutrient Balance

For many plant species, adding a synthetic fertilizer is not recommended because it can harm the soil organisms needed by the native plants. Instead, choose a product with a high organic content, long term release of nitrogen, potassium and phosphorous and a high calcium content. This product is applied during the hydroseeding phase.

5...Soil Stabilization

On steep slopes where seed and soil erosion will be a concern, adding a soil stabilizer (tackifier) will bind the seed and soil amendments to the hillside. This product is also applied during hydroseeding.

6...Seed

Since the goal is to establish perennial vegetation and prevent soil erosion, native species known to do well at similar sites, disturbed or not, should be used.

7...Application

On steep slopes, one-step hydroseeding is an obvious choice for applying seed, organic amendments, composted mulch and soil stabilizer in a cost effective manner.

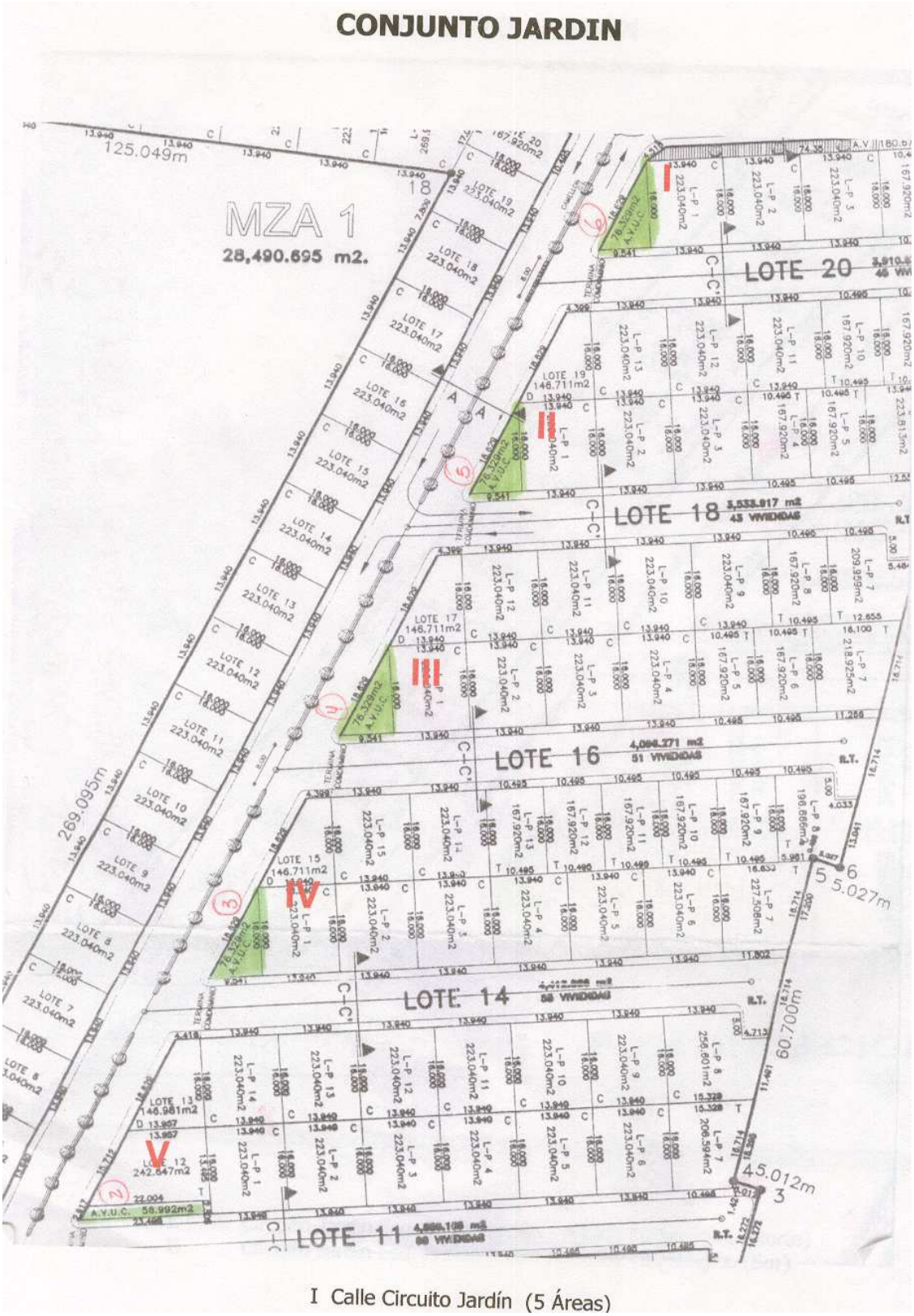
8...Moisture

Use plants that have the ability to survive what your specific jobsite will throw at them, whether it is sporadic and limited moisture or high moisture.

The weak link factor is simply that one's level of plant growth and plant establishment will correspond to the weakest link in the process of field implementation. For many reasons, erosion control professionals sabotage themselves with low bids that skip many of the key factors that will ensure good plant establishment and a successful project. What the public ends up with is a failed seeding job that is ultimately judged as poor at best, and gives both the erosion control professional and the project a black eye. The soil erosion control professional is currently only responsible for getting plant growth started. The industry as a whole, from the designer to the contractor should start considering what happens to the soil after the construction phase. Perhaps the contractor could provide a secondary contract that would include an on-going maintenance program to ensure plant establishment. Maintenance itself, would be reduced to next to nothing if a good layer of living soil was installed at the start. If the soil erosion control managers were responsible for a longer term of plant establishment and growth, they would be accountable for building and establishing a living soil system that could continue to support plant life.

APPENDIX C
SAMPLE GREEN AREA MAP

CONJUNTO JARDIN



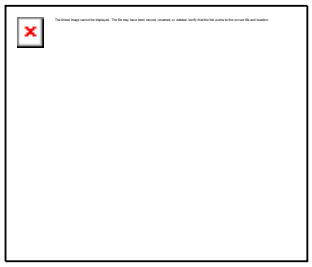
I Calle Circuito Jardín (5 Áreas)

APPENDIX D
INFORMATION SUMMARY ON COMPOSTING

CONALEP - SONORA

Plantel Nogales

ELABORACIÓN DE COMPOSTA



OBJETIVO

CREAR EL HABITO DE RECICLAR LA BASURA ORGANICA EN LA COMUNIDAD, FORTALECIENDO LOS ASPECTOS DE CULTURA Y EDUCACIÓN INTEGRAL.

QUE ES UNA COMPOSTA?

ES UN ABONO ORGANICO DE EXCELENTE CALIDAD PARA LOS ÁRBOLES Y PLANTAS DE JARDÍN.

BENEFICIOS:

1.- MEJORA LA ESTRUCTURA, TEXTURA Y VENTILACIÓN DE LA TIERRA.
2.- CONTIENE NUTRIENTES Y ELEMENTOS ESENCIALES PARA LAS PLANTAS.
3.- FERTILIZA LA TIERRA.
4.- REDUCE EL USO DE FERTILIZANTES QUÍMICOS. CON ELLO, AHORRAS DINERO Y AYUDAS A EVITAR QUE SE ARROJEN DESPERDICIOS QUÍMICOS A LOS RIOS.
5.- REDUCE EL USO DE AGUA DE TU JARDÍN.
6.- REDUCE LA PRODUCCIÓN DE BASURA.

INGREDIENTES DE UNA COMPOSTA

EN TU COMPOSTA PUEDES USAR:
1.- PAN
2.- RESTOS DE CAFÉ
3.- CASCARAS DE HUEVO
4.- PULPA O CASCARA DE FRUTAS
5.- VEGETALES
6.- CASCARAS DE NUEZ, CACAHUATES, ETC.
7.- PASTO Y HIERBA
8.- HOJAS, FLORES Y TALLOS
9.- PAPEL (NO MUCHO)
10.- HOJAS DE TE
11.- ESTIÉRCOL DE VACAS Y CABALLOS

PERO NUNCA LE AGREGUES:
1.- HUESOS
2.- ESTIÉRCOL DE GATO O PERRO
3.- POLLO Y AVES
4.- CARNE Y PESCADO

5.- ESPINAS DE PESCADO
6.- ACEITES VEGETALES
7.- GRASA ANIMAL
8.- ADEREZOS DE ENSALADAS
9.- PLÁSTICOS
10.- FIBRAS SINTETICAS

EL COMPOSTERO

EL COMPOSTERO ES UN RECIPIENTE DONDE SE JUNTARAN LOS DESECHOS ORGANICOS. HAY DIFERENTES FORMAS DE HACER UN COMPOSTERO:

BOTES DE BASURA DE PLASTICO: PERFORA 100 AGUJEROS DE 0.5 CM. EN TODA SU SUPERFICIE

TAMBOS DE 200 LTS.: DE PREFERENCIA PINTARLO DE COLOR NEGRO, HACER PERFORACIONES EN EL FONDO Y A LOS LADOS.

OTROS MAS SENCILLOS: UN HOYO EN EL PATIO, CILINDRO DE MALLA DE ALAMBRE, DE BLOQUES, MADERA, ZANJAS, SURCOS EN EL JARDÍN, ETC.

¿CUÁLES SON LOS PASOS A SEGUIR PARA LA ELABORACIÓN DE LA COMPOSTA?

EXISTEN DIVERSOS METODOS PARA OBTENER COMPOSTA, A CONTINUACIÓN SE PRESENTA EL MAS SENCILLO:

PRIMER PASO:
SE COLOCA EN EL FONDO DEL COMPOSTERO UNA CAPA DE ASERRÍN. ESTE IMPIDE LA LIBERACIÓN DE MALOS OLORES Y ABSORBE EL EXCESO DE HUMEDAD.

SEGUNDO PASO:
SE COLOCA UNA SEGUNDA CAPA CON LOS DESECHOS ALIMENTICIOS, SI ESTOS ESTAN MUY SECOS AGREGAR UN POCO DE AGUA PARA MANTENER LA HUMEDAD.

TERCER PASO:
DEPOSITAR LA SIGUIENTE CAPA DE DESECHOS DEL JARDÍN (HOJAS SECAS, RAMA SECA, TALLOS, FLORES ETC.), SI ESTOS ESTAN MUY SECOS AGREGAR UN POCO DE AGUA PARA MANTENER LA HUMEDAD.

CUARTO PASO:

ANTES DE DEPOSITAR LA SIGUIENTE CAPA DE DESECHOS ALIMENTICIOS, ES RECOMENDABLE REVOLVER Y HUMEDECER LAS ANTERORES Y SIEMPRE REMATAR CON UNA CAPA DE ASERRÍN SECO.

QUINTO PASO:
AUNQUE NO HAYA DESECHOS ALIMENTICIOS QUE AGREGAR, DEBE AIREARSE CUANDO MENOS CADA SIETE DIAS, PARA PERMITIR LA LIBERACIÓN DE LOS GASES, PRODUCTO DE LA DESCOMPOSICIÓN Y PARA PROPORCIONAR OXIGENO A LA COMPOSTA.
SE AIREA, VACIANDO EL CONTENIDO A OTRO CONTENEDOR, REVOLVIENDO CON UNA PALA Y SE ROCIA CON UN POCO DE AGUA, SOLO PARA MANTENER LA HUMEDAD.
SI PRESENTA MAL OLOR AGREGAR MAS ASERRÍN.

SEXTO PASO:
CUANDO ESTE CASI LLENO, SE TERMINA CON UNA ULTIMA CAPA DE ASERRÍN Y SE EMPIEZA A LLENAR OTRO COMPOSTERO. SE SIGUE REVOLVIENDO CADA SITE DIAS.

SÉPTIMO PASO:
LOS DESECHOS ALIMENTICIOS SE CONVERTIRAN EN COMPOSTA ENTRE LOS DOS O TRES MESES, DEPENDIENDO DE LA NATURALEZA DE LOS DESPERDICIOS. ESTO SERA, CUANDO EL PRODUCTO SE OBSERVE HOMOGÉNEO, CAFÉ OBSCURO Y DESMENUZADO. SE RECOMIENDA CERNIR A LOS DOS MESES ESTA COMPOSTA. EL PRODUCTO DEL CERNIDO, SE PUEDE UTILIZAR Y LO QUE QUEDA EN EL CERNIDOR SE PUEDE INCORPORAR A OTRO COMPOSTERO.

EL PRODUCTO RESULTANTE (LA COMPOSTA), SE UTILIZA COMO ABONO, YA QUE CONTIENE TODOS LOS NUTRIENTES QUE SE NECESITA PARA AYUDAR A CRECER A LAS PLANTAS. SE PUEDE USAR EN MACETAS O JARDINES, MEZCLÁNDOLA CON LA TIERRA.

SI NO HAY PLANTAS EN TU CASA, ES EL MOMENTO DE EMPEZAR A SEMBRARLAS; SI POR ALGUNA RAZON NO ES POSIBLE, ENTONCES SE PUEDE REGALAR EL EXCELENTE ABONO, INTERCAMBIAR O DEPOSITAR EN PARQUES O JARDINES DE TU COLONIA.

APPENDIX E
COMPOSTING GUIDE

A Composting Guide

Prepared By:
Justin Gaines

A Brief History of Compost

Composting, what is it? Simply put, composting is the complex biological process of the decomposition of organic materials into a nutrient rich soil conditioner. Composting occurs naturally and regularly in nature as a way of replenishing soil and recycling energy. A beautiful example is that which takes place on the floor of a coniferous forest. The first layer consists of undecomposed, or fresh, organic materials such as pine needles, leaves and bark. As you go deeper into each successive layer, the material, through the process of decomposition, begins to look less like its counterpart on top, and more like a dark, earthy, humus material (Fig1.1).

Fig1.1

Although nature's way can take up to a year, depending on the methods that are used, compost can be made available for use within just a few weeks. Historically, composting has been used primarily as a soil conditioner for insuring soil fertility to sustain intensive agricultural practices. More contemporary uses of composting are to reduce the amount of recyclable organic materials being entombed in quickly-filling landfills (it is estimated that by 2009, 80% of the current landfills in the United States will be full), to turn human waste sludge into non-toxic, eco-friendly material and as an alternative form of energy.

Two examples of using compost as an alternative form of energy are 1) as a means to increase the temperature in a greenhouse and 2) as a form of home heating. Because the temperature of a compost pile can reach upwards of 150º F (65.5º C), a large pile inside of a moderately-sized greenhouse radiates enough heat to either help maintain a warm temperature or help increase the temperature. As a form of alternative energy for heating a house, large compost piles have been created in basements with PVC piping (filled with water) running through the pile and throughout the house. The extreme temperature of the pile heats the water causing it to radiate warm energy as it circulates throughout the plumbing.

The first recorded use of compost, in the practice of placing manure on crops for the benefits of its high nitrogen content, was recorded in the Mesopotamian Valley on

cuneiform tablets from the Akkadian Empire 1,000 years before the birth of Moses (Fig1.2).

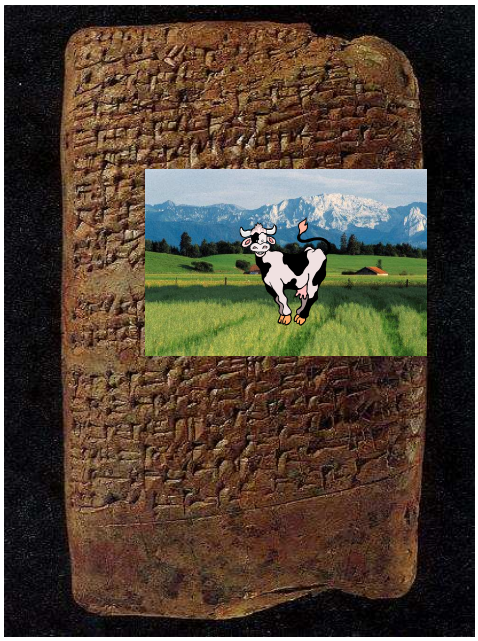


Fig1.2

It is thought that humans first discovered the benefits of using manure on crops through the observation of prolific flora growth around manure piles. The Akkadian Empire eventually fell to the Babylonian Empire, which fell to the Syrian Empire. Despite a cycle of conquering and egregious loss of cultural knowledge, the knowledge of composting from each previous Empire was assimilated by the conquering Empire and built upon. This indicates the recognition of compost as a valuable resource for maintaining agriculturally intensive arable land.

The Tribes of Israel, the Greeks and the Romans all used composting practices. The first recorded compost recipe was developed by a Roman statesman, scientist and farmer named Marcus Cato. In America's prehistory, Native Americans were known to use compost on their crops, as were the early European settlers. American historical figures such as George Washington, Thomas Jefferson and James Madison were all known to be proponents of composting, boasting its importance for soil fertility.

Throughout at least the last 4,500 years of history, humans have relied on compost to sustain their agricultural way of life. It was not until the 19th century that composting began to decline in prevalence in America and in other parts of the world. This resulted primarily, in America, from people moving westward where land was very fertile and, from the perception of many, that there simply was no more need to compost. The second reason, globally, was the introduction of chemical fertilizers, which began to become substitutes for organic methods of farming.

Originally, it was thought that plants actually ate humus for their nutrients until a German chemist named Justus von Liebig disproved this 1840. In his work *Organic Chemistry in its Application to Agriculture and Physiology*, he demonstrated that plants could absorb their nutrients from certain chemicals in solutions. Since humus was not

water soluble, he disproved the humus theory. This sparked the belief that to stimulate plant growth, all that was needed was the addition of chemical solutions, hence the beginning of the chemical agricultural and chemical fertilizer revolution. With our current understanding of soil structure, level of micro and macro-nutrients, organic composition, and with chemical fertilizers failing to address these soil needs, causing massive erosion, increasing insect resistance to toxic pesticides, contributing to groundwater and surface water contamination and an overall decrease in plant and soil fitness, organic farming has seen a resurgence in the last 50 years with high emphasis placed on composting for soil conditioning.

This resurgence is primarily the result of Sir Albert Howard. Howard is considered the father of the modern organic farming method. As a British government agronomist, he spent 29 years in India, ending in 1934, studying agricultural practices. In 1940, he published his groundbreaking research, *An Agricultural Testament*, which became the basis for organic farming. In his work, he places extremely heavy emphasis on composting as a way of ensuring soil fertility and increasing crop yields with greater nutrient value.

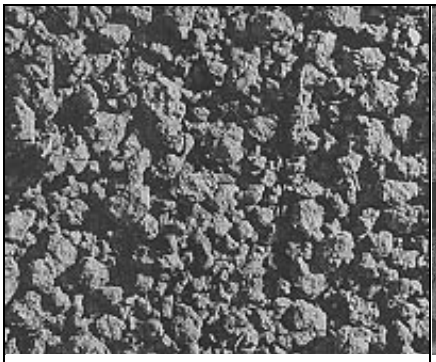
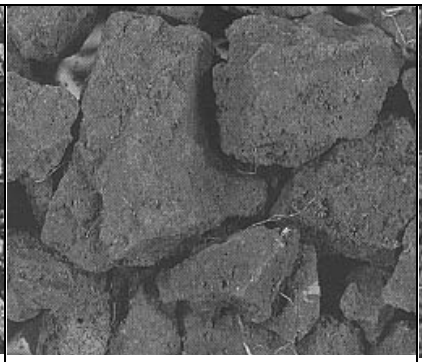
What's in a Soil?

Land constitutes only 25% of the earth's surface. Of this 25%, 50% is not arable due to geographical and climatological impediments such as extreme climates, mountains, glacier coverings and vast barren deserts. Of the remaining 12.5%, 40% has limited use because of difficult terrain, unfavorable climate and poor soil fertility. What land is depended on for reliable food production constitutes the remaining 10% (2.5% of earth's total land). This 2.5% of land competes with cities, landfills, urban sprawl and inefficient meat production; all serving the earth's burgeoning population of 6 billion people (Levin, http://soil.gsfc.nasa.gov/app_soil/hmsoil.htm).

Dr. Elissa Levin, from NASA's Goddard Space Flight Center, explains soil's importance for humans and other animals because it serves as a medium for crop production; a source of natural materials for construction, medicine and art; it filters water and waste; serves as a medium for plant growth (the base of all food-webs); it is home to many organisms; and it produces and absorbs gases (Levine, http://soil.gsfc.nasa.gov/soillet/elisalet.htm).

Levine simplifies the process of making soil as consisting of five factors: the parent material, climate, topography, biota and time (Levine, http://soil.gsfc.nasa.gov/soilform/parmat.html). Parent materials are the primary sources for the foundation of soil: organic materials, bedrock, and deposits of volcanic, wind and glacial activity. The most notable by-products of the parent materials are the minerals produced. Climate is responsible for the weathering, or the breaking down, of the parent materials into much smaller units (minerals). Weathering comes from a variety of sources such as heat, cold, wind, ice and water. Biota is the organic matter present during the soil formation process: plants, micro and macro-organisms. The topography helps to determine what type of environment the soil will form in. Determinants include altitude and slope, both of which help determine deposit formations. The final factor, time,

determines the type of soil production. The soil types produced range anywhere from fertile to unfertile soils, and vary in the proportions of sand, silt and clay that are present. This process of soil formation operates at a rate of about one inch of soil produced every 500 years. The soil structure is determined by the combination, quantity and quality of the factors above (Table 1.1, Levine, http://soil.gsfc.nasa.gov/pvg/prop1.htm).

		
Granular: Resembles cookie crumbs and is usually less than 0.5 cm in diameter. Commonly found in surface horizons where roots have been growing.	**Blocky**: Irregular blocks that are usually 1.5 - 5.0 cm in diameter.	**Prismatic**: Vertical columns of soil that might be a number of cm long. Usually found in lower horizons.
		
Columnar: Vertical columns of soil that have a salt "cap" at the top. Found in soils of arid climates.	**Platy**: Thin, flat plates of soil that lie horizontally. Usually found in compacted soil.	**Single Grained**: Soil is broken into individual particles that do not stick together. Always accompanies a loose consistence. Commonly found in sandy soils.

		
Massive: Soil has no visible structure, is hard to break apart and appears in very large clods.		

Table 1.1

The level of nutrients found in the soil help determine the level of soil fertility for plant growth. Types of macronutrients that are important for plants include: nitrogen-important for the synthesis of proteins and chlorophyll; phosphorus-important for the synthesis of enzymes and the storage of energy; potassium-important for the control of water use through osmosis; carbon-important for the synthesis of carbohydrates for strengthening the plant. Types of micronutrients that are important for plants include: copper-important for the synthesis of certain enzymes that are responsible for photosynthesis; molybdenum-important for nitrate fixation; and boron-important for cell division.

For more information on soil see Vogt, 2005.

Benefits of using compost

The benefits of using compost over chemical fertilizers are immense: 1) soil conditioning, 2) drought resistance, 3) erosion control, 4) an extremely high source of plant nutrients, 5) bringing soil pH into balance and 6) reducing reliance on chemical fertilizers and petroleum for food production.

One, unlike chemical fertilizers, compost helps build soil structure by increasing the amount of organic matter in the soil. Individual particles of sand, clay and silt group together to form larger units called aggregates. Soil aggregates form when fungi grow on organic material, then soil bacteria come along and turn the fungi into cementing agents which bind the soil particles and create the soil structure. It is the shape of these aggregates that determines the soil structure. Healthy, fertile soil has the granular structure (Table 1.1). Efficient aggregate formation in the soil promotes aeration, water drainage and water retention. Healthy soil structure allows for a thin film of moisture to develop on the surface of each granule within the aggregate where plant roots utilize the thin film of moisture. Poor soil structure limits root use by limiting space, air and water.

For example, compost will help increase water drainage if mixed with clay soils, and will increase water retention when mixed with sandy soils.

Two, using compost makes plants more drought resistant. With good soil structure, water remains on the surface of the granules longer so roots can access it even after periods of no rain. Chemical fertilizers do not provide this benefit.

Three, using compost also helps prevent erosion. Erosion results from wind, water and intensive agricultural practices. As stated, healthy soil is bound together through organic matter as well as the presence of microorganisms. As the level of organic matter and microorganisms in the soil decreases, the soil becomes more susceptible to erosion through wind water and intensive agricultural practices. In this model, severe erosion is the end result of a decrease in soil fertility. Sixty-nine percent of all erosion in the United States is linked to agricultural practices. For every one pound of food consumed in the United States, 22 pounds of topsoil are lost (Martin & Gershuny, 1992). Having strong soil structure, created by organic matter and microorganisms working to bond soil particles together, makes the soil more resistant to erosion from wind, water and intensive agricultural practices.

Four, compost is an excellent source of nutrients. Chemical fertilizers provide a high dose of nutrients for the plant's immediate use. Not all of this is used and much of it is leached out and contaminates ground and surface water. Applying compost to soil turns it into a storehouse of nutrients. These nutrients are released slowly at a rate consumable by the plant. As temperatures increase, so does plant growth and energy requirements. At the same time, microbial activity in the soil increases, meaning that more nutrients are naturally released when they are needed.

Five, because chemical fertilizers give the soil a large dose of chemical nutrients, and plants do not use all of the nutrients, much of them are leached out into our ground and surface water. In 1984, 134 pounds of chemical nitrogen were applied per acre for corn production in the United States. Thirty-five percent of the nitrogen applied and 15-20% of the phosphorus and potassium applied to the land is lost because it is applied in amounts greater than the plants can absorb. Nitrates and other substances in chemical fertilizers have been linked to nitrogen poisoning, cancer, deterioration of healthy soil, the destruction of earthworms and other beneficial micro and macro-organisms. Chemical fertilizers have also been known to alter the vitamin and protein content of some crops making them more vulnerable to disease and decreasing their nutritional value.

When applied to soil, compost is effective at neutralizing toxins. For example, compost can reduce the heavy metal toxicity of the soil, as well as bring the soil pH back into balance. Chemical fertilizers do not do this.

And most importantly, the use of compost reduces reliance on chemical fertilizers and petroleum. The foundation of the chemical agricultural and chemical fertilizer industry rests on the assumption that what a plant removes from the soil can be analyzed and replaced in chemical form. Chemical fertilizers trade short-term, rapid growth for taste, disease resistance, a decrease in nutritional content and long-term gain in soil structure. Applying 134 pounds of nitrogen fertilizer per acre requires 51 gallons of gasoline per acre for application. Increases in the use of chemical fertilizers continue to make the land less and less arable creating an even greater need to continue using more of the chemical fertilizers. As this need increases, so does our reliance on petroleum to apply the fertilizers. As nonrenewable energy resources become more limited, less accessible, and

more costly and our reliance on chemical fertilizers becomes greater, the use of energy intensive chemical fertilizers will become even more expensive with less food being produced.

Composting Methods

Composting is done at two different levels: large scale composting and small scale composting. Large scale composting is usually done at the municipality level (such as with human waste sludge), and by micro and macro businesses. This section will deal with small scale composting only. For more information on large scale composting see Haug, 1980, *Compost and Engineering: Principles and Practice*.

Now the question becomes, "What materials can be composted?" The answer to this question is anything.[1] More common yard and household materials include vegetables and fruit scraps, lint, paper products, coffee grounds, and yard waste such as leaves, grass, hay, manure[2] and weeds. One risk associated with using weeds is that if the compost does not attain a high enough temperature, the seeds will not be rendered sterile and when applying the compost you will propagate the weeds.

Composting materials are divided into two categories: wet or green materials (high in nitrogen content) and dry or brown materials (high in carbon content). Examples of green materials are fruit, vegetables, freshly cut grass or fallen leaves, manure and coffee grinds. Examples of brown materials are dry grass and leaves, lint, paper. It is the combination of these materials that make the ecology of composting possible. However, too much brown material causes decomposition to occur very slowly (if this happens, just add more green materials). Too much green material can cause an unpleasant odor (if this happens, just add more brown materials). It is usually recommended to have a 1:3 or a 2:2 ratio of green to brown materials. However, sometimes, you just have to work with what you have.

It is important to remember that in composting, you are creating the environment for the micro and macro-organisms to work and live in. This usually requires the three necessities of life: air, water and food. Micro and macro-organisms feed on the organic matter in the compost, and thus use and deplete its water and oxygen content. It is this process of "living" that produces the degradation process (through their feeding). The waste products create the storehouse of the nutrients that further support the burgeoning population of micro and macro-organisms that make the extraordinary soil conditioner.

Composting methodology can be divided into the three most common approaches: anaerobic, aerobic and vermiculture.

Anaerobic Composting

[1] Meats, diary products, road kill and human waste sludge (human waste sludge is usually composted at the municipality level) can all be composted, but they carry a greater risk with the attraction of unwanted pest, increased foul odor and the production of pathogens harmful to human health. None of these are recommended for personal, school or community composting.

[2] Be careful not to add too much manure due to its high nitrogen content. Too much nitrogen in the pile, when applied to plants and the root area can burn the roots and destroy the plants.

Anaerobic composting takes place in an environment without air (actually, the first half of the process is with air, but as it runs out, it is not replenished). This is more of a fermentation process. One of the main reasons for anaerobic composting is to reduce the amount of nitrogen loss. One of the drawbacks to anaerobic composting is that it takes much longer than aerobic composting and vermiculture. There is also the production of unwanted gases such as methane and hydrogen sulfide. There are several ways to compost under anaerobic conditions. One that farmers have had much success with is covering the pile with a large black tarp and leaving it that way until the process is done. Another method is to dig a hole in the ground and fill it with waste or place the materials in a plastic bag and seal them in an "air tight" container such as a trashcan.

Aerobic Composting

Aerobic composting, a much more popular and widely used method, occurs with the help of oxygen. Since the microorganisms are using oxygen and water when they work to decompose the organic material, "mixing" or "turning" is necessary to replenish the oxygen supply. In addition water must be added due to loss from evaporation and the use by microorganisms.

There are two ways to compost under aerobic conditions: a static pile or a managed pile. Static composting means creating the pile and leaving it alone, except for the addition of new materials, until the decomposition process is complete. This process takes much longer but requires very little work. To add materials, just dig a hole in the top of the pile, place the new organic matter within, and cover the hole. A managed pile will require a little more time (at most, 20 minutes a week), but the decomposition process goes much faster. In addition to adding new materials, be sure to turn the pile once every week to replenish the oxygen supply for the microorganisms, as well as to add water for proper moisture content[3] (consistency of a wet sponge).

There are a variety of structures that can be used when aerobic composting (Fig1.3). A basic and easy design is a cylinder form using chicken wire or a trashcan with holes drilled in the side and the bottom removed. When it becomes time to turn the compost, pull the cylinder off the pile and place it in a new location, then just reload the material into the cylinder in its new location. Another structure is the one bin system. This is basically a three-sided bin that holds the composting material in it. Mixing the compost is a little more difficult due to space restrictions. There is also the 3-bin system, the "Cadillac" of composting bins. With three-bin systems, you can have two piles going at the same time. When it is time to turn the heap, you just transfer one pile over to the next bin and back again. An easy method is to just start a pile right on the ground. The pile is not contained and may be a little messy, but a composting container is not absolutely necessary.

[3] Be sure not to add too much water, or the microorganisms will "drown." If this happens, before the decomposition can began again, the pile has to dry out and there is a lag time while the pile becomes re-populated with microorganisms.

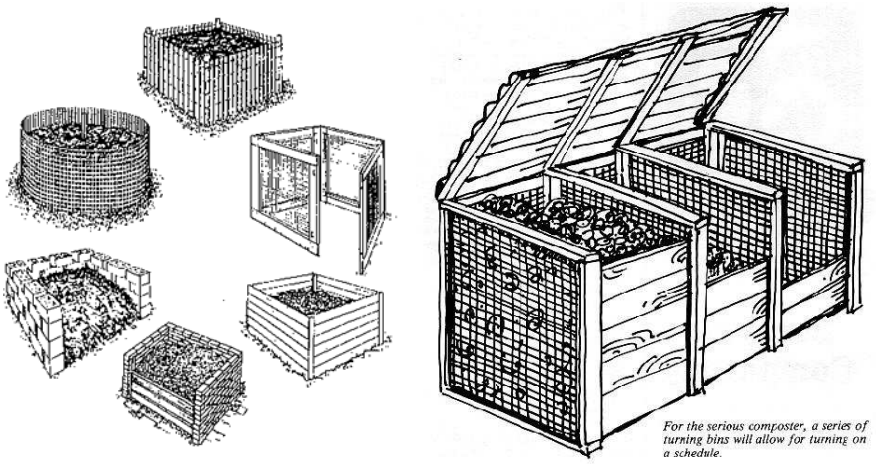


Fig1.3

When adding materials under either aerobic or anaerobic conditions, there are two main methods: layering and mixing. Basically, layering involves alternating layers between green and brown materials and mixing involves just throwing it all together. To reiterate a previous point, when adding materials, it is suggested to have a 1:3 or 2:2 ratio of green to brown materials. For the real avid composters, there are a variety of specific recipes one can find access to easily on the web. Since the microorganisms feed on the surface area of the organic material, the more surface area one has, the faster the decomposition process, i.e., when preparing organic materials, break them into smaller pieces.

Vermiculture

> "Worms have played a more important part in the history of the world than most persons would at first suppose." -Charles Darwin (1881)

Charles Darwin was well ahead of his time in recognizing the importance of earthworms as a form of ensuring soil fertility. He realized that their castings were loaded with nutrients; which replenish the soil. Any place that there is earthworm activity, two benefits are provided: one, the burrowing activity giving a constant source of aeration for roots to utilize; and two, wherever the worms burrow, they leave their nutrient rich castings where ever they go. In Darwin's view, earthworms were the most important species on earth, for without them, Earth's flora would diminish and would no longer be capable of sustaining the great level of biodiversity.

Vermiculture is the use of worms for the decomposition process. Earthworms are capable of eating their own weight a day in soil and organic matter. The castings of this endeavor contain 5-11 times the amount of nutrients that the soil originally contained before it was eaten. The secretions in worms' intestinal tracks chemically liberate micro and macro plant nutrients. Earthworms tunnel through the soil (increasing aeration for root utilization) dropping the most nutrient rich food for plants and trees wherever they go. They are a great addition to any form of gardening or agricultural practices.

Earthworms, whether in a shoebox under the sink or in tub-sized container, quickly decompose organic material creating exceptionally nutrient rich humus. The trick is to maintain the environment that is conducive to worm longevity. This requires a little bit of research due to the fact there is a variety of earthworms, and each has different requirements. For example, red worms (*Lumbricus rubellus*) and brandling worms (*Eisenia foetida*) thrive in warm temperatures, and field worms (*Allolobophora caliginosa*) and night crawlers (*Lumbricus terrestris*) will die in warm temperatures but will proliferate under cooler temperatures. In general, if you have a 4'x6' bin, you should purchase about 1 thousand worms. If they are cared for under optimal conditions, within a year, they can multiply up to one million! When adding material to worm bins, it is recommended to dig little holes or trenches and bury the organic material within them.

Applying Compost

When applying compost, if the plant is already established, it is recommended to mix the compost in with the top 2-3 inches of soil and spread it out up to three feet from the stem of the plant (depending on plant size). If applied when planting, it is recommended to mix it in with the soil at a 1:3 ratio of compost to soil.

Below is a trouble-shooting guide for composting (Table 1.2, http://compostguide.com/).

Problems	**Possible Causes**	**Solution**
Damp and warm only in the middle of the pile.	Pile could be too small, or cold weather might have slowed composting	If you are only composting in piles, make sure your pile is at least 3 feet high and 3 feet wide. With a bin, the pile doesn't need to be so large.
Nothing is happening. Pile doesn't seem to be heating up at all.	1. Not enough nitrogen 2. Not enough oxygen 3. Not enough moisture 4. Cold weather? 5. Compost is finished.	1. Make sure you have enough nitrogen rich sources like manure, grass clippings or food scraps. 2. Mix up the pile so it can breathe. 3. Mix up the pile and water it with the hose so that there is some moisture in the pile. A completely dry pile doesn't compost. 4. Wait for spring, cover the pile, or use a bin.
Matted leaves or grass clippings aren't decomposing.	Poor aeration, or lack of moisture.	Avoid thick layers of just one material. Too much of something like leaves, paper or grass clippings won't break down well. Break up the layers and mix up the pile so that there is a good mix of materials. Shred any big material that isn't breaking down well.

Stinks like rancid butter, vinegar or rotten eggs.	Not enough oxygen, or the pile is too wet, or compacted.	Mix up the pile so that it gets some aeration and can breathe. Add coarse dry materials like straw, hay or leaves to soak up excess moisture. If smell is too bad, add dry materials on top and wait until it dries out a bit before you mix the pile.
Odor like ammonia.	Not enough carbon.	Add brown materials like leaves, straw, hay, shredded newspaper, etc.
Attracts rodents, flies, or other animals.	Inappropriate materials (like meat, oil, bones), or the food-like material is too close to the surface of the pile.	Bury kitchen scraps near the center of the pile. Don't add inappropriate materials to compost. Switch to a rodent-proof closed bin.
Attracts insects, millipedes, slugs, etc.	This is normal composting, and part of the natural process.	Not a problem.
Fire ant problems.	Pile could be too dry, not hot enough, or has kitchen scraps too close to the surface.	Make sure your pile has a good mix of materials to heat up, and keep it moist enough.

Table 1.2

The Ecology of Composting

The ecology of the compost pile is utterly fascinating. Thanks to the diligent inquisitiveness of chemical engineers and microbiologists, we are able to begin to understand the complexity of the decomposition process.

To keep it short and simple, as previously stated, compost happens through a complex biological process of degradation that is still not completely understood. The seven main ingredients necessary to make compost happen under aerobic conditions are microorganisms, macro-organisms, nitrogen and carbon in the organic material, heat, water and air. Inside of this compost amalgamation, an entire ecosystem develops. At its base are the primary consumers, the ones mainly responsible for the degradation of the organic material. These are bacteria (Fig1.4), fungi (Fig1.5), actinomycetes (Fig1.6) and protozoa (Fig1.7). *Bacteria* are single-celled organisms that come in a variety of shapes including rods, spirals and spheres. They live in colonies and reproduce quickly. The bacteria, fungi, actinomycetes and the protozoa use the organic material by excreting a hydrolytic enzyme on organic matter that breaks it down, allowing them to re-absorb whatever nutrients they need. Bacteria are the second largest population in the compost pile and the ones most responsible for the degradation process due to their ability to eat almost anything and to exist in a wide range of temperatures. Other base consumers are *fungi*. Fungi can be single-celled or multi-cellular and are divided between yeasts and molds. They are mainly filamentous in shape and most do best in middle range

temperatures from 70-75º F (21.1º-23.8ºC) in the compost heap. *Actinomycetes* are important in the formation of humus. Unlike bacteria that just work in the top foot of soil, actinomycetes work deep beneath the soil to break down organic matter making nutrients available to the roots of the plant. Because actinomycetes have the ability to produce antibiotics, as their colonies grow, any bacteria they encounter tend to die off. *Protozoa* are single-celled organisms, the simplest form of life. They compose the largest population in the compost heap, but they are of the least importance.

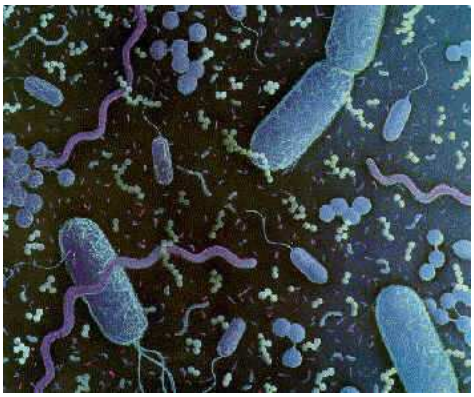


Fig1.4

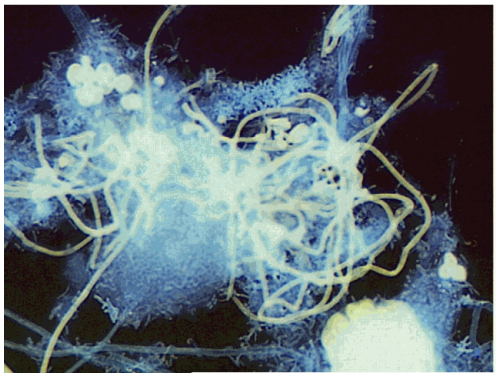


Fig1.5

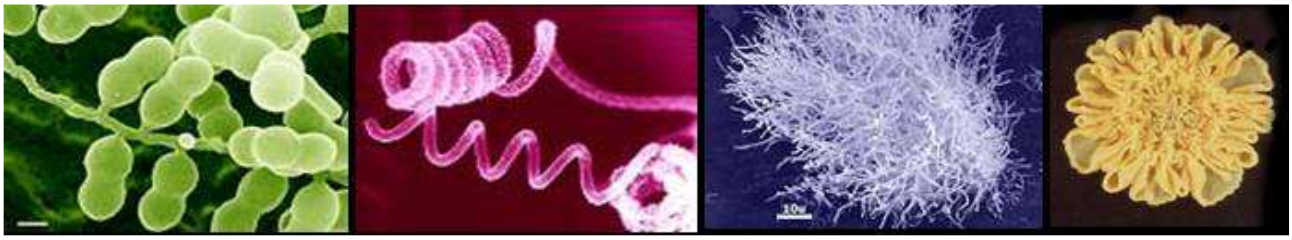


Fig1.6

Fig.1.7

Secondary level consumers include roundworms (Fig1.8), soil worms (Fig1.9), beetles (Fig1.10) and mites (Fig1.11), to name a few.

Fig1.8

Fig1.9

Fig1.10

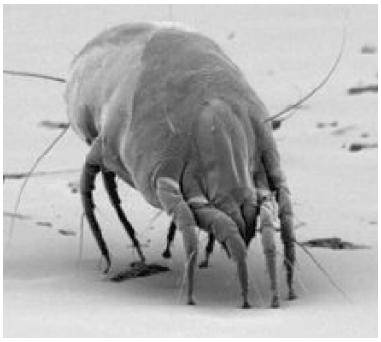


Fig1.11

Tertiary level consumers include ants (Fig1.12), predatory beetles (Fig1.13), centipedes (Fig1.14) and pseudo scorpions (Fig1.15).


Fig1.12


Fig1.13

Fig1.14

Fig1.15

One of the most defining characteristics of a compost pile is its change in temperature. Three things influence the initial and long-term temperature of the pile: 1) the temperature of the organic matter added; 2) the outside temperature of the environment; 3) the surface area to mass ratio.[4] After an initial lag phase, the temperature of the compost pile begins to steadily increase. At its peak, the temperature of the compost pile can reach up to 150º F (65.5º C). It is during this high temperature phase that most of the decomposition in the pile takes place. After the majority of the decomposition takes place, the temperature begins to steadily decline and the pile enters into the maturation phase (like aging a fine wine) at the end of which the compost is ready to use.

It is the activity of decomposition from the microorganisms that cause the change in temperature. In the beginning, the pile becomes populated with mesophilic microorganisms. (those that live in moderate temperatures). These microbes attract the secondary consumers that then attract the tertiary consumers. The change in temperature results from an increase in the microbial activity of degradation of the organic matter, which increases their metabolic activity, which increases the temperature of the pile. During the temperature increase, the mesophilic microbes and some of the macro-organisms move to the outer edges of the pile where it is cooler and the center of the pile becomes populated with thermophilic microbes (those that live in hot temperatures). As the temperature increases, the water content (originally contingent on the water present in the organic material and any that which is added) is used up by the increased metabolic

[4] Greater mass to surface area will allow for better insulation and production of heat and leads to less heat loss.

activity of the microbes and what is not used is evaporated from the pile due to the heat. During this phase, the oxygen supply is also depleted due to the increase in microbial metabolic activity. If the oxygen and water are not replenished the result is of consequence. The thermophilic bacteria populations, and the much smaller thermophilic fungi populations, will dwindle and decomposition will slow or even halt (hence the need for turning and the addition of water). After the majority of the decomposition is finished, the temperature begins to decrease as it enters into the maturation phase. The center of the pile begins to become repopulated with the mesophilic micro and macro-organisms. It is the end result of this complicated process that produces the nutrient rich soil conditioner.

Conclusion

Composting is applicable to daily life as way of recycling kitchen and yard waste and turning them into a nutrient rich soil conditioner, as a way of reducing the amount of bio-degradable waste being buried in our quickly filling landfills, reducing the impact the impact of processing toxic human-waste sludge and as alternative forms of energy. The benefits from composting are immense. They range from higher nutrient content of crops, ensuring soil fertility, reducing erosion, and increasing plants' resistance to insects and diseases. With the investment of as little as five minutes a week, one can practice composting at home and contribute to a sustainable future.

Bibliography

Compost Guide: A Complete Guide to Composting
2004 How to Make Compost, a Composting Guide. Electronic document, HTTP://CompostGuide.com/. Accessed September 2004.

Darwin, Charles
1881 [1897] The Formation of Vegetable Mould through the Action of Worms. D. Appleton & Co., New York, New York.

Harmonious Technologies
1992 Backyard Composting: Your Complete Guide to Recycling Yard Clippings. Harmonious Press, Ojai.

Haug, Roger Tim
1980 Compost Engineering: Principles and Practice. Ann Arbor Science Publishers Inc., Ann Arbor.

Insam, Herbert, Nuntavun Riddech, and Susanne Klammer
2002 Microbiology of Composting. Springer, Verlag Berlin and Heidelberg, Germany.

Levine, Elissa
2001a How Much Soil Is There? Electronic document, http://soil.gsfc.nasa.gov/app_soil/hmsoil.htm. Accessed October, 2005.
2001b Electronic document, http://soil.gsfc.nasa.gov/soillet/elisalet.htm. Accessed October 2005.
2001c Soil Forming Factors. Electronic document. http://soil.gsfc.nasa.gov/soilform/parmat.htm. accessed October, 2005.
2001d Soil Structure. Electronic document http://soil.gsfc.nasa.gov/pvg/prop1.htm. Accessed October, 2005.

Lindsell, Denis
1998 Pasture Management for Horses. Electronic document, http://www.denislindsell.demon.co.uk/pasture/index.htm. Accessed October, 2005.

Martin, Deborah, Grace Gershuny
1992 The Rodale Book of Composting. Rodale Press, Emmaus.

Smargon, Adam J.
1999 Global Perspectives on Solid Waste management. Electronic document, http://www.afn.org/~recycler/waste.html. Accessed October, 2005.

Vegweb
1996 Introduction to composting. Electronic document, http://vegweb.com/composting/. Accessed September, 2004.

Vogt, Wendy
2005 Preventing Soil Erosion in Nogales, Sonora. Unpublished manuscript. Bureau of Applied Research in Anthropology, University of Arizona, Tucson.

APPENDIX F
GREENHOUSE MANUAL

ARAN Greenhouses
Invernaderos de ARAN

A Manual
Un Manual

December 2005 – January 2006
diciembre 2005 – enero 2006

ARAN Greenhouses: A manual

Prepared for:
The Association for Reforestation in Ambos Nogales
Nogales, Arizona, U.S.
Nogales, Sonora, Mexico.

Prepared by:
Brian Hawkins
Bureau of Applied Research in Anthropology
Universtiy of Arizona
Tucson, Arizona

With the assistance of:
Jesus Garcia
Gail Rolinger
Leo Powell
Diane Austin

December 2005 – January 2006

TABLE OF CONTENTS

The Bureau of Applied Research in Anthropology

THE UNIVERSITY OF ARIZONA.

Funding for ARAN greenhouses was provided by the U.S. Environmental Protection Agency through its Border 2012 program.

1. Acknowledgements

This manual and the greenhouses it covers would not have been possible without the efforts, assistance and patience of many people within ARAN.

I would first like to thank and congratulate the faculty and students of the CETis, CONALEP, and AJ Mitchell schools for their fantastic efforts and willingness to take risks towards new ideas. Without them and their inspiring hard work, ARAN would not be the same.

I also wish to acknowledge the great help of Jesus Garcia from the Arizona-Sonora Desert Museum. His help with and enthusiasm towards ARAN in general and greenhouses specifically has been profoundly influential and of exceptional importance for the organization and for this manual.

Diane Austin, of the University of Arizona's Bureau of Applied Research in Anthropology, was a tremendous help in the editing and formation of this manual. She has also been a fundamental figurehead in ARAN and a driving force behind ARAN's success.

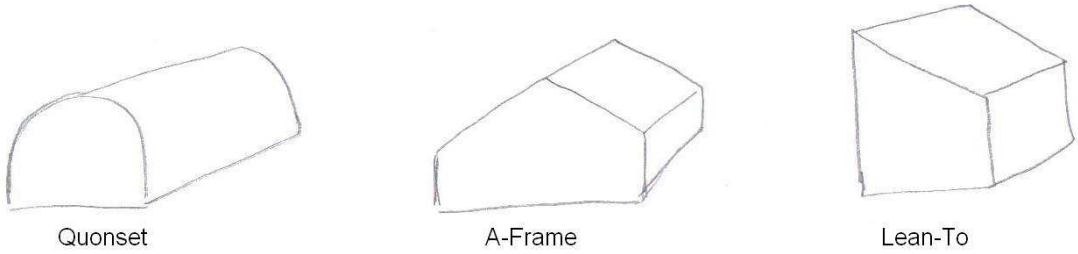
All of the interns, research assistants, and faculty of the Ambos Nogales Revegetation Project at the Bureau of Applied Research in Anthropology have assisted either directly or indirectly with the realization of ARAN successes, this manual and its greenhouses included.

Finally, I would like to acknowledge and applaud all ARAN members, whose admirable cause marches forward with each outstanding effort they produce. This manual is but one product of that cause.

1. Introduction

Throughout 2005, members of the Association for Reforestation in Ambos Nogales (ARAN), a collaboration of students, teachers, community members, institution employees, and government officials, built a number of greenhouses from scratch. The styles built spanned a spectrum of greenhouse possibilities and illustrated well the requirements and challenges for each. A wealth of experience and knowledge has since been gained by these ARAN members concerning their built-from-scratch greenhouses and greenhouses in general. The purpose of this manual is to concentrate the available knowledge and experience into a single source of information to share, so that successful greenhouses may be realized throughout the Ambos Nogales community based on the lessons and experiences of others.

There are three essential types of greenhouses, each of which is covered in this manual. These are Quonset, A-Frame and Lean-To styles. The size, cost and complexity



Quonset A-Frame Lean-To

of these three types varies greatly. Some greenhouses cost in the thousands, whereas those built by ARAN members are more local models costing in the hundreds or below. The primary purpose of a greenhouse is to assist plants in growth by providing them favorable conditions such as controlled temperatures and humidity. Usually a greenhouse is used to get a plant to seed, and once a seedling has grown the plant is transplanted outside to grow under normal conditions. Each greenhouse type approaches this goal in a different way dependent upon size, cost and complexity of the structure.

There is a secondary goal however to greenhouse construction within the context of ARAN. That goal is to use the construction of a greenhouse as an educational tool for the learning and enhancement of those building them. It is important to note that all but one of the greenhouses covered in this manual were built on school grounds by students. This is because the built-from-scratch ARAN greenhouses, beyond functioning as enhancements for ARAN schools' nurseries, were intended to act as educational tools that taught the students planning, problem solving, team work, resource allocation and research skills. Furthermore, these greenhouses were built from scratch so that the students would have a sense of attachment and responsibility towards what they built. It can be easily argued that something built from the ground up by one's own hands lends that object a certain value, and instills a sense of pride in the builder over his or her accomplishment. For ARAN members, this educational goal weighed in with equal importance alongside the utilitarian greenhouse goal of nursery augmentation.

This manual specifically covers information regarding the location, materials and construction process of each ARAN greenhouse as well as the advantages and disadvantages of each in the words of those who built them. There are also sections

detailing the lessons learned by these groups or individuals, as well as an advice section for those building greenhouses in general or those building the specific style being reviewed. At the end of the manual there is a conclusion section reviewing the information from each greenhouse. Finally, a basic "how-to" guide written by Christine Hawkins has been included, reprinted here with her permission. Miss Hawkins is a graduate of the California Polytechnic University in San Luis Obispo, California, which is famous for its horticultural and crop science studies.

This manual also offers a number of photos to illustrate the basic construction plans of each greenhouse. Though no specific instructions for each greenhouse are given, contact information is available for those who need that information. It should be noted that some of the greenhouses in this manual are waiting to be finished or reconstructed, while others have been completed and are in use.

2. Jesus Garcia's Greenhouse

Location: Jesus Garcia's home in Tucson, Arizona.

Style: Quonset.

Materials:

- PVC glue, connectors and pipe.
- Greenhouse plastic.
- Recycled wood.
- Recycled screen door.
- Nails and screws.
- Recycled rebar poles.

Cost: Given that the wood, screen door and rebar poles were all already available, the cost for this greenhouse was approximately $50. It is estimated that if all the materials were paid for and not recycled, the cost would be approximately $100.

Advantages and disadvantages: The primary advantages of this greenhouse are that it is cheap, easy to build and requires very little time. The disadvantages lie in the fact that it requires a significant amount of maintenance and it is not as durable as other types, such as Lean-Tos made out of wood.

Status as of December, 2005: Semi-standing, and in need of reconstruction.

Construction process: The construction process started with a basic sketch of the greenhouse design. An area was then cleared for the greenhouse and four rebar poles were driven into the ground, forming a square within the area. The PVC tubes were then cut and glued with connectors. The PVC tubes were then placed on the rebar poles making the arch of the greenhouse. From there, the front end of the greenhouse was made with wood and a screen door added for an entryway. Finally, the greenhouse plastic was placed over the structure. It was stapled to the wood in front and wrapped in wood and rocks on the sides and back to hold it in place. A few improvisations were made from the base design as the greenhouse was built.

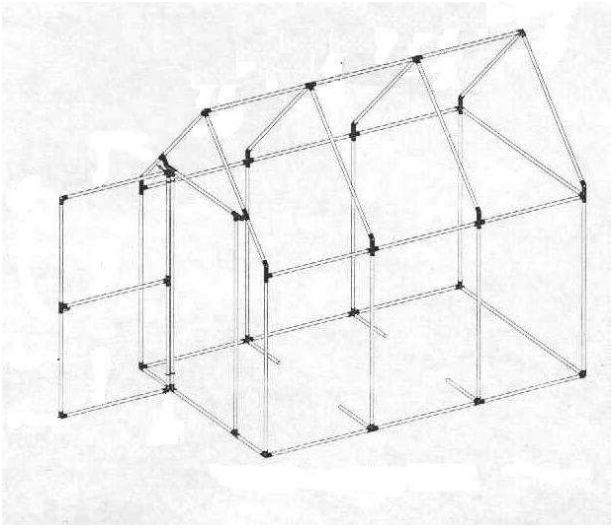
Problems encountered: Making sure that the greenhouse plastic was well stretched over the structure proved difficult. The roof plastic consequently sagged, allowing rainwater to collect in pockets over time. The weight of these water pockets eventually caused the PVC holding the roof up to buckle and crack.

Lessons learned: Lack of maintenance of this greenhouse was its primary cause for downfall. Thicker PVC pipes may have prevented the pipes from cracking under the weight of the water on the roof, though regularly removing the water would have been

most helpful. Furthermore, a number of pipes positioned like columns in the centerline of the structure would have been a good idea for extra support. Finally, it is very important to make sure that the plastic over the greenhouse is either well stretched so that it won't sag and collect pools of water, or angled so that water will run off the sides.

Advice: Regular maintenance of one's greenhouse is a necessity. It is very important that one not ignore problems and let them accumulate until they become serious. For this specific style of greenhouse, it is very important to not make it too large. The smaller a greenhouse is, the simpler and cheaper it is to build. It is important to think in the long term and allow that to influence one's decision on what style of greenhouse to build. Furthermore, remember that the learning process involved in greenhouse's construction is what is truly valuable.

3. AJ Mitchell's Greenhouse



Location: AJ Mitchell Elementary School in Nogales, Arizona.

Style: A-Frame.

Materials:

- PVC glue, connectors and pipes.
- Greenhouse shade and plastic.
- Greenhouse plastic bracers.
- Bricks.

Cost: Most of the materials for this greenhouse were purchased online (www.acfgreenhouses.com) and in Home Depot in Nogales, Arizona. Very few were recycled materials donated or scavenged. Its cost was approximately $250.

Advantages and disadvantages: The primary advantage of this greenhouse is its mobility. It is not attached to the ground in any way, and is instead weighted down and held in place by bricks placed on the floor sections of PVC. Thus, it can be lifted and moved from place to place as is deemed necessary. The disadvantages are that the structure is fairly weak given it is made completely out of PVC and uses no wood or metal. Also, the roof proved to be an issue in that it made the structure top-heavy, making it sway in strong winds.

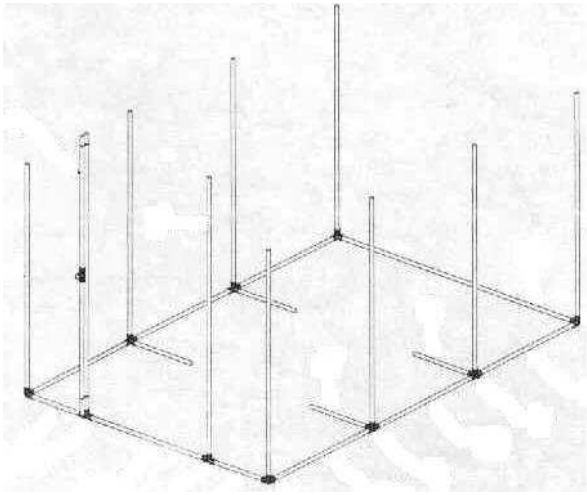
Status as of December, 2005: Partially reconstructed, awaiting finishing.

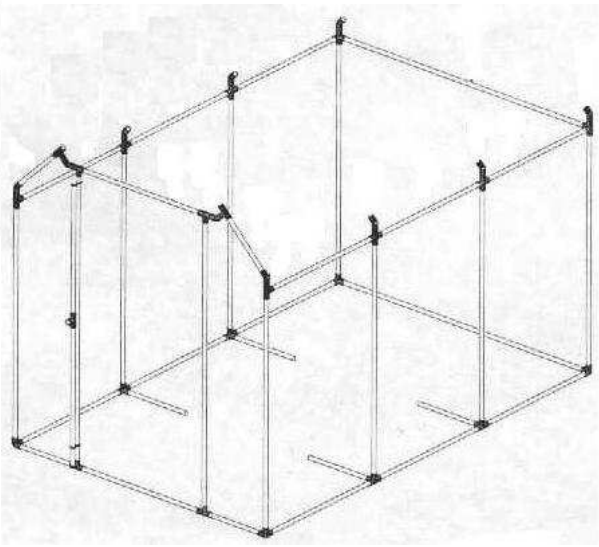
Construction process: The plan for this greenhouse was obtained online (www.acfgreenhouses.com). The first step was to measure, cut and label each of the PVC pieces according to the plan. Then the pieces were glued together as the plan dictated. However, some of the roof pieces were not glued together before being added to the structure. Also, a piece of shade covering was attached to the roof but none was added to the sides of the structure. Some improvisation and changes were made to the original plans during this greenhouse's construction process. Visit www.acfgreenhouses.com for specific instructions on this construction process (note: the photos here, though modified, are from www.acfgreenhouses.com as well).

Problems encountered: The shade covering placed on the roof acted like a parachute when strong winds came. This, combined with some of the roof pieces not being glued together, allowed the roof to be lifted off, causing most of the greenhouse to fall apart. Also, there were some issues during the construction process because of imprecise measurements and cutting by the school students working on the project.

Lessons learned: The structure could have been saved if all the shade or plastic was put on at once. Given that only the roof had shade covering on it, the wind was able get under the roof and lift it off. If the structure were completely sealed with shade covering or plastic on all sides, the wind could not have entered and would not have lifted the roof off the structure. Also, the students who helped build the greenhouse were young (9-11 years) and too many (10-20). It may be best to allow the younger students to participate in the design and measurement phases and then use a concentrated and smaller group of older students during construction days, as it was difficult to organize the construction process with so many young students doing different things. Finally, the construction of this greenhouse illustrated well the necessity of balancing the educational goal of greenhouse construction and limiting the number of students involved. It is important to allow students to learn through the construction process, but too many students constructing can mean too many mistakes and can prove counterproductive. There are other activities concerning the greenhouse that students can be involved in, such as planting seeds, watering the plants and performing maintenance.

Advice: For building greenhouses in general, it is advised to use a smaller, concentrated force of students or individuals on the actual building process. This will prevent disorganization and mismanagement of the project. Also, it is imperative that in one sitting the plastic or shade covering is attached to all parts of the greenhouse's structure. This will prevent winds from using open or uncovered walls as entry points and ruining the structure. For this greenhouse specifically, it is advised that one make it a bit smaller than the plans call for, and perhaps find an alternative solution for the roof and the door that is simpler and more stable.

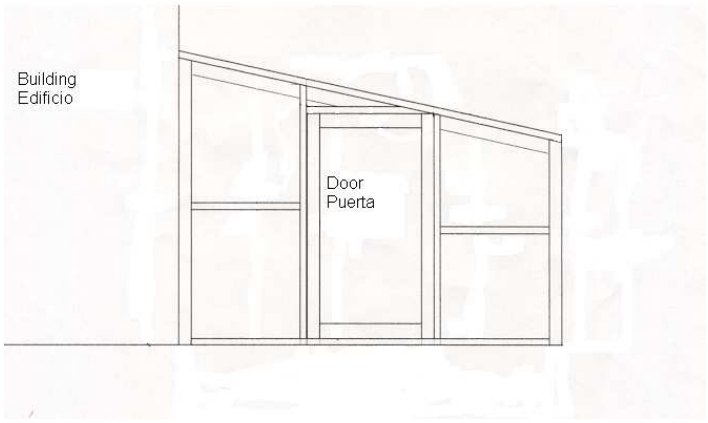




4. CETis' First Greenhouse

Location: Not available.

Style: Lean-To.



Materials:

- Wood.
- Greenhouse plastic.
- Metal brackets and connector plates.
- Nails, screws and staples.

Cost: Assuming all materials are purchased from Home Depot and not donated or scavenged, approximately $450.

Advantages and disadvantages: The primary advantage of this greenhouse is its durability and resistance to weather. This is because it is made completely out of wood and consequently weighs a lot, thereby resisting strong winds. The wood also allows the greenhouse to last much longer than ones made out of PVC. PVC greenhouses can be expected to last anywhere from 6 months to 2 years because PVC tends to crack if under sunlight for extended periods of time. It should be noted that PVC is intended for underground usage, normally for sewage or watering systems. Greenhouses made out of treated or sealed wood can be expected to last anywhere from 5 to 15 years, as wood naturally resists sun and weather. The disadvantages of this greenhouse are its permanence as a structure and cost. Because it is made entirely out of wood, it is very difficult to move or to deconstruct. Also, the wood, if not donated, is expensive, and significantly increases the total cost of the greenhouse.

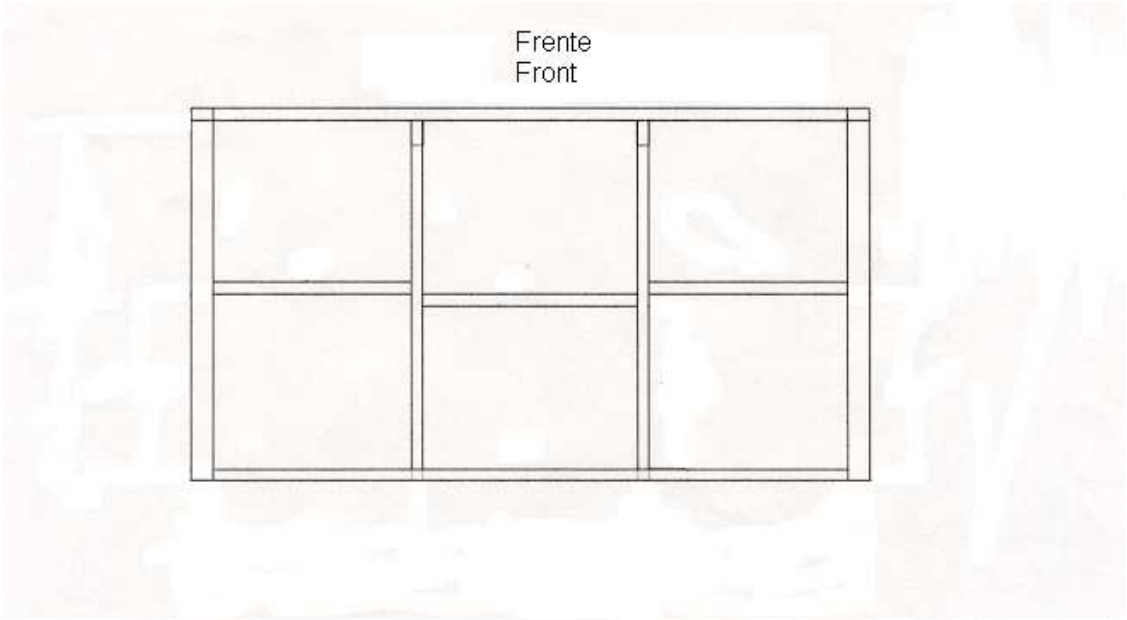
Status as of December, 2005: This greenhouse has not been constructed.

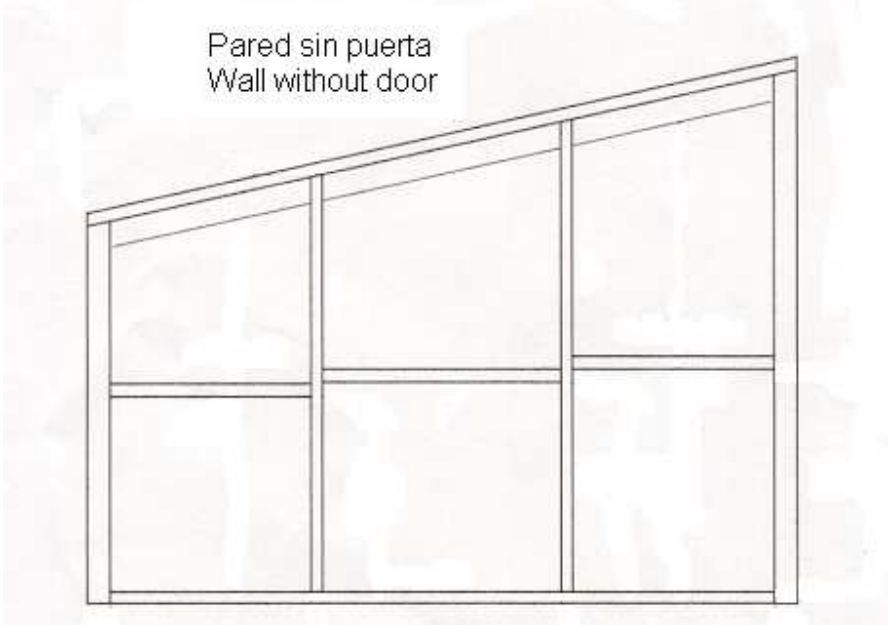
Construction process: It would be best to construct the walls and ceiling separately, and fill in the support beams once the structure is standing. The construction process would likely take around 5 workdays with a small team of people. It should be noted that Lean-To greenhouses are best constructed off of south-facing walls, as they will receive the best sunlight on an average day that way. Contact Brian Hawkins at b.w.hawk@gmail.com for specific blueprints and instructions for building this greenhouse.

Problems encountered: Not available.

Lessons learned: This greenhouse was not constructed because of its cost and complexity to build. A simpler and cheaper design was chosen for CETis instead.

Advice: This greenhouse is a good choice if one wishes to build a structure that will last for many years and is willing to put in the money and time to build it. If anything, this greenhouse illustrates that before building a greenhouse, one must think in the long term about what is desired. Is a greenhouse that lasts for years on end necessary, or is a simpler and cheaper greenhouse that will last for the course of a year or so more ideal given resource limitations and the goal of education? If what is desired is a greenhouse that is stout and durable, and if the time and money are available, then this greenhouse is a good choice. If, however, a greenhouse that will last for a course of years and serve more of an educational purpose towards those building it, then some of the other designs available in this manual are perhaps better choices.





5. CETis' Second Greenhouse

Location: CETis school in Nogales, Sonora.

Style: Mixture of Quonset and Lean-To.

Materials:

- PVC pipes.
- Greenhouse plastic.
- Metal posts.
- Metal brackets and connector plates.
- Wood.
- Wire.
- Liquid-Nails.
- Nails, screws, staples and tape.

Cost: Given that most of the wood, the greenhouse plastic, the metals posts and wire were all either recycled or donated, this greenhouse cost approximately $80. If all materials were purchased and not recycled or donated, then cost would range from $150-$175.

Advantages and disadvantages: The advantage of this greenhouse is that it is both cheap to build and durable, as it is a mixture of the Lean-To and Quonset styles. The structure itself proved fairly resistant to winds. The disadvantage was its location, where extreme winds were frequent.

Status as of December, 2005: Deconstructed with materials used being recycled.

Construction process: The first step was to insert the metal poles into the cement. Then the wood was attached to the wall of the building with screws and Liquid-Nails. The PVC pipes were the tied to the poles with wire and attached to the wood with metal brackets and screws. After this, the walls were improvised and built with recycled wood. The plastic covering was then wrapped around two small pieces of wood that were placed at the top and bottom of the structure, and nailed into the wood on the wall and cement on the floor. The sides of the structure were covered with plastic nailed into the wood there. Most of the improvisation for this greenhouse revolved around getting the plastic put on and constructing the two walls of the structure. Contact Brian Hawkins at badslink@email.arizona.edu for specific details on this construction process.

Problems encountered: The construction process for this greenhouse was fairly easy. However, the location proved to be too windy for a greenhouse, as it was situated on the exposed outer edge of a building with no wind-breakers. The wind eventually caused the plastic to tear and come off of the structure. Also, the metal wire used to hold the PVC to

the metal poles was not initially covered with tape, and this tore the plastic as the wind moved it about. Eventually, it was decided the winds in this area were too strong for a greenhouse of this style. It should be noted that the structure of the greenhouse withstood the wind well. The real problem was securing the plastic to the structure without it being torn off by the wind.

Lessons learned: Building this greenhouse illustrated the extreme importance of choosing the right location for one's greenhouse. Locations with strong winds can be seriously problematic for greenhouses. It was known beforehand that the winds in the chosen area were strong, but it was decided to build the greenhouse there anyway to have the greenhouse be south-facing. Despite what improvisations or changes were made, it proved impossible to keep the plastic attached to the structure in one piece because of the wind.

Advice: While planning one's greenhouse, spend a good deal of time looking for a proper location. It can be argued that the number one thing of importance for a greenhouse, beyond its structure or design, is its location. A good location for a greenhouse has little wind or a number of wind-breakers in the area, a good amount of sunlight, and is not in an area where water pools when it rains. The location chosen for this greenhouse fulfilled only two of those necessities (sunlight and water drainage). Also, keep in mind the educational aspect of greenhouse construction. The students at CETis were aware of the risk of building this greenhouse in windy its location. But, the problems encountered with this greenhouse provided a wealth of lessons and knowledge gained, which were transferred to other projects.

6. CETis' Third Greenhouse

Location: CETis school in Nogales, Sonora.

Style: Mixture of Quonset and Lean-To.

Materials:

- PVC pipes.
- PVC plastic clips.
- Greenhouse plastic and tarp.
- Metal posts.
- Wood, cement and bricks.
- Metal brackets and connector plates.
- Nails, screws, staples, wire and tape.

Cost: Given that most of the wood, the greenhouse plastic, the metals posts and wire were all either recycled or donated, this greenhouse cost approximately $80. If all materials were purchased and not recycled or donated, then cost would range from $150-$175.

Advantages and disadvantages: This particular structure has proven to be fairly resilient and resistant to winds. It is also cheap to build. However, Lean-Tos require a proper wall to build from, and that can limit ones options and present some issues during the construction process.

Status as of December, 2005: Waiting to be finished in Spring 2006.

Construction process: The idea for this greenhouse came from the previous one. The major differences are a change in location and an increase in overall size. The current location features much less wind, but also less sunlight. The first step was to dig holes for the metal poles and fill them with cement with the poles inside. Then the wood was attached to the roof of the building where the PVC tubes would be attached with screws. Then the PVC tubes were modified and a support beam added. Once that was done they were attached to the posts with wire and tape and then screwed into the wood on the roof. The final steps were to construct the walls and put on the plastic. Contact Brian Hawkins at badslink@email.arizona.edu for specific details on this construction process.

Problems encountered: The left wall and the structure's roof had been covered in plastic and completed before the right wall was ever completed with plastic. This allowed wind to enter through the right wall and remove the plastic from the roof and left wall. This is a problem very similar to what AJ Mitchell experienced, in that only part of the greenhouse was covered with plastic and left to sit for a number of days, consequently

allowing the wind to enter and remove the plastic. Also, there were certain sections of the building that this greenhouse was being built against that were harder to drill into than others. This forced a number of setbacks and improvisations.

Lessons learned: This greenhouse reinforced the necessity of completely covering and sealing one's greenhouse with plastic in one construction day. If only part of the structure is covered in plastic and left to sit, it is very likely that winds will remove that plastic and cause some major setbacks. Thus, if possible, getting the entire structure covered and sealed in plastic in one day is the best option. Also, this greenhouse required heavy improvisation, due to the odd nature of the building it was being constructed against. This caused a variety of setbacks and delayed the greenhouse's finishing date to spring 2006. Thus, the fewer improvisations one has to make the better. Finally, if this greenhouse were made slightly smaller, it may have been easier to handle and required less improvisation.

Advice: The greenhouse building experience at CETis has illustrated a number of important lessons towards building greenhouses in general. First, a well thought out plan can seriously facilitate the construction process. That means going beyond the base design plans and thinking through each detail of the structure and process in an effort to make as few improvisations as possible. The more improvisations one has to make, the longer the construction process takes and the more issues one has to tackle. Second, one must take into strong consideration the location of one's greenhouse. Finding the right location is a critical first step in building a successful greenhouse. Third and finally, one must think in the long term about what one wants out of their greenhouse. Is a durable and long-living greenhouse desired, or a more temporary one that will last a matter of months or years? What is the educational value of either option? These decisions will greatly affect the design, cost and complexity of construction process for the greenhouse.

7. CONALEP's Greenhouse

Location: CONALEP school in Nogales, Sonora.

Style: Quonset.

Materials:

- PVC pipe.
- Greenhouse plastic.
- Cinder blocks.
- Wood.
- PVC plastic clips.
- Boulders.

Cost: Approximately $130, with some materials including the greenhouse plastic donated. If the greenhouse plastic were purchased, the cost would be approximately $180.

Advantages and disadvantages: The PVC pipes feel feeble compared to wood, for example. Also, the structure is rather permanent given the use of cement to hold the PVC in place. However, the location chosen is relatively wind-free and thus the greenhouse is still standing.

Status as of December, 2005: Constructed and in use.

Construction process: A general idea of design was created before construction. Some improvisations were made - like anchoring the greenhouse plastic and creating the door – throughout the process. The process started with digging the holes for the cinder blocks where the PVC pipes would be cemented into place. Once the cinder blocks were placed inside, the PVC pipes were inserted and cemented in. Then tables were built inside the structure with wood. After this the plastic was placed on the structure and fastened with the PVC plastic clips. The plastic sections were glued together given that the plastic covering was composed of more than one piece. Finally, a hole was cut in the front for the door. This greenhouse took approximately 20 hours to build with a small team of students.

Problems encountered: Dividing labor for the construction process proved to be difficult. Also, in retrospect, a welded steel structure would be more stable and durable. This would require resources such as tools, money and skilled labor to be available.

Lessons learned: More time spent on organizing labor and planning the design would have been a good idea.

Advice: In the words of one who helped build this greenhouse, spending one's time raising money for and organizing skilled labor to be put into the project would be a good

idea. This would allow the greenhouse to be completed in a matter of a day or so and eliminate problems that can arise from inexperienced work, ultimately resulting in a stronger and better built structure. However, given the secondary educational goal of ARAN greenhouse construction, it is important to allow students to have a significant hand in the construction of their greenhouse. Perhaps what would be best is getting hired and experienced labor to work with the students, and act as mentors as well as laborers.

8. Conclusion

The greenhouses that are reviewed in this manual show a number of important lessons, concepts and factors that can determine the success or failure of a built-from-scratch, community greenhouse and greenhouses in general. This manual was designed to assist in the planning and construction of greenhouse by and for community members. Many of the lessons concepts presented here may not be thought of by someone new to greenhouse construction. Thus, in this conclusion section, the lessons, concepts and factors are compacted and reinforced. That way, the hard work, mistakes and learning of others will not be wasted, and successful greenhouses can be realized in the future.

To begin with, regular maintenance of one's greenhouse is of extreme importance. Though this may appear an obvious and rudimentary fact, it is one that cannot be overstated and is one that is often overlooked. One can not simply build a greenhouse and let it sit, as if that was the end of the project. Any greenhouse requires regular attention and patching well after it is constructed. If a problem is allowed to remain for a period of time post-construction, such as a tear in the plastic covering, then it can grow and cause serious problems over time and likely cause the downfall of the structure. Therefore, repairs and attention to details post-construction are of utmost importance.

Second, a crucial detail that most greenhouse novices do not realize is the importance of covering the entire structure with plastic in one workday. In the cases of the AJ Mitchell greenhouse and CETis' third greenhouse, the partial covering of the structure with plastic actually proved counterproductive. These greenhouses were partially covered with plastic in order to get as much work done in one day as possible and advance the project. They were then allowed to sit for a week or so afterwards. Consequently, the wind had sufficient time to enter and remove what plastic was attached through the uncovered sections of the greenhouse. Were all the plastic attached in one day and the greenhouse sealed off before workers or students left for the day, this would not have occurred and the greenhouses may have been finished as of the writing of this manual.

Third, it can be argued that one of the most important aspects, if not the most important aspect, about a greenhouse is its location. An ideal location receives a good amount of sunlight, has a nearby water source, has mechanisms such as sloped ground that allows rainwater to drain, and is protected from winds. Both of the greenhouses at CETis have been either set back or deconstructed because of the exceptionally strong winds at the school, though they did satisfy the other location requirements. Unfortunately the CETis school is situated on top of a hill in an already windy area, and thus there are very few if any locations at the school that are truly suitable for a sizeable greenhouse. As of the writing of this manual, CETis students are finishing their current greenhouse project, and have other options in mind should the wind ultimately prove too formidable for the greenhouse size they have chosen. Fortunately, the students at CONALEP took the lessons learned by CETis students and have chosen an excellent location for their greenhouse, the primary reason for it still standing and being used. The CONALEP location features a number of nearby buildings that serve as wind-breakers, and is not situated atop a hill or on a high and exposed area.

Fourth, when building a greenhouse at a school, like most of those covered in this manual, one must take into consideration the educational value of greenhouse construction for the students of the school. It is possible to purchase a greenhouse construction kit that comes with instructions and all parts necessary. The problem with the pre-made greenhouse kits is that not only are they expensive, but they minimize the planning, problem solving, team work, resource allocation and research skills that students can acquire through building their own greenhouse from scratch. It is also possible to hire skilled labor to construct one's greenhouse, but that also decreases the educational value of the project for the students of the school. Furthermore, students will have far less interest in something they did not build themselves than something they did. Putting in one's own efforts and energy into a project like a greenhouse creates a sense of attachment towards the project. This sense of attachment helps facilitate the post-construction process (repairs and maintenance), as the students will care more about the greenhouse at their school given they planned and built it themselves.

Finally, when deciding on the design of one's greenhouse, one must take into consideration the combination of factors that have been discussed here. These include resources available (materials, money etc.), long term plans (a more expensive and durable structure or a more temporary and cheap structure), intent of the greenhouse (an educational tool, an augmentation to one's nursery, or both), and location (ideally wind free and with plenty of sun). It is possible to build greenhouses that exist seasonally, which are deconstructed and the materials recycled as necessary. At the same time, more permanent structures can be made that are used throughout the year and that last for years. One must take into consideration each of the factors listed when making the decision concerning the design of the greenhouse.

With the lessons and factors outlined in this manual in mind, follow the basic steps from the subsequent "how-to" guide by Miss Hawkins. The combination of using the lessons, factors and outlined in this manual with the basic "how-to" guide should allow one to realize a successful greenhouse.

9. A Basic Guide by Christine Hawkins

December 2004

Why are Greenhouses so cool? Actually, they aren't just cool, they're hot! They're often also called 'hothouses' because their primary function is to keep delicate plants warm during cold weather. While this can be done in many ways – *i.e.* covering plants with protective fabric – greenhouses have the unique advantage of not simply protecting plants from the cold, but also providing light and air. In essence, they provide a prime growing environment for your plants. This means they grow faster and healthier than they would if they were left to the outdoor elements.

Steps:

1. **Choose your site.**
    a. Consider orientation (south-facing is better than north facing).
    b. Consider water source (is there a pump, well or hose nearby? Can you get a hose into the structure?).
    c. Optionally, consider a nearby shed or storage area to house soil, pots and tools.
2. **Draw out plans and take measurements.**
    a. When deciding to build a greenhouse, first decide what you are going to grow. This may help you decide how big you need to build and how fancy you might want to get.
3. **Find supplies and labor.**
    a. Don't be afraid to hit up suppliers for extra supplies. They often times can spare ends of plastic sheeting or some materials to you for a tax deduction.
    b. There are some great web pages about greenhouses. Most suppliers can be found there too! Try http://www.greenhouse.net/. About half way down the page there are some great links to how-to's and information you might find useful. Try typing in a search like "Arizona greenhouse supply."
4. **Build it!**
    a. Grade the site – slope the soil so that any water that runs off of pots or from rains does not pool next to the building or in the greenhouse. It should drain downhill or into a ditch nearby and away from structures.
    b. Install corner posts. If possible use pre-treated 4x4 lumber. Pre-treated lumber will rot less quickly. Dig postholes, set poles in holes and compact the fill dirt with the flat end of a digging stick. Use 2x4's to create the framework
    c. Put a few inches of gravel down on the floor. This helps to prevent weeds from growing, keeps you and your plants out of the mud and keeps things drier.
    d. Staple plastic sheeting as appropriate over the sides of the greenhouse such as where the door is.
    e. Lay plastic sheeting over the roof so that it drapes down and over the end wall. Staple only to roof. Leave the endwall draped so that during hot

days it can be rolled up and doors opened to allow the greenhouse to be vented. Otherwise the plants may cook!

5. **Plant it!**
    a. Decide what plants are appropriate to grow during your season. Search the web for 'winter vegetables' or ask a local garden center.
    b. Get pots, labels, potting soil (do not use regular ground dirt as it does not have the ability to keep plants in pots growing well), fertilizer, hoses and other tools.
    c. You can either install benches or grow in pots on the ground.
    d. Monitor regularly for signs of harmful insects or plant disease. Your primary line of defense is to keep the greenhouse clean of weeds, dead material and empty pots. Do not bring in 'sick' plants or use the greenhouse for storage (slugs love when you do!). Use good, clean, healthy material. Keep watered and fertilized for a great crop!

APPENDIX G
REPORT ON SURVEY OF HIGH SCHOOL STUDENTS

Air Quality and Environmental Awareness Among Nogales Youth
Summary Report: Fall 2005
Nogales, Arizona, U.S.
Nogales, Sonora, México

Dana Mastro, Ph.D.
University of Arizona
mastro@email.arizona.edu

José Sprigg
University of Arizona
jsprigg@u.arizona.edu

Contents

I. Introduction

Studies of environmental risk exposure indicate that residents of the U.S.-Mexico border region manifest disproportionately high rates of morbidity and mortality due to environmental pollutants (Stephen et al., 2003; Williams & Florez, 2002), including heightened concentrations of air pollution and atmospheric particulate matter (ADEQ, 1999). An extensive investigation of air quality in Ambos Nogales conducted by Arizona Department of Environmental Quality (ADEQ, 1999) revealed elevated concentrations of particulate matter in this region which was attributed to unpaved roads and excessive levels of hazardous air pollutants resulting from the operation of motor vehicles, the storage of petroleum products, and industrial processes on both sides of the international border. This increased exposure to air pollutants has been estimated to significantly elevate the rate of hospitalizations, asthma episodes, lower respiratory diseases, and premature deaths from respiratory or cardiovascular diseases among the residents of Ambos Nogales (ADEQ, 1999; see also Siegel, Berliner, Adams & Wasongarz, 2003).

I-A: Background

Because they are situated at the crossroads of multiple jurisdictions (federal, state, local), the residents of this region face a unique set of challenges if they desire to learn more about the health risks posed by the degradation of air quality. The purpose of the current effort, funded in part by a grant from the U.S. Environmental Protection Agency, has been to examine some of these challenges and to understand the determinants of information seeking about the issue of air quality among a sample of Mexican and Mexican American youth in Ambos Nogales. In so doing, (a) awareness of how demographic, cultural, and communication factors relate to past and future information seeking and sharing is enhanced and (b) the development of effective health

communication programs aimed at promoting local environmental health pertaining to air quality is facilitated.

Involving youth in the region in environmental health efforts is essential as they are valuable liaisons through whom environmental information can reach entire families (Federal Advisory Committee to the U.S. Environmental Protection Agency Report, 1999). In addition, high school students in Nogales, Arizona frequently belong to the first English speaking generation in their families (Pavlakovich-Kochi & Walker, 2002). As such, they are likely to serve as mediators for their families, who may increasingly rely on these children to interpret interactions with the social environment (Chu, 1999).

I-B: Framework

To achieve these objectives, this project applied empirical and theoretical research on the comprehensive model of information seeking (CMIS), which describes information seeking and the outcomes of information seeking in terms of the role played by: (a) background factors such as demographics, direct experience, and knowledge, (b) personal relevance factors including the salience of the issue and belief in personal efficacy, (c) characteristics and utility of the channels of information, and (d) individual information seeking actions (Johnson et al., 1995; Johnson & Meischke, 1993). Insights from findings in this area were utilized as individual information seeking has been found to be a critical element in determining health behaviors. More specifically, active and effective information seeking has been shown to play a fundamental part in the adoption and implementation of beneficial health practices (Johnson & Meischke, 1993). Together, the variables specified by the CMIS provide a flexible, conceptual model useful in the creation of appropriate and manageable health intervention strategies. As such, this collaborative

effort applies the CMIS to the issue of air quality and environmental health among youth in Ambos Nogales.

II. Method

II-A: Participants

The participants were 303 high school students from the Ambos Nogales area including students from a U.S. school (n = 140) and a Mexican school (n=163). The U.S. participants were somewhat more likely to be female (64%) with an average age of 15.14 (SD = 1.09). Ninety-seven percent of the U.S. participants reported their ethnicity as "Mexican" or "Mexican-American"; one reported as "White" and one as "Asian-American"; 2 participants did not report their ethnicity. The participants from Mexico had an average age of 16.59 (SD = 1.19) and there were somewhat more males (60%) than females. All of the respondents from Mexico reported their ethnicity as "Mexican" with the exception of 2 participants who did not answer the question.

II-B: Procedures

After consent was obtained, participants completed the survey in approved class-time during the regular school day, in the 2004-2005 academic year. No incentives were provided for survey completion. The students were offered the questionnaire in either English or Spanish. The Spanish version was translated and back-translated to ensure accuracy of translation.

II-C: Measurement

Alongside demographics (i.e., age, sex, & race/ethnicity), questions pertaining to existing knowledge, attitudes, and behaviors about air quality also were measured. These follow:

1) Perceptions About Air Pollution:
   - General perceptions of severity of air pollution in Nogales
   - Perceptions of severity of air pollution relative to other environmental issues in Nogales

2) Knowledge About Air Pollution:
- General knowledge about sources of air pollution (e.g., diesel truck emissions, dust, etc.)

3) Perceived Responsibility for Air Pollution:
- Personal responsibility for air pollution in Nogales (e.g., individuals, businesses, etc)
- Responsibility to improve air quality in Nogales

4) Attitudes About Air Quality:
- Personal importance of air quality and involvement with the issue
    - direct importance for individuals
    - perceived effect on health
    - perceived effect on environment
- Perceptions of individual ability to improve air quality (e.g., self-efficacy, empowerment)
- Willingness to support air quality improvements
    - Willingness to make personal changes in lifestyle to improve air quality
    - Willingness to encourage others to make changes to improve air quality

5) Information About Air Quality:
- Sources of information
- Credibility of information sources
- Depth of information
- Satisfaction with level of information
    - Interest in learning more about air quality
- Satisfaction with quality of information

II-D: Analyses

Descriptive statistics and t-tests were used to provide baseline, comparative information about participants in the U.S. and in Mexico. Whenever appropriate, scales were constructed using confirmatory factor analysis, including tests of internal consistency and parallelism.

In order to assess the model of information seeking among this sample of Ambos Nogales students, a statistical technique known as path analysis was used. Simply put, path analysis tests the causal effects across a series of variables linked together in a structural diagram, of sorts. More technically speaking, path analysis tests the fit of factor

models using an ordinary least squares estimation procedure that allows parameters to be corrected for measurement error without biasing the test toward finding significant paths, as standard errors are increased as a result of this correction (Hunter & Gerbing, 1982). Thus, findings from these path analyses are essential for the development of health communication efforts aimed at improving awareness, knowledge, and actions pertaining to air quality.

III. Results

III-A: Descriptive Findings: <u>U.S.</u>

1) Perceptions About Air Pollution:

- When asked to list their top three environmental concerns in Nogales (22% responded "None"):

First Mentioned	*Second Mentioned*
1. Air Quality (34%)	1. Air Quality (32%)
2. Water Quality (19%)	2. Littering (25%)
3. Vehicle Emissions (7%)	3. Water Quality (21%)

- On a scale from 1-5, with 1 indicating 'not at all' and 5 representing 'very much' students were asked their perceptions of the severity of air pollution as an environmental problem in Nogales and the importance of air quality relative to other environmental concerns. They reported:
  - Average rating of severity of problem of air pollution: 3.19
  - Average rating of relative importance of air pollution: 3.52

- On a scale from 1-5, with 1 indicating 'strongly disagree' and 5 representing 'strongly agree' students were asked to identify the origin of the majority of air pollution in the community. They reported:
  - Nogales, Arizona: 2.56
  - Nogales, Sonora: 4.19

2) Knowledge About Air Pollution:

- On a scale from 1-5, with 1 indicating 'not at all' and 5 representing 'very much' students were asked to rate the extent to which the following sources contribute to air pollution in Nogales. On average, they reported (in descending order):
  - Diesel truck emissions: 3.90
  - Emissions from buses: 3.59
  - Emissions from cars: 3.53
  - Emissions from large industries/factories: 3.32
  - Construction work: 3.14
  - Household cleaning products and paints: 3.10

- Outdoor burning of things other than wood or charcoal (e.g., newspaper, trash, etc): 3.07
- Dust from unpaved roads: 2.87
- Outdoor wood or charcoal burning: 2.79
- Dust from land without plants: 2.77
- Indoor burning of things other than wood or charcoal (e.g., newspaper, trash, etc): 2.64
- Indoor wood or charcoal burning (e.g. fireplaces/stoves): 2.54
- Emissions from small businesses: 2.45

3) Perceived Responsibility for Air Pollution:

- On a scale from 1-5, with 1 indicating 'not at all' and 5 representing 'very much' students were asked to rate how much responsibility should be placed on each of the following to improve air quality in Nogales. On average, they reported (in descending order):
  - The Nogales, Sonora Local Government: 4.15
  - The Nogales, Arizona Local Government: 4.07
  - Large industries: 4.04
  - The Mexican Federal Government: 3.81
  - The U.S. Federal Government: 3.57
  - Individual residents in the Nogales area: 3.45
  - Small business: 3.04

4) Attitudes About Air Quality:

- On a scale from 1-5, with 1 indicating 'disagree strongly' and 5 representing 'agree strongly' students were asked to rate how personally important the issue of air quality was to them, their health, and their environment. On average they reported:
  - Air quality in Nogales is important to me: 3.66
  - Air quality in Nogales directly affects me: 3.41
  - Poor air quality can be dangerous to your health: 4.47
  - Poor air quality can damage the environment: 4.46

- Perceptions of individual ability to improve air quality (e.g., self-efficacy) measured using a 3-item scale with response options ranging from 1-5, with a score of 1 representing 'disagree strongly' and 5 indicating 'agree strongly'
  - Average perceived self-efficacy: 3.35

- Willingness to support air quality improvements, assessed on a 5-point scale from strongly disagree (1) to strongly agree (5):
  - Average reported willingness to make personal changes in lifestyle to improve air quality: 3.74
  - Average reported willingness to talk to friends about air quality issues: 3.21
  - Average reported willingness to talk to family about air quality issues: 3.59

- Average reported willingness to ask friends to take action to improve air quality: 3.55
- Average reported willingness to ask family to take action to improve air quality: 3.62
- Average reported willingness to grow native plants in order to improve air quality: 3.64
- Average reported willingness to write a letter in support of improving air quality: 3.34

5) Information About Air Quality:

- 54% of students report *never* having seen or heard information or messages about air quality in the past year. Among those who have been exposed to air quality information, half (50%) report seeing/hearing between 1-3 messages in a year.

- On a 5-point scale from not often (1) to very often (5), how often have you discussed air quality with each of the following? Averages follow in descending order:
  - Teachers or School Officials: 2.39
  - Family: 2.38
  - Environmental Group: 2.35
  - Community Organizations: 1.76
  - Government Officials or Organizations: 1.54
  - Doctor/Nurse: 1.49
  - Religious Organizations: 1.14
  - Friends: 1.12

- On a 5-point scale from not often (1) to very often (5), how often have you been exposed to air quality messages from each of the following? Averages follow in descending order:
  - Newspapers: 2.49
  - TV: 2.46
  - Internet: 2.24
  - Pamphlets or Brochures: 2.14
  - Radio: 1.91

- Credibility of information sources was scored on a 5-point scale from not trustworthy (1) to very trustworthy (5). Specifically, students were asked who they trusted as a source of information about air quality in Nogales. Averages follow in descending order of trustworthiness:
  - Local Public Health Clinics: 3.74
  - State Public Health Agencies: 3.58
  - Teachers: 3.33
  - Community-Based Organizations: 3.26
  - Doctors: 3.17

- Family Members: 3.10
- Internet: 2.88
- TV: 2.78
- The Federal Government: 2.75
- Radio: 2.62
- Friends: 2.56
- Newspapers: 2.23
- Religious Leaders: 2.20

- Depth of information, satisfaction with current level information, and satisfaction with quality of information each were measured on a 5-point scale, with 1 designating 'not at all' and 5 indicating 'very'. Averages follow:
  - Depth of information: 2.19
  - Satisfaction with level of information: 2.17
  - Satisfaction with quality of information: 2.58

- Interest in learning more about air quality was assessed on a 5-point scale from strongly agree (1) to strongly disagree (5). Specifically, students indicated the extent to which they would like to learn more about air quality in Nogales. On average, they reported a score of: 3.74

III-B: Descriptive Findings: <u>Mexico</u>

1) Perceptions About Air Pollution:

- When asked to list their top three environmental concerns in Nogales (14% responded "None"):

First Mentioned	**Second Mentioned**
1. Littering (34%)	***1. Water Quality (21%)***
2. Water Quality (14%)	2. Littering (16%)
3. Air Quality (13%)	3. Air Quality (15%)

- On a scale from 1-5, with 1 indicating 'not at all' and 5 representing 'very much' students were asked their perceptions of the severity of air pollution as an environmental problem in Nogales and the importance of air quality relative to other environmental concerns. They reported:
  - Average rating of severity of problem of air pollution: 3.78
  - Average rating of relative importance of air pollution: 4.25

- On a scale from 1-5, with 1 indicating 'strongly disagree' and 5 representing 'strongly agree' students were asked to identify the origin of the majority of air pollution in the community. They reported:
  - Nogales, Arizona: 2.61
  - Nogales, Sonora: 3.32

2) Knowledge About Air Pollution:

- On a scale from 1-5, with 1 indicating 'not at all' and 5 representing 'very much' students were asked to rate the extent to which the following sources contribute to air pollution in Nogales. On average, they reported (in descending order):
    - Emissions from large industries/factories: 4.18
    - Diesel truck emissions: 3.94
    - Emissions from cars: 3.90
    - Emissions from buses: 3.89
    - Outdoor burning of things other than wood or charcoal (e.g., newspaper, trash, etc): 3.76
    - Dust from unpaved roads: 3.53
    - Indoor wood or charcoal burning (e.g. fireplaces/stoves): 3.52
    - Outdoor wood or charcoal burning: 3.50
    - Dust from land without plants: 3.38
    - Indoor burning of things other than wood or charcoal (e.g., newspaper, trash, etc): 3.36
    - Household cleaning products and paints: 3.10
    - Construction work: 3.04
    - Emissions from small businesses: 2.78

3) Perceived Responsibility for Air Pollution:

- On a scale from 1-5, with 1 indicating 'not at all' and 5 representing 'very much' students were asked to rate how much responsibility should be placed on each of the following to improve air quality in Nogales. On average, they reported (in descending order):
    - The Nogales, Sonora Local Government: 3.80
    - Large industries: 3.79
    - The Mexican Federal Government: 3.74
    - The Nogales, Arizona Local Government: 3.28
    - Individual residents in the Nogales area: 3.26
    - The U.S. Federal Government: 2.88
    - Small business: 2.75

4) Attitudes About Air Quality:

- On a scale from 1-5, with 1 indicating ‘disagree strongly’ and 5 representing ‘agree strongly’ students were asked to rate how personally important the issue of air quality was to them, their health, and their environment. On average they reported:
    - Air quality in Nogales is important to me: 4.04
    - Air quality in Nogales directly affects me: 4.04
    - Poor air quality can be dangerous to your health: 4.61
    - Poor air quality can damage the environment: 4.59

- Perceptions of individual ability to improve air quality (e.g., self-efficacy) measured using a 3-item scale with response options ranging from 1-5, with a score of 1 representing ‘disagree strongly’ and 5 indicating ‘agree strongly’
    - Average perceived self-efficacy: 4.10

- Willingness to support air quality improvements, assessed on a 5-point scale from strongly disagree (1) to strongly agree (5):
    - Average reported willingness to make personal changes in lifestyle to improve air quality: 4.17
    - Average reported willingness to talk to friends about air quality issues: 3.90
    - Average reported willingness to talk to family about air quality issues: 4.03
    - Average reported willingness to ask friends to take action to improve air quality: 3.95
    - Average reported willingness to ask family to take action to improve air quality: 4.06
    - Average reported willingness to grow native plants in order to improve air quality: 4.01
    - Average reported willingness to write a letter in support of improving air quality: 4.02

5) Information About Air Quality:

- 71% of students report having seen or heard information or messages about air quality in the past year. Among these, the students report most often seeing/hearing between 4-6 messages in a year (37%).

- On a 5-point scale from not often (1) to very often (5), how often have you discussed air quality with each of the following? Averages follow in descending order:
    - Teachers or School Officials: 3.23
    - Family: 2.93
    - Environmental Group: 2.72
    - Friends: 2.34

- Community Organizations: 2.03
- Government Officials or Organizations: 1.87
- Religious Organizations: 1.68
- Doctor/Nurse: 1.67

- On a 5-point scale from not often (1) to very often (5), how often have you been exposed to air quality messages from each of the following? Averages following descending order:
  - TV: 2.77
  - Radio: 2.71
  - Newspapers: 2.67
  - Internet: 2.56
  - Pamphlets or Brochures: 2.55

- Credibility of information sources was scored on a 5-point scale from not trustworthy (1) to very trustworthy (5). Specifically, students were asked who they trusted as a source of information about air quality in Nogales. Averages follow in descending order of trustworthiness:
  - Family Members: 3.48
  - Teachers: 3.42
  - Newspapers: 3.29
  - Internet: 3.26
  - TV: 3.23
  - Friends: 3.15
  - State Public Health Agencies: 3.14
  - Radio: 3.06
  - Local Public Health Clinics: 2.95
  - Community-Based Organizations: 2.94
  - Doctors: 2.47
  - The Federal Government: 2.44
  - Religious Leaders: 2.10

- Depth of information, satisfaction with current level information, and satisfaction with quality of information each were measured on a 5-point scale, with 1 designating 'not at all' and 5 indicating 'very'. Averages follow:
  - Depth of information: 2.88
  - Satisfaction with level of information: 2.30
  - Satisfaction with quality of information: 2.85

- Interest in learning more about air quality was assessed on a 5-point scale from strongly agree (1) to strongly disagree (5). Specifically, students indicated the extent to which they would like to learn more about air quality in Nogales. On average, they reported a score of: 4.15

III-C: U.S.-Mexico Comparisons

Perceptions About Air Pollution:

- Participants differed significantly in their perceptions of the severity of air pollution as an environmental problem [t (303) = 7.84, p = .001, r = .41]. Specifically, the students in Mexico identified local air pollution to be a more serious problem than did their counterparts in the U.S.

Knowledge About Air Pollution & Perceived Responsibility for Air Pollution:

- Students in the U.S. were significantly more likely than those in Mexico to suggest that the origin of the majority of air pollution in Nogales emanated from Nogales, Sonora [t(299) = 7.03, p= .001, r = .38].

Attitudes About Air Quality:

- Participants differed significantly in the extent to which they perceived air pollution to be a personally important issue [t (303) = 4.61, p = .001, r = .26]. Specifically, participants in Mexico reported higher levels of personal involvement with issues of air pollution than their counterparts in the U.S.

- Participants differed significantly in their perceptions of self-efficacy around taking steps to decrease air pollution problems [t (303) = 6.41, p = .001, r = .35]. The students in Mexico reported higher levels of perceived self-efficacy in terms of their ability to facilitate improvements in air quality in Nogales.

- Participants differed significantly in their intentions to take behavioral action to improve air quality [t (299) = 4.64, p = .001, r = .26] and in their intentions to share information about air quality issues with their family and friends [t (299) = 4.60, p = .001, r =.26]. In each case, students in Mexico reported higher intentions than their peers in the U.S.

Information About Air Quality:

- Participants differed significantly in their perceptions of their own knowledge about air pollution in Nogales [t (297) =7.78, p = .001, r = .41], with students in the U.S. reporting lower levels of knowledge about air pollution in their community.

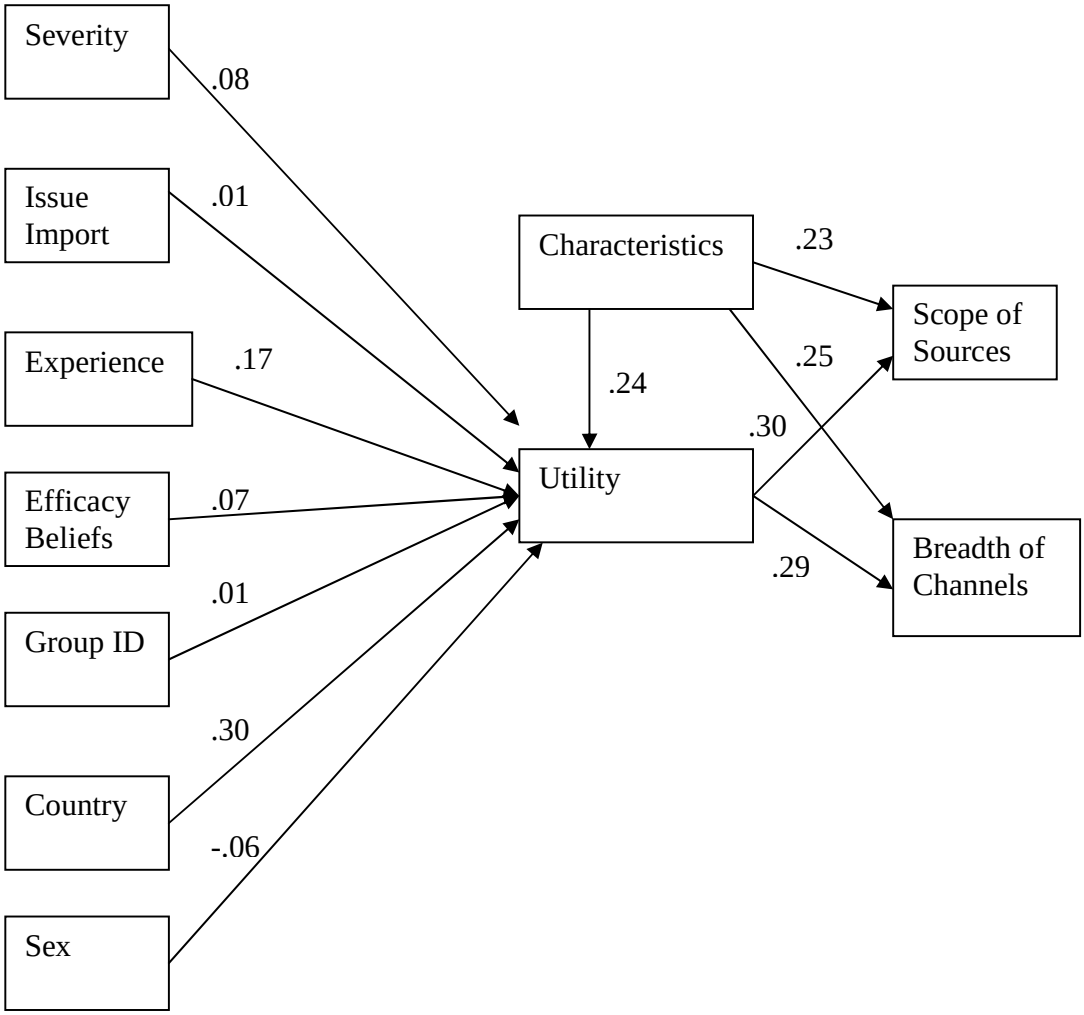
- Participants in both Mexico and the U.S. reported low levels of satisfaction with their understanding of the implications of exposure to air pollution on their health. Students in the U.S. revealed significantly lower levels of satisfaction [t(295) = 2.05, p<.05, r = .12] than their peers in Mexico.

IV. Ongoing Collaboration

In order to aid in the development of a collaborative information outreach program between the participating schools (both in Nogales, Arizona & Nogales, Sonora), a model of information seeking and sharing was tested based on the CMIS (Johnson et al., 1995; Johnson & Meischke, 1993). See model below.

It was hoped that a single model could be found, based on the specifications of the CMIS, which would successfully predict a process of information acquisition and sharing, such that a unified educational program could be implemented. In so doing, this has allowed the collaborating partners at each school, students at each school, and researchers on the project to participate collectively in the creation of a single informational program on local air quality.

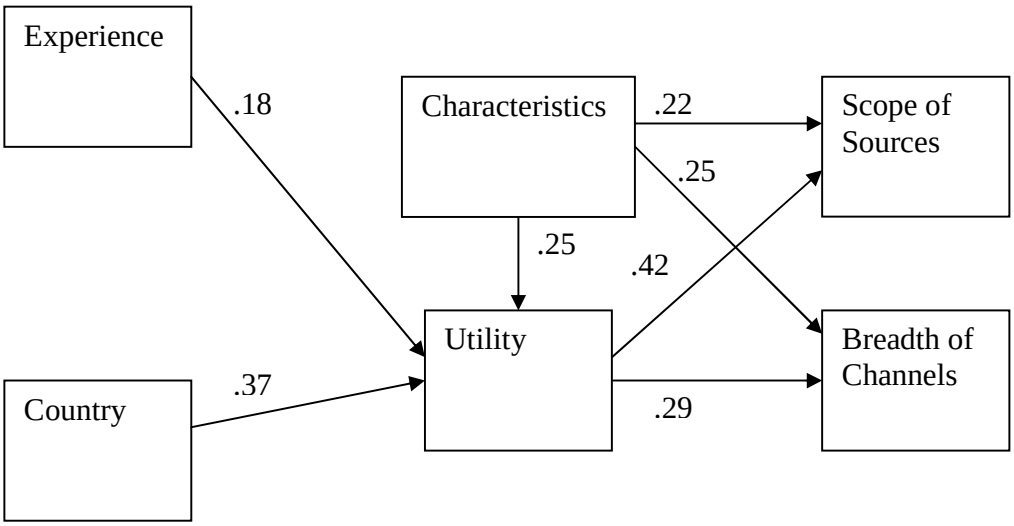
IV-A: Test of the Comprehensive Model of Information Seeking



The results of the test of the CMIS indicated that the data were not consistent with the complete CMIS model reported above. Therefore, the revised model (below) was

proposed and tested. Analyses revealed that the data were indeed consistent with the revised model. In terms of implications for a unified health communication outreach program, this model indicates that perceptions of the utility of air quality information are a function of two factors: country of origin and prior experience with air quality information. Specifically, participants from Mexico reported greater perceived utility of information than those from the United States. Similarly, those with previous experience with air quality information reported greater perceived utility of information. Utility perceptions also were substantially influenced by the information carrier characteristic of credibility, with higher credibility scores resulting in greater perceived utility. Finally, both of these factors positively influenced information seeking and sharing actions. Increasing scores on utility and credibility scales resulted in greater scope of sources and breadth of channels of information seeking and sharing. See model below.

IV-B: Test of the Revised Model



Although this unified model is meaningful in that it provides the framework for the continued collaborative efforts between the schools and the researchers on this project, it is clear that more effective education programs in this area will need to utilize models tested separately for each school. It is unmistakably the case that context (specifically, country of residence) plays a critical role in delineating the central features of information seeking and sharing. Although this is not surprising, it is of particular consequence to the present effort in that a number of key variables have been lost as a result of differences across the two samples. Therefore, although the ongoing collaborative efforts between the schools and the researchers on this project continue to be a priority, individually tailored programs are additionally in progress. Such individualized models offer the most comprehensive understanding of the factors that contribute to information acquisition and communication about air quality at the local level. As a result, each school's efforts will be improved by the incorporation of more customized approach.

V. References

ADEQ: Arizona Department of Environmental Quality (1999). *Ambos Nogales hazardous air pollution and particulate matter air quality study final report*. (Document No. 049-016-300). Phoenix, AZ.

Chu, C. M. (1999). Immigrant child mediators (ICM): Bridging the literacy gap in immigrant communities. Paper presented at the 65th IFLA Council and General Conference, Bangkok, Thailand. Retrieved September 15, 2005, from http://www.ifla.org/IV/ifla65/ papers/109-145e.htm

Federal Advisory Committee to the U.S. Environmental Protection Agency. (1999). *Unheard voices from the border: A report on environmental justice in the U.S.-Mexico border region from the past to the future.* A report developed from the Proceedings of "The NEJAC International Roundtable on Environmental Justice on the U.S.-Mexico Border (August 19-21, 1999, National City, CA)".

Hunter, J. & Gerbing, D. (1982). Unidimensional measurement, second order factor analysis, and causal models. In B. Staw and L. Cummings (Eds.), *Research in Organizational Behavior Vol. 4*, (pp. 267-320). Greenwich, CT: JAI Press, Inc.

Johnson, J. D., Donohue, W. A., Atkin, C. K., & Johnson, S. H. (1995). A comprehensive model of information seeking: Tests focusing on a technical organization. *Science Communication, 16*, 274-303.

Johnson, J. D., & Meischke, H. (1993). A comprehensive model of cancer-related information seeking applied to magazines. *Human Communication Research, 19*, 343-367.

Pavlakovich-Kochi, V., & Walker, M. P. (2002). *Arizona's Border Issues: July, 2002*. Retrieved September 30, 2005, from http://www.commerce.state.az.us/pdf/prop/sesreports/ order.pdf

Siegel, B., Berliner, H., Adams, A., & Wasongarz, D. (2003). *Addressing health disparities in community settings: An analysis of best practices in community-based approaches to ending disparities in health care*. New York, NY: School University, Robert J. Milano Graduate School of Management and Urban Policy.

Stephen, G. A., McRill, C., Mack, M. D., O'Rourke, M. K., Flood, T. J., & Lebowitz, M. D.
(2003). Assessment of respiratory symptoms and asthma prevalence in a U.S.-Mexico border region. *Archives of Environmental Health, 58* 156-162.

Williams, B. L., & Florez, Y. (2002). Do Mexican Americans perceive environmental issues
differently than Caucasians: A study of cross-ethnic variation in perceptions related to water in Tucson. *Environmental Justice, 110*, 303-309.

APPENDIX H
SUMMARY OF FINDINGS OF HOUSEHOLD ASSESSMENT OF TRIGGERS FOR ASTHMA AND RESPIRATORY DISORDERS

ENCUESTA SOBRE CONDICIONES DE VIDA QUE PUEDEN PROVOCAR ASMA

1.-TIENE MASCOTAS?

2.-QUE USAS PARA COCINAR?
ESTUFA,BRACERO,ORNILLA, OTRA.

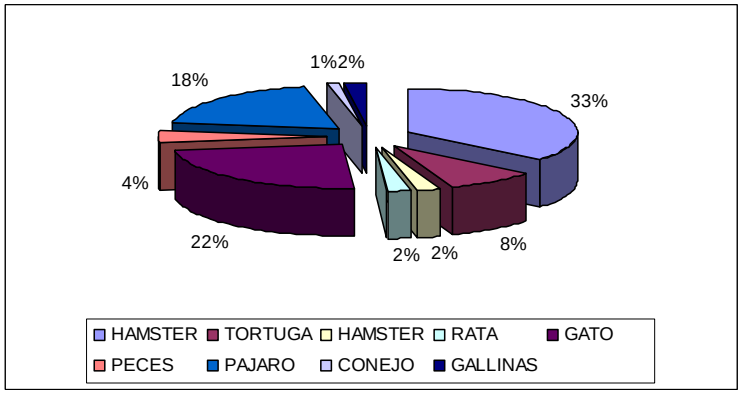
3.-ESTA DENTRO O FUERA DE LA CASA?

4.-QUE HACEN CON SU BASURA?
QUEMAN, RECOGE EL CAMION, TIRA EN OTRA PARTE, OTRO.

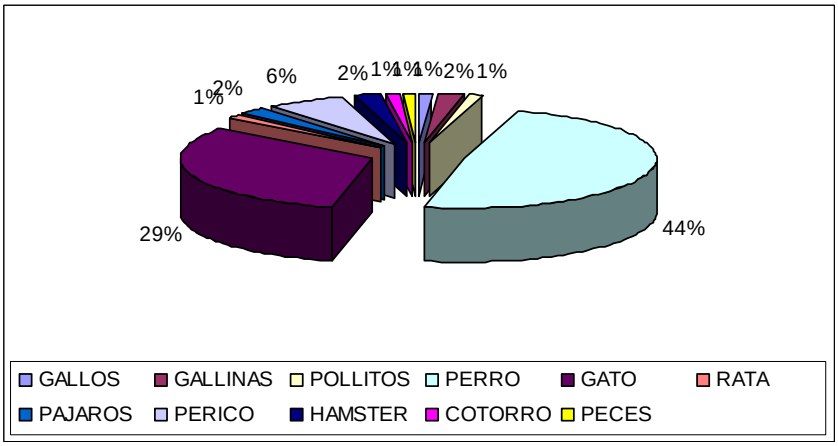
5.-QUE METODOS UTILIZA PARA LIMPIAR SU CASA?
BARRER, TRAPEAR, SACUDIR, ASPIRADORA, TODOS, OTRO.

6.-QUE UTILIZA PARA MANTENER ALEJADOS INSECTOS, CUCARACHAS
Y OTROS ANIMALES?
SPRAYS, VENENO EN POLVO, METODOS NATURALES, ART. DE ASEO,OTRO.

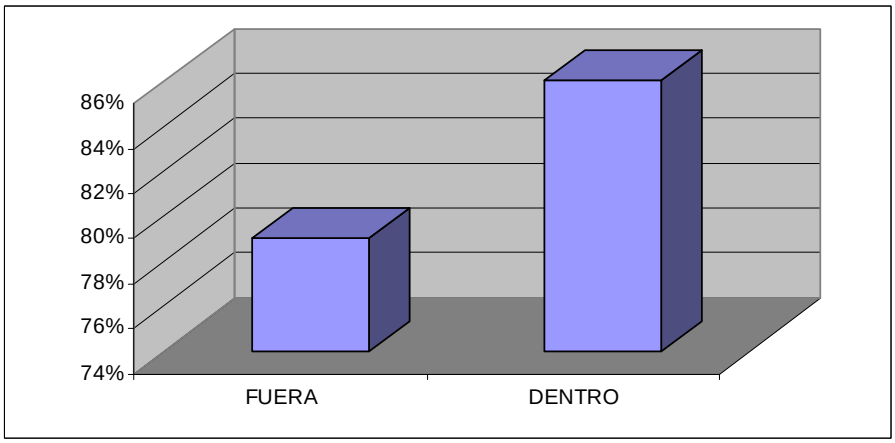
1.-Tiene mascotas?
Es la respuesta al si y que tipo de animales tienen los habitantes de la colonia Colosio esta encuesta representa la cantidad de animales que tienen los habitantes.



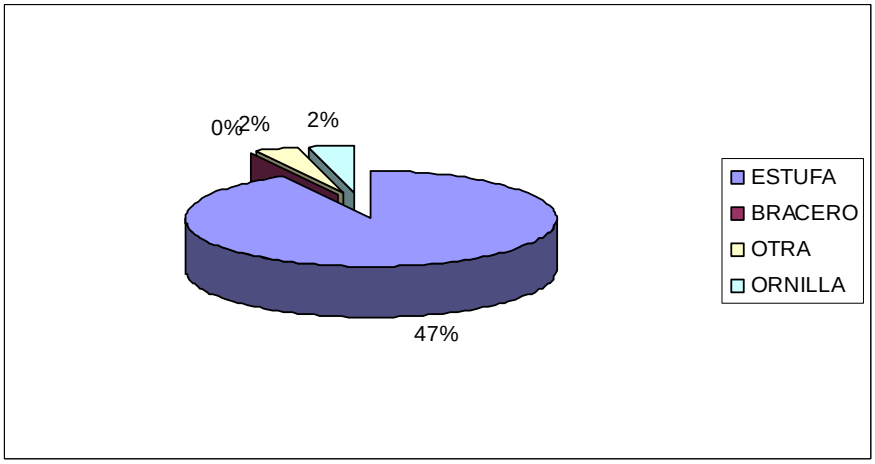
Es la respuesta al si y que tipo de animales tienen los habitantes de la colonia Bella Vista esta encuesta representa la cantidad de animales que tienen los habitantes.



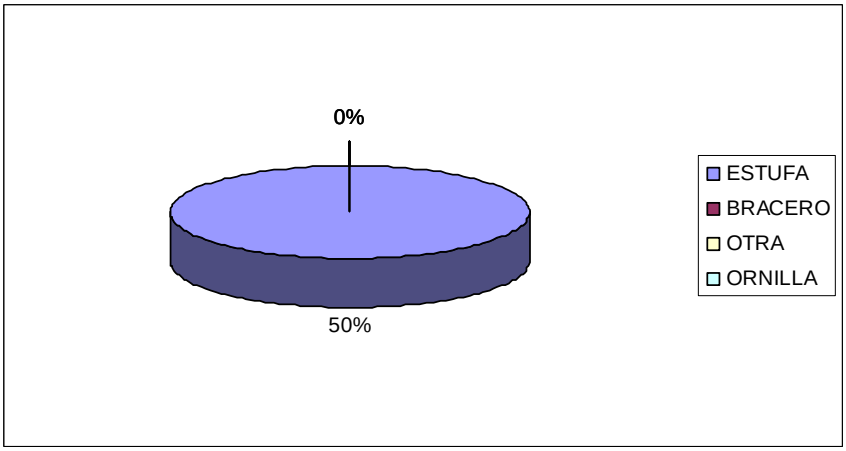
Esta grafica muestra la cantidad de personas que mantienen a sus mascotas dentro de su hogar y es parte de la pregunta anterior, donde ambas colonias tienen esemalhabito que afecta a la salud.



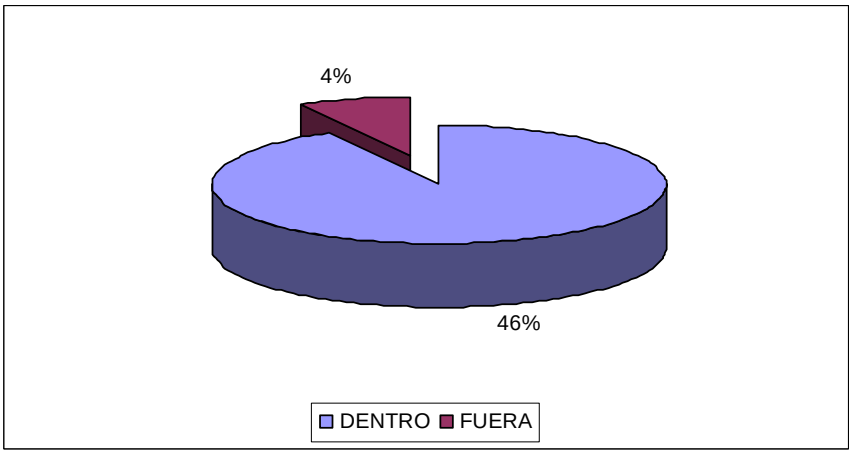
2.-Que usas para cocinar?
Esta demuestra lo que las personas de Colosio utilizan para cocinar sus alimentos tomando en cuenta las posibilidades de que generaran humo dentro de su casa que es un desencadenante de asma.



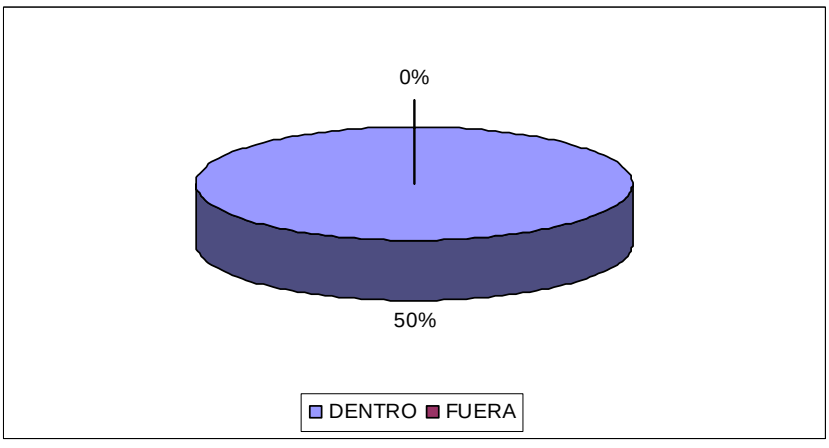
2.-Que usas para cocinar?
Esta demuestra lo que las personas de Bella Vista utilizan para cocinar sus alimentos tomando en cuenta las posibilidades de que generaran humo dentro de su casa que es un desencadenante de asma.



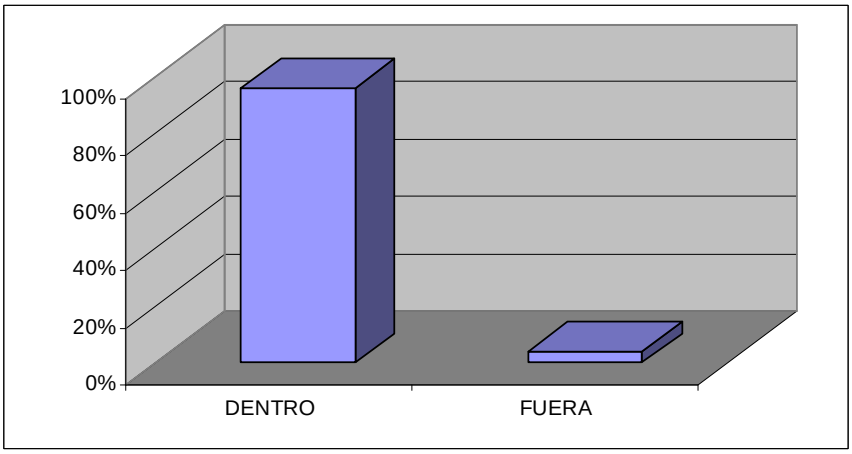
3.-Esta fuera o dentro de la casa?
Esta pregunta define el lugar donde tiene ubicadas sus estufas y el 46 % de colonia Colosio la tiene dentro



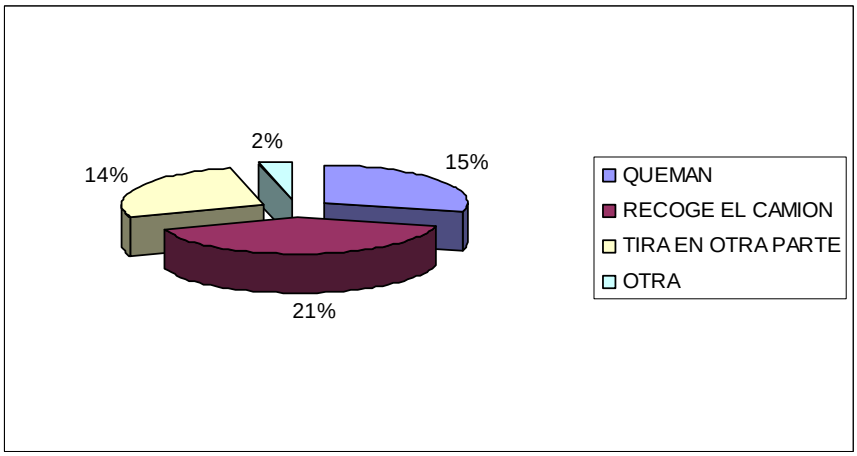
3.-Esta fuera o dentro de la casa?
Esta pregunta define el lugar donde tiene ubicadas sus estufas y el 50 % de colonia Bella Vista la tiene dentro



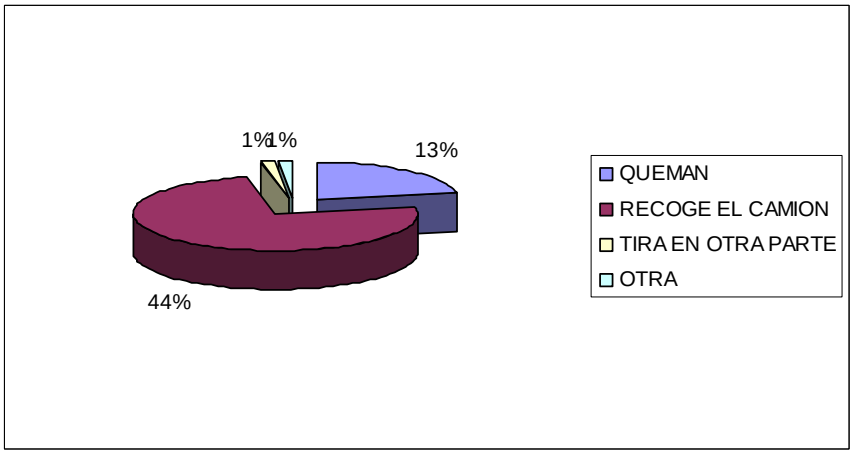
Esta grafica es parte de la pregunta 3 donde se ve indicada la parte donde esta el Utencilio de conica que usan los habitantes de las 2 colonias.



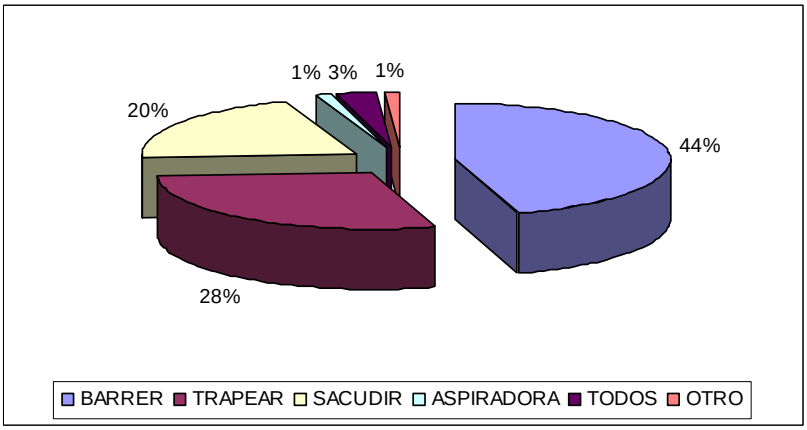
4.-Que hacen con su basura?
Esta pregunta muestra la actividad que realizan las personas que viven en colonia Colosio, segun los datos que se arrojaron el camion recolecta la basura pero aun asi existen un pequeno detalle que se sigue, es decir queman la basura y es un gran problema que se debe evitar.



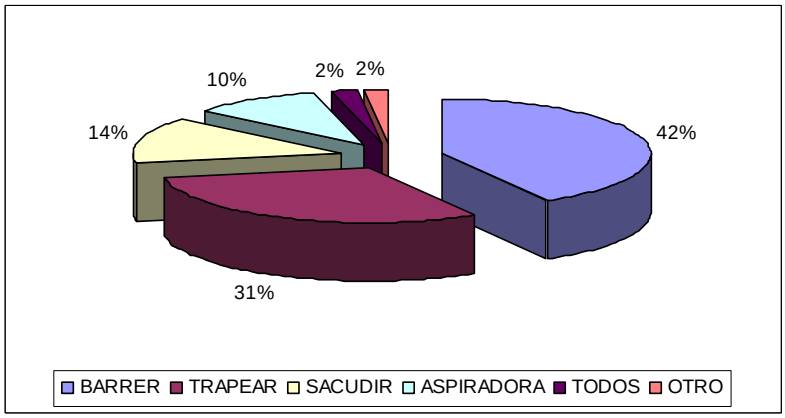
4.-Que hacen con su basura?
Esta pregunta muestra la actividad que realizan las personas que viven en colonia Bella Vista, segun los datos que se arrojaron el camion recolecta la basura pero aun asi existen un pequeno detalle que se sigue, es decir queman la basura y es un gran problema que se debe evitar.



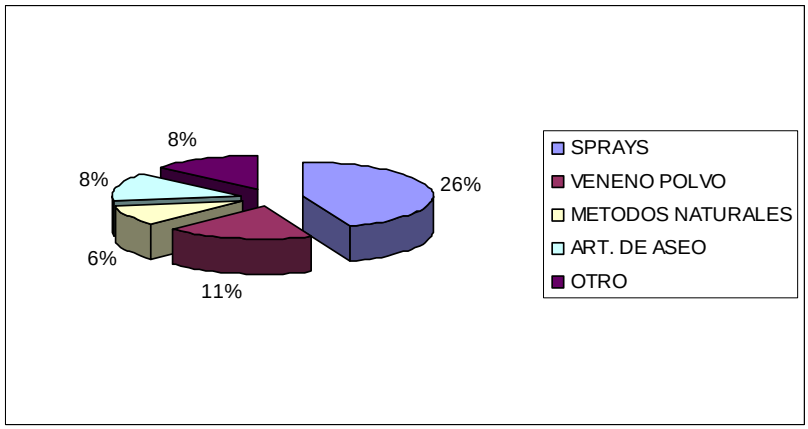
5.-Que metodos utiliza para limpiar su casa?
Esta pregunta nos da un tip muy importante el saber si en la casa de los habitantes de Colosio realizan algun tipo de actividad que perjudique la salud y evidentemente en las casas no tienen piso(cemento), solo es tierra y al barrer levantan polvo y con ello otra serie de microbios que son desencadentantes de asma.



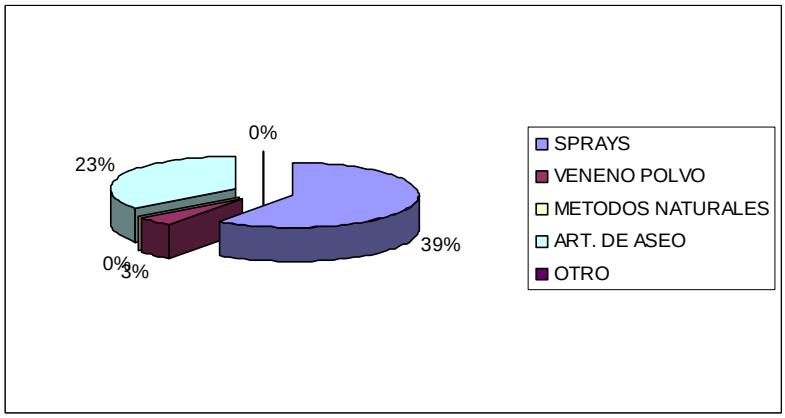
5.-Que metodos utiliza para limpiar su casa?
Esta pregunta nos da un tip muy importante el saber si en la casa de los habitantes de Bella Vista realizan algun tipo de actividad que perjudique la salud y evidentemente en algunas de las casas no tienen piso(cemento), solo es tierra y al barrer levantan polvo Y con ello otra serie de microbios que son desencadentantes de asma.



6.-Que utiliza para mantener alejados insectos,cucarachas y otros animales?
Esta pregunta tiene la finalidad de saber que medio utilzan las personas de Colosio para mantener protegidas sus viviendas de animales, las personas utilizan los comunes sprays, lo cual aparte de perjudicar directamente el ambiente afecta a la salud y provoca asma debido a los quimicos que estos contienen.



6.-Que utiliza para mantener alejados insectos,cucarachas y otros animales?
Esta pregunta tiene la finalidad de saber que medio utilzan las personas de Bella Vista para mantener protegidas sus viviendas de animales, las personas utilizan los comunes sprays, lo cual aparte de perjudicar directamente el ambiente afecta a la salud y provoca asma debido a los quimicos que estos contienen.



APPENDIX I
REPORT FROM PUNTA VERDE CONSULTANTS ON WORKSHOP FOR NOGALES, SONORA TEACHERS

"Del Aula a la Naturaleza: Construyendo Hábitats
en Patios Escolares"

COLEGIO DE EDUCACION PROFESIONAL TÉCNICA DEL ESTADO DE SONORA
PLANTEL NOGALES y ASOCIACIÓN DE REFORESTACION DE AMBOS NOGALES (ARAN)

24 al 27 de agosto de 2005

Antecedentes

Durante 2004, PV y Diane Austin empezaron a explorar la posibilidad de llevar este taller a los maestros de la región fronteriza de los Dos Nogales a través de ARAN. Esta iniciativa se concretó en agosto de 2005, con el apoyo de la gente de ARAN quienes organizaron toda la logística para llevar a cabo el taller.

Descripción de la herramienta

"Del Aula a la Naturaleza: Construyendo Hábitats en Patios Escolares", es una herramienta pedagógica que:

- Se aplica de manera transversal en todas las materias y para todos los grados: preescolar, primaria y secundaria
- Ayuda a cumplir con los objetivos académicos planteados por la Secretaría de Educación de una manera concreta, activa, constructiva y divertida.
- Permite que los niños internalicen los conceptos y problemáticas relacionadas con el agua, de tal forma que se fomenten conductas proactivas en ellos.
- No implica trabajo extra para los maestros, por lo que es un modelo práctico que les facilita su labor docente.
- Sirve como complemento a la carga de trabajo ya establecida para los maestros.
- Facilita la enseñaza de ciertos objetivos curriculares.

"Del Aula a la Naturaleza: Construyendo Hábitats en Patios Escolares" fue desarrollada por Nacional Wldlife Federation (NWF) y traducida y adaptada al español por Punto Verde Consultores S. C. (PV). Esta metodología ha sido utilizada en los Estados Unidos de Norte América por más de 10 años. En México, desde 2002 PV ha capacitado a más de 1500 maestros y personal que labora en ONGs.

"Del Aula a la Naturaleza…" fue piloteada por primera vez en el país durante el año escolar 2002 - 03 en el estado de Nuevo León en 15 escuelas, de las cuales la mitad eran escuelas públicas estatales. Debido al éxito de este programa piloto, durante el ciclo escolar 2003 -04 PV logró un acuerdo con la Secretaría de Educación de Nuevo León (SENL) para llevar a cabo el curso en un formato diplomado para 900 maestros de todo el Estado.

Este proyecto ha sido implementado en diferentes sedes de la República Mexicana, con una red de socios locales y fondos de diferentes fuentes:

Sede	Año	Beneficiarios	Socio local	Financiamiento
Monterrey, NL	2004	60 maestros	Talentum, AC	National Wildlife Federation
Monterrey, NL	2004	900 maestros	Secretaría de Educación de Nuevo León	National Wildlife Federation
Guanajuato, Guanajuato	2004	40 estudiantes	Universidad de Guanajuato	Universidad de Guanajuato
San Diego, California	2004	20 promotores comunitarios, maestros y personal de ONGs	Probea	Nacional Wildlife Federation
Piedras Negras, Ciudad Acuña y Parras de la Fuente, Coahuila	2004	70 maestros e instructores	Instituto Coahuilense de Ecología	Agencia para la Protección Ambiental de los Estados Unidos Parte del programa de Frontera 2012
Ciudad de México	2004	40 maestros e instructores	Pronatura, AC	National Wildlife Federation
Ciudad de México	2004	Directivos de ONGs y otras instituciones y organismos descentralizados	CICEANA AC	Nacional Wildlife Federation
Reynosa y Matamoros, Tamaulipas	2005	50 maestros e instructores	Pronatura Noreste Matamoros	Agencia para la Protección Ambiental de los Estados Unidos Parte del programa Frontera 2012

Objetivos

Impulsar entre los miembros de ARAN, maestros y personal de ONGs de la región técnicas didácticas y metodológicas innovadoras que permitan el conocimiento de las interacciones en el medio ambiente de una manera vivencial.

Adicional a esto la herramienta pedagógica que se ha compartido con los maestros pretende:

1. Llevar la naturaleza al salón de clases
2. Aprender técnicas participativas de enseñanza
3. Construir un aula al aire libre
4. Cumplir con los objetivos marcados académicos marcados por las autoridades de una manera más eficiente y divertida

Audiencia

El público meta fueron los maestros de preparatoria de diferentes planteles de la ciudad, convocados por ARAN

El taller se realizó en instalaciones del CONALEP, en la ciudad de Nogales, Sonora, del 24 al 27 de agosto de 2005. Hubo una participación de XX maestros, de los cuales XXX permanecieron hasta el final del curso y contestaron las evaluaciones Post Taller.

Elementos a Evaluar

Para evaluar el curso Punto Verde aplicó dos encuestas de evaluación, una antes y otra después del taller:

Encuesta Pre-Taller

Antes de iniciar el taller, se pidió a los asistentes que contestaran una encuesta con el objeto de conocer las características de los participantes, así como el conocimiento previo que éstos tenían en 5 temas y sus opiniones respecto a la utilidad que el hábitat escolar podría tener en su escuela.

Encuesta Post-Taller

Después de terminar el taller, se pidió a los participantes que contestaran otra encuesta para conocer su opinión a cerca de los temas de mayor utilidad, su interés en llevar a cabo el proyecto y las barreras potenciales para el mismo. En la sección final de esta encuesta se les preguntó a los maestros su grado de acuerdo con los contenidos, el material, las actividades, la agenda y la facilitación del taller.

Resultados

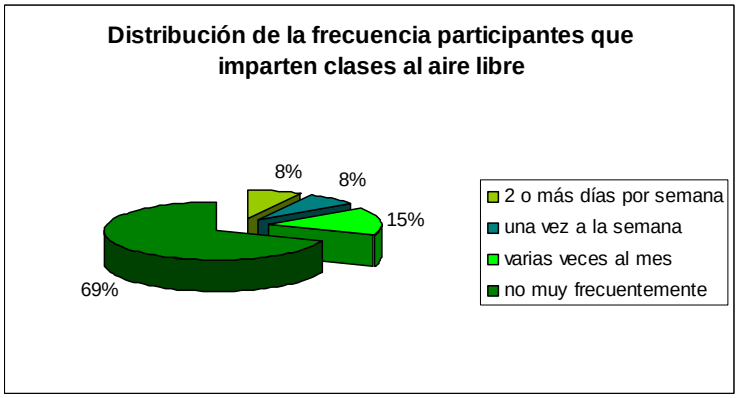
En general, los resultados del taller "Del Aula a la Naturaleza.." fueron exitosos ya que los maestros participaron activamente y mostraron mucho interés en las actividades, además de que tienen la posibilidad de implementarlo en sus planteles educativos.

Los maestros participaron en actividades en grupo y estuvieron con una actitud inquisitiva durante los periodos de exposición teórica.

Con estos elementos, podemos suponer que el proyecto de Hábitats Escolares podrá ser implementado con éxito en escuelas de la localidad.

A continuación se muestran algunos aspectos relevantes de los resultados de los talleres.

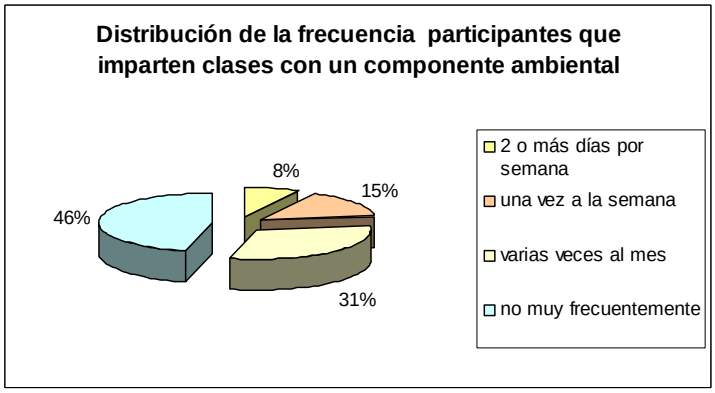
Frecuencia con la que imparten clases al aire libre
Como se muestra en la siguiente gráfica, sólo el 8% de los participantes imparte clases al aire libre, 2 o más días por semana; la mayoría (69%) no imparte este tipo de clases frecuentemente, es decir, menos de una vez al mes.



Uno de los objetivos del taller es que los maestros empiecen a incorporar la enseñanza al aire libre como una alternativa para enriquecer el proceso enseñanza – aprendizaje y para establecer los vínculos entre los alumnos y la naturaleza.

Frecuencia con la que imparten clases utilizando un componente ambiental
En cuanto al componente ambiental, los resultados de la encuesta parecen indicar que los maestros no necesariamente lo incluyen en sus

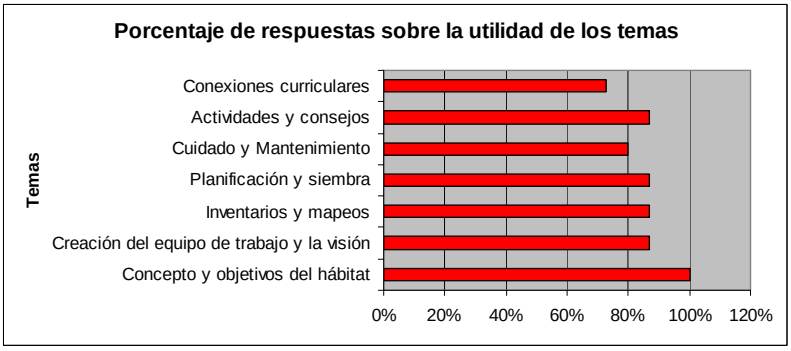
clases. Apenas el 31% de los participantes indicó impartir clases con un componente ambiental varias veces al mes.



Con los temas y herramientas tratadas durante el taller, se espera que los maestros tengan más elementos para incorporar componentes ambientales desde una perspectiva más integral.

Utilidad de los temas del taller

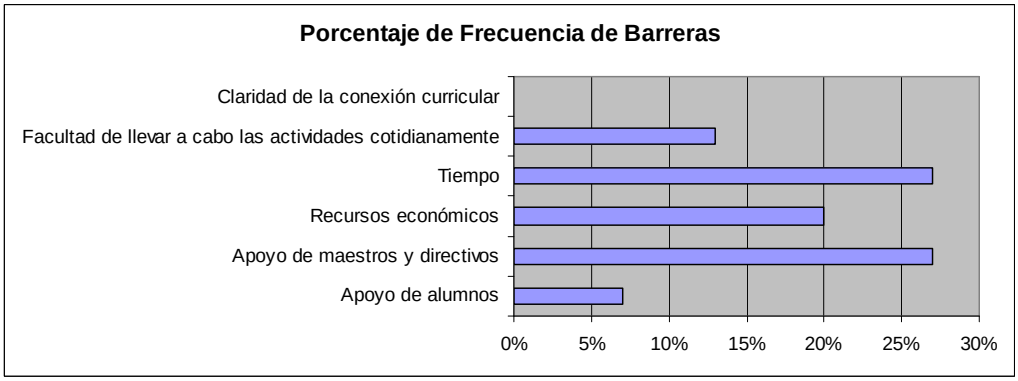
Con el fin de que los contenidos del taller sean de interés y de utilidad para los maestros participantes, Punto Verde preguntó a los maestros qué temas consideraban más útiles. Los resultados indican que en general, todos los temas son de utilidad.



Barreras u obstáculos

Un elemento a considerar es la presencia de barreras u obstáculos que limiten el éxito del proyecto. Por tal motivo se les preguntó a los participantes si consideraban que existía alguna barrera u obstáculo que les impida llevar a cabo exitosamente su proyecto de hábitats

escolares. La siguiente gráfica muestra los porcentajes de frecuencias de las barreras que señalaron los participantes.



Memoria fotográfica

APPENDIX J
DESCRIPTION OF MATERIALS IN TEACHERS' POLLINATOR RESOURCE KIT

The Pollinator Habitat Kit

The Pollinator Habitat Kit provides resources and instructions for K-5 teachers to help them design and implement a Schoolyard Wildlife Habitat Garden with their students. Includes activities developed by Desert Museum Education Staff for using the Garden as an outdoor classroom to teach principles of plant biology, pollination ecology, plant/pollinator interactions, and adaptations of desert plants and animals. Plant cards, instructions, and activities were translated into Spanish. We created 6 English Kits and 4 Spanish Kits that will be available for teachers to check out. In addition, we will provide teacher-training workshops in Tucson and Nogales.

Each Kit includes:

- 36 pollinator plant cards that include original illustrations of desert plants in bloom and detailed descriptions of plant care, natural habitat, uses, and pollinator associations.

- Step-by-step instructions for designing, planting, and caring for wildlife habitat garden and background information on plants, animals and their interactions.

- K-5 activities for designing the Wildlife Habitat Garden and using it as an outdoor classroom.

- Resource Lists for funding, local organizations, websites, and other reference materials, activity books, and science kits related to wildlife habitat gardening.

- Additional resources for teachers for designing, implementing, and using a schoolyard pollinator garden. This section includes activity books, gardening/ xeriscape books and guides, school gardening program guides, wildlife guides and brochures, and children's books.

- Our newest publication Pollinators of the Sonoran Desert: a field guide

Teacher-training workshops are been planned for Tucson and Nogales, Sonora, in March 2006, limited to 25 teachers. FREE.
Contact: ygray@desertmuseum.org

APPENDIX K
GUIDE TO DEVELOPING SCHOOLYARD HABITATS AND GARDENS

Community Networking for Sustainable Schoolyard Habitats and Gardens

Prepared by:
Justin Gaines

Background

The *Asociación de Reforestación en Ambos Nogales* (ARAN) is a bi-national partnership between the communities of Nogales, Sonora and Nogales, Arizona composed of government and non-government agencies, private business, community and neighborhood organizations, a maquiladora association, volunteer groups and schools. Their goals are environmental education, erosion control, development of green areas, and revegetation of native habitats and the incorporation of water-harvesting techniques, to name a few.

Under the guiding principles of Community Based Research, acting as researcher, network facilitator and community educator, I have been working with three schools in Nogales, Arizona. One objective of my partners was the development of schoolyard habitats and gardens, for the purpose of environmental education and the establishment of satellite nurseries to help with the revegetation process and development of green areas. In response to this objective, I developed an exploratory research project in Tucson, Arizona examining what factors influenced successful schoolyard habitats and gardens.

History

Much advice has been written on steps and tips for creating a successful schoolyard habitat and garden. Main areas of focus are structural and technical considerations. Structural considerations include recruiting, supporting and maintaining volunteers (Guy:1996; Fazio:1994); seeking outside sources of funding (Guy:1996); getting principal, district, teacher and other staff support and involvement (Guy:1996; NWF:2006), budgetary considerations (Guy:1996; Albert 2002); how to include students in site design process (Albert:2002); determine how site will fit into curriculum (Taylor:1992); how will site responsibility be decided (Guy:1996) and finding donated materials. Technical considerations suggested are research gardening methods (Albert:2002; NWF:2004); research plant, vegetable and soil information relevant to your biome (Brookbank:1991); choosing an irrigation system; how to select, design and map out site (Albert:2002: NWF 2004); and learn about native ecology (NWF:2004).

Methods

Using preexisting data compiled in 1999, Schoolyard Habitat & Garden Resource Directory: A Sampling of Local Projects, Tucson Audubon Society, I sampled 27% (9) of the 35 schools listed. Using purposive, convenience, and snowball sampling, I focused on schools that most closely resembled characteristics of my Nogales, Arizona partners (grade level, curriculum links) and intention of site use (vegetable gardens, growth of native fauna). Several of the selected schools' sites were no longer in use and 80% of schools research had new site handlers. The result was the collection of incomplete site biographies before the arrival of the handler. For schools that I was able to contact, I used open-ended interviews with teachers and principals at each site who were responsible for and used the sites.

I have left out names, gender and other information that could directly identify which schools I researched and the identities of those I interviewed.

DATA

School A

Background

The greenhouse project began in 1999 by a teacher and the school's science club, using funds from The School to Work Partnership. It was intended to foster science, business and retail skills for middle-school students. Several years after its completion, the teacher who was primarily responsible for beginning the project and managing the greenhouse left. With no one to replace that role, the use of the greenhouse stopped and its condition deteriorated. In 2003, a new teacher took initiative, fixed the site and began using it for their special education class teaching vocational and life skills.

Staff characteristics

None of the staff using the site have any background in science or gardening. There is no one officially assigned to care for the greenhouse full-time or part-time. The responsibility is diffused between the special education teacher, their five teacher aids and students. The primary teacher involved is very dedicated to using the site to teach the students "applicable life skills" (interview notes, 3-2-05) such as gardening, growing and preparing food.

Site use

The greenhouse is used once a week for teaching life skills, the rest of the time the students loiter there. Before, the life skills program had students doing grounds work and cleaning the cafeteria after lunch. Now they plant, grow and prepare their own food. The students have three raised beds, each with four quadrants they can use to plant and grow whatever they want. The students grow flowers, herbs, spices and vegetables. The remaining raised beds are used by the primary teacher and the five aids. The greenhouse is locked when it is not in use.

Community Support

Currently, the funds that support the site come from a penny drive that is used to raise money for the Special Olympics. The drive typically raises $600. Half is used for the greenhouse; the other half is for the Olympics. Some funds are also diverted from the Special Ed. program. They receive no support in the form of labor from the community. Materials have been donated to the site from one of the student's parents (shelves) and fill dirt from a local pool company. Parents support the use of the site, but only verbally. They donate neither time nor money nor any other materials.

School Support

Beyond the initial district and principal approval to create the site, district support has come in the form of the Superintendent donating personal gardening tools, and the administration paid for the greenhouse's new roof and provided jobs for the students by having them plant flower gardens outside of classroom and office windows. Another type of district and principal support comes from non-involvement; they neither dictate nor inhibit site use. The custodians

offer their help whenever needed and the home economics teacher buys herbs and spices that are grown in the greenhouse for class.

Challenges

Challenges faced by these teachers using the site are vandalism from other kids and javelinas, both of which are responsible for tearing up plants.

School B

Background:

The inner-courtyard habitat and garden project began in 1990. The initial funds for the project came from the PTO/PTSO, Arizona State Crime Prevention Fund, Heritage Fund, Hitachi Corp., donations from the community and supplies, and materials donated from several local businesses. The site was originally intended for gardening curricula, FOSS Kits, GLOBE, art, poetry, and writing for grades K-5. The site includes a vegetable garden, wildflower garden, native desert garden, compost pit, bat habitat, weather, and soil stations. Site use has greatly reduced because of Aims testing, low funding, larger class size, reduced school, and community support and lack of teacher interest. The site's responsibility has fallen to five teachers who struggle with keeping the gardening component in their curriculum. It is only with help of a custodian and a retired volunteer that the site has been able to remain active

Staff Characteristics

None of the teachers interviewed had any prior gardening experience, nor did they know of any other teachers' foreknowledge. There is no one assigned for site care full-time or part-time. The sites responsibility is diffused among three kindergarten and two first grade teachers. Their dedication to continue using the site is great. For the teachers, "the hardest part [is] to find time to plan for future garden projects and work in the garden" (Interview notes, 11-8-2004), as a result of AIMS testing and limited school and community support. These teachers remain dedicated because they feel "the most important learning the students receive is through oral language and hands on activity" (Interview notes, 11-8-2004).

Site use

Currently, the site is used as part of a class to supplement gardening curriculum, art, poetry, and writing. Depending on the teacher, class lessons, and how much supervisory help is present, the kids cycle through the garden from twice a week to every other week, and spend about 30 minutes per visit in the garden.

Community support

Currently, the only source of funding the site receives is from a school soda and pencil dispenser. The funds cover the cost necessary to feed their pig (Belle) in the habitat area. Community involvement is limited to a retired volunteer who comes to the school between once and twice a week, and is primarily the one responsible for the students actually getting to work in the garden. Originally, gardening supplies were donated by a local business and a state cooperative extension. Since then, they have not received any more.

School Support

Beyond allowing site development, the district and principal provide very little support. The district informed the custodians that since site care was not in their job description, they will not be paid for it. The old principal was very active in finding and sustaining community involvement for site maintenance, the new principal has no involvement with the site. Currently, district and principal support is through non-involvement, they neither dictate nor inhibit site use. One custodian volunteers his time every week to help with site maintenance and watering, even during summer and winter breaks.

Challenges

Challenges faced with teachers using this site are AIMS testing causing decreased site use and maintenance, minimal community and school support, and vandalism.

School C

Background

Site construction began in 1989 with initial funding from school programs, EM Technologies grant and materials and supplies donated by several local businesses. The site was intended and still is used is to teach deaf, blind and mildly retarded middle and high school students environmental awareness, job shadowing and serve as a natural resource careers pathway. Since its initial construction, the site has continued to expand. Currently, the site has two full-time attendants, three large raised beds, shade covering the entire garden site, composting facility capable of producing nine tons of compost every two weeks, a large inside arts and craft workroom, and a handicap-accessible park, pond and hydroponics system all under construction. The site continues to receive much community support in the form of labor.

Staff characteristics

The teachers involved not only had experience in gardening, but they also attended workshops on organic gardening and composting methods. A teacher and teacher's aide are employed full-time just for site management. They are both very dedicated, "we work full-time and over-time to not even keep up" (Interview notes, 11-8-2004)

Site use

The site is used to teach several classes: environmental awareness, job shadowing and serve as a natural career pathways. The site has no outside of school use, with the exception of a summer program in 2004.

Community support

External sources of funding for the site come from purchases of site products (compost, produce, mugs, tiles and plant holders) by staff, private individuals, and through small purchase orders from local organizations and businesses. The Eagle Scouts play an important role in site expansion. The Scouts involvements began four years ago and have since been engaged in the ongoing project of site development, such as the recent construction projects. Recently, the teachers were approached by a city leadership development class which contributed to over thirty

people with an array of skill and technical background to help build the pond and handicapped-accessible park. In addition, occasionally they get a few individual volunteers but they rarely stay long. A few years ago, Home Depot donated over seventy tools. Since then, no other materials have been donated to the site.

School Support

Currently, outside of what is allocated by the school budget, the district and principal support the site through non-involvement; they neither dictate nor inhibit site use. Other staff and teachers support the site through the purchase of site products.

Challenges

The major challenge faced by these teachers is being understaffed for the management of such a large site.

School E

Background

A teacher began the garden project in 1997 using monies from the Fulbright Memorial Fund Teacher Program. The target ages are K-5th grade. The project involved the development of a Japanese Zen Garden and a knowledge exchange system with another elementary school in Japan. From the garden and the knowledge exchange, the students learned about Japanese culture such as art, poetry, gardening and literature. This has been an after school club since the project has been completed.

Staff Characteristics

The teacher involved not only had prior experience with gardening, but the original grant paid for them to attend a three week and six week workshop in Japan to learn about Japanese culture and gardening in 1997 and 2002 . This teacher is very dedicated by running the after school club and caring for the site all in their free time.

Site use

The site is used for some classroom activities, but its main use is from the after school Japanese club. When students are not in class, they typically loiter in the garden area. The teacher uses the loss of garden privileges to motivate students to stay on task and complete assignments.

Community support

Currently, there are no sources of funding for the site or the club. In the beginning, Home Depot had donated some tools, but no other donations have been made or sought and only occasionally do parents volunteer.

School Support

Beyond the district and principal allowing site development, the district paid to expand the garden to include a raised garden bed. Other district and principal support is through non-

involvement; they neither dictate nor inhibit site use. Teachers have volunteered their time on works days and help care for the site during summer and winter months.

Challenges

The challenge faced by this teacher is the invasive properties of bamboo into the rest of the garden.

School F

Background

This project began in 1996 by three teachers using funds from an EM Technologies grant, Educational Enrichment Foundation, Wells Fargo grant, and a State of Arizona grant. Eight local businesses were involved. The site was intended to supplement math, science, art, and language art, grades PK-8th. The original teachers involved included the students in the site design and species selection process. Once completed, the site had a wildflower garden, experimental garden, a secret garden, family garden plots, hummingbird/butterfly garden, composting facility, and a work area for arts and craft. The entire site is decorated with various arts and crafts that the students have made. In 1998, a new teacher took responsibility for the site and has since continued to expand with student involvement despite decreased use by other teachers due to AIMS testing.

Staff characteristics

The current teacher involved has experience in landscaping and attended classes at the Tucson Botanical Gardens for creating pollinator gardens and desert habitats. The landscaping experience allows the teacher and students do most of the site expansion work by themselves. The teacher was employed full-time for site management, but has been recently reduced to part-time. The other half is now spent teaching special education. However, the teacher is successful in coordinating students and parent involvement for site maintenance every Monday and twice a year respectively. Since taking responsibility, the site has expanded to include a succulent garden, Australian Biome region, lounge area, mini Grand Canyon, pigeon farm, and an ocotillo fence. This teacher is very dedicated. Despite having less time to devote to the site, there is still the same investment of energy into site maintenance, expansion and development with student involvement. At the same time, the teacher volunteers their time to run an after school gardening club and cares for the site during summer and winter breaks.

Site use

The site is still used to foster math, science, art and language skills. In the past, every class used its own garden plot. Today, less than half are being used. Reasons given were:

> Some lacked enthusiasm; others who wanted to participate faced greater demands from the new standards and testing from the No Child Left Behind Act; other teachers were new, and were not able to balance the curriculum with the garden and were not using it yet" (Interview notes, 12-30-04).

Currently, a plot is only assigned to a teacher if they request it. None the less, the site still receives much use; especially by the special education class. That class spends two hours a day in the garden. Other uses of the site are as hangout places for students during breaks and lunch, as an after school club with over fifteen members and as a safe and relaxing place school councilors come to have sessions their students.

Community Support

Currently, there is no source of funding for the site. Two to three times a year the teacher organizes a workday and up to fifteen parents come to help maintain the site. Materials, supplies and shaded structures have been donated from local businesses, non-profits and clients from the teacher's landscaping jobs.

School Support

Beyond initial district and principal approval of site development, the district does not involve itself with anything surrounding the site. The old principal was very active in supporting and helping to maintain the site. The new principal "supports the program, but that it is not her thing. She does not participate in the garden activities or volunteer for its upkeep" (Interview notes, 12-30-04). Other district and principal support is through non-involvement; they neither dictate nor inhibit site use. Several teachers volunteer their time to help supervise the after school club and for site maintenance. One teacher is responsible for reviewing grant applications and notifies the primary teacher of any applicable grants.

Challenges

Challenges faced by this teacher are not enough time and people for site maintenance, no source of power in the site area and vandalism.

School G

Background

The garden plots at this school were included in the initial school design. The plots' uses are intended for teaching ecological concepts to elementary students. There are four lowered plots per grade. Teacher use of the site has always been optional. If they choose to use the plots, it is their and the students responsibility to care for it. In addition, there is a small greenhouse attached to the side of the science classroom.

Staff Characteristics

There is one science teacher who develops garden and science related projects for the teachers. These include growing seedlings in class with the students, then transplanting them to the garden bed. Once in the bed, it is the teachers' and students' responsibility to care and maintain the garden. The science teacher also volunteers time to help care for the garden. The science teacher has a PhD in organization and leadership, a Masters in education administration, and a BA in biological and physical science education. He also has a long history with gardening, and "says that he really knows plants" (Interview notes, 2-9-05). All of the teachers involved are dedicated to using their site by choosing to voluntarily use it year after year. The greenhouse is an extension of the science classroom and as such, it is only taken care of and used

by the science teacher. The science teacher is currently looking into community resource for site expansion.

Site use

The gardens are integrated into the curriculum through ecological concepts such as plant life cycles and growing your own food. This results in the plots being used once a year per class. The Greenhouse is always in use and serves as a place to store and cultivate specimens that cannot be done in or outside of class. No teacher is required to use the garden for their lesson plan, but every grade is except for the sixth graders because their curriculum does not support its use.

Community Support

No outside monies have ever or currently come from the community. The biggest forms of support from the community are parents volunteering. The school has about twenty parents volunteering there a week. When preparing the gardens, parents come out every year and many bring their own tools. The fourth grade, in particular, gets more parent involvement on workdays than other grades. It is not often that they get any non-parent volunteers. The only materials donated are the occasional seeds and some tools from the science teacher.

School Support

Neither the district nor the principal allocate any funds for site development, maintenance, materials or supplies. Other district and principal support is through non-involvement; they neither dictate nor inhibit site use. Beyond the teachers who are actively integrating the gardens into their lesson plans, no other teachers or staff helps with the maintenance of sites.

Challenges

Challenges faced by these teachers are the inaccessibility of water at certain plots and with absence of a rototiller, the plots are very difficult to turn every year.

School H

Background

The greenhouse project began in 2002 by a teacher using monies from a Wells Fargo grant. Its original use was to supplement science curricula and life skills for special education high school students. The original teacher is no longer involved. Last year a new teacher filled the role with the help of an aide. Now the site is used for the special education class teaching life skills.

Staff characteristics

The primary teacher involved has extensive history with gardening and has taken tours of local desert nurseries and gardens with the students to learn more. Site responsibility is diffused between the primary teacher and her aide. The teachers are very dedicated to using the site because they continue to closely integrate its use for teaching life skills.

Site use

The sites main use is to teach students how to grow food, where to buy food, plant identification and plant life cycles. The students spend time in the greenhouse everyday to water and hangout. Outside of school hours, the site has no other use.

Community support

This site receives very little community support. Since the original grant, the teachers have received no new monies. The only labor from the community is the volunteering of the primary teacher's husband. He has also donated and sold at a discount gardening supplies and materials from his business. Other small forms of community support are the purchase of garden products.

School support

Beyond initial district and principal approval for site development, the district paid to have a handicapped accessible ramp installed for the greenhouse and the principal gives his verbal support only. Other district and principal support is through non-involvement; they neither dictate nor inhibit site use. One teacher supports the site through the purchase of garden products for their culinary class. Another teacher donated succulents priced at over $300.

Challenges

The challenge faced by theses teachers is not having a proper irrigation system. Currently they use a hose which gets water every, they would prefer a drip irrigation system.

School I

Background

The desert habitat and garden project began in 1996 by four teachers using monies from a Wells Fargo grant. Since then, the site has expanded on two more occasions to include a nocturnal and cactus garden using monies from an Arizona Game and Fish and National Wildlife Federation grants. The sites intended use was to teach elementary students to identify and garden with native species. Site use by other teachers has decreased due to time restraints from new AIMS testing standards

Staff characteristics

The primary teacher involved with the site had some personal experience with gardening, but also sought out workshops and specialist to learn xeroscaping principles. This teacher has primary responsibility for the site, but is active in organizing students and parents to contribute to its maintenance. The teacher is very dedicated; all of the time invested into site management and running the after school club is volunteer. The teacher "[does] not know what would happen to the site if [they] were to leave… they don't pay you extra, whoever is to be in charge needs to be dedicated" (Interviewer notes, 3-07-05).

Site use

The site has no formal curriculum use, but teachers connect it through FOSS Kits, reading and poetry. However, "with the testing pressing so much on teachers' time in the class

right now, it is very difficult to find one who can and will devote the time necessary to use and care for the site" (Interview notes, 3-7-05). Another use is by an after school gardening club that meets twice a month. The only other site use is from community members who hangout in the site on the weekends and even plant their own plants and from students who hangout during breaks and lunch.

Community support

Since the original grant monies, the only other form of funding are gardening club dues. Labor comes in the form of parents volunteering. One parent was very active in writing the second grant. They attained letters of recommendation from the community for the grant application as well as attended the workshops on xeroscaping. Other parents volunteer time for summer and winter care and maintenance. Other forms of community support include members using the site on weekends, after school and planting their own plants. Of their supplies and materials, "20% donated comes from parents, 30% comes from businesses and the rest were purchased with the grant monies and the club dues" (Interview notes, 3-7-05).

School support

To be eligible for the NWF grant, the district had to sign a contract that they would care for the site for at least five years, independent of the teacher's role, before the monies would be approved. Beyond that, the district has no involvement with the site and the principal and superintendent give only their verbal support. Currently, district and principal support is through non-involvement; they neither dictate nor inhibit site use. For the first two grants there was an additional three and four teachers involved, respectively. Now, it is just the primary teacher involved with site management. The custodians have actively worked against the site since its beginning. Their reasons range from the insistence that the soil is theirs and the teachers do not have the right to use it; the site creates extra work for them; the site creates too much pollen, mold and mud. In protest, "they were 'completely violent' about it; they would knock their stuff over and run over their plants and materials with the lawn mower" (Interview notes 3-7-05).

Challenges

Challenges faced by these teachers are custodial resistance, AIMS testing causing less time to be spent using the site, limited school and community support and the burden of site management on one teacher.

School J

Background

The site began in 1995 by four teachers using various donations (sources unknown). There were eight local businesses involved. Target ages were grades K-5th grades. Links to the curriculum were through science, math, writing and art. The site includes a butterfly garden, pond and waterfall, vegetable garden and more recently, a Sundial garden and Ramada. Due to current AIMS testing and increased class size, the gardens are only being used by the kindergarten classes.

Staff characteristics

Originally, the teachers involved took gardening classes at the Tucson Botanical Gardens and one had experience from being raised on a farm. Now, only one teacher remains, the primary teacher responsible for the site. However, once a teacher begins using a garden plot, they are responsible for its maintenance. At time of interview, the primary teacher was in the process of switching site responsibility to a volunteer parent. Reasons were time restraints from AIMS testing and other events taking place in their life to be able to handle site responsibility. The primary teacher is very dedicated to using the site through being involved with site development from the beginning, through the organization of workdays, mowing and trimming the site.

Site use

Site use was and still is linked to the curriculum through science, art and literature. Now, only the kindergarten classes use the site. New AIMS testing allows very little time to integrate the site into the curriculum. Every week, a group of retired volunteers come to the school and mentor students. Most of them spend that time in the site. Even at time of interview, the primary teacher had already stopped using the site for their class.

Community support

Since the original grant, there has only been one other source of community funding. A boy from this school had died from leukemia. The community's response was to donate money for constructing the Sundial garden made in his honor. Support in the form of labor used to come from parents who volunteered their time for workdays, and, in the case with the primary teacher, taking responsibility for the site. The new principal no longer allows workdays, which only increased the primary teacher's workload for site maintenance. Other material donations were concrete mix for the Ramada, red rocks and riverbed rocks for landscaping.

School support

In the beginning the district and principal were not supportive of the site, but did not inhibit it. Now, they support the site in the form of allocating some custodial duties for site maintenance. There was an agreement between the teacher and the new principal that the principal would not interfere with the site as long as it was maintained. Site maintenance was predicated on having workdays. When the principal no longer allowed workdays, site maintenance fell behind. Now that the district has allocated some custodial duties to the site, the situation has improved. Currently, outside of the kindergartner teachers, no other teachers or staff have been involved with or helped with the site use or maintenance.

Challenges

Challenges faced by these teachers are reduced site use because of AIMS testing, reduced teacher interest, and increased class size necessitating the need for more supervision when using the site, the principal inhibiting maintenance strategies causing a reduction in volunteer labor and the burden of site management by one teacher.

Analyses

Through data analyses, four general patterns emerged, each with several sub-categories. These categories showed themselves to be influential factors in the development and sustaining

of successful schoolyard habitats and gardens. Although these categories are neither mutually exclusive nor exhaustive and many are interrelated, for the purpose of this paper, they have been separated to more closely exam which factors influence successful schoolyard habitats and gardens.

The categories are as follows: A) Staff characteristics: 1. teacher's credentials, 2. teacher's role, 3. dedication; B) site use: 1. a class itself, 2. part of a class, 3. other; C) Community support: 1. money, 2. labor, 3. materials; D) School support: 1. district involvement, 2. principal/administration involvement, 3. extra-teacher/staff involvement.

Schoolyard habitats and gardens have a greater chance of success when having have strong staff characteristics. Important characteristics are staff knowledge of or experience with gardening, science and organization which helps site design, use, functionality, maintenance and longevity. However, staff credentials do not necessarily guarantee site success. Diffused site responsibility among at least two staff members reduces the burden of site management on one person, and can increase site maintenance, longevity and reduce staff burn out causing the abandonment of site. New time limitation of AIMS testing; reduced community and school support; and, in some cases, the shifting of site responsibility to one staff member, can all act as barriers to site use. Teachers who, despite these barriers, continue to use and integrate the site have high levels of dedication. Overall, dedication to site use has resulted in increased site use, expansion, maintaining current site use, deterring site abandonment and can contribute to site longevity.

Site use is another influential factor. Sites that tend to have greater curriculum integration and non-school use, such as life skills classes, after school clubs and community use have greater success at site longevity. Interestingly, sites used for teaching physically and mentally challenged students had greater site stability from community and school support.

Community support plays a large role in successful schoolyard habitats and gardens. Every site visited relied on community support (money, labor, materials) to begin site development and to sustain site use. Types of monetary support from the community have come from private, state and federal sources. Support in the form of labor is typically from community members, organizations and parents volunteering their time for site maintenance, management, expansion or helping supervise site use. Materials and supplies donated from the community range from fill dirt, riverbed and red rocks for landscaping, seeds and tools from local businesses and individuals. Quantity of community support is important, but in some cases it was quality that made a difference. Site C receives a lot of community support from the Eagle Scouts and the city leadership development classes which have been primarily responsible for site expansion. Conversely, community support at school B comes from one retired volunteer who has been credited with being the only reason that students and teachers are still able to use the site.

School support is very important to the development and sustaining of schoolyard habitats and gardens. District and principal approval are needed to begin the site. The continuation of district and principal support have ranged from non-involvement, neither dictating or inhibiting site use; financially supporting the site, such as the purchase of the new greenhouse roof, raised garden beds and handicapped ramps; donating personal materials; providing special education student with jobs planting flower gardens around campus; and allocating site care under custodial duties. Other teacher and staff support play and important role as well. Their support ranges from helping with site maintenance and expansion; supervising students during site use; donating supplies and materials; and purchasing site products.

Challenges schools have faced with schoolyard habitats and gardens have been vandalisms; unequal distribution of site responsibility; time restrictions because of new AIMS testing causing reductions in site use; decreased teacher interest; declining or minimal school and community support; the original care taker of site leaving and having no one else to fill that role causing site abandonment.

Conclusion

Due to the nature of exploratory research, purposive, convenience and snowball sampling, these results are in no way definitive. More research is needed. However, these results indicate that to establish and maintain a successful schoolyard habitat and garden, there are four main areas to consider: staff characteristics, site use, community support and school support. Stronger staff characteristics, greater site use (particularly curriculum integration), active community and school support all increase the likeliness of establishing and maintaining a successful schoolyard habitat and garden.

Bibliography

Albert, Lisa
2002 Creating a wildlife habitat on school grounds. Electronic document, http://wildlifestewards.4h.oregonstate.edu/creating%20your%20wildlife%20garden/. Accessed October, 2005.

Brookbank, George
1991 Desert Gardening: Fruits and Vegetables: The Complete Guide. Tucson: Fisher Books.

Fazio, James, Tree City USA Bulletin No. 36
1994 How to Work with Volunteers-Effectively. Nebraska City: National Arbor Day Foundation.

Guy, Linda with Cathy C. Cromell and Lucy K. Bradley
1996 Success with School Gardens: How to Create a Learning Oasis in the Desert. Phoenix: Arizona Master Gardener Press.

National Wildlife Federation
2004 a. Start a habitat team. Electronic document, http://www.nwf.org/backyardwildlifehabitat/create_startateam.cfm. Accessed November, 2004.
b. Schoolyard: Educator Resources. Electronic document, http://www.nwf.org/backyardwildlifehabitat/educatorresources.cfm. Accessed December, 2004.

Sunnyside Unified School District with the Tucson Audubon Society
1999 Schoolyard Habitat & Garden Resource Directory: A Sampling of local projects. Tucson.

Taylor, Barbra
1992 Green Thumbs Up! The Science of Growing Plants. New York: Random House.

APPENDIX L
FLIER ON ASTHMA TRIGGERS

DIEZ PASOS PARA HACER SU CASA ACOGEDORA PARA ASMATICOS.

1.-Vaya afuera a fumar.

2.- ¡Adiós, ácaros!

3.- Juegue a lo seguro.

4.- Poco a poco se llega lejos.

5.- Proteja su casa de animales domésticos.

6.- Eche a los invitados indeseables (cucarachas).

7.- Piense antes de fumigar.

8.- Acabe con el moho.

9.- Ventile para reducir la humedad.

10.-Planee antes del ataque.

Es tu Salud y tu Ambiente

¡¡Hay que cuidarlos!!

Programas y Voluntarios Sociales

Para mayor información sobre temas de salud y ambiente ó asesorías comunicarse a los siguientes teléfonos.
31-9-05-42 y 31-4-29-69
044-631-10-5-24-47
044-631-10-6-74-07
044-631-11-2-79-91.

¡¡Solo llama y pregunta no dudes!!

" Proyecto sobre ASMA"

Asociación de Reforestación en Ambos Nogales.
A R A N

Finalidad:

Es mejorar la salud por medio de calidad ambiental enfocándose en el problema de mayor trascendencia en adultos y jóvenes que es el "Asma"; con ayuda de nebulizadores y otras alternativas entre ellas:

- Pasos para hacer la casa más acogedora para asmáticos.
- Medios de prevención de Asma.
- Conocer que factores provocan ésta enfermedad.

As Ma

Es una enfermedad que afecta los pulmones. Es la enfermedad de duración prolongada más común entre los niños, causa episodios repetidos de jadeo, dificultad para respirar, presión en el pecho y tos durante la noche o temprano en la mañana. La enfermedad esta presente todo el tiempo.
Es una enfermedad seria; durante un ataque de asma, las vías respiratorias se estrechan haciendo muy difícil respirar. El asma puede ocasionar la muerte.

ADEMAS...

El polvo de la casa puede contener desencadenantes del asma. Quite con frecuencia el polvo con un trapo húmedo, aspire alfombras, etc.
Las cucarachas son factores que provocan el asma y esto se debe al excremento que estas arrojan.
Cuando los pronósticos del tiempo anuncien un día con un alto nivel de ozono, trate de permanecer en casa lo más posible.

¿Cómo se trata el Asma?

Es tomando la medicina correctamente y evitando los factores que lo provocan. Así mismo s importante que se deshaga de los factores del lugar donde vive. Los medicamentos son diferentes en cada persona unos son inhalados o tomados en forma de pastillas y vienen en dos tipos de alivio rápido y de control a largo Plazo.

EFECTOS QUE CAUSAN EL ASMA

- **Humo de tabaco en el medio ambiente.**-Decida no fumar en su hogar a su automóvil ni permita que otros lo hagan.
- **Ácaros del polvo.-** Escoja muñecos de peluche que sean lavables, y lávelos con frecuencia en agua caliente, secándolos completamente.
- **Mascotas.**-Considere el mantener a las mascotas fuera de la casa o encontrarles un nuevo hogar si es necesario. Mantenga a sus mascotas todo el tiempo fuera del dormitorio o cualquier lugar que utilice para dormir.
- **Moho.-** Lave el moho de las superficies duras y séquelas completamente. Los materiales absorbentes, tales como las baldosas de los techos y alfombras.

APPENDIX M
COMITÉ TREE REPORT OF ACTIVITIES

INFORME DE SERVICIO SOCIAL

Brigada_____X_____ Horas laboradas____480 hrs_.

Lugar de prestación _____ITN Comité TREE_____.

Periodo de cubre el informe: ___10 Enero 05 __al __10 Julio 05 .

_____

Nombre y firma del coordinador del Programa

_____.

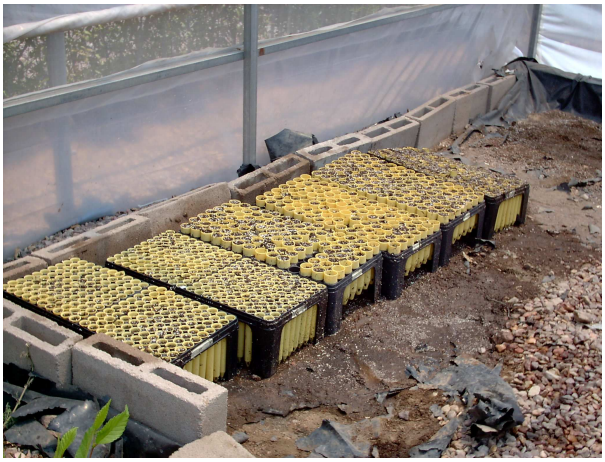
COORDINADORA DEL SERVICIO SOCIAL DEL ITN

ACTIVIDADES REALIZADAS

Construcción de protecciones para arbolitos.
Del programa de

Almácigos de mezquite chileno. En el invernadero de OTIS

Almácigos de nogal silvestre en invernadero de OTIS.



Almácigos de mezquite, nogal, pinos ciprés, trueno.

Vivero en OTIS mantenimiento y fertilización de las plantas.

Colocación de canaletas para captar el agua de lluvia.
En centro comunitario casa de la misericordia.

Instalación de tuberías 2da. Fase concluida.

Instalación de los tubos de pvc para recolectar agua pluvial. Cisterna de 10,000 lts.

INTRODUCCIÓN

Todas las actividades realizadas en este semestre fueron hechas una realidad gracias a la cooperación de los jóvenes del servicio social comunitario del ITN. Nuestros objetivos eran pocos, pero se necesitaba de un gran esfuerzo para llevarlos a cabo.

Una de las deficiencias que se habían detectado en el semestre pasado en los programas de reforestación fue la falta de protección de los árboles, por lo que nos dimos a la tarea de contactar a un empresario que se dedica a la construcción y venta de tarimas para que nos donara madera y poder hacer dichas protecciones.

Por otra parte, era de suma importancia concluir el proyecto de colecta de agua pluvial el cual se había retrasado por falta de fondos. Y por ultimo producir mas plantas nativas en el invernadero de Otis que tan amablemente nos brindan ese espacio para continuar con nuestra labor.

RESULTADOS

Se hicieron 24 protecciones para los arbolitos plantados en el área verde del comedor comunitario de casa de la misericordia, se pintaron y esto gracias al apoyo recibido del **Sr. Tomas López** propietario de tarimas industriales.

Se consiguieron semilleros nuevos para la producción de 1,000 plantas nativas y se fertilizaron las 600 que había en inventario.

Se hicieron almácigos de nogal silvestre, pinos cipres, trueno y mezquite chileno.

Se concluyo el sistema de colecta de agua pluvial en el centro comunitario casa de la misericordia con un valor de $25,000 que fueron proporcionados por la EPA (Agencia de Protección Ambiental EUA), se colectaron 10,000 litros de agua pluvial en el mes de julio y agosto del 05. la cual se destinara para áreas verdes exclusivamente del centro comunitario.

CONCLUSIONES

Nos sentimos muy satisfechos con los resultados obtenidos, cuando se inicio con el proyecto de comité Tree jamás imaginamos que llegaríamos tan lejos, pero cabe destacar que esto no seria posible sin la valiosa participación de los jóvenes del servicio social comunitario del Tecnológico de Nogales.

Este valioso proyecto de la colecta de agua pluvial, beneficiara enormemente al centro comunitario el cual no cuenta con suministro de agua potable, aquí tienen que comprar el agua para los baños y apenas si alcanza para lo mas indispensable por lo que no había la posibilidad de crear áreas verdes. Ahora esto no será un problema ya que esta cantidad de agua será suficiente para cuando menos 5 meses por lo que dará oportunidad de recargarse la cisterna con las lluvias de Diciembre y Enero.

RECOMENDACIONES Y SUGERENCIAS

Es importante seguir con el monitoreo de la colecta de agua pluvial, ya que esto puede ser de gran ayuda para crear un programa colectivo en las colonias marginadas, utilizando los techos de las casas y canaletas para guiar el agua hasta un tinaco, esta agua puede servir para bañarse, lavar y si se filtra hasta para tomar.

H. Nogales Sonora a 7 de Septiembre de 2005.

TS. Belem Arroyo Lozano.

Por medio de la presente le doy un grato saludo y le notifico que los jóvenes abajo mencionados, han concluido su servicio social comunitario en el programa de comité TREE. Ellos cubrieron un total de **480 hrs.** Por lo que le solicito que se les libere su servicio social.

Aldo Everardo Cuevas Fregoso.

Moisés Rábago Nieblas.

Maria del Socorro Guillermo Cruz.

Neftali Galván Bautista.

Sin mas por el momento me despido de usted, quedando a sus ordenes.

ATENTAMENTE

_____

Carmina Cervantes Sinohui.

APPENDIX N
COLONIAS MANUAL

MANUAL

DE

COLONIAS

GUADALUPE SANTOS DE ALCANTAR

201

I N D I C E

El Comité de Colonias es tan solo una parte, un sub-grupo dentro del grupo de ARAN. Como residente de una colonia, estamos llamados a trabajar en bien de nuestra comunidad.

La idea de tener un Manual de Colonias es para que sirva de guía, una base para todas aquellas colonias que mas adelante estén interesadas en trabajar y embellecer su lugar de residencia.

A los vecinos corresponde preocuparnos por el entorno en donde se desarrollan nuestras familias, de nosotros depende el que crezcan en un ambiente sano; y los colonos debemos de ser los principales promotores de cambie en nuestra forma de ver la naturaleza, sabemos que es un regalo que se nos dio, es un tesoro que desafortunadamente se nos está agotando, ¿queremos un mejor futuro?

Empecemos a trabajar hoy.

Como residente de la Colonia Jardines del Bosque, puedo decirles que es una satisfacción muy grande el poder ser parte de este cambio. Nos tomo mucho tiempo y esfuerzo, y lo hicimos. Estamos en proceso de cambio, tenemos un proyecto ambicioso que es; lograr la colaboración de todas las familias que viven aquí, sabemos que la participación de los niños y los jóvenes en la integración de un Club de Ecología es un paso adelante en nuestro compromiso por crear conciencia, y estamos seguros que serán ellos quienes logren interesar a sus papas.

Damos una calurosa bienvenida a las Colonias que están por integrarse. ¡Felicidades! Por su acertada decisión.

2. Objetivo del Manual de Colonias:

- Lograr que las nuevas colonias den pasos seguros en la formación de sus comites.
- Aprender que es ARAN y quienes lo forman.
- Informar sobre los diferentes procedimientos a seguir.
- Lograr obtener un Comodato del area verde.
- Mantener abiertas las vias de comunicación con ARAN.

3. ¿Qué es ARAN?

- Es conocida por sus siglas como “Asociación de Reforestación en Ambos Nogales”

4. ¿Quiénes lo forman?

- Personas comprometidas con nuestro medio ambiente, dentro de los diferentes niveles de trabajo, escuelas secundarias, prepas, universidad y gobierno de ambos Nogales, maquilas y colonias.

5. ¿Qué necesito para ser miembro de ARAN?

- Tener deseos de trabajar en equipo con y para la comunidad.
- Acudir a todos los eventos de ARAN que le responda.
- Tener disposición para apoyar a los demás equipos.
- Vivir dentro de la Colonia.

6. ¿Qué es una Colonia?

- Es una agrupación de personas que viven juntos en lugar determinado de la ciudad.

7. ¿Qué es un Comité?

- Grupo de personas que se unen para atender un asunto en común. En este caso, las áreas verdes.

8. ¿Qué es un Comodato?

- Es un contrato entre vecinos y gobierno, por medio del cual se da y se recibe un área verde, con la obligación de cuidarla y protegerla.

9. ¿Cómo me organizo?

- Localizar área verde dentro de tu Colonia.
- Formar comité (indispensable que sean seis vecinos como mínimo y estén comprometidos a trabajar).
- Reunirte con tu comité por lo menos dos veces al mes.

10. ¿Cómo obtengo un Comodato?

- Acudir al Ayuntamiento (Depto. De Desarrollo Urbano y Ecología).
- Solicitar mapa de su área verde.
- Solicitar área verde en Comodato (sindicatura).
- Estar al pendiente de todo el proceso.

11. ¿Cómo obtengo recursos monetarios?

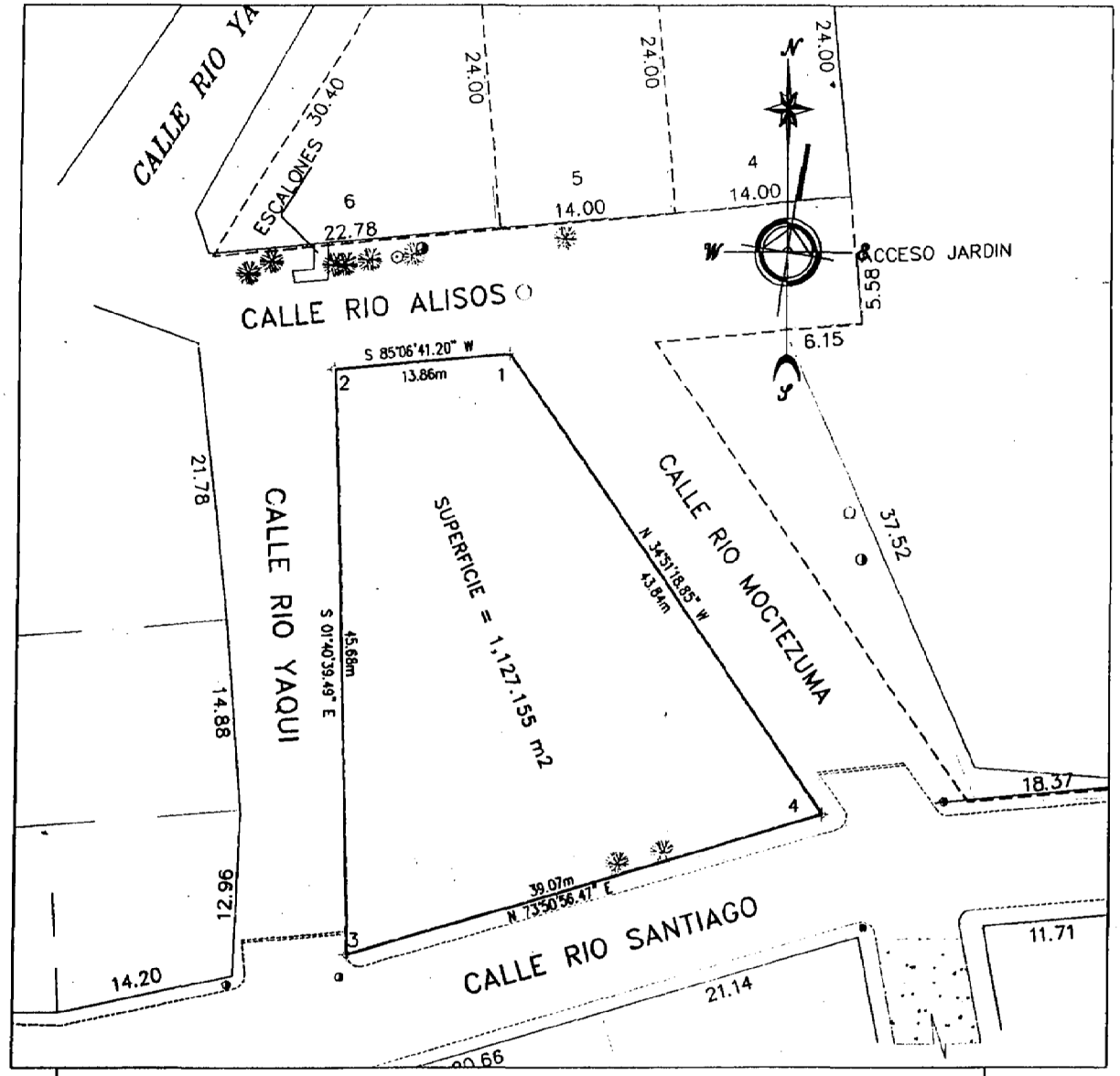
- Solicitar ayuda al Ayuntamiento y a otras organizaciones altruistas.
- Organizar eventos en tu Colonia y darles difusión.

12. ¿Qué necesito para solicitar *recursos de ARAN?

- Ser miembro activo de ARAN.
- Debe existir un comité de Colonia (minimo seis personas, su dirección y teléfonos).
- Debe existir un Comodato de Colonia.
- Asistir a las reuniones generales de ARAN y a sus eventos (si es posible, todos los vecinos en comité).
- Tener un proyecto a corto y a largo plazo.

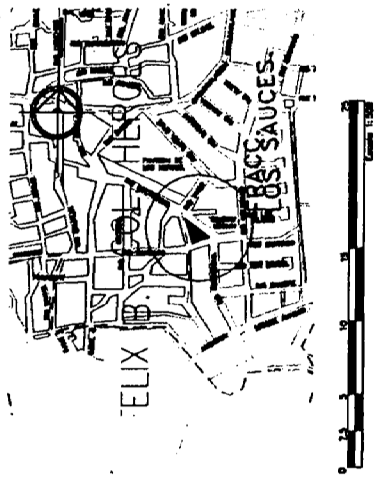
*NOTA: Estos recursos no necesariamente deben ser monetarios, pueden ser de tipo laboral o técnico (ayuda para desarrollar sus proyectos o para trabajar en sus áreas verdes).

APPENDIX O
PLANS FOR COLONIA HEROES



SIMBOLOGIA

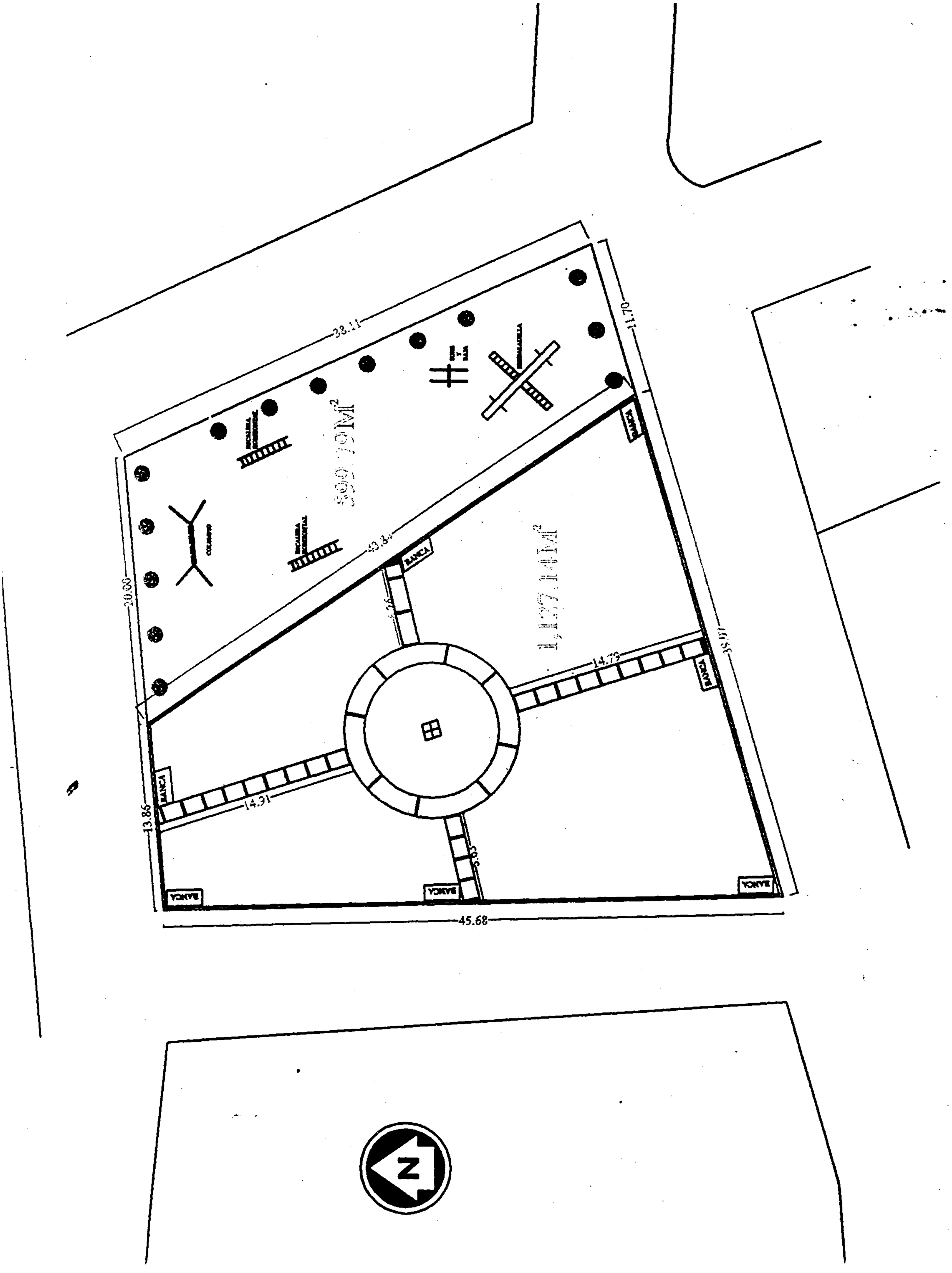
- POSTE TELMEX
- POSTE C F E
- POZO DE VISITA EXISTENTE
- POSTE DE ALUMBRADO PUBLICO
- LIMITE DE CALLE EXISTENTE
- DIVISIONES EXISTENTES
- CERCO
- PAVIMENTO EN PROYECTO
- GUARNICION EXISTENTE
- PAVIMENTO EXISTENTE



CUADRO DE CONSTRUCCION

LADO	RUMBO	DISTANCIA	AZIMUT	VERT.	ANG.INT.	Y	X	COLINDANTE
1-2	S 85°06'41.20" W	13.862	265°6'41.20"	1	119°58'0.05"	65,340.5354	05,918.1458	CALLE RIO LOS ALISOS
2-3	S 01°40'39.49" E	45.677	178°19'20.51"	2	83°12'39.31"	65,339.3541	05,904.3343	CALLE RIO YAQUI
3-4	N 73°50'56.47" E	39.068	73°50'56.47"	3	75°31'55.96"	65,293.6965	05,905.6715	CALLE RIO SANTIAGO
4-1	N 34°51'18.85" W	43.835	325°8'41.15"	4	71°17'44.68"	65,304.5641	05,943.1980	CALLE RIO MOCTEZUMA

SUPERFICIE = 1,127.155 m2



38.11
11.70
20.00
43.84
14.79
14.91
13.86
5.63
45.68
BANCA
N

APPENDIX P
INTERVIEW PROTOCOL

Questions for Interviews Related to ARAN Evaluation:

1. How would you describe ARAN and its overall goals?
2. How does your group/organization fit into ARAN?
3. To what extent does ARAN achieve its goals?
4. What benefits do you receive from your association with ARAN? Has this changed over time?
5. What are the major weaknesses in ARAN at this point?
6. Are there things that prevent you from being more involved with ARAN? If so, what are they?
7. What do you and your group/organization need to be more effective in working with ARAN and helping ARAN achieve its goals?
8. How has the EPA grant affected ARAN? Positively? Negatively?
9. What changes can you suggest to improve ARAN?
10. Where do you see ARAN in five years? Do you expect you will still be involved?
11. *What has been your most memorable experience with ARAN?

Spanish translation:

1. En sus palabras, que es ARAN y cuales son sus metas sobre todo?
2. Que papel juega su grupo/organización dentro de ARAN?
3. A que punto se cumple (se logra) ARAN con sus metas?
4. Que beneficios le da a Ud. su colaboración con ARAN? She ha cambiado tras el tiempo (desde el princípio)?
5. Cuales son las debilidades mayores de ARAN en este momento?
6. Existen límites a su participación más activa en ARAN? Cuales son?
7. Que necesita su grupo/organización para ser más efectivos en su trabajo con ARAN y en ayudar que ARAN logre sus metas?
8. Como ha afectado a ARAN la beca de la EPA? Positivo? Negativo?
9. Que sugerencias de cambios tiene Ud. para mejorar a ARAN?
10. Como ve a ARAN en cinco años? Espera Ud. ser involucrado(a) todavía?
11. *Cual ha sido su experiencia más gozada con ARAN?