Opening a door to dignity in South Nuevo León, México

Engineers Without Borders Johnson Space Center Mexico- Chapter Project

South Nuevo Leon Assessment Report

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Background of Project

In the fall of 2006, Engineers Without Borders – Johnson Space Center (EWB-JSC) gave the initiative to a team of individuals interested in starting a project in Mexico. The initial focus was targeted towards selecting a community near the border of El Paso, TX for practical reasons. The idea was to assist the poor colonias of the city of Juarez, however through further analysis and discussions; it was foreseen as a big challenge due to the urban conditions a big city represents: infrastructure, local government restrictions, bureaucracy and possible risks such as compromising the safety of the team due to high crime. Ultimately, the idea was disregarded and the organization decided to explore further south into the border with the help of local members who had contacts in Nuevo León, Mexico. As a final step to this initiative, two members were chosen to lead the Mexico team to start the contact process and the budgeting.

As a first resort, EWB-JSC explored the possibility of teaming with other local EWB chapters who had already been working in Mexico with the benefit of facilitating the process on selecting a community. A meeting with EWB-Rice Mexico project leads was held to exchange ideas, tips and advise on how to initiate contact, select a community and deal with the socio-cultural aspects of its inhabitants. Upon previously contacting several organizations from the State of Nuevo León, EWB-JSC got a response with the best pre-disposition to collaborate on the community selection process. With such positive response, the team decided to focus the selection process in the state of Nuevo León.

In December 2006, a representative from EWB-JSC visited Nuevo León and Linares (the main gateway to the South of the State), and was hosted by a representative of the Instituto Tecnológico de Linares (IT-Linares), Dr. Ernesto Ruíz Cerda (professor of agricultural engineering). His guidance and knowledge of the region facilitated the evaluation of certain communities and the communication with local authorities on both official and socio-cultural levels. A formal partnership was established with IT-Linares in February of 2007 to provide logistics support and involve local engineering students in the project. Contacts were also established with Jeepers Club and the Rotary Club of South Monterrey. Establishing contacts with local institutions were critical not just for logistics, but to help ensure the project is appropriate and self-sustaining.

Community Identification Trip to South Nuevo Leon

The EWB-JSC chapter planned an identification trip to South Nuevo Leon and contacted several organizations in the State of Nuevo Leon to identify rural communities in need of clean water and other public health needs. Several partnerships were established with IT-Linares, the Consulate of Mexico in Houston, Club Jeepers of Monterrey and Rotary Club of South Monterrey. The

consul of Mexico in Houston, Jose V. Borjon contacted a local bus company whose owner is from Monterrey; The Autobuses Adame Company donated the transportation tickets for the EWB-JSC travel team.

In March of 2007, EWB-JSC team members traveled unofficially to South Nuevo Leon. A EWB-JSC identification team visited the communities of El Milagro, Jesus María, La Puerta de Aguilar, La Siberia, and La Joya in from March 21-25, 2008 to identify communities in need of clean water and other public health needs based on water quality testing and brief health surveys. The travel from Houston to Monterrey was done over night by bus and it lasted about 10 hours. Permits to enter the country are required at the border with a fee of $25 per person, which allows travelers to stay for 6 months. The team members arrived in the morning of the 22nd of March to Monterrey and were greeted by representatives of Rotary Club of South Monterrey (Fig 2) who transported EWB-JSC to Linares (the host city to IT-Linares 1 hour away south of Monterrey).

Fig. 2 - Rotary Club of South Monterrey with EWB-JSC team members

The objective of the visit served 2 purposes: to meet with IT-Linares representatives in person to solidify the partnership, and to see where material could be stored for future implementation trips to rural communities. During the visit, EWB-JSC team members were given a tour of the school followed by a meeting with IT-Linares professors (Fig 2.1a & b).

Fig. 2.1a & b: Presentation and Tour

The EWB-JSC team made a presentation to IT-Linares students and faculty about EWB, water contamination, and the need of clean water in third world countries. The presentation was well received and a panel of questions and answers followed it. Once the activities were concluded, IT-Linares transported the EWB-JSC team to Matehuala, a city 3.5 hours south of Monterrey in the State of San Luis Potosi. Matehuala is a small city of about 200,000 people and it is a major commercial venue for rural communities around it, including communities in the bordering State of Nuevo Leon. The EWB-JSC team stayed in Matehuala over night and took the opportunity to explore hardware stores, and grocery stores to purchase bottled water and food.

The next morning, IT-Linares faculty transported the EWB-JSC team to 4 rural communities in the South of Nuevo Leon. These communities are about 1.5 hours East of Matehuala going towards the city of Dr. Arroyo on highway 61. The highway is a paved 2-way road and it's in pretty good shape. Along this road many rural communities are found in this extreme dry area.

In contrast with the relative wealth of industrial Nuevo León in the North, the Southern part of the state remains rural and poor. The contrast from the North to the South is obvious and so is the change in climate as well as the change of terrain (Fig 2.2). During the travel, the EWB-JSC team started to mark any points through a GPS unit for future reference. The first 45 minutes of the travel are driven through the paved road up to the village of El Charquillo, followed by the village of La Lajita. Once these two villages with running water are passed, a gravel road begins and the contrast of the landscape changes drastically to a handful of cactuses, palms, and mesquite trees.

Fig 2.2 Contrasts from the North to the South of Nuevo Leon

The villages visited in the semi-arid region of South Nuevo Leon are El Milagro, Jesus Maria, and La Puerta de Aguilar. The teams conducted water quality testing, interviewed families, conducted health surveys and talked to villagers about the general public health needs. For the most part, these villages all depend on water catchment reservoirs and man made-ponds for their water needs. All of these villages have electricity but pay a higher rate than a normal urban city. Some houses have gas tanks for cooking, but most of them rely on fire-wood to cook. The

villagers depend on agriculture, cattle trade, and a few rely on commerce. Most of the villagers are farmers; however their crops depend on the rainfall. This is the major halt for the villages since the rainy last only for 3 months of the year, and the rest of the year water is scarce for farming, drinking, and house hold chores. The majority of the villagers get sick really often from water related causes due to contamination, and the nearest clinic is about 5 KM away. The sources of drinking water are water catchment reservoirs, man made water ponds, and bottled water (for a few families who can afford it). During the dry season when water is scarce, the reservoirs and ponds are empty and most villagers have to rely on the nearest village of La Lajita (the only village with running water) or San Ramon to get water. Families get charged to use this water and they're only allowed to get water from the reservoirs (not actual running potable water). The most basic health needs for these villages are water purification for drinking purposes, improvement to water structures such as reservoirs, and a way to improve irrigations systems and farming to alleviate the problem of the lack of rain.

(A)

(B)

(C)

(D)

(E)

Fig 2.3 A) EWB-Team members conducting water quality tests B) Dry season, drinking water is scarce for villagers and cattle C) Empty Reservoir in El Milagro D) Only one of the ponds had any water left in Jesus Maria E) Reservoir in Jesus Maria almost empty F) Smallest reservoir in Puerta de Aguilar and the only source of drinking water

After the end of the day, EWB-JSC members went back to Matehuala and met with the Jeepers club. A meeting was conducted to talk about the routes to take and the next villages to visit in the mountainous Eastern region of Nuevo Leon. The Jeepers is a group of aficionados who own jeeps around the country and explore tough terrain in their 4 X 4s. The Jeepers offered to transport EWB-JSC to the villages that can only be accessed through these types of vehicles and also due to their familiarization with this region. After the meeting, EWB-JSC members were interviewed by a local TV station from Matehuala

and also from the National News Paper El Norte (Fig 2.4). It was an opportunity to create a public awareness of the region and to explain the public health needs many people suffer from.

Fig 2.4 – Members of EWB-JSC talking to the Media


Fig 2.5 – Jeepers transporting EWB-JSC members

The villages visited in the mountainous region are La Siberia and La Joya. It takes about 3.5 hours to get to these villages from the municipality of Dr. Arroyo. As a general observation, the villages of the "Sierra Madre Oriental"' in of this region have adobe houses illuminated by the stars of the sky and its habitants drink fresh water from the streams, but the trade-off is walking 8km to get it. The recreational activities for the children are to transport water by burros, carts, or to walk carrying buckets on their backs. Others walk to the wilderness to look for wood to cook the meals and others help out their parents to plow the fields when water is available, however drought for 2 years has kept agriculture stagnant. The nearest hospital is 3 hours away and during emergencies the fight against time becomes a battle for survival.

Even though the villages of this region don't suffer from extreme dry weather conditions, it is difficult for them to get rainfall and to get drinking water; these factors represent a major hurdle for the people due to the lack of agricultural, livestock, and economic development. There are small clinics in these villages and the clinics are run by student doctors who rotate from year to year by new student doctors. The doctors interviewed (Fig 2.6) reported gastro-intestinal and respiratory illnesses as the most recurrent diseases.


Fig 2.6 – Interviewing a student doctor

The gastro-intestinal diseases such as diarrhea are due to poor health practices and water contamination from the reservoirs. The majority of the villagers don't have electricity due to its high rate and none have gas due to the high prices for transporting the tanks to each house. Due to the poor conditions of the water reservoirs, most villagers prefer to bring water from the mountain

streams, and this takes them about 1 hour walking (~11Km). Usually kids or youngsters are sent to get it on the weekends and they bring water either walking or by burros and the same situation applies for fire-wood (Fig 2.7).

Fig 2.7 – Transporting water

Fig 2.8 – Getting a sample of water

Most families try to ration two tanks per week, mostly for drinking and cooking. The government has drilled water wells, but the technology is unreliable. These villages have non-working water wells for several reasons: Some parts that go bad never get replaced, there is not enough water drawn from the wells, or the water is too salty. While in the village of La Joya, the men of the village helped us obtain water samples from the wells and from the streams (Fig 2.8). The villagers reported they don't help from the government even when promised and most people are reluctant to help due to the difficult access to these villages. The majority of the villagers rely on cattle, farming, and the sell of tea-leaves and herbs obtained in the mountains (Fig 2.9). Bottled water is not consumed due to its high price and the difficulty to obtain it.

Fig 2.9 A family cutting tea-leaves to sell

Socio-Economic and Health Trends

Once all the criteria were reviewed, as well as the health and community surveys, the EWB-JSC concluded on the following socio-economic trends for all of the communities assessed: The water consumption is less than the minimum under UN standards (20L water/day). A 20L container costs about 18 pesos ($1.80 USD) and it only last 3 days for a family of 4. The purchase depends on money and availability. Women and children are the prime transporters of water and the modes of transportation are walking, by burro or paying someone else to get it. The average distance to get water is about 6-8 KM. As far as energy, villagers pay about 30-50% more than people who live in urban areas. The cost of gas for a 30Kg tanks is about 280 pesos ($28 USD) and it lasts about 1-2 months depending on the size of the family and the times used. The cost for electricity ranges from 400 – 10,000 ($40 - $1000 USD) every 2 months. The communities that pay the most are the ones in the mountains. Most of these people are abused by the electric companies and when they can't afford the bill, the electricity is cut. The fee to re-install electricity in a house is extremely expensive, so most people decide to live without it. In general, the men and boys are farmers and cattle traders while the women and girls are in charge of food production. The agriculture in both regions (however contrasting in terrain) has been stagnant as well as raising cattle due to lack and access to water. In the villages in the mountains the majority of the young have migrated to bigger cities in Mexico and in the villages in the dry area, most of the young adults have migrated to the United States. There are a lot of families who live from money their families send from the United States. As a result of this migration, a lot of the villagers are elderly, women head of household, and children.

The Health trends found in all of these communities are as follows: Infants get sick about 2-4 times per month and the most common diseases are diarrhea, conjunctivitis, and respiratory infections. Adults get sick about 5-8 times per year with gastro-intestinal diseases. Basic medical treatment and medications, however each family has to pay about 100 pesos per year. More expensive medications are not available through public health clinics and have to be purchased at their own expense. Home remedies are a common practice to treat gastro-intestinal illnesses. Most adults die from natural causes and the most common diseases are high blood pressure, diabetes and cancer. The women are usually in charge of the general health of their families and also in charge of health education. Even though doctors recommend villagers to boil the water, it is not commonly practiced. When the villagers where asked why they didn't like to boil the water, several reason were given; among them the cost of fuel is too much and they don't want to waste the little gas they have or the fire-wood to boil water because it takes a lot of energy. Another

reason is the water doesn't have the same taste they're used to, as explained by some: "it doesn't have the fresh taste of dirt".

Conclusions on the pre-assessment trip and selection of a community

The EWB-JSC team returned back to Houston with all the data required to make a pre-assessment of the villages and rank them in order of priority with the most need. The team made a decision based on several factors: Accessibility, nature of the problem, possibility to expand with future projects, difficulties with implementation, rain water and accommodation/receptiveness. The accessibility to the community was considered as a major factor since this project would be the first one for EWB-JSC in Mexico and we wanted to have more sense of security in case an emergency occurred while assessing the community and implementing the first project. As part of the other criteria, physical characteristics and water quality tests were considered (see tables below).

Physical Characteristics

Village	Distance/Time from Matehuala*	Size	Dry Season	Rain Season	Number of ponds/condition	Number or reservoirs/condition
El Milagro	45km/28miles 1h15	25 families (~100 pers.)	March-July	Aug-Sep	1: very small, almost dry, very turbid, cattle drink from there	1: good size (15m x15m x 3m) and walls, but already dry and bottom is dirty/muddy
Jesus Maria	45km/28miles 1h15	120 families (~450 pers.)	May-June	July-Sep	3: large, full, but turbid	2: fence around, muddy water, half-full; 20m x 20m
La Puerta de Aguilar	50km/30miles 1h30	70 families (~250 pers.)	May-June	July-Sep	1: very contaminated	2: 1 small (10m x 15m x 4m), and one big (70m long) but unused because too much algae
La Siberia	105km 2h30 Alt.: 2080m (6000ft)	57 families (260 pers.)	March-May	June - February	1 pump: water fairly clear, but extremely small reservoir	1 well: dry 1 windmill+tank:broken
La Joya	105km 2h30 Alt.: 2080m (6000ft)	50 families (~200 pers.)	March-May	June-February	1 large for animals only Several holes in the ground to collect rainwater	1: new, but unused!

Water Quality Analysis Results

Sample	Source	pH	Alkalinity	Turbidity (readings) = avg	Bacteria	
					First 24 hrs	After 48 hrs
1	Milagro (from elder lady)	7	120	(19.2,17.2,17.3) = 17.9	Negative	Positive-black, lots of particulates
2	Jesus Maria-back-up pond	8	100	(207,178,193) = 193	Negative	n/a
3	Jesus Maria-main reservoir	8	150	(160,158,160) = 159	Negative	Positive-dark, no particulates
4	Aguilar- bucket in yard	9	150	(404,404) = 404	Negative	Positive-black, particulates finer than #1
5	Aguilar - main reservoir	8	160	(15.4,14.1) = 14.8	Negative	Positive-dark, no particulates
6	La Siberia-manual pump/well	7	220	4.1	Positive-black, particulates finer than #1	
7	La Siberia-windmill pump	7	220	9	Positive-dark, no particulates	
8	Joya de San Diego - drinking pond	7	160	(4.14,4.97,4.38) = 4.45	Positive-dark, no particulates	
9	Joya de San Diego - reservoir	7	100	20.1	Positive-black, lots of particulates	

After the identification team analyzed results for water quality tests and reviewed the surveys conducted, La Puerta de Aguilar represented the village with the most water challenges. The team also discussed the pros and cons of each community. The pros would be to start with a small enough community in Mexico as well as the possibility to expand further projects and the distance from the nearest city. The Cons would be if the community was hard to access, too big or if the need ranked lowest based on the quality of water, access to water, and immediate public health need (see table below).

Pros and Cons Summary Table

Village	Pros	Cons	Comments
El Milagro	• small size (~100 people) • closest from Matehuala • is quite isolated and "abandoned" compared to other communities around Dr. Arroyo, especially after flood rains • is probably in the driest region (run out of water really fast) • already has some infrastructure (reservoir) we can work with • could develop a micro-enterprise from the water business and save money for other things • possibility to expand water projects to electricity and biogas • cool name :-)	• hard to install RWC systems on roofs	• We couldn't measure the water they collect (dry reservoir), but a mix of it with water from La Lajita • We didn't get the chance to talk to talk to the community leaders
La Puerta de Aguilar	• we can help more people (250 persons) • close from Matehuala • have a small reservoir they use, and a big one they don't • real turbid water • seem to be well structured/organized • possibility to expand water projects to electricity and biogas	• too big? • is along a road that connects different communities, so gets more attention than El Milagro • hard to install RWC systems on roofs	
La Joya	• begged for help • have to walk a long way to get clean water (spring)	• quite remote • don't want to use the reservoir they have (prefer to walk 11km to get cleaner spring water)	
Jesus Maria	• closest from Matehuala	• may be too big (~450 people) • already have 2 reservoirs and 4 ponds	
La Siberia		• quite remote • acknowledged La Joya needs more help	

Based on all of the criteria and after analyzing results and discussing the pros and cons of each community, it was concluded the communities with the most need were El Milagro, La Puerta de Aguilar and La Joya. At the end, even though El Milagro was the ideal community due to its size, proximity to the nearest city, and its isolation from other villages; La Puerta de Aguilar represented more needs due to the higher contamination of the water and lack of access to it (small reservoir for drinking water factoring in the size of the village compared to El Milagro). Another point in favor of Aguilar is the villagers kept asking for the help and the chief of the village showed his best disposition to help facilitate our stay if we chose their village. Even though La Joya had a great need of water, their water didn't seem as contaminated compared to the other two villages and the distance to the nearest city is greater. The rest of the villages are still considered for future expansion of EWB-JSC projects once we have gained experienced in Aguilar.

Post-Assessment Summary Report

After the pre-assessment trip, the identification team analyzed results for water quality tests and reviewed the surveys conducted at the villages. With La Puerta de Aguilar representing the most water challenges, the EWB-JSC team decided to contact representatives of Aguilar to notify them of the selection of Aguilar and to let them know of our plans to travel in the Fall of 2007 to conduct a more detailed assessment of the village.

Day 1 – Arrival to Mexico

The assessment trip occurred from Nov 10 – 14, 2007 to conduct water quality tests, health, energy and community surveys, and to do a surveying of the terrain. Five of the EWB-JSC members traveled via airplane and arrived to Monterrey City around 4:00 PM while another one traveled by bus. The bus drive takes 10 hrs from Houston to Monterrey. Even though it is not recommended that team members travel on their own, an exception was made since the person traveling by bus is a native from Monterrey City and is well familiarized with the territory, the language and the culture. A vehicle was rented at the Mariano Escobedo International Airport and the rest of the team met there; the vehicle rental requires you to purchase insurance to be covered for accidents unless specified a personal insurance will be used. The person renting the vehicle is the only person allowed to drive the vehicle. The team took off from Monterrey City around 5:00 pm and arrived to Matehuala City around 9:00 PM staying at Hotel del Parque in downtown and commuted every morning and evening from Matehuala to Aguilar (the drive is usually about 1.5 hours). It was decided to commute every day instead of staying at Aguilar to avoid putting any kind of burden to the small community and so that Aguilar villagers wouldn't feel obligated to accommodate us.

Day 2 – Village Meeting and observations

On November the 11th, the EWB-JSC team arrived to Aguilar and the village was already aware of our arrival. From Houston an arrangement was made over the phone to call for a meeting with the locals to discuss our plans for an assessment, the methodology, experiments to be conducted, and what it was needed from the people to have a successful assessment. The meeting started at 11:00 AM in the village hall (Fig 3.1), and Professor Ernesto Ruiz and two others students from IT-Linares met us in Aguilar to be part of the meeting. Since the Chief of the village was already aware of EWB-JSC's visit, he had

Fig 3.1 Meeting in the village Hall

already informed villagers about EWB-JSC's plans to conduct health and community surveys from house to house. The Chief Balbino Sauceda introduced the project Lead Dorothy Ruiz to the villagers and gave a brief background of her engineering profession and skills to set the tone of respect and credibility for the men in the meeting. Once the Lead was introduced, she talked about the purpose of the meeting and the visit; she also introduced the rest of her team members: Tien Nguyen, Technical Lead in charge of the water quality and testing as well as his team partner Dean Muirhead. Jody Muniz and Gerson Vasquez in charge of surveying the terrain, and Mike Martinez partnering with the team Lead to conduct Health and Community Surveys. The students from IT-Linares made a presentation about bio-gas and their plans to do an assessment of the village to see if the installation of small bio-gas reactors was possible.

Village Meeting Protocols

The men of communities in this area of South Nuevo Leon as well as the communities visited during the pre-assessment trip usually gather on the last Sunday of each month to talk about community issues. The meetings are presided by the Chief of the village or by the President of the village committee. The committee has around 5 elements, a President, a Vice President, a Treasurer, Secretary and two other members. The whole purpose of having these committees are to make decisions that affect the village, to raise money for community related events or structural constructions of use for the entire village. Women are not allowed to participate in the meetings, they are allocated different days to meet for different purposes, such as health education, cooking, and family planning. During the meetings, the President of the committee raises the topic of concern and every decision is voted on by all the heads of each family. To be considered head of the family, a person must own land to farm (the size of the land doesn't matter). The secretary usually writes the minutes of the meeting and they keep record of each agreement reached. In case of a disagreement, they keep calling to more meeting until they reach a consensus. While the meeting is being conducted, the elderly are given priority to speak out of respect and each person may speak taking after raising their hand to indicate they wish to speak.
The meeting comes to a closure once everyone comes to an agreement. It is preferred to do meetings between 11AM – 1PM since most men are working at the fields before and after those hours.

Forming a Water Committee

At the end of the meeting, a local water committee for the EWB-JSC project was formed. The committee has a President, a Secretary, a Treasurer and a Vocal or representative. The EWB-JSC Lead proposed creating this committee and afterwards, the villagers decided to propose names of

people who were present. As a cultural note, to avoid family conflicts, when two persons of the same family were nominated for the same position, both of the proposed nominees would withdraw themselves from the nomination and would appoint a different person instead. After the nominations, the President preceding the meeting would ask people to vote and if people wouldn't vote, he would suggest a different position for the nominee. At the end, no vote is necessary once there was an agreement on what nominee would best fit each position. The person making the nomination would explain the reason of the nomination and why the nominee was best fit for the position. After the Water Committee was created, it was agreed between all the villagers the Committee would inform the village of all the proposed decisions regarding the EWB-JSC project and everything would have to be voted on by the villagers. The main objective of the committee is to act as the liaison between the village and the EWB-JSC chapter, to keep the village informed about water related projects, and to raise funds for maintenances and upgrades to the project.

Fig 3.2 a,b – Water Committee talking to EWB-JSC members and IT-Linares professor talking to villagers during the meeting

The rest of the meeting was followed by questions and answers from the villagers. Most of the villagers had concerns for the veracity of the project and wanted us to clarify if we had anything to do with an affiliated party of government organization. When the meeting was concluded, the Chief of the village asked the men to greets us in a friendly manner, to accommodate us as much as possible, to instruct their wives and children to lets us in to their houses so we could conduct surveys, and to feed us if necessary for EWB-JSC members traveled from a very far away land volunteering their time and efforts to try to improve their way of life. At the end of the day the EWB-JSC team took the opportunity to get to know the villagers and to go look at their different sources of water to get ready for the next day. The villagers were extremely receptive and helpful at directing the EWB-JSC team to the different sources (Fig 3.3 a,b).

Fig 3.3a – Giving EWB-JSC team water samples from the main reservoir

Fig 3.3ab – Villagers show EWB-JSC the different sources of water around the village

Days 3 & 4 – Surveys and Interviews

The next two days were dedicated to conduct a full assessment of Aguilar. The EWB-JSC team divided itself into 4 teams: One team conducted water quality testing, another team performed land surveying, and the two other teams were split to conduct community and health surveys from family to family. Each of the IT-Linares students (Edgar Pintor and Bertha Fernandez) integrated themselves into these two last teams and interviewed the families while taking pictures. The IT-Linares students were extremely helpful and interviewing families and writing all the answers down. They also had their own energy survey to do an assessment on the potential for bio-gas reactors. IT-Linares decided to undertake his project and required graduating students to write reports on bio-gas study as part of their graduation technical reports. The students tested bio-gas prototypes at IT-Linares using local resources and materials. All the funds used for prototype testing and helping us conduct surveys came from the Department of Higher Public Education from the IT-Linares branch.

Socio-Economics of Aguilar

As far as the community and energy surveys, about 20 families were interviewed. The majority of the families who live in Aguilar depend on agriculture, cattle trade and a few families depend on local commerce. The main type of consumed food is beans, tortillas (corn), rice, cheese, potatoes, meat, eggs, chiles (peppers), spinach/mustard greens and Mexican squash. During the season, people consume nopalitos (cactus), flores de palma (flowers from palm trees), tunas, and orejones (dry squash cooked in a blend of corn soup). Meat is only consumed about once per week and most if it comes from pork, goat, and home raised chickens. In average, families own about 2 cows, 3 horses, and one burro per household. Some other families own chickens, goats, and cows. The main source of income comes from agriculture y livestock. Their income is obtained from corn and beans

from the temporal territories. Other income comes from the sale of milk, cheese, and meat. The farming season starts in May when it starts to rain and when the dry season comes, people start to sell the stored corn (Feb-May). One Kilogram of corn sells for about 2.50 pesos (25 cents) and on average a family may sale up to 25 kg during the sowing season.

Other sources of income from public welfare and public education scholarships given to families who have children attending public schools. There is an elementary school and a kindergarten school in the village. There is a program called "Opportunities" which gives a scholarship to children who attend 3rd grade of Elementary school or higher and who maintain a certain GPA. The scholarship is for 300 pesos ($30 USD) every 2 months. When the children start going to secondary school, the scholarship increases just a little bit more. Most families have extra sources of income from grown children working in bigger cities in Mexico and across the border in the United States. A family gets about 800 pesos ($80 USD) from these types of sources every 2 or 3 months. The majority of these children work in construction, public service, maids, and low paying wage jobs. Most families with children have to incur transportation cost (5 pesos per person daily) to send their children to the next village of San Ramon (6 Km to the north) so they can attend secondary school. For the families who cannot afford the vehicle transportation cost, the kids have to walk about 45 minutes or ride a bike. The kids pay an average of 12 pesos for lunch every day. The tables below show average costs and demographics of the village (this doesn't include the village extension of 6 families who are part of Aguilar, what is actually called La Puerta).

Demographic Data

People (Ages)	Masculine	Feminine
< 1	**0**	**3**
1-4	**7**	**5**
5-14	31	20
15-19	**16**	**21**
20-24	**7**	**4**
25-29	**2**	**2**
30-34	**4**	**6**
35-39	**5**	**8**
40-44	**8**	**8**
45-49	**8**	**4**
50-54	**0**	**1**
55-59	**2**	**3**
60-64	**3**	**4**
65-69	**4**	**8**
70 or older	**12**	**9**
TOTALS	**109**	**106**
TOTAL Population	**215**	

Average Costs per family

Type	Occurrence	Cost in pesos
Electricity	Every 2 months	$150 - $410
Gas (30 Kg tank)	1.5 months	$240
20L bottled water	3 days - depends on size of family	$20
Bus to Matehuala	One way	$50
Kg of whitewash for latrines	1 kg/day	$4
Clinic fee	Yearly	$100
Transportation to clinic	Avg. 2 / month	$220
Medications	Yearly	$200 - $800 depends on severity of illness
Beans	1 Kg for 2 days	$12
80L Tank of water for household chores	3 days	$15 pesos to transport it from reservoirs
Mill corn	1/2 bucket	$6

Conditions (Table 3C)

Type	Number
General population	215
Number of families	62
Persons who can't read (15 yrs old or more)	50
Men	26
Women	24
Housing	
1 bedroom	26
Dirt floors	36
No potable water	62
No drainage	62
No electric energy	2

Fig 3.4 – Adobe house with vigas

The houses are built from adobe, rocks, wood, vigas, mud, and lime. Only about 2-3% of the houses are made out of concrete (Table 3C and Fig 3.4). Houses have electric service inside, but the village lacks public lighting. Most of the houses are fenced by cactuses. The households cook with hydrocarbon gas, which are bought from outside suppliers and are stored in tanks. On average, a 35 Kg tank of gas last about 2 months depending on the size of the family. However, most families prefer to cook with fire-wood to avoid wasting gas due to its high cost (Fig 3.4). Families use fire-wood to cook the stuff that takes the most energy, such as to boil water, cook beans, and cook corn to get ready for nixtamal. On the other hand, people are so used to cook over wood camp fires due to the flavor it gives to the corn tortillas and other dishes such as beans, tamales, and chicken broths.

Fig 3.4 – Campfires inside kitchens

Health Assessment and Hygiene Practices

The handling of personal, food, and water hygiene deficiency (as well as waste problem) is very poor, which results in a frequent incidence of gastrointestinal diseases and dermatitis. The most common diseases are diarrhea and respiratory illnesses. The highest incidence of diarrhea occurs between the months of May to October (coincidental with the rainy season) and during the driest months (due to the problem with such low water and animals are able to get into the ponds and all the water is stagnant due to the lack of flow). Infants are the ones who get sick most of the time and miss school due to vomiting, diarrhea and dehydration. Only 44 families own latrines and 59 own trash disposals. The families with latrines use "cal" daily to avoid fermentation and flies. The trash is disposed and burned in a hole dug in the backyards. Oil and lard are used for cooking, and they're usually reused 4-5 times before it is disposed. This cooked oil is used as fuel to burn the trash as well as gasoline. The burning of wood used to cook inside the houses creates respiratory problems and produces headaches to the women cooking. The wood is obtained from the wilderness and young children have to get it by burros (every 3 days). Most people own small refrigerators but hardly use them to save on electricity. During the rainy season, sometimes the village is out of electricity for one to two days, a major problem being the roads are in bad shape. People wash their hands with water from the "aljibe", which is the small water reservoir. Of course this water is contaminated and they don't want to use bottled water to avoid wasting it. The nearest clinic is in La Lajita (about 1 hr away walking) and in case of emergencies; people have to pay someone else to drive them. People use transportation sometimes as a ludicrous business and at times charge up to $200 pesos to drive an ill person ($20 USD). The main causes of death for adults are due to respiratory infections, arterial hypertension, diabetes, diseases due to acute diarrheas, and gastritis. The main causes of death in minors are respiratory acute infections, diseases due to acute diarrheas, dermatitis, medium acute otitis, and various types of urinary infections. Minors get sick about 2-4 times per month and adults get sick about 5-8 times per year with gastro-intestinal diseases. Basic medical treatment and medications are provided in the Clinic at the village of La Lajita, however each family has to pay about 100 pesos per year. More expensive medications are not available through public health clinics and have to be purchased at their own expense. Home remedies are a common practice to treat gastro-intestinal illnesses. The women are usually in charge of the general health of their families and also in charge of health education. They meet with the doctor from La Lajita on a monthly basis and it's basically to get medication, for consultation and to talk about general health practices (Fig 3.5). Even though doctors recommend villagers to boil the water, it is not commonly practiced. When the villagers where asked why they didn't like to boil the water, several reason were given; among them the cost of fuel is too much and they don't want to waste the little gas they have

or the fire-wood to boil water because it takes a lot of energy. Another reason is the water doesn't have the same taste they're used to (it doesn't have the dirt fresh taste).

Fig 3.5 – The doctor had a meeting with the women in the village Hall and EWB-JSC took the opportunity to talk to them.

History, Culture and Education

The elderly of the village narrate the village started as an old hacienda that was owned by a Spanish family. The hacienda owner possessed all the land and the rest of the inhabitants were laborers who worked for the owner. After the Mexican Revolution, the land was taken away from the hacienda owners and was given to the common people who divided the territory amongst themselves. The village Hall is now what used to be part of the old hacienda. There is an elementary and a kindergarten school in the village. The Elementary School has 3 classrooms and the students are divided in age groups to teach classes from 1st to 6th grade. The school times are from 9am – 1pm and one of the teachers lives in Aguilar. The elderly of the village don't know how to read and write and the ones that do only went to school up to the 3rd grade. The hobbies for the women include knitting, visiting family, and making the preparations for the village festivities. The major festivities are on Oct 23rd to celebrate the "fiesta ejidal", July 16th to celebrate "Virgen del Carmen", and Holy Week in the spring. Women are very religious and celebrate old traditions during the Christmas and religious Holidays. Women rehearse for the Church choir and are active participants during mass celebrations. Most celebrations take place in the village square, where music,

dancing and cooking occurs. The children usually get together in the evenings and play after they finish their chores and homework. Most of them enjoy just hanging out to talk about ghosts, to play hide and seek, and to play some soccer.

During our visit, EWB-JSC team members had the opportunity to give a presentation to the kids of the village during school hours and also requested the help of two students so they could learn how to conduct water quality testing. Kids learned about water in Space and as narrated by one of the astronauts in the International Space Station.

Water Quality Survey

Water for human consumption and for domestic labor is obtained from a man made pond, which is located down the village. It is supplied by rainwater but doesn't have any protection. For this reason, it is normal for the water to get contaminated from trash, animal fecal matter and waste. Due to the lack of water in the region the people depend on 2 small water catchment reservoirs one is called "tramp" (measures 70m long) used to trap water from the rain and it is used for human consumption. Although this trampa was built by a team of local universities 30 years ago, it never proved to be successful (Fig.3.6). The idea was to collect streaming water from the mountains of the East when it rains, however that's a major problem due to all the animal waste in the soil. The water stored in the trampa is also not used due to poor maintenance, algae, and bacteria growth inside the structure. The other reservoir has the cleanest water, but is really small for the entire village *(10m x 15m x 4m)* (Fig 3.7). These reservoirs only get replenished only during the rain season (July-August).

Fig 3.6 - Trampa

Fig. 3.7 – Pila or Aljibe

The rest of the year is the dry season and therefore 70 families have to figure out a way to get it from other sources such as other villages or by purchasing bottled water. This is time consuming and it's not an affordable option for the villagers. During the dry season (March-May) the water becomes completely scarce and the villagers only depend on the smallest reservoirs) since the other one becomes empty and it's hardly used due to contamination. This water is rationed between families every Sunday (200L/family) and people have to improvise on water management for their household chores, cooking and to feed the animals. The man-made pond is available to feed the animals but during the rain season fecal matter gets dragged from streams created on the runways made out of dirt. This is one major challenge for the village since fecal deposits are hard to control. During serious drought, villagers of Aguilar have to walk 2-4 Km to the nearest villages of San Miguel and San Ramon to get water. The local government has done well drilling; however limited technology has only made it possible to find water with high salinity content. Other drilling attempts have been made but the locals don't know why people never come back to report any results. The major problem according to villagers interviewed is the animal waste along the path of streaming water, and there has been a conflict with the families who live along that path (they keep all their goats, sheep, and animals in their backyards – Fig 3.8). The people don't want to move their animals to a different place and therefore they don't see how the problem can be solved since the major deposits of water occur in that area. Talks about building a different another water reservoir in a different locations have been discussed.

Fig 3.8 – Water path current in the rainy season, it picks up everything in its way. People have animals in there backyards and all that waste gets dragged towards the pond when it rains.

Figure 3.9 shows a schematic of the major water reservoirs used by the townspeople. Reservoir sizes and distances are not to scale.

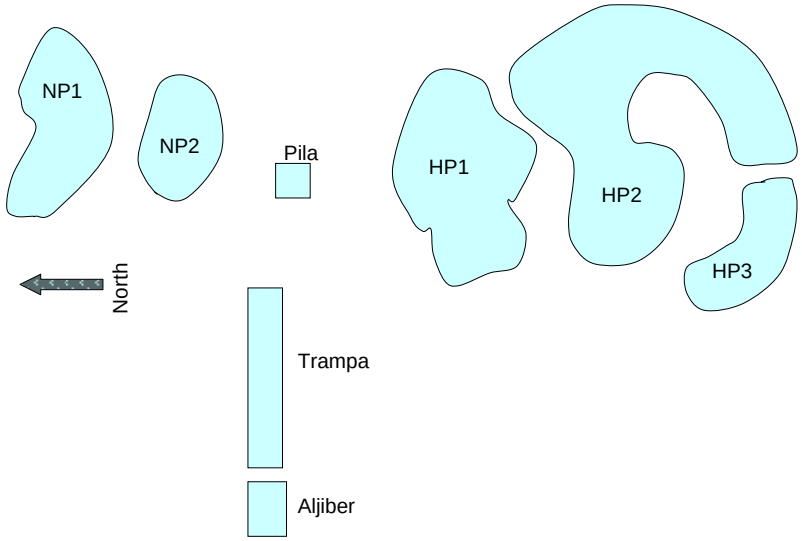


Figure 3.9. Major Water Reservoirs of Puerta de Aguilar

From discussions with the townspeople, the Aljibe, Trampa, HP1, HP2, and HP3 reservoirs are used most frequently. Aljibe (Figure 3.7) and Trampa (Fig. 3.6) reservoirs are concrete lined pits with a fence surrounding Aljibe while Trampa has sheet metal panels covering most of the surface to minimize livestock access to the water. HP1, HP2, and HP3 (Figure 3) reservoirs are large pits which are open and accessible to the livestock. NP1 & NP2 are furthest north of the town and according to the townspeople,

are rarely used. The Pila is concrete lined pit that is fed from a pump, however the pump operates intermittently and the water extracted from the pump is very salty and useable; this was confirmed with water conductivity data and will be discussed later.

Figure 4. View overlooking HP1, HP2, HP3 Reservoirs

Water Quality Data

The data collected consisted of temperature, conductivity, and turbidity for each of the major reservoirs as well as from a water container obtained from a family residence. Table 4 shows the data for all the reservoirs and the family residence. The family who provided the sample obtained the water from the Aljibe reservoir and then used a cloth strainer to filter the organisms and particulates before consumption.

Table 4.1. Water Quality Data from Reservoirs

Reservoir name	Temperature (F)	Conductivity (µSiemens/cm)	Turbidity (NTU)
NP1	24	340	769
NP2	25	284	272
Aljiber	20	240	6
Trampa	20	260	15
Pila	20	6190	18
HP1	23	276	87
HP2	23	280	72
HP3	18	310	92
Family Residence	n/a	n/a	14

Note the high conductivity of the water from the Pila reservoir, confirming claims from the residents regarding the high salinity of the water extracted from the well which supplies Pila. Another interesting point is that the Aljibe and Trampa have the lowest turbidity, which seems reasonable since these reservoirs have barriers to prevent the livestock from accessing the water, thus minimizing contamination.

Water Bacterial Contamination

A 3M Petri film count plate system was used which detects both E. coli and other coli forms in the water samples obtained from the different sources. Samples were tested in ratios of 1:1, 1:100, and 1:1000; the results are summarized in Table 4.2.

Table 4.2. 3M Petrifilm Data from Water Samples

Reservoir name	Petrifilm Count (E. coli/Total coliforms) at Various Dilution Ratios		
	1:1	1:100	1:1000
NP1	1/39	0/6	0/0
NP2	2/40	0/0	0/0
Aljiber	0/8	0/0	0/0
Trampa	0/112	0/5	0/0
Pila	0/50	0/0	0/0
HP1	0/0	0/0	0/0
HP2	0/50	0/0	0/0
HP3	0/28	0/0	0/0
Family Residence	0/Too numerous to count	0/104	0/28

The surprising result here is that the coliform count from the family residence was so high compared to the source; the coliform count was way off-scale and much higher than Aljibe, the source of the sample. The woman of the house stated that they strain the water through a cloth to filter out visible organism and particulates. This could be the source of increased coliforms, but may not be the only reason. This is an issue worth investigating with a more thorough analysis in the next trip to Puerta de Aguilar.

Surveying

Existing Conditions:

Aguilar is located 30 Km away from the municipal city of Dr. Arroyo. The size of the village is about 1,660 hectares, of which 828 are for common use, 770 for temporal use, and 60 for urban use. The climate is desert biome/semi-arid having the hottest months of May, June, July and August and the most rain during the months of April, May, September and October. The average temperature is from 16-20 centigrade. The Altitude is 1,8000 meter above sea level. Aguilar's scrubland is made of short spiky brushes, nopales (cactus) and graminea. There is a great variety of wildlife: rattle snakes, coralillo snakes, bats, rabbits, cardinals, calandra, raccoons, wild cats, deer, foxes, pumas, frogs, etc

The community presently uses the water from the water reservoirs located in the general area. The water accumulates in large quantities from the storm and surface runoff from the surrounding mountains and higher elevations. During large amounts of rainfall the water travels overland thru the community itself to the largest of the water reservoirs and becomes contaminated as it travels thru the community latrines that are at ground level. GPS points were taken at the perimeters of all existing reservoirs used by the community as well as for the general layout of the community. These will be transposed onto a map.

The Mexican government previously installed electric utility poles and a power feed to an electric pump station. The pump is connected to a tank thru an underground pipe system that fills a ground level concrete water tank located in the community. Testing of this water supply shows that the high salt concentrations make treatment of this water supply difficult and costly.

The government also began installation for a large elevated water tank and pipe system that is capable of providing enough water supply and distribution for the entire community. The installation was not competed and the tank was never sanitized or commissioned into service. We were unable to locate the pipe distribution layout that was installed or field verify any pipe runs in the field. Sanitization and commissioning of the tank at this point is estimated to outweigh the available funds from the community.

Recommendations:

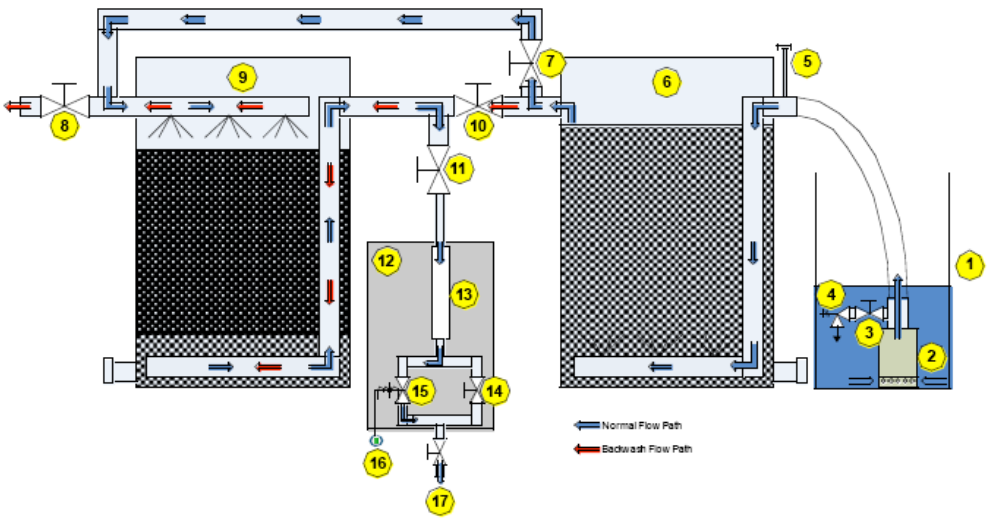
We are recommending the installation of a low cost and low maintenance solar powered water purification system for the existing water reservoirs fed by the ground runoff water collection system.

In Country Relations

The collaboration of its inhabitants, community leaders and regional partner institutions is vital not only for logistical purposes, but to ensure the appropriation, operability and maintenance of the projects. The participation and compromise of all the participants is necessary to reach the desired objective: Open the door to clean and safe water and start a walk to a dignified life. Currently, partnerships have been established with InstitutoTecnológico de Linares, Club Jeepers, the Department of Foreign Affairs of the State of Nuevo Leon, and Rotary Club of South Monterrey in México. In Houston, EWB-JSC is actively collaborating with Consulado General de México and The Rotary Club of Seabrook.

Implementation Recommendations

WB-JSC is actively planning to return to implement a water filtrations system to Aguilar based on the findings analyzed during the assessment trip. The BYOW (Bring Your Own Water) Filtration System previously installed in Rwanda, Africa is the most appropriate technology for this community. EWB-JSC has been working on a modification prototype to add a pump to meet the needs of the community since mostly children and elderly will be using it. Energy solutions such as rainwater catchment systems, water purification, biogas, solar electricity, and micro-enterprises will also be considered as part of an expansion effort to keep improving other needs of the community. The host community will be trained to operate the systems without external assistance. Once the BYOW System is installed, other neighboring communities will be assessed to see if the same system can be installed and to expand clean water efforts in South Nuevo Leon.



Normal Operation of the BYOW System

During system installation the pressure regulator (4) will be set to 5 psi to limit the maximum flow rate through the system. The pump is placed in the source water container with the pressure regulator bypass valve (3) open. The sand filter inlet valve (7), sand filter outlet valve (11), and UV outlet valve (17) are open. The backwash inlet valve (10), backwash outlet valve (8), and UV bypass valve (14) are closed. Pressing the system start button (16) on the UV box begins a one minute timer to warm up the UV light, as which point the UV solenoid valve (15) is opened and the pump (2) is started. Water follows an up-flow path through the roughing filter (6) where flocculation occurs in the gravel bed to remove larger suspended particles. Water then enters the rapid sand filter (9) where smaller particles and bacteria are removed through the physical straining process. The final treatment step in the process directs the flow into the UV sterilization box (12) where the water is exposed to ultraviolet light which achieves a 99.99% reduction of bacteria, viruses, and protozoa. The clean water is collected at the collection tap (17).

Backwash Operation

Periodic backwashing of the rapid sand filter is required to remove collected particulates and increase flow. A minimum of 50 gallons is required to adequately fluidize the filter bed and purge the system. The pressure regulator bypass valve (3) is closed to ensure full flow through the system. The sand filter inlet valve (7) and sand filter outlet valve (11) are closed. The backwash inlet valve (10) and backwash outlet valve (8) are open. The pump (2) is turned on and allowed to run until at least 50 gallons have been pushed through the system.