WATER MATTERS:
A RETROSPECTIVE HEALTH IMPACT ASSESSMENT (HIA) OF WATER AND SANITATION INFRASTRUCTURE IN SOCORRO AND SAN ELIZARIO, TX

(Short Title: LVWD HIA)

FINAL REPORT
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And
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HEALTH IMPACT ASSESSMENT
The Lower Valley Water District (LVWD)
El Paso County, TX
WATER AND WASTEWATER PROJECTS

Objective

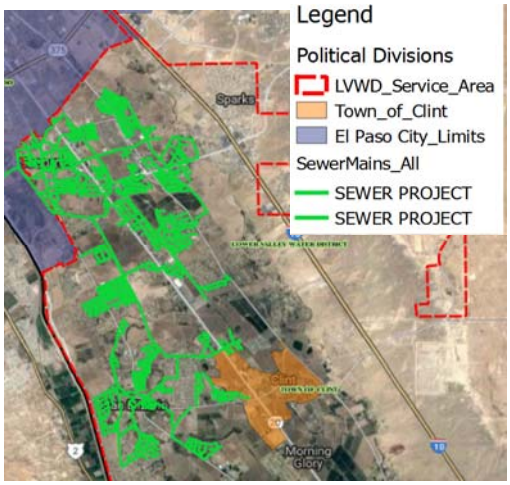
Assess the health and quality of life impacts of water and wastewater services provided through Lower Valley Water District project completed in 2003, using the tools of HIA, as defined by WHO.

Context

- The population of Socorro and San Elizario was 22,995 and 4,385, respectively, from 1990 Census.
- Before (the water & wastewater project) 2003, residents and businesses in San Elizario and Socorro were mostly dependent on private domestic wells for water and septic tanks for sanitation.
- Inadequately designed and constructed on-site treatment systems led to contaminated shallow wells in the area. Studies by UTEP (1988) and the CDC (1992) found that 100% and 50% of wells tested, respectively, were bacteriologically contaminated.
- EP County Health Department (1992) reported high rates of Hepatitis A (5x the national average) and *shigella* dysentery (3x the national average) in the area.
- UTSA Health Sciences Center (1988) found that 90% of San Elizario residents sampled had been infected with Hepatitis A before reaching the age of 35.

General Characteristics and Cost of the Project

Cost	$98 million	Funding Sources	EPA, TWDB, USDA
Implemented	1995 - 2003	13,729 connections	Benefitting 33,729 people
Water Infrastructure	Purchase of existing infrastructure, 3 MG ground storage tank, 28 MGD added pumping capacity, 265,000 lineal feet of water line ranging from 6-inch to 24-inches in diameter		
Wastewater Infrastructure	Construction of 8 sewer lift stations, 650,000 lineal feet of collection line, main collectors and force main ranging from 8-inch to 42-inches in diameter		



The Assessment

- Interviewed 11 key informants
- Survey of 100 households from a total of 223 who had lived in the same home for >25 years
- Review of secondary data related to health, economic, and quality of life impacts

Results

Household Survey

Sources of Water & Sanitation before and after

- Before the infrastructure project, 52% of residents obtained water through some combination of hauled water, domestic wells, and bottled water. 15% depended on hauled water only, and 8% depended on domestic wells only. For those who hauled water, 64% of them hauled water more than once per week.
- 100% of residents depend on septic tanks and cesspools.
- After the infrastructure project, 100% of residents had piped water, and 93% connected to sewer

Perceptions of service

- Today from the survey, 93% of residents are satisfied with water service, and 89% are satisfied with the sewer service due improved reliability, pressure, and health / "sewer service": due to improved treatment, health, and cost savings
- Currently 90% of residents utilize municipal water for cooking and hygiene needs.

Self Reported in Health Conditions	Before	After
Skin problems (rash, itchy, dry)	22%	9%
Gastrointestinal illness (diarrhea, nausea, gastritis)	9%	3%
Stomach infections (salmonella, cholera, H. pylori)	1%	0%

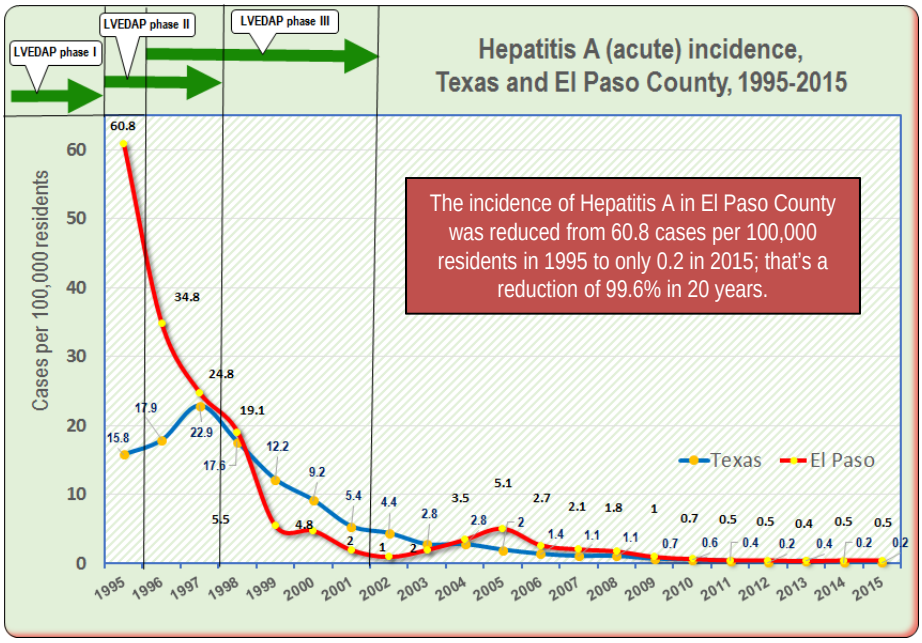
Economic, Community Development, Quality of life, Before & After

- 93% of the respondents believe that the water and sewer benefitted the community trough to expanded healthcare services, local businesses, parks and recreation and improve fire safety.
- 88% of residents believe quality of life has improve.

Secondary Data

LVWD Connections

- Water service connections, 1997 = 3,725; 2016 = 17,454 (increase of 368%)
- Residents without services in El Paso County decreased from 40,000 to 16,000



Community Development and Economic Impact

- Medium Household Incomes grew in the area by 12% to nearly 28% or an increase of up to $6,500 per year for some families.
- Property values increased by 41% in Socorro and 23% in San Elizario between 2000 and 2010 (American Fact Finder). The average is 20% in El Paso County after first time water service (EPW).
- Expanded residential development (~4500 ha) includes access to conventional water and wastewater services extended from the project's infrastructure investments.

Section I. Introduction

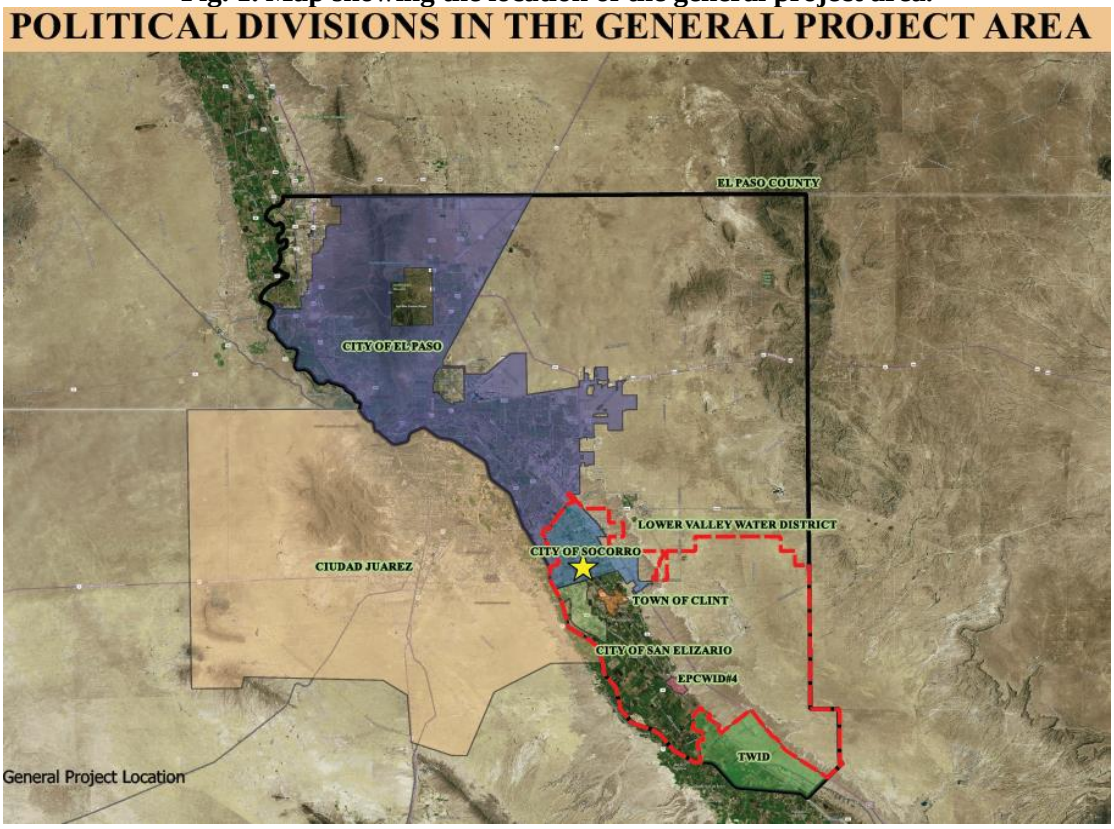
A. The Objective

A significant portion of Socorro and San Elizario, TX received water and wastewater service through an infrastructure project completed in 2003 with primary funding from the Texas Water Development Board's (TWDB) Economically Distressed Areas Program (EDAP), and from several other agencies including BECC, USDA, and EPA. The objective of this project was to assess the public health and quality of life impacts of this major infrastructure project, hereafter referred to as the EDAP Project, by conducting a retrospective Health Impact Assessment (HIA) using the tools of HIA as defined and described by the World Health Organization (http://www.who.int/hia/about/glos/en/index2.html). The results are intended to inform BECC stakeholders and, in particular, its Board of Directors, about the impacts of investments in water and sanitation infrastructure.

B. The Context

Conditions before the EDAP Phase II and III Project. The Lower Valley Water District (LVWD), created as a municipal utility district in 1986, is located in the southeastern portion of El Paso County, Texas (see map in Fig. 1.). The cities of Socorro and San Elizario (in 1998, not incorporated) are located within the LVWD's authority. At the time of the initiation of construction of the EDAP project, the population was approximately 34,000.

Fig. 1. Map showing the location of the general project area.



In 1987, an estimated one-third of the Socorro/San Elizario population was connected to a conventional water system owned and regulated by the LVWD. The remaining two-thirds of the

population obtained their potable water from domestic wells or hauled water. A conventional wastewater system did not exist in the area. A majority of the residents used individual septic systems, many of which were improperly designed and constructed. Consequently, they caused contamination of groundwater and spread of disease in the area. The health conditions were summarized in the 1994 planning document for the LVWD's application to BECC (LVWD, 1994). The document cited the following conditions:

- In 1992, the El Paso County Health Department reported high rates of Hepatitis A (5x the national average) and *Shigella dysenteriae* (3x the national average) in the area.
- A 1988 study by the University of Texas at San Antonio Health Sciences Center found that 90% of San Elizario residents sampled had been infected with Hepatitis A before reaching the age of 35.
- At the same time, studies by UTEP and the CDC found that a high percentage of domestic wells in San Elizario were contaminated with fecal coliform bacteria.

The EDAP Project. In 1987, the LVWD applied for and received a research and planning grant from the Texas Water Development Board (TWDB) to prepare a Water and Wastewater Management Plan for El Paso County. This management plan was completed in May of 1988 and presented a method for providing water and wastewater service by the year 2010 to the residents of El Paso County who live outside the City of El Paso. After completion and approval of the Water and Wastewater Management Plan, the LVWD applied for additional funds from the TWDB to design and construct a water and wastewater system for the City of Socorro following the recommendations in the management plan. Facility Engineering Plans were developed in 1993 from the original 1988 documents, proposing the phasing of the full project into three parts. The first phase consisted of the construction of a water supply system for several colonias in the City of Socorro. Phase II consisted of the construction of a wastewater collection system and a water supply for a portion of the City of Socorro. Phase III consisted of the construction of a wastewater system for the remaining portion of the City of Socorro and a portion of San Elizario. Wastewater flows were to be directed to the Roberto Bustamante Wastewater Treatment Plant.

The TWDB, USDA-Rural Development Agency, and USEPA committed funds for the Phase II and III Projects from several of their programs as follows:

	Phase II	Phase III
Grants:		
EDAP	$8,081,900	$ 26,742,000
RD	2,938,300	967,000
CWTAP (EPA)	8,070,000	16,666,000
Loans:		
EDAP	1,275,400	4,539,000
SRF	1,347,000	2,270,000
RD	466,000	
WSA	0	
Other	2,800,000	5,210,000
Subtotal	$24,978,600	$56,394,000

The total funding commitment was $81.4M. The TWDB requested that the EPWU be the program manager for the Phase II and III Projects. The Phase II and III portions of the project were constructed during the time period of 1998-2003.

Construction information descriptions (CID's) were retrieved through an Open Records request to Texas Water Development Board (TWDB), Public Information Act and Records Management. A list of the itemized contracts that we received is presented in Appendix A. The information we received pertained to the Phase I, II, and III EDAP-related projects. The information describing the actual infrastructure that was installed was extracted and categorized, and total items installed and construction costs were calculated for water and sewer. Costs associated with insurance, dewatering, material testing, traffic control plans, video tapes, concrete backfill support, additional vertical depths, filter fabric installations, and small fixtures were not itemized.

The Phase I project was to provide first time water service to six colonias, Phase II was to improve water service and provide first time wastewater service for approximately 21 neighborhoods, and Phase III was to improve water service for approximately 18,820 residents in 19 colonias, including some households that would receive first time sewer service. Phases II and III of the project were scheduled to provide 260 water connections, and 5,772 wastewater connections. Based on a Project Performance Inspection Report, October, 2003, they had installed 140/260 water connections, and 3,980/5,772 wastewater connections at that time. It was also noted in this report that it was the property owner's responsibility to connect to the main lines for water and sewer, and not all met this responsibility. It took approximately 11 years to complete the project starting construction for Phase I on 10/13/1992, and ending the final contract in Phase III on 5/19/2003.

LVWD, TWDB, nor BECC had firm numbers on the number of connections or beneficiaries from the EDAP project. To estimate the number of connections/beneficiaries, a GIS shape file of LVWD customers was provided by the engineering department of LVWD. These accounts dated back from 1975 up to 2001; the files did not specify whether customers connected to water or sewer or both services for the first time by the EDAP project. There were a total of 3,378 beneficiaries, which 3,218 of them were residential, and 160 of them were commercial, in Socorro, San Elizario, and Clint (Table 1). This included all new connections to water, sewer, or both provided by the EDAP Project and includes connections now outside the city limits of San Elizario.

Table 1. Number of EDAP Related Connections, 1978-2001

Community	Residential	Commercial	Total
Socorro	2,080	101	2,181
San Elizario	983	49	1,032
Clint	155	10	165
Total	3218	160	3,378

A summary of the primary water and sewer infrastructure that was installed to achieve these connections is presented in Table 2 and a summary of water and sewer fittings, valves, and other

selected construction items is presented in Table 3. The goal of our assessment was to document the impact of this infrastructure.

Table 2. Summary of primary water and sewer infrastructure that was installed.

Installations	Phase I	Phase II	Phase III	Total
Water Linear Footage				
2"	0	2,206	0	2,206
4"	2,472	75,593	0	78,065
6"	26,364	7,385	2,851	36,600
8"	32,616	5,930	18,508	57,054
12"	0	15,435	25,051	40,486
16"	0	0	34,133	34,133
18"	0	0	8,795	8,795
24"	0	0	9,528	9,528
30"	0	0	2,410	2,410
36"	0	0	39,274	39,274
Total Water LF	61,452	106,549	140,550	308,551
Water Meters	0	0	140	140
Water Meters >4"	5	0	0	5
Fire Hydrants	72	8	47	127
Booster Station	0	0	1	1
Cathodic system	0	0	1	1
Steel Reservoirs	0	0	2	2
Installations	**Phase I**	**Phase II**	**Phase III**	**Total**
Sewer Linear Footage				
2"	0	1,831	0	1,831
4"	0	47,670	0	47,670
8"	0	135,964	315,722	451,686
12"	0	15,849	64,402	80,251
15"	0	5,075	21,604	26,679
18"	0	4,964	35,151	40,115
20"	0	0	7,162	7,162
21"	0	13,119	27,922	41,041
24"	0	0	1,786	1,786
30"	0	7,280	7,280	14,560
36"	0	6,107	4,765	10,872
48"	0	3,904	0	3,904
Total Sewer LF	0	241,763	485,794	727,557
Lift Stations	0	2	7	9
Decommissioned Septic Tanks	0	1,365	0	1,365

Table 3. Summary of fittings, valves and other selected construction items for water and sewer.

Installations	Phase I	Phase II	Phase III	Total
12" Gate Valves	24	0	19	43
Butterfly Valves				
16"	0	0	8	8
18"	0	0	31	31
24"	0	0	4	4
Other Valves				
2" ARV	0	0	1	1
3" ARV	0	0	10	10
6" tapping valve	0	0	1	1
6" blow off valve	0	0	2	2
8" low off valve	0	0	7	7
8" tapping valve	0	0	5	5
8" end of line clean	0	0	7	7
12" tapping valve	0	0	1	1
Casing Linear Footage1				
12"	30	364	0	394
16"	172	1,122	345	1,639
20"	0	363	1,211	1,574
24"	100	0	2,268	2,368
27"	0	0	597	597
30"	0	505	1,543	2,048
32"	0	0	160	160
36"	0	0	900	900
42"	0	519	64	583
48"		355	2,187	2,542
66"	0	381	0	381
3/4" Copper Tubing	0	0	4,840	4,840
Connections				
Short Service ea.	270	0	0	270
Long Service ea.	260	0	0	260
4" connections	0	0	7	7
4"PVC connection	0	1,960	3,383	5,343
4" PVC service taps	0	54	2,502	2,556
Manholes				
4"	0	423	13,030	13,453
6"	0	27	30	57
8"	0	7	0	7
48"	0	0	767	767
72"	0	0	57	57
Pavement Repair, ft	1,946	102,505	309,432	413,883
Trench Safety, ft	275	183,187	337,335	520,797

C. Scoping

Based on our knowledge and experience with HIA of water and sanitation infrastructure projects and a review of EDAP project documents made available to us by BECC, we conducted a scoping exercise beginning with identification of important health determinants and development of pathway diagrams focused on water quality, sanitation, economic impacts, and community development/quality of life. Our pathway diagrams are presented in Appendix B.

From the pathway diagrams, we developed a logic model for the project, presented in Appendix C, and from the Logic Model, we identified key indicators to be measured/quantified. The list of key indicators is presented below in Table 4. We developed our assessment methodology (described in next section) based on our experience, the pathway diagrams, logic model, and list of indicators. In particular, we attempted to quantify the indicators through one or more of the assessment methods.

Table 4. Indicators of Health and Quality of Life Impacts Associated with Water and Sanitation

Indicators for Outputs	**Indicators for Outcomes**	**Indicators for Impacts**
Infrastructure: *Water infrastructure* • Length of distribution lines (linear feet) • Number and capacity of storage tanks • Number and capacity of pumping stations *Wastewater infrastructure* • Length of collection lines (linear feet) • Capacity of Waste water treatment (GPD) • Number and capacity of lift stations *Fire hydrant installations* • Length of water lines • Number of hydrants *Implementation Plans* • Business plan • Monitoring and Evaluation plan • Final report	Household: • # of water connections • # of wastewater connections • Flow of wastewater treated • Flow of potable water delivered • Average one-time connection cost for properties • Average monthly service costs • Water and sanitation costs Environmental: • # of latrines, cesspools, and septic tanks closed Community and Economic Development: • Fire hydrant to households ratio • # of parks • # of registered fixed food establishments with El Paso Department of Public Health • # of healthcare providers and type of services provided • # of new residents	Household: • Change in property values and taxes Health: • Cases of gastrointestinal and skin irritation symptoms, and incidence of Hepatitis A • Perceived quality of life improvement because of water security (quality, reliability, and affordability), change in local infrastructure, and access to health, economic, recreational opportunities Economic: • Change in property values and taxes Environmental: • Better conditions in shallow ground water

D. Assessment Methodology

There were four important aspects to our assessment: 1) a literature review; 2) key informant interviews; 3) two household surveys; and 4) review of secondary data and information. A brief

description of the methodology for each of these is presented below. For all activities relating to human subjects research, including the key informant interviews and household survey, protocols were approved by the Institutional Review Board for Human Subjects Research at the University of Texas at El Paso (#637598-7). All subjects gave their informed consent for inclusion before they participated in interviews and surveys.

Literature Review. One of our graduate research assistants, Amit Raysoni, reviewed and summarized the published literature relating to the impacts of poor water quality on public health in El Paso County, focusing especially on San Elizario, the community that had been studied the most. His review is presented in Appendix D. A summary of the important findings from this review is presented in the Results (Section II.A.).

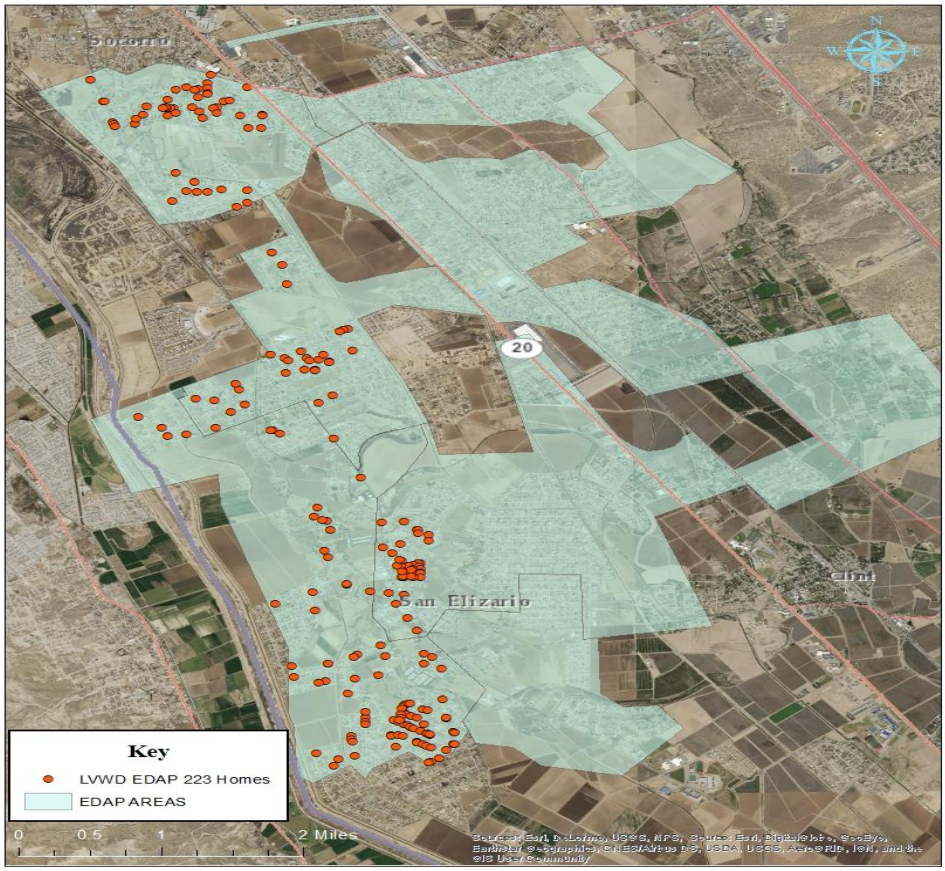
Key Informants. Key informants were identified by "snowball" process and contacted by email, phone, or in person. A total of 58 persons were identified as potential key informants, who had knowledge of conditions before water and sewer infrastructure. Many of these persons no longer worked at the same place, contact information was not current, did not remember conditions before, represented an already interviewed organization, or unfortunately had died. We actually interviewed 14 key informants. A list of the key informants and their agencies, organizations, or businesses that they represent is provided in Appendix E. The key informants represented professionals from a range of sectors including health, education, business or economic development, and local government. We used a standard list of 12 open-ended questions to interview each individual. The questions focused on water issues and the health and economic impacts of lack of access to water. The list of questions is provided in Appendix F. Each interview required about 30-45 minutes. The interviews were audio recorded, transcribed, and analyzed for key qualitative codes. The results were organized into key themes, outcomes, challenges, and concerns.

Review of News Stories. Two faith-based organizations in El Paso who have been active in advocating for water and sewer infrastructure include the El Paso Interreligious Sponsoring Organization (EPISO) and Border InterFaith. These two groups share an office in El Paso. Over the years they have documented their activities by keeping a file of news stories about the projects that they care about and work on, and their activities relative to those projects. They allowed us to come to their office and review their files. We summarized information from their files regarding the EDAP project and present it as part of our results.

Household Survey. LVWD provided a list of names and addresses for the water accounts that had been under the same name for 20 years or more. The list included 223 households. Since these households would be in the best position to describe to us the conditions before the water and sanitation infrastructure project and then the changes after completion, we decided to focus on these 223 households as our population of interest. The location of these 223 households is shown in the map in Fig. 2 below.

For the household survey, we developed and administered a 44-question survey (in English and Spanish) for community members aimed at the 223 households identified in Fig. 2. The survey focused on water use, management, health, economics, and sanitation before and after the EDAP project. We obtained informed consent from each participant. We surveyed only adults in each

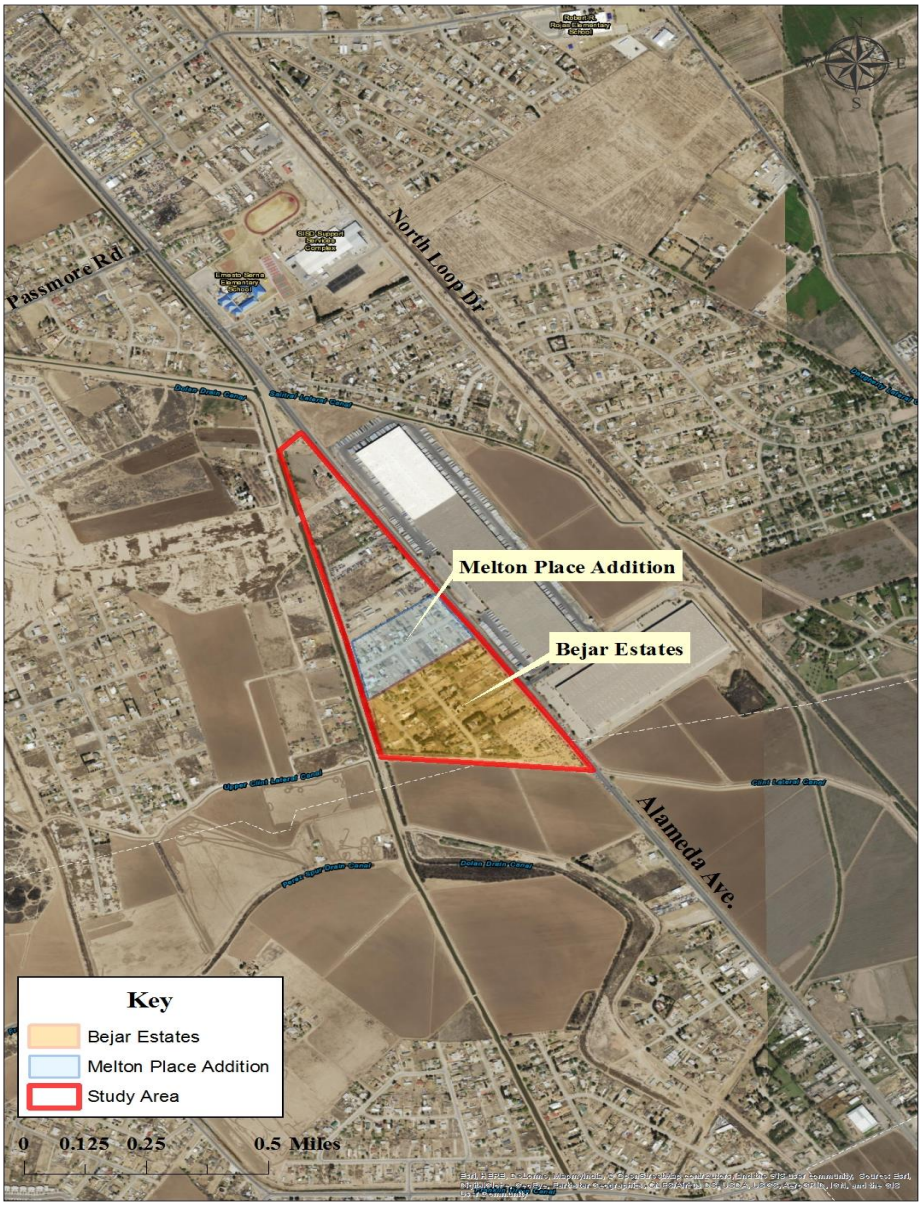
Fig. 2. Map identifying the location of the targeted 223 households.



household. The survey instrument is presented in Appendix F. We obtained 96 household surveys in the first round of contacts. We went door to door to every residence and returned if no one answered the door until we found someone at home to answer the survey. We also attempted to contact residents who were not at home during the first round of visits by telephone to try to schedule an appointment. Residents were reluctant to schedule an appointment with someone unknown, but a few agreed to answer the survey over the phone. We got four more surveys by telephone to make a total of 100. We also attempted to invite residents to a local restaurant to complete the survey, offering refreshments and a safe setting for them to meet us. No one showed up and we got no additional surveys using this approach.

Sanitation Survey in Bejar Estates. A number of individual homes and even whole neighborhoods within the project area still do not have sewer service. One such neighborhood is Bejar Estates, bounded by Melton Rd on the north, Alameda Avenue on the east, Skov Road on the south, and the Franklin Irrigation Canal on the west (See map in Fig. 3.) This neighborhood was originally targeted to be connected to sewer in the EDAP project but for some reason was not actually connected. Residents were promised sewer service since shortly after the EDAP project was completed, but have not been connected as of 2017. By our estimation, using active water accounts provided by LVWD and addresses, there are 62 occupied households in the neighborhood. Because residents have been demanding sewer service and were anxious to collect some information about the status of septic tanks in the neighborhood, we agreed to do a focused survey in the Bejar Estates neighborhood. The survey instrument is presented in

Fig. 3. Map of study area for sanitation survey, referred to as Bejar Estates



Appendix H. With the help of four volunteers who are residents combined with three trained researchers from our group, we collected 35 completed surveys about the status of sanitation and septic tanks in the neighborhood.

Collection and Analysis of Secondary Data/Information. We collected relevant secondary data on conditions relating to health, economics, and community development. The variables that we considered and the source of information for each are presented in Appendix I.

E. Challenges

The U.S./Mexico border region presents some unique challenges for HIA because: 1) it cuts across so many jurisdictional boundaries, including international, national, state, and local

county and municipalities; 2) it is for the most part bilingual; and 3) much of the area of interest is comprised of rural areas with many small cities and towns that are resource poor and limited in capacity. These factors present challenges in implementing an HIA program compared to urban areas where HIA has been more common.

Additionally, we were challenged in a couple of other ways in terms of conducting this retrospective HIA. For the results to be meaningful, we needed to survey households in the project area that were in the same home for the past 20 years or more; or to interview individuals who had memory of the situation before 2003. To meet this challenge, we requested names and addresses of households from LVWD whose water account had been under the same name for 20 or more years and focused on those addresses for our household survey. Also, since so much time has gone by since completion of the infrastructure project (at least 15 years), results about conditions before 2003 with respect to public health and quality of life are of questionable reliability, just because people's memory is not that sharp after that much time.

Another challenge was that we were trying to do the survey work in November and December, 2016 at a time when under Daylight Savings Time, darkness came at an early hour (about 5:30 pm), the weather was often cold and windy, and people were getting ready for the Holidays. From our experience in other places, residents were not as responsive compared to other periods of the year under nice weather (spring and summer).

However, our team is experienced in facing these challenges and in promoting public and stakeholder participation in the unique border setting. We are accustomed to collaboration with multiple jurisdictions; most of our personnel are bilingual; and we are experienced in working in poor communities with limited resources. In spite of the challenges that we faced, we collected a robust set of relevant data through interviews, our survey, and secondary data. The lessons learned from this retrospective HIA in a border community should be applicable to other parts of the border region, and to other rural regions in the U.S. where adequate water and sanitation infrastructure are lacking. Results should be useful to state and federal agencies who make decisions about funding for water and sanitation infrastructure in terms of quantifying the benefits of public investment in such infrastructure improvements.

The challenge of clean water in colonias (from El Paso Times, 1998)

SECTION II. HIA Results

A. Literature Review

The complete literature review is presented in Appendix D. Here we summarize the main findings from the literature review that relate to environmental contamination and public health impacts relevant to the study area.

1. The Rio Grande was tested for microbial contamination from Sunland Park to Fort Hancock during the timeframe of 2000-2002. *H. pylori* was found at all sampling sites. Fecal coliform bacteria were sometimes high but also variable over time (Mendoza et al., 2004). This study demonstrated the prevalence of *H. pylori* in the river. The significance of this finding is that river water was used frequently to flood lawns, gardens, and other areas, possibly causing contamination of wells, fresh fruits and vegetables, and soil where children play. *H. pylori* in irrigation water has been found to be a source of infection of humans (Aziz et al., 2013; and Mazari-Hiriat et al., 2001). *H. pylori* antibodies, an indication of current or past infection, were found in 21% of children age 4-7 years in San Elizario (Redlinger et al., 1999).

2. A study of Hepatitis A infection was conducted by Redlinger et al. (1997) in San Elizario. 17% of 561 children tested were positive for total anti-Hepatis A virus, and one student tested positive for IgM anti-hepatitis A virus. In this study, 50% of the households tested did not have access to a municipal water supply, and 88% of the households had septic tanks. In another study in San Elizario, 33% of 8-yr old children, 60% of 12-yr olds, and 90% of adults over 30 tested positive for anti-Hepatitis A; 74% of these households had wells; 90% were contaminated (Sawyer et al., 1989).

3. In a survey of water quality in domestic wells in the area, 18% of 73 domestic wells were contaminated with fecal coliform bacteria, an indicator of fecal contamination (Mroz et al., 1994). Most homes in the area had domestic wells as their source of water and septic tanks for sanitation.

These results combined with those that were available at the time of the decision to fund the project, discussed in Section I.B., clearly demonstrate that inadequate water infrastructure and the reliance on septic tanks posed a public health threat to the population in the study area.

B. Key Informant Interviews

From the key informant interviews, we developed a community baseline description for the time period before the LVWD EDAP project. This baseline description is presented below followed by the outcomes identified by the key informants and the challenges and concerns about the project.

Community Baseline Description (before 1998). All key informants remembered the conditions and practices the communities did before connecting to water and sewer services. Families would get water for drinking, cooking, bathing, and washing in one or a combination of the following ways: 1) hauled from a nearby business or neighbor that was connected to city water, using a hose to fill jugs, containers, or barrels; 2) contract with a commercial hauler or a neighbor to haul water, delivered to their outdoor storage tanks; 3) domestic wells; 4) purchased bottled water; or 5) water from the irrigation canal/river. Nonpotable water for direct

consumption, especially if from the irrigation canal/river, was filtered, boiled, and treated with chlorine before drinking or use in cooking. Some said that water quality from domestic wells was dependent on the particular area. For some the water was of good quality and was used for all household purposes including drinking, but for others it was too salty to drink, cook, bathe, or wash clothes. One key informant stated that arsenic was a problem. Some residential properties had water rights for water from the irrigation canal and used that water for mostly outdoor uses, like agriculture or home gardens. But some residents in very remote areas, where irrigation water was all to which they had access, would treat irrigation canal water to make it drinkable. The quality of the water in the irrigation canal was also declining at the time, becoming too salty to grow cotton, pecans, and alfalfa in some areas. For those who hauled water, their storage tanks were outside. Some had two tanks, one each designated for drinking water and the other for washing or other nonpotable uses. But the water would sometimes be stored too long, allowing algae to grow or the water to be otherwise contaminated. Some households purchased bottled water and either used it exclusively, though very expensive, or combined it with another source to meet their needs, thereby reducing the cost. Some families faced transportation challenges which compounded the access to and availability of clean sources of water.

As for wastewater, families depended on self-built or commercially bought septic tanks, and open cesspools. They recognized that domestic wells and even water from the irrigation canal was getting contaminated with wastewater because people didn't practice sanitary methods to discharge or clean their septic or other wastewater system. Some families emptied their wastewater into a nearby ditch or in open fields. In many cases, septic systems were failing, and some were built near their wells, contaminating the water. Some key informants saw families transition from having cesspools, to getting septic tanks, and then eventually connecting to sewer service.

These problems were a result of improperly subdivided properties into residential lots with no basic utilities and infrastructure, which were then sold to families needing affordable homes. Many buyers of these lots were promised by sellers that water and other services would come in 1-2 years. In many cases, these properties had no infrastructure at all, lacking water, sewer, electricity, gas, and roads. Families who purchased the properties felt at the time that they could wait the 1-2 years. Unfortunately, most residents of these properties realized that after 20 years, services were not going to be provided. These communities are now what we know as c*olonias*.

Many key informants realized that poor quality water and improper sanitation were resulting in high incidence rates of stomach infections and other gastrointestinal ailments, skin irritation and related ailments, and Hepatitis A. Poor water access and availability also led to poor hygiene in general due to lack of water to take baths, wash hands, and practice safe food handling. Sometimes there was also direct contact with wastewater and/or trash on residential properties. Children from these communities were stigmatized at school because of their poor hygiene.

In the early 1970's, some families in Socorro got piped water from El Paso Water Utilities in efforts by the City of El Paso to annex areas of the county to the east. But, it was only water service, not sewer service, and thus, residents were still having issues with septic tanks like releasing gases, foul smells, having wet areas that attracted mosquitoes and other pests, and also having waste seeping onto their property. In the late 1980's, the issues with water and

wastewater got serious enough that several grassroots movements led by residents and faith-based groups like EPISO were organized to advocate for water and sewer service. It was a challenge because there was a lot of opposition by the City of El Paso and Public Service Board to extend water and sewer services outside the city limits because of high costs and incurred debt. Getting funding from either the state or federal government was also a challenge because the needy areas were mostly unincorporated. In order to get funding, the residents needed to establish a legal subdivision within Texas. As a result, the Lower Valley Water District, a municipal utility district, was established in 1986. Low interest loans became available from the Texas Water Development Board in the late 1990's but there was concern that the loans would not be paid back. The community was forced to pass a tax pledge to secure funding, a pledge that held residents responsible to pay back water and sewer loans if LVWD failed to do so. The tax pledge passed, and TWDB provided loans, which combined with EDAP funds and grants from the EPA and other sources, allowed the implementation of water and sewer infrastructure.

Outcomes from the EDAP Infrastructure Project. A summary of the project outcomes identified by the key informants is presented in Table 5. The identified outcomes are overwhelmingly positive with respect to health, economic factors, the environment, and community development. One negative economic factor is higher property taxes.

Of primary concern is the improvement in health conditions for the residents. Improved water and sanitation resulted in less: 1) gastrointestinal illnesses, 2) stomach infections and bleeding ulcers, 3) Hepatitis A, and 4) skin irritation and infections, all resulting from improved hygiene, better water quality, improved food handling conditions, and reduced contact with waste. Economic, environmental, and community factors also all improved with the exception of greater property taxes. The net benefit of these outcomes is not only an improved quality of life for residents but also the support of continued population growth and economic and community development in the area. Results from other *colonias* show that without piped water, communities slowly die over many years, as residents leave or die, and no new building occurs (Hargrove and Del Rio, 2016).

Continuing Challenges and Concerns from Key Informants. Key informants identified a number of continuing challenges and concerns; these are summarized in Table 6. Chief among them is the fact that many households remain unconnected to sewer service. This gives rise to several issues: 1) fewer funding sources today to support sewer service connections, 2) delays in other infrastructure while the city or other entities wait for sewer service to be put in, 3) failing septic tanks and their negative impact on health, and 4) gray water being released into yards, resulting in mosquitoes and other hazards. Inadequate planning and resources at the city and county government level and at LVWD also contribute to the continuation of these problems. Also with increasing frequency and severity of droughts, decreasing flows in the Rio Grande, and expanding groundwater extraction to support agriculture, water availability and access have become major concerns and water conservation a major goal for the foreseeable future.

Table 5. Summary of outcomes from the EDAP project, identified by key informants

Category of Outcome	Description
Health	• Reduced illnesses related to drinking contaminated water (stomach ailments, stomach infections, and Hepatitis A) • Reduced skin irritation and infections • Improved personal, home, and business hygiene • Improved food handling conditions for restaurants • Enabled health care services to expand • Reduced personal contact with wastewater
Economic	• Increased property values • Increased property taxes • Increased residential development • Increased restaurants • Reduced cost associated with replacing plumbing and fixtures due to corrosion from poor water quality • Reduced costs related to water • Reduced costs associated with septic tanks • Improved tourism of historic locations
Environment	• Improved water quality for drinking, cooking, and bathing • Decreased irrigation water use • Reduced soil and ground water contamination • Reduced agriculture areas • No change in using domestic wells for gardens or landscape • Reduced foul smell and pests
Community	• Improved fire safety (fire hydrants, & sprinkler systems) • Enabled public spaces to have restrooms (parks, and tourist sites) • Pavement of roads • Enabled parks to develop • Increased population growth • Reduced trash pollution • Improved living conditions • No stormwater improvements

Table 6. Continuing challenges and concerns identified by key informants

Challenges	Concerns
• Existing communities that need water and sewer services • Health care and emergency services needs • Funding sources for water and sewer household connections • Inadequate city planning • Subdivision and land use designations • Delaying other infrastructure, waiting on sewer • Poor storm water management • High cost of irrigation water rights	• Losing “farm” culture • Availability of funding to provide services • Current health issues with failing septic tanks • Gray water released into yards creating standing water • Conserving water • Population and traffic growth

C. Review of News Stories

We interviewed staff from EPISO and Border Interfaith as key informants and learned that they had files of news stories about the EDAP project and their activities related to advocating for water and sanitation infrastructure in the area. We reviewed their files of news stories and provide a summary below in Table 7 (from review of 42 news stories).

Table 7. Summary of issues and challenges that were common themes in the civic discourse led by EPISO as documented in 42 news stories

Health and Environmental Issues
• Higher rates of water borne illnesses like Hepatitis A, and Shigellosis in the border region compared to the rest of Texas • Higher rates of dysentery and parasitic illnesses in the border region compared to the U.S. • Higher risk from drinking contaminated water from non-potable sources, hauling, handling water with unwashed hands, or drinking water from a shallow well too close to septic system or cesspool • Wastewater from Juarez Mexico contaminating irrigation water, canals, and soil/dust. Farmers report getting eye infections, dysentery illnesses, stomachaches, and colds • Local medical professionals recognize that children in EP County are experiencing water-borne illnesses • Drain lines from septic tanks contaminating soil and water
Challenges to Improving Water & Sanitation
• Projecting a rapid population growth, especially East of El Paso • Lack of affordable housing in the city • Legality of subdivisions: selling properties without basic utilities (water and electricity), and not registering properties to city or county, a.k.a. colonias • Water supply for drinking, and irrigation in El Paso County • PSB policy that does not allow extension of water and sewer lines outside EP City limits. • Water haulers propose to increase prices, by as much as $30/week • Bureaucracy of water service providers, many small water districts, and wholesale water purchased from EPW unable to serve new commercial customers • Both Juarez and El Paso County lack safe drinking water and adequate solid waste disposal • Need a political subdivision under Texas law to apply for water infrastructure funding • Tax pledge needed from LVWD potential customers in order to apply for funding • Deficiencies in financial and engineering planning and management of LVWD • High cost to provide water and sewer service • Households can't afford to connect to water and sewer main lines • Water billing that is affordable for LVWD customers but still repays infrastructure loans, without LVWD consolidating with EPW • Colonias lack physical and social infrastructure, like paved roads (for school buses and emergency vehicles), access to healthcare, and job opportunities

These themes reflect a solid understanding of the dangers of contaminated water and the contribution of the built environment and social determinants to public health. The import of these themes are further emphasized by the quotes on the following page, excerpted from the news stories. EPISO played a significant role in keeping these issues and challenges in the forefront of the civic discourse in the El Paso community.

Quotes from the news stories in EPISO files

- "the most miserable housing conditions anywhere in the developed world." –Father Ed Lucero, Jan. 1999. Magazine of American Catholic Missions.
- "We need to prevent the spread of disease…people who are sick from bad water in the colonias can spread illnesses to others in the population. It's important that we provide clean water to everyone."- Physician Dr. Elaine Barron, Nov. 25, 1998, El Paso Times.
- "It's sad that these people-who can least afford it, have to pay these kind of prices for water."- EPISO member Manny Flores, June 23, 2000. El Paso Times.
- "Many of them have been lured to the colonias by job opportunities and affordable land-part of the American Dream. However, most have found that, once they arrive, it will take them between five to seven years to build a house, and even longer for adequate water and sewer facilities to be connected, if they are." Maribel Villalva, El Paso Times.
- Definition of Colonias: Impoverished, unregulated, and illegal urban and rural subdivisions along the border with inadequate sewage treatment and dangerous drinking water.- Bill Hutchinson, April 12, 2000. El Paso Times.

The convergence of public awareness, government funding opportunities, local leadership, and political will resulted in a number of actions that resulted in several stepwise improvements and eventually the EDAP project that connected an estimated 2000 households to water and about 6000 households to sewer. These stepwise actions are documented in the news stories and summarized below in Table 8.

Table 8. Actions that were taken to address issues and challenges, for which EPISO advocated (obtained from news stories in EPISO files)

Steps Taken to Address Challenges
• LVWD created in 1986 • EDAP funding became available in 1998, a total of $250 M in grants and loans • A tax pledge loan was adopted in 1998 by LVWD area residents to pay for water and sewer loans if LVWD failed to repay • $37.8 M was granted to expand The Jonathan Rogers Water Treatment Plant to increase capacity and install 32,000 ft. of water pipeline in 1999 • Two wastewater treatment plants were funded in 1999 for Juarez, reducing by 50% the organic pollution from wastewater. • $4.1 M was granted by EPA (through NADBank), EPDNHF, and TWDB in 1999 to provide about 6,000 sewer connections in Socorro, San Elizario, and Sparks • It was estimated that LVWD was serving 9,200 customers by 2000 • $500,000 was awarded by TDHCA in 2000 to install 14,250ft of water lines, 2 fire hydrants, and 22 service connections

Some of the impacts of these actions are documented in the following sections describing the results from our surveys and review of secondary data.

D. Household Survey

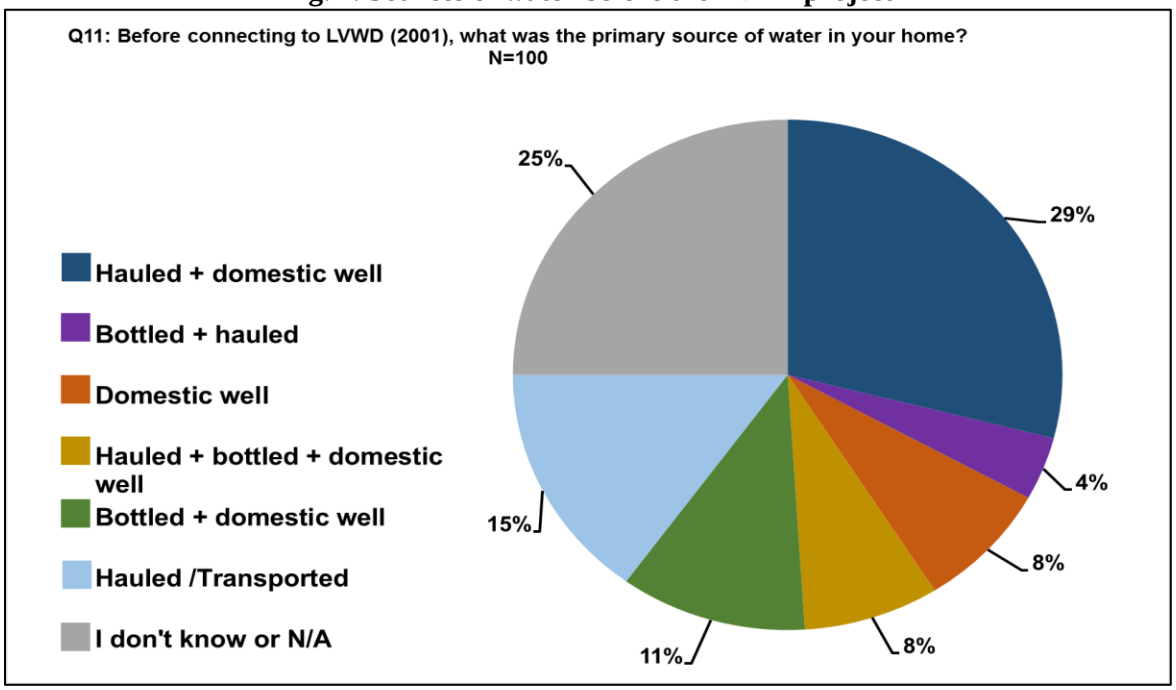
The demographic characteristics of survey respondents are summarized below in Table 9. Persons responding to the survey tended to be older and retired, had lower levels of education and income, and answered our survey in Spanish. 7% of those surveyed had water only, no sewer service.

Table 9. Demographics of Survey Respondents

CHARACTERISTIC	VALUE	%
Households surveyed	100	45 (of target of 223)
Socorro	29	29 (of total surveys)
San Elizario	71	71 (of total surveys)
Gender		
Male	38	38 (of sample)
Female	62	62 (of sample)
Median Age	59.5	
Preferred Language		
Spanish	73	73
English	27	27
Mean # persons living in home	3.6	
Mean # of years		
Living in the same home	27.2	
Connected to water	22.7	
Connected to sewer	15.1	
Household annual income level		
<$11,000	28	28
$11,000-20,000	25	25
$21,000-30,000	18	18
$31,000-40,000	8	8
$41,000-60,000	4	4
>60,000	10	10

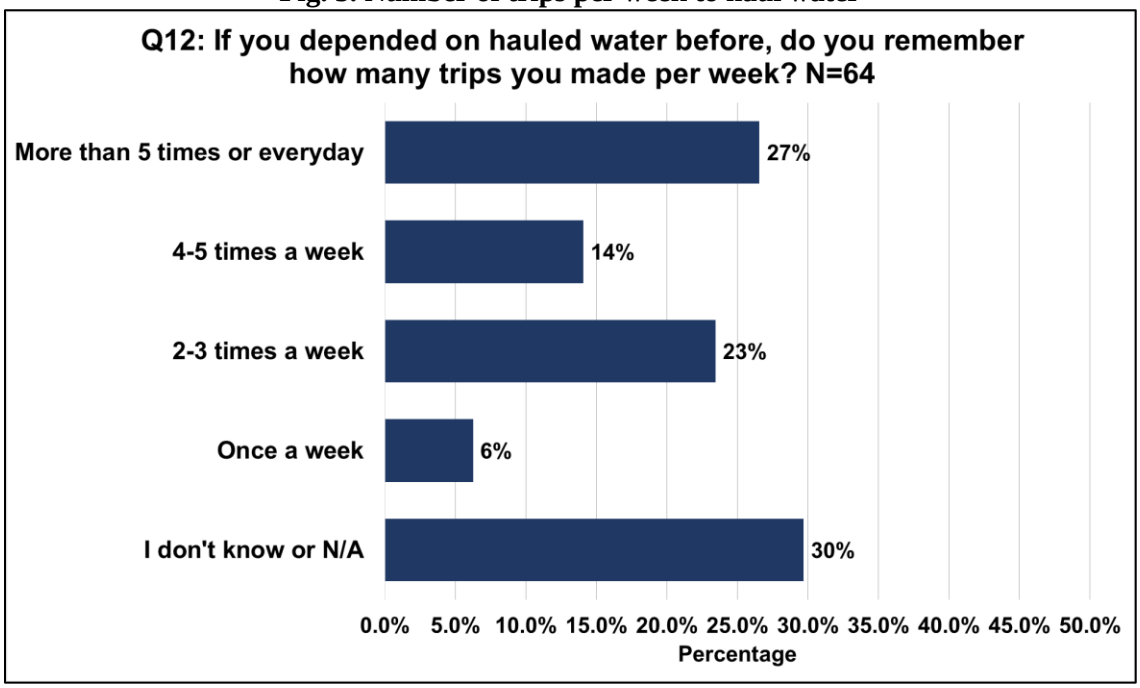
The sources of water before the EDAP project are presented in Fig. 4. For the majority of residents who we surveyed, the main source of water came from some combination of hauled water, bottled water, and domestic wells (52% of respondents). 15% of respondents depended on hauled water alone and 8% relied on well water alone. Several of those who depended on hauled water used a paid service provider, which was very costly, averaging $70/month. Respondents also shared their stories of the difficulty, stress, and inconvenience of obtaining water through hauling or maybe transporting short distances like from neighbors. Residents were aware of the bad water quality of their domestic wells and many complained of the salty taste of their well water or the salt residues left from washing clothes with their well water. Almost none of the residents drank their well water, but instead either bought bottled water or transported water from a good potable source for drinking. A few businesses in the area allowed residents to fill containers of potable water for transport to their homes.

Fig. 4. Sources of water before the EDAP project



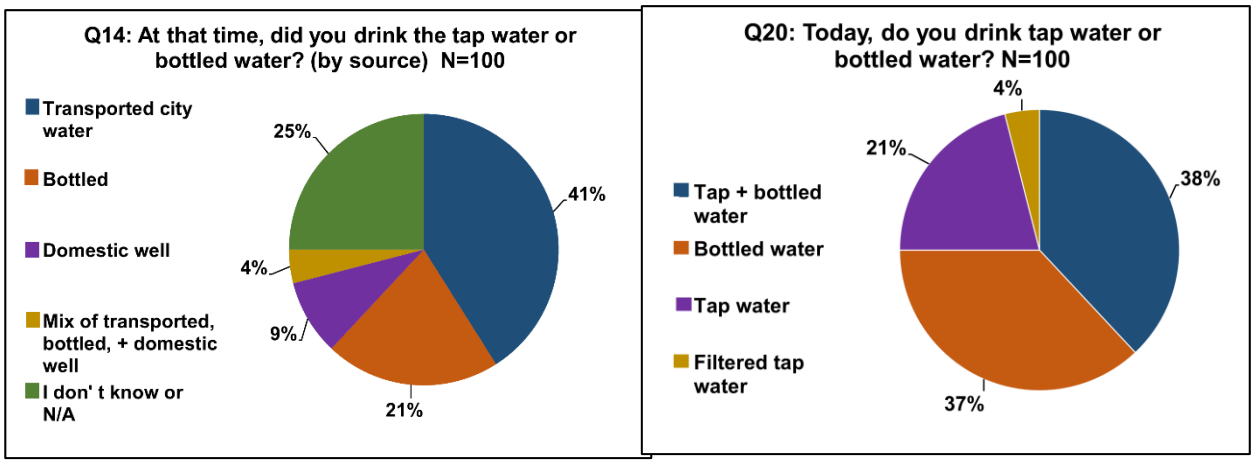
From the survey, the number of trips per week made for obtaining water is shown in Fig. 5. For those who relied on hauled water, the majority (64%) hauled water 2 or more times per week. A significant number (27%) hauled water 5 or more times per week. The inconvenience and level of effort required to obtain potable water is readily apparent.

Fig. 5. Number of trips per week to haul water



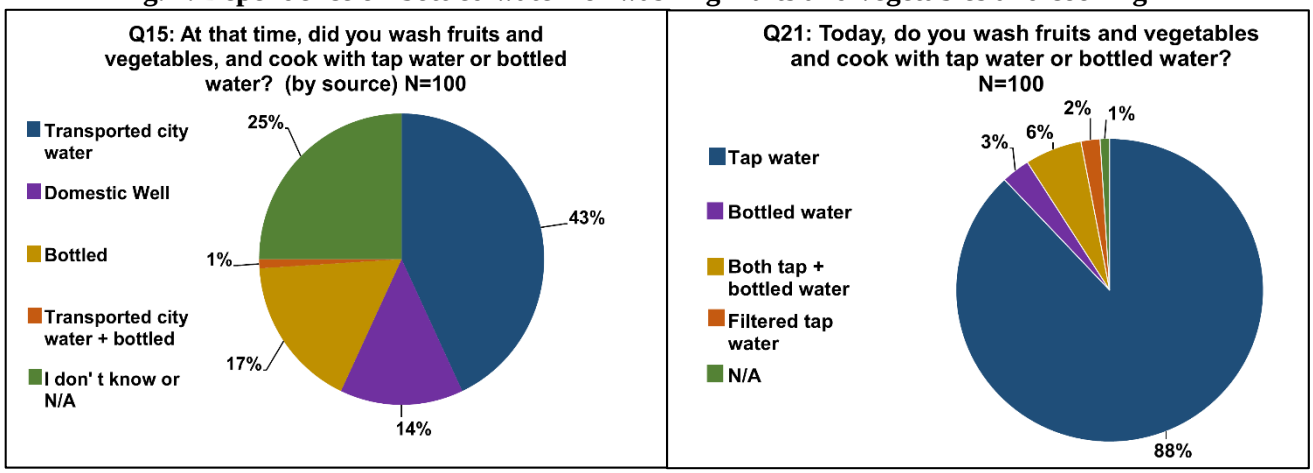
The sources of drinking water before and after the EDAP project are shown in Fig. 6. Before the project, 41% of residents drank hauled water from a potable source, mainly El Paso Water (EPW). 21 % relied solely on bottled water. Only 9% of respondents drank their well water. After the EDAP project, 96% of respondents relied on some combination of tap water and bottled water for drinking. The fact that 37% of respondents still relied on bottled water for drinking is not surprising. Results from other small communities in El Paso County show that at least 40 % of households use bottled water even after connecting to EPW (Hargrove et al., 2015).

Fig. 6. Sources of drinking water before and after the project



A much greater percentage of households used tap water for washing fresh fruits and vegetables and for cooking (88%) after connecting to LVWD (Fig. 7). Half that amount (43%) used transported city water for washing fruits and vegetables and cooking before the EDAP project.

Fig. 7. Dependence on bottled water for washing fruits and vegetables and cooking



The level of trust in tap water today after being connected to LVWD for 15 or more years, shown in Fig. 8, is strong (62%) and similar to other communities that have service from EPW (Hargrove et al., 2015). The level of satisfaction with the water and sewer service provided by LVWD is also quite high (95% for water and 89% for sewer, shown in Figs. 9 & 10). These levels of satisfaction with service are similar to those for EPW in El Paso (Guerrero, 2016).

Fig. 8. Level of trust in tap water

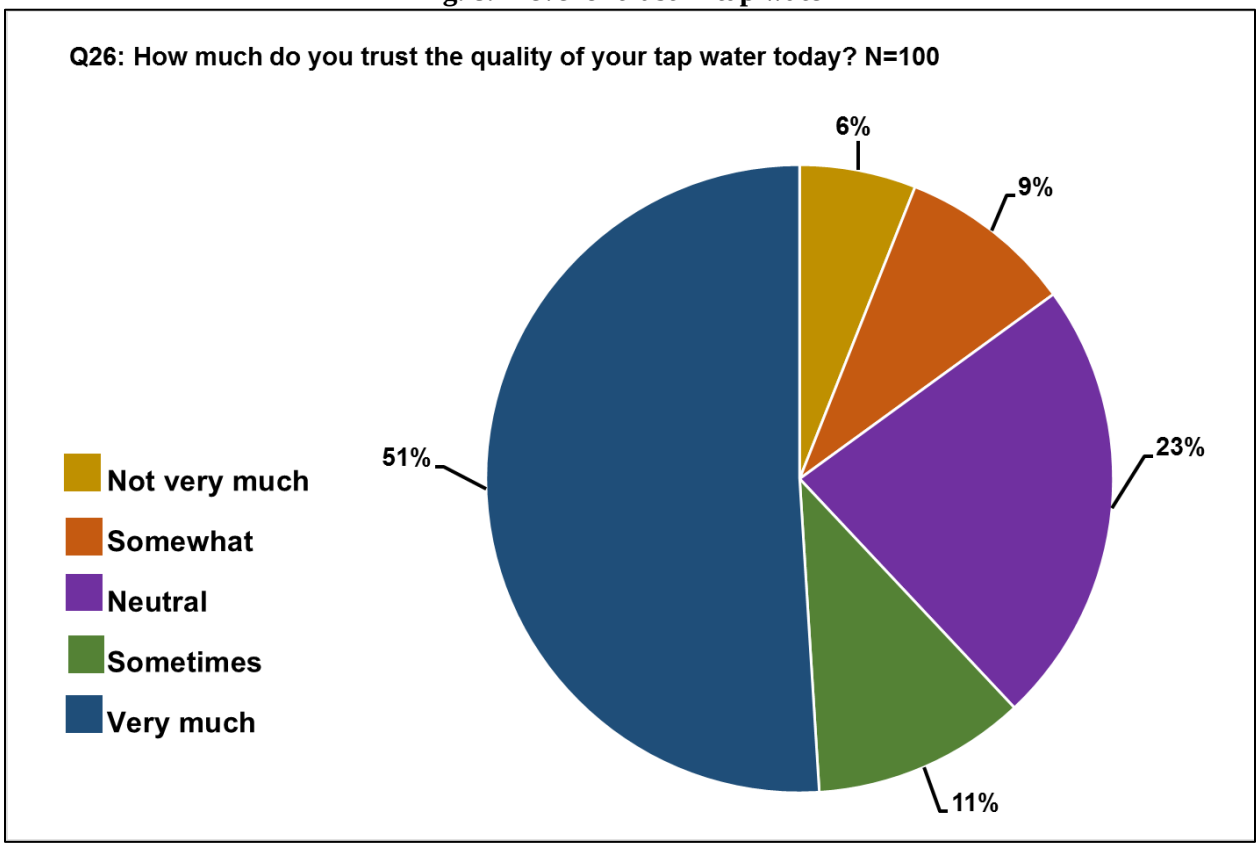
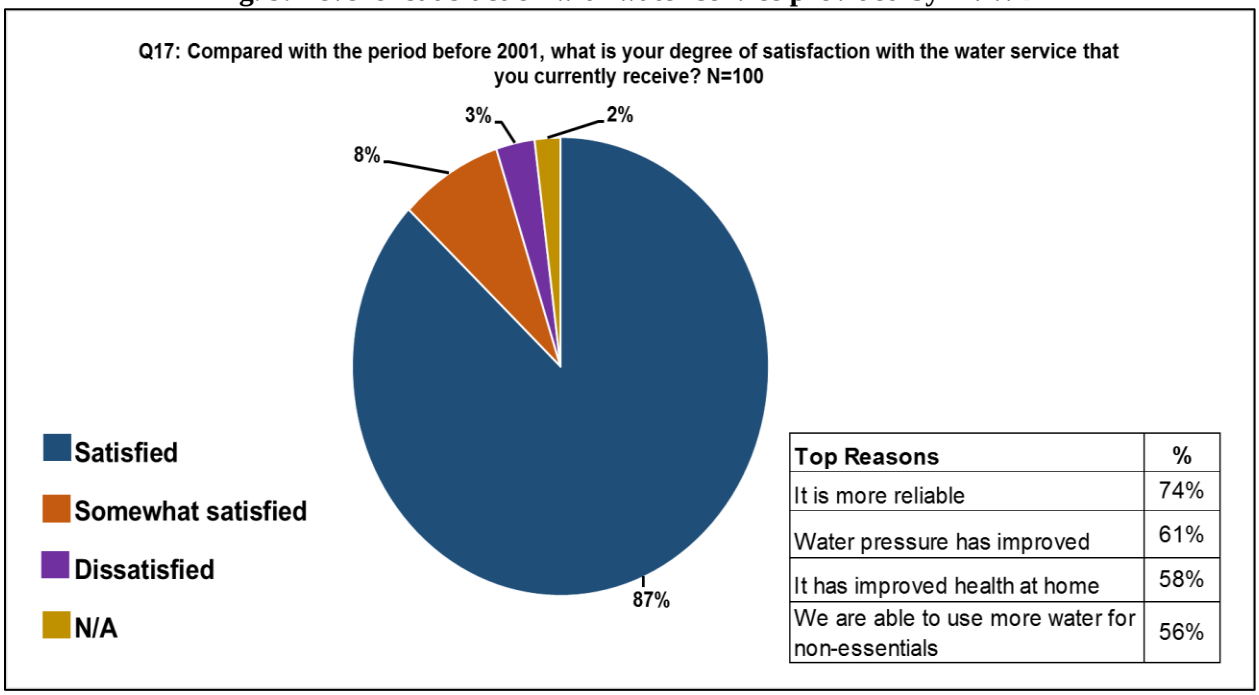


Fig. 9. Level of satisfaction with water service provided by LVWD



Top Reasons	%
It is more reliable	74%
Water pressure has improved	61%
It has improved health at home	58%
We are able to use more water for non-essentials	56%

Fig. 10. Level of satisfaction with sewer service provided by LVWD

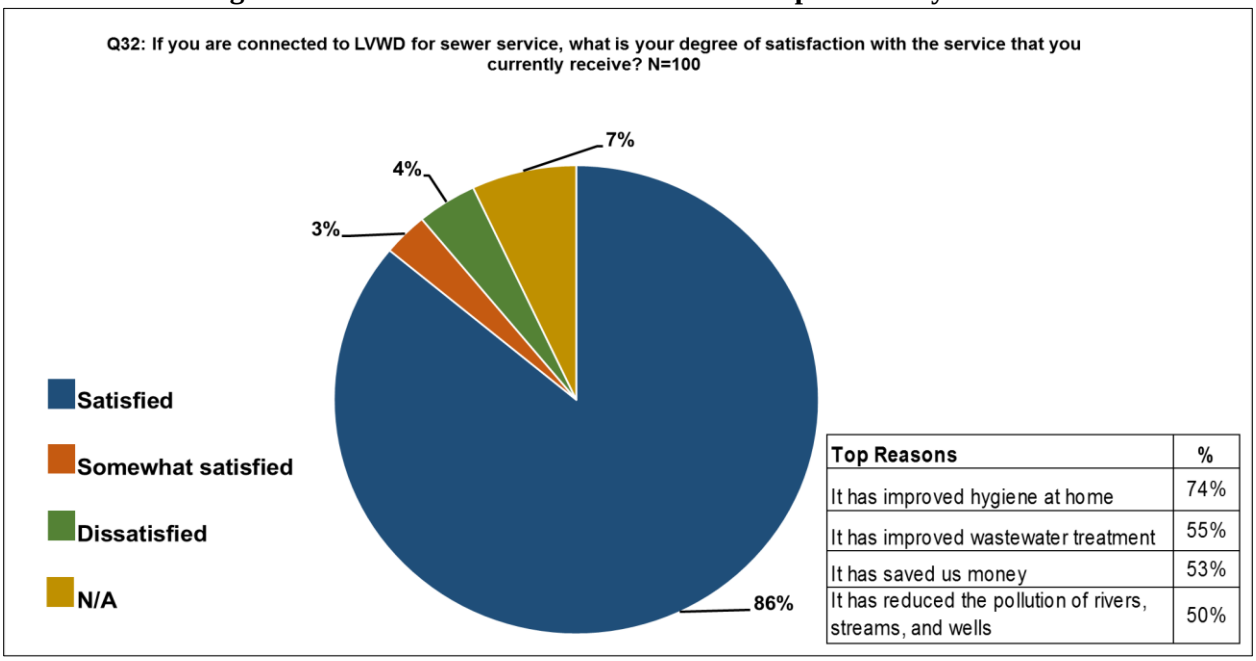


Table 10 shows self-reported health conditions before and after connecting to LVWD. Observable decreases in the incidence of skin problems, neuropathy, and gastrointestinal illnesses occurred after connection to LVWD. Skin problems can be associated with washing/bathing in high salt content water. Neuropathy can be associated with drinking water with high arsenic content or high salt content. Gastrointestinal illnesses can be associated with drinking water with biological contaminants, such as E. coli, or also water high in arsenic concentrations. Results from a study such as this are not definitive in terms of cause and effect. To determine cause and effect relationships would require a much more rigorous epidemiological research study. But certainly there is a likely association.

Table 10. Self-reported health conditions before and after connecting to LVWD

SELF-REPORTED HEALTH CONDITION	BEFORE % of respondents	AFTER % of respondents
Skin problems (rash, itchy, dry)	**22**	**9**
Neuropathy (numbness, cramping, tingling)	**10**	**4**
Gastrointestinal illness (diarrhea, nausea, gastritis)	**9**	**3**
Stomach infections (salmonella, cholera, *H. pylori*)	**1**	**0**
Cancer	**1**	**1**
Vector borne illnesses (i.e. West Nile virus)	**1**	**0**
(*No reports of Hepatitis A, E, or Blue Baby Syndrome*)		

In addition to asking respondents about the incidence of health condition before and after connection to water and sewer, we asked about their perceptions of how water and sewer have benefitted the community. 93% of respondents think that water and sewer have benefitted their community. We asked them to identify specific ways in which water and sewer have benefitted the community. The results are shown in Table 11. The majority of respondents 78-86% believe

that water and sewer service resulted in expanded health care services, expanded local businesses (especially restaurants and other types of food services that require good quality water), improved fire safety, and expanded parks and other recreation opportunities. At least two new health clinics have been built in the area in the past 10 years. Restaurants are especially sensitive to good quality water and adequate sewer services. We were unable to find historical data on the number of restaurants in the area, but the current number of restaurants is provided in the section on secondary data (Section II.D.). Improved fire safety stems from the installation of fire hydrants which were installed according to El Paso County code requirements, one per 500 ft radius. Several residents mentioned more parks and green space. We were unable to get historical information on the number of parks before the project but the current number of parks is presented in the section on secondary data (Section II.D.).

Table. 11. How water and sewer have benefitted the community

93% of Survey Respondents Think that Water and Sewer Have Benefitted the Community;	
How?	**% of Respondents**
Expanded health care services	**86**
Expanded local businesses (esp. restaurants, food services)	**84**
Improved fire safety	**82**
Expanded parks and other recreation	**78**

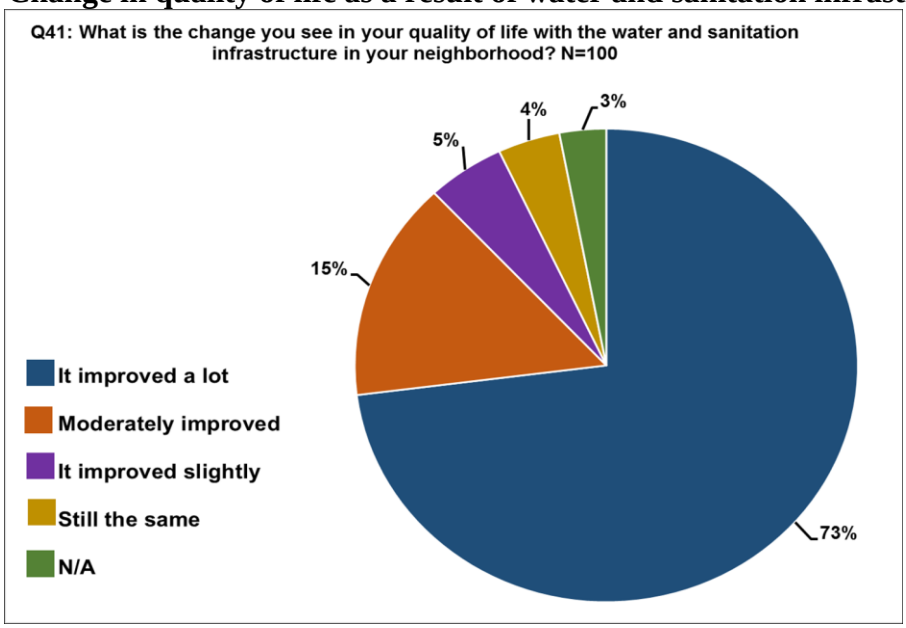
Respondents also identified economic impacts both at the household and the community level. These are presented in Table 12. At the household level, the most commonly cited economic impacts were negative in the sense that the cost of water and sanitation and property taxes all increased for a significant number of individual households (40-42%). This is offset of course by the removal of the inconvenience and cost of hauling water and the reliability of the new source of safe potable water, plus the removal of poorly functioning septic tanks and connection to the sewer system. In contrast, the perceptions of community level impacts were much more positive. The majority of respondents (69-83%) believed that connection to water and sewer resulted in expansion of local businesses, local shopping opportunities, residential development, and other community improvements like paved streets, street lights, and sidewalks. Also a significant number (32%) thought that connection to water and sewer resulted in more local jobs. Some of these perceptions were borne out by secondary data, which we discuss in Section II.D.

Table 12. Economic impacts identified by survey respondents

IMPACTS	% of Respondents
Household Level	
Monthly costs of water increased	**42**
Monthly costs of sewer increased	**40**
Property taxes increased	**41**
Community Level	
More jobs locally	**32**
More local businesses	**73**
More local shopping	**69**
Residential development/expansion	**83**
Other community improvements (street lights, sidewalks, paved streets, etc.)	**71**

The general perception of how quality of life has changed in the area as a result of water and sewer infrastructure is shown in Fig. 11. The majority of respondents (73%) believe that quality of life improved a lot, while a total of 93% of respondents believe that quality of life improved from slightly to a lot. Only 4% thought the quality of life was unchanged.

Fig. 11. Change in quality of life as a result of water and sanitation infrastructure



The attitude of respondents with regards to quality of life and some of the improvements that they experienced as a result of water and sewer infrastructure are hard to quantify but are best illustrated through some quotes from community members presented below.

Quotes from Survey Respondents

- "By having water, we have a restroom, now we just open the faucet. Before I had to warm the water. Now one goes to work more clean, fresh. Without water we can't live, water is life, water gives you energy and everything."
- "…we used to struggle to bathe, brush our teeth, and without water we are nothing."
- "Huge difference, we don't have to bother neighbors for water even though we would pay for it. I used to shower with a bowl to pour water."
- "The clothes used to come out with salt, it tasted like salt."
- "***Sin agua, somos nada; no hacemos nada***."

E. Sanitation Survey in Bejar Estates

The number of residences and businesses in Bejar Estates is difficult to quantify exactly as there are some lots with multiple homes, but we estimate 62 residences and three businesses total in the neighborhood. We obtained a total of 35 completed surveys (34 residences and one business), or 54% of the total number possible. The demographics of the survey respondents are presented in Table 13. Of particular note, is the result that the median age of respondents was 57 and the median number of years in the residence was 25 years. This is an indicator that residents are older and have lived in their homes for a significant time period, making most of the septic systems older as well, a median age of 25 years. It is also clear from these results that the majority of the residents are low income (40% with a household income less than or equal to $20,000/yr and another 17% in the range of $21,000-$30,000/yr).

Table 13. Demographics of survey respondents

Variable	Result
# of surveys	35
% males	51.4%
median age, yrs	57
mean yrs of residence	18.5 ± 13.0
median yrs of residence	25
mean household or business size (# persons)	3.6 ± 2.1
median household or business size (# persons)	3
# single family homes	32
# multi-family housing	2
# businesses	1
Annual Household Income	
# ≤ $20,000 (% of total)	14 (40)
# $21,000-30,000 (% of total)	6 (17)
# $31,000-60,000 (% of total)	9 (26)
# More than $80,000 (% of total)	1 (1)
# Not willing to share (% of total)	5 (14)

The characteristics of the water and sanitation services of survey respondents are presented in Table 14. All but one household was connected to LVWD water service. This one home still has a domestic well. All but one of the survey respondents depended on septic tanks for sanitation. The one exception was the one business which is located on Alameda Ave and was connected to LVWD sewer service. The mean age of septic tanks was 26 years; the median was 27 years. The history of pumping septic tanks out varied widely. Nine respondents are pumping their septic tanks multiple times per year, from one to four times annually. This would indicate either failing drainfields, or that the tank cannot meet the capacity of the household, or both. Another 10 respondents said that they pumped their septic tanks every 2-5 years. And finally, 11 respondents said that they had never pumped their tank. Five respondents had no knowledge of whether the tank had been pumped or not. The life expectancy of a drainfield varies widely by installation type (conventional soil absorption system versus a sand bed filter, for example), by soil conditions (clay or rock or sand), and importantly, by the frequency of maintenance and

cleaning which has been performed on the septic system. Most drainfields if properly installed and if the tanks are properly maintained should have a life of about 20 years. After that time, they can fail at any point. Certainly the majority of septic tanks in Bejar Estates are older than 20 years and subject to a high rate of failure.

Table 14. Characteristics of water and sanitation services from survey respondents

Variable	Value
# connected to water	34/35
mean yrs with water	16.1 ± 6.6
# with septic tanks	34/35
mean age of septic tank	26.0 ± 6.3 yrs
median age of septic tank	27 yrs
mean cost per pumping	$167 ± 57
median cost per pumping	$160

Through the survey and respondents' comments we found a number of indications of failing septic tanks. Thirty of the 35 respondents (86%) said that they had observed a wet area or free standing water near their septic tank or in the drain field (photos in Figs. 12-14). Several complained of smelling sewage in the area of their drainfield. Several respondents said that they often smelled their septic tank inside the house through their drain lines. Respondents told us that they were worried about drainfield failure and of not being "up to code". One person said that they were cited by the city of Socorro for having tall weeds growing in their yard in the drainfield. This individual also complained of mosquitoes stemming from free water standing in the drainfield. Residents complained that meetings at LVWD and in other venues about sewer service are conducted in English making it difficult for them to participate. One family is particularly desperate; their septic tank is not up to code and LVWD refuses to connect them to water until their septic tank is functioning properly. So this family does not have water service, sewer service, or trash service (because it is connected to water service). Several residents water their yards by flood irrigation from the Franklin canal. This adds to septic tank problems because they pond water on top of the septic tank which contributes to filling it and making it drain more than normal. This could also account for some of the residents having to pump their tanks multiple times per year. Flood irrigating lawns could also lead to H. pylori infection as discussed in the literature review in Section

Fig. 12. Photo of septic drainfield in Bejar Estates (area of tall green grass/weeds)

Fig. 13. Photo of septic drainfield in Bejar Estates (area of tall green grass/weeds)

Fig. 14. Standing surface water in septic drainfield in Bejar Estates

Self-reported health conditions from survey respondents are presented below in Table 15. 45% of respondents reported frequent gastrointestinal illnesses of bleeding ulcers (which can be caused by H. pylori, a bacteria that can be found in irrigation water and possibly in septic drainage). There was one report of Hepatitis A and one of West Nile virus. Though causation of these illnesses cannot be certain without more detailed study, certainly they can be associated with poor sanitation.

Table 15. Self-reported health conditions from survey

Health condition	#	%
Frequent stomach-intestinal ailments	11	31.4
Stomach infections or bleeding ulcers	5	14.3
Hepatitis A, or E	1	2.9
Illnesses borne by pests (i.e. West Nile virus)	1	2.9

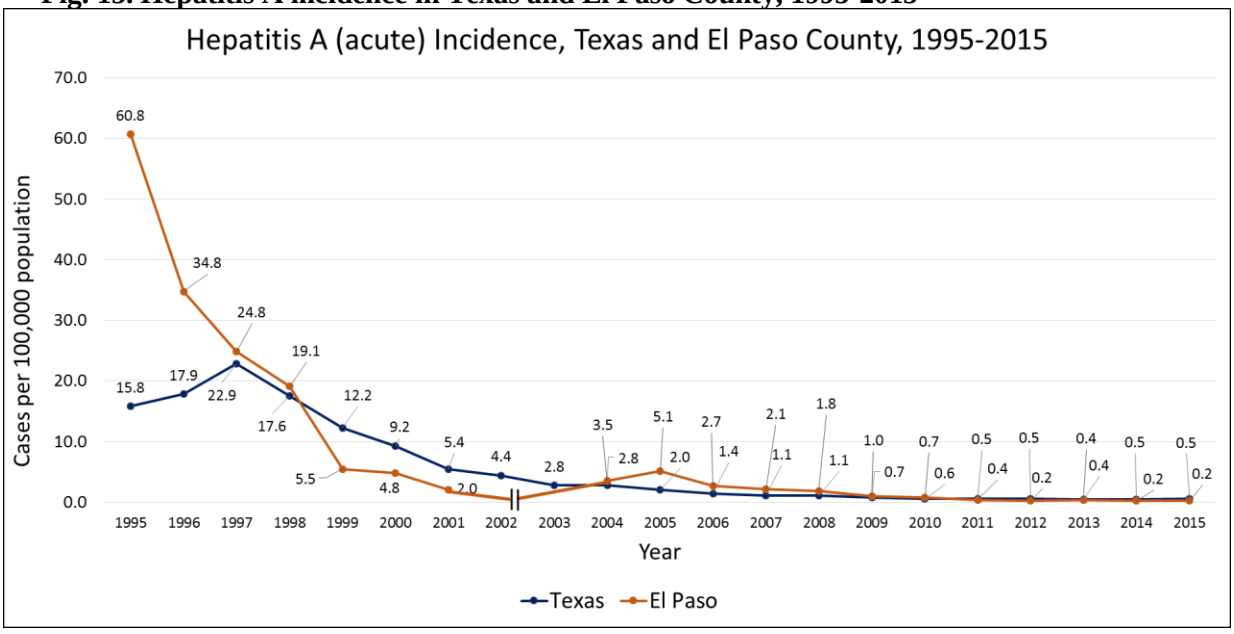
F. Secondary Data/Information

We reviewed a number of sources of secondary information/data relating to: 1) incidence of Hepatitis A, 2) economic impacts, 3) community development/improvement; and the history of and current situation with respect to providing water and sewer in El Paso County. These are discussed below.

1. Incidence of Hepatitis A and other Water and Wastewater Related Illnesses

One of the chief indicators of public health impacts from poor sanitation and contaminated water sources is the incidence of water and wastewater related illnesses, which have been a historical problem in the project area (see the Section I.B. on the context). We obtained data for a number of water and wastewater related illnesses including Hepatitis A over time for the state of Texas as a whole and for El Paso County. Reported cases of a number of illnesses were retrieved from online Texas Epidemiology Annual Reports for the years 1995-1999, 2004-2015 (TDSHS, 2017), and from El Paso County Notifiable Conditions Reports for the years 2004-2015 (City of El Paso, 2016). Then incidence rates (number of cases per 100,000 population) were calculated for each year 1995-2015 for Texas and El Paso County using US Census population estimates. The results for Hepatitis A are presented in Fig. 15 and the less prevalent illnesses are summarized in Appendix J. Incidence of Hepatitis A was much greater in El Paso County compared to the state as a whole before 1997, but incidence was similar after 1997. At least some of the decrease in incidence in El Paso County can be attributed to the large effort to

Fig. 15. Hepatitis A incidence in Texas and El Paso County, 1995-2015



connect households to piped potable water during the late 1990s. In the 135 surveys that we obtained in the EDAP area and Bejar Estates, there was only one case of Hepatitis A reported.

There are several challenges associated with interpreting these results. First, reported cases are aggregated at county, region, and state level; cases specific to the study area cannot be identified. Local clinics do not keep records more than 10 years and are reluctant to share information on local cases in order to protect the local community members' privacy. So it is almost impossible to show a decrease of Hepatitis A in this particular study area. Second, in general, cases of Hepatitis A are under-reported; it is difficult to diagnose, many do not express severe symptoms, and physicians need to confirm the diagnosis in order to report to the county. Third, in 1995, a Hepatitis A vaccine became available in the U.S., and in 1998, there was a vaccination initiative in the U.S.-Mexico border region of the state. In 1999, a law was passed requiring all day care attendees and school-age children who lived in the 32 Texas counties within 100 km of the Texas-Mexico border to receive the 2-dose Hepatitis A vaccine by August 2000. These precautions most certainly also had some effect on the rate of incidence in the time period of 1995-2000. Nonetheless improved water and sanitation most certainly had an effect as well.

2. Economic Impacts at the Household Level

We examined a number of household level economic impacts including the monthly costs of water and sewer, monthly incomes, and changes in property values as a result of connecting to water and sewer service. A summary of the cost of water and sewer service from LVWD compared to El Paso Water plus the monthly incomes in Socorro, San Elizario, and El Paso are presented in Table 16. The sources of this information are identified in the footnotes.

Table 16. Cost of Water and Sewer for LVWD and El Paso Water Customers

Customer Average Monthly Costs		
Service	**LVWD[a]**	**EPW[b]**
Total Water and Sewer Bill	$55.95	$61.26
Water Only	$30.72	$36.98
Sewer Only	$25.13	$24.28
Bottled Water[c]	$20.39	$20.39
Total Water Costs[d]	$51.11	$57.37
Total Water and Sewer Costs	$76.24	$81.65
2015 Household Monthly Income [e]		
City	**Mean**	**Median**
Socorro	$3,287.92	$2,565.73
San Elizario	$2,840.75	$1,880.42
El Paso	$4,878.08	$3,564.33

[a] Lower Valley Water District. GIS Department
[b] El Paso Water. Financial Budget Report: Statistical. Available at: http://www.epwu.org/public_information/reports/2017/Budget/PART10-STATISTICAL%20329-336.pdf
[c] from our household survey
[d] Total of piped water plus bottled water
[e] U.S. Census. American Fact Finder. 2015. Annual mean and median household income for City of Socorro, City of San Elizario, and City of El Paso. Available at https://factfinder.census.gov

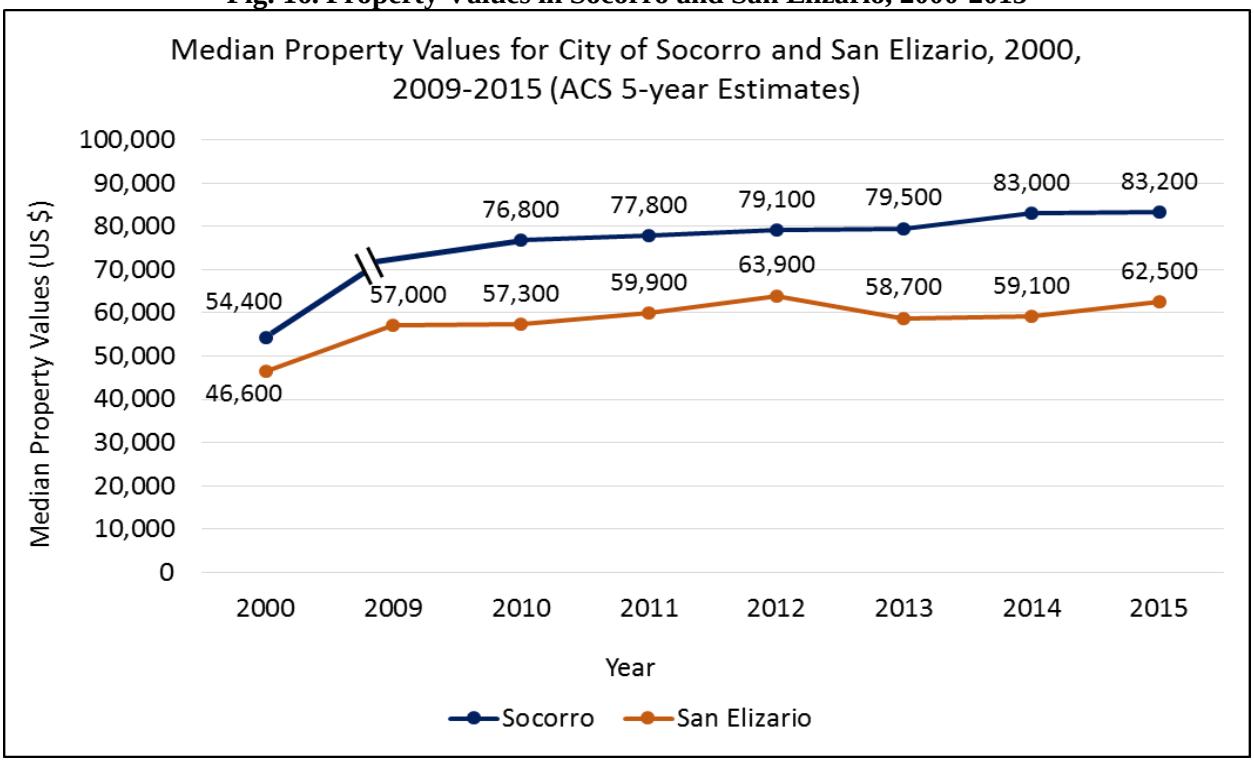
The costs of water are about $6 more per month, on the average, in El Paso compared to LVWD. The costs for sewer service are similar but slightly more in LVWD by only $0.85 per month on average. However, the monthly income levels in El Paso are considerable higher in El Paso compared to Socorro and San Elizario. The monthly income in Socorro is 67% that of El Paso, and in San Elizario is 58% that of El Paso. This means that residents of El Paso are spending only 1.7% of their monthly income on water and sewer service, while residents of Socorro are spending 2.3% and residents of San Elizario are spending 2.7% of their monthly income on water and sewer service. One of the residents of Bejar Estates provided the following quote.

"Vivimos pobres, pero pagamos como ricos."

"We live poor, but we pay like the rich."

Another household economic impact is the increase in property values as a result of water and sanitation infrastructure. Our experience in other parts of El Paso County show that property values go up by about 20% within five years after a community gets water and sewer service for the first time. Results from this study, shown in Fig. 16, show that property values in Socorro and San Elizario went up by about 41% in Socorro and 23% in San Elizario, between the year 2000 and 2010. Socorro is on the growing edge of El Paso so part of the increase in Socorro must be related to the leading edge of suburban growth from El Paso, but clearly water and sanitation infrastructure had some impact.

Fig. 16. Property Values in Socorro and San Elizario, 2000-2015



3. Community Development/Improvements

We also investigated a number of community level economic improvements and changes in community development indicators. Table 17 summarizes a number of indicators for community development and improvement.

Table 17. Selected indicators of community development/improvement

Variable	Prior Time (year)	Today (year)	% Change
Population			
Socorro	27,152 (2000)	33,222 (2015)	19.2
San Elizario	11,046 (2000)	8,999* (2015)	-2.7
LVWD Connections (all service area)			
Water	3,725 (1997)	17,454 (2016)	368
Sewer	3,552 (1997)	14,455 (2016)	307
Annual Median Household Income			
Socorro	$24,087 (2000)	$30,789 (2015)	27.8
San Elizario	$20,145 (2000)	$22,565 (2015)	12.0
Businesses			
Registered Businesses	3,851 (2002)	4,147 (2012)	7.7

* Decrease in population because in 2014, San Elizario was incorporated as a city and excluded areas that were in CDP designation in 2000.

Source of 2000 population and household income data: U.S. Census. American Fact Finder. Census 2000 summary.
Source of 2015 household income data: U.S. Census. American Fact Finder. Economic Census.
Source of registered businesses: U.S. Census. American Fact Finder. Economic Census.
All three of these available at: https://factfinder.census.gov

Source of 2015 population data: U.S. Census Bureau. Population and Housing Unit Estimates [datasets].
Available at: https://www.census.gov/programs/popest/data/datasets.html

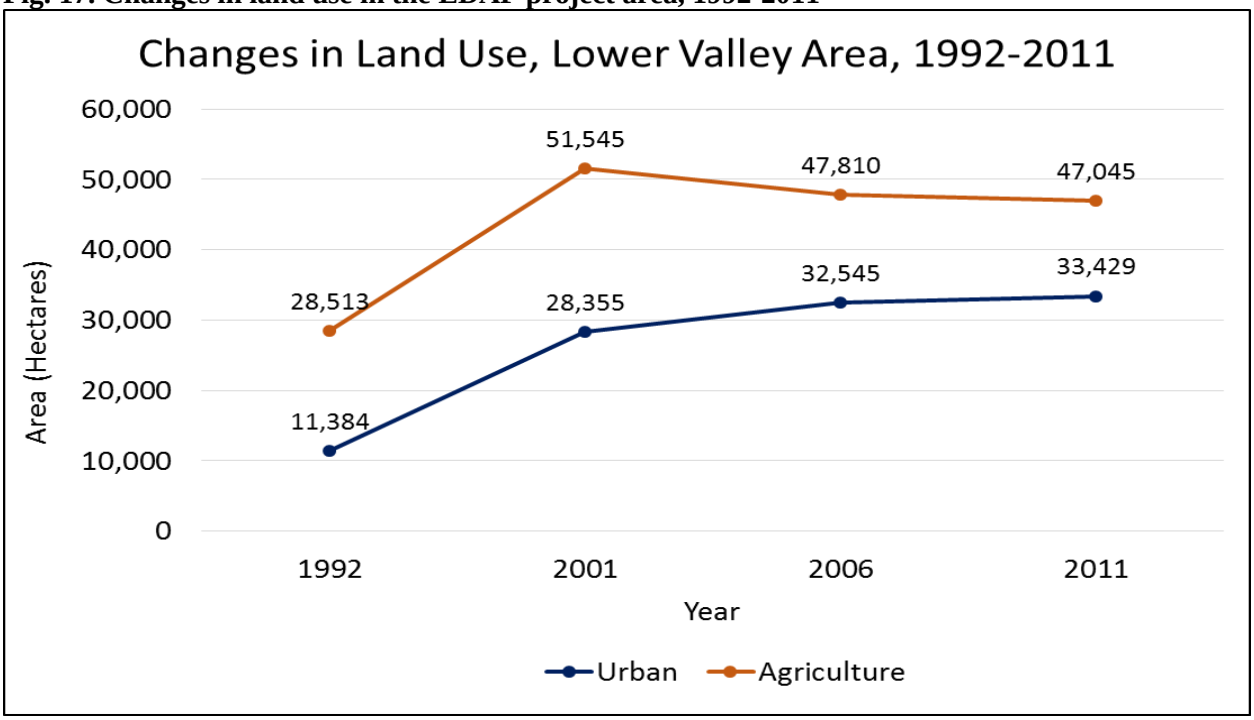
Source of LVWD Connections: LVWD

Population growth (+19%) and household income (+28%) in Socorro were high for the period from 2000-2015. During roughly the same time period, from 1997 to 2016, the connections to water and sewer in the LVWD area increased by 368% and 307%, respectively. The growth in San Elizario was less than Socorro. The number of registered businesses in the LVWD service area increased by about 8%. We tried to compare these growth numbers to the city of El Paso but found that actually El Paso grew even more in population and household income than Socorro or San Elizario. Thus, it is hard to make a claim that water and sewer infrastructure

fueled this growth in Socorro and San Elizario. We can only say that San Elizario remains a relatively rural area, while Socorro is on the leading edge of El Paso. We can only surmise that without water and sanitation infrastructure, the growth would have been less than what was estimated in this analysis.

We can also quantify the residential and suburban growth of the area by looking at the changes in land use during this time period. We obtained satellite imagery of the study area from the National Land Cover Database (NLCD) for the years 1992, 2001, 2006, and 2011 (based on availability). The NLCD 2011 land use classification system was used to classify land uses and compare them over the timeframe of interest. The results from this analysis, aggregating the urban land uses into a single urban classification and the agricultural land uses into a single agriculture classification, are shown in Fig. 17.

Fig. 17. Changes in land use in the EDAP project area, 1992-2011



The time period of 2001-2006 is of particular interest because this would have been the time period immediately following the implementation of the EDAP project. During this time period, agricultural land uses decreased by 3735 ha, while urban land uses increased by 4190 ha, almost a one to one relationship. Certainly it is clear that water and sanitation infrastructure spurred residential development and urban/suburban growth during this time period immediately following the installation of water and sanitation infrastructure.

4. Progress in Water and Sanitation and Remaining Population Lacking Piped Potable Water and Sewer Service

Obtaining an exact number of connections in the LVWD service area was somewhat difficult as the GIS and the accounting offices have different numbers. This could be because of some accounts having multiple meters/connections on one bill and other issues. Using the numbers

based on meters from the GIS department, there are a total of 17,296 connections for water, 95% of which are residential, and 14,361 connections for sewer, 96% of which are residential. This leaves 2935 water customers still without sewer service, or about 17% of their total customers.

We obtained estimates of the progress made in El Paso County in terms of providing piped potable water and sewer service to residents. Table 18 summarizes the population lacking these services in 1985, 2003, and how many remain today. These numbers were estimated by EPW and are used by EPW for planning purposes. Great progress has been made since the mid-1980's as the number of people lacking services has been reduced by more than half. Still, the number of residents still lacking piped potable water and sewer service are significant as of 2016, 16,000 lacking water and 32,000 lacking sewer.

Table 18. Population in El Paso County lacking piped potable water and sewer service over the past 30 years

Year	Total Population	Population Lacking Piped Water (% of total)	Population Lacking Sewer Service (% of total)
1985	538,809	40,000 (7%)	80,000 (14%)
2003	705,200	20,000 (3%)	40,000 (6%)
2016	837,918	16,000 (2%)	32,000 (4%)

Estimates of population lacking water and sewer service from EP Water; El Paso County population estimates from: Texas State Library and Archives Commission. Population estimates of Texas Counties, 1985-89. Available at: https://www.tsl.texas.gov/ref/abouttx/popcnty85-89.html

U.S. Census Bureau. Population and Housing Unit Estimates [datasets]. Available at: https://www.census.gov/program-surveys/popest/data/data-sets.html

Rev. Ed Lucero, local priest, speaking at EPISO event about the need for clean water and sanitation

SECTION III. Summary and Conclusions

A. Summary of Findings

A summary of our findings is presented below in Table 19.

B. Conclusions and Recommendations

Below we identify and discuss a number of conclusions from our findings and recommendations for further action.

1. Conclusions Regarding Impacts of Water and Sanitation Infrastructure

The infrastructure that was installed benefitted at least 3218 residential households and 160 businesses who received water, sewer, or both for the first time. Before the EDAP project these residents and businesses depended on some combination of hauled water, bottled water, and/or domestic wells and septic tanks for sanitation. At the time of the completion of the project the combined population of Socorro and San Elizario was about 38,000; today the combined population is about 42,000. Today LVWD continues to purchase water wholesale from EPWU and deliver it to their customers. Wastewater is delivered from the service area to EPWU's Bustamante Treatment Plant. LVWD pays $1.62 per 1000 gallons for water and $1.16 per 1000 gallons for waste treatment.

From our findings, we conclude that the infrastructure and service provided by LVWD has resulted in the following impacts.

Health Impacts. Health conditions have improved greatly as a result of the EDAP project. From the results of our key informant interviews, surveys, and review of secondary data, the following illnesses or ailments have all decreased since the implementation of water and sewer service in the area:

- Hepatitis A
- Gastrointestinal illnesses
- Stomach infections, bleeding ulcers
- Neuropathy
- Skin irritation/infections
- Mental stress/anxiety
- Vector borne diseases like West Nile Virus

The reduction in these illnesses can be related to improved drinking water quality, hygiene, food handling processes, and waste management. In addition, fire safety has improved as a result of the installation of fire hydrants. The greatest beneficiaries of these impacts include the most vulnerable populations, namely children and the elderly.

For neighborhoods like Bejar Estates or individual households who still do not have sewer service, the predicted impacts of connecting to sewer service and decommissioning septic tanks would be reduced incidence of Hepatitis A, gastrointestinal illnesses, stomach infections, and vector borne illnesses like West Nile Virus. Connection to sewer service could benefit several thousand residents in the area.

Environmental Impacts. Though we did not make any direct observations of groundwater quality, reducing the reliance on septic tanks and open cesspools for waste management surely

resulted in less soil and water contamination in the area. Our results did show that the complaints of residents regarding odors and other septic drainfield-related nuisances have been reduced where sewer service has been provided, while in neighborhoods without sewer service, like Bejar Estates, these complaints have continued and even grown. Our results confirmed that older neighborhoods like Bejar Estates that have had water service now for 15-25 years, but still do not have sewer service, are at risk with regards to failing septic systems, contamination of soil and shallow groundwater, and negative public health impacts.

Economic Impacts. Water and sewer infrastructure have had a number of positive impacts at the household and community level. At the household level, water and sewer infrastructure has resulted in:

- An estimated 10-20% increase in property values
- The benefits to household income are difficult to quantify; household income has risen but not as fast as in the City of El Paso; it is safe to say without water and sewer infrastructure, the rise would likely have been less.
- Higher monthly costs for water and sewer, but less expensive if you include the costs of hauling water, buying bottled water, and the maintenance of septic tanks

At the community level, water and sewer infrastructure has resulted in:

- Residential development, mostly at the expense of agricultural land uses
- Growth in local businesses, thus local jobs
- Improved tourism of local sites (mainly Spanish Missions)

Community Development Impacts. A major impact of the water and sewer infrastructure has been the overall improvement in these communities as a place to live. The benefits are manifested as:

- Improved local health care access due to more clinics
- Growth in the number of parks and other recreation opportunities
- Improved public safety due to fire hydrants
- Other community improvements like paved streets, sidewalks, street lights, etc.
- Improved overall quality of life

Continuing Needs. Although much progress has been made in El Paso County in terms of providing water and sanitation infrastructure to residents, much remains to be done. The numbers of people without piped water and sewer service have dropped considerably over the past 30 years. About 75% of the population in El Paso County who lacked water and sewer in 1985 now have water and sewer, but about 16,000 people still lack piped water and about twice that many, 32,000, lack sewer service (estimates from EPWU). The results of our survey in Bejar Estates show that for older neighborhoods in which homes are 15 to 30 years old and who rely on septic tanks, septic systems are failing and posing a public health and environmental problem. Connection to sewer service could decrease the risk of Hepatitis A, gastrointestinal illnesses, and vector borne diseases. Attention to sanitation infrastructure should be a priority for such neighborhoods lest we revert to conditions of 20 years ago in this area.

Finally, we present a Fact Sheet that summarizes our project, including results and conclusions, in Appendix K.

Table 19. Summary of Findings

SCOPING CATEGORY	DIRECT OR INDIRECT IMPACTS	HEALTH DETERMINANT/ OUTCOME	INDICATORS	RESULTS
WATER QUALITY/ AVAILABILITY/ ACCESS	**Direct**	Gastrointestinal disease	Frequent stomach and/or intestinal ailments by at least one family member before and after infrastructure	Self-reported gastrointestinal illnesses went from 9% before to 3% after water infrastructure
		Hepatitis A or E	Confirmed cases before and after infrastructure	Hepatitis A cases dropped from 60.8 /100,000 in EP County to 19.1/100,000, about the same as for the state of Texas as a whole after infrastructure installation
		Skin rash, irritation	Skin infections, rash, itchiness due to drying/irritation from washing in high salt content water, before and after	Self-reported skin ailments went from 22% before to 9% after water infrastructure
		Neuropathy	Strange feelings in extremities like numbness, cramping, tingling by at least one family member, before and after infrastructure	Self-reported neuropathy went from 10% before to 4% after water infrastructure
		Stomach infection/ bleeding ulcers	Stomach infection or bleeding caused by H.pylori	Self-reported stomach infections and/or bleeds went from 1% before to 0% after water infrastructure
	Indirect	Stress	Mental stress due to anxiety about running out of water, inconvenience of having to haul water	All respondents who depended on hauled water expressed this stress
		Quality of life	*Water security* – do households have sufficient good quality water	93% of respondents expressed increase in quality of life
		Fire safety	Ability to fight a household fire	82% of respondents expressed improved fire safety
SANITATION	**Direct**	Gastrointestinal disease	Frequent stomach and/or intestinal ailments by at least one family member before and after infrastructure	Self-reported gastrointestinal illnesses went from 9% before to 3% after sewer infrastructure; 31% of Bejar Estates respondents (where there is no sewer service) reported frequent gastrointestinal illnesses
		Hepatitis A or E	Confirmed cases before and after infrastructure	Hepatitis A cases dropped from 60.8 /100,000 in EP County to 19.1/100,000, about the same as for the state of Texas as a whole after infrastructure installation; one confirmed case in Bejar Estates where there is no sewer
		Vector borne diseases	Mosquito-carried or other vector-borne diseases like West Nile virus	One case of West Nile virus reported in Bejar Estates where they are not connected to sewer

		Stomach infection/ bleeding ulcers	Stomach infection or bleeding caused by H.pylori	Self-reported stomach infections and/or bleeds went from 1% before to 0% after sewer infrastructure; 14% of Bejar Estates respondents (where there is no sewer service) reported frequent stomach infections or bleeds
	Indirect	Odors	Residents' complaints about odors	A few survey respondents complained about odors before infrastructure; several Bejar Estates respondents complained about odors around septic drainfields
		Nuisances	Residents' complaints and city actions against residents	At least one respondent from Bejar Estates reported city action regarding septic drainfield
		Environmental/ groundwater contamination	# of septic tanks still in operation and # decommissioned	# of septic tanks still in operation unknown; septic tanks decommissioned
ECONOMICS	**Indirect**	Cost of water and sewer	Willingness and ability to pay for monthly costs of water and sewer	Costs for water and sewer have gone up as a result of infrastructure but lower than in El Paso; most residents willing to pay to have quality water and sewer service
		Property values & taxes	Appraised property values & property tax bills	Property values went up from 20-40% after infrastructure; not all of this increase due to infrastructure, but probably at least half of it (10-20%)
		Cost of connection	Willingness and ability to pay for household connections	Most respondents did not have to pay for connection in EDAP project; but the majority of those who did were willing to pay; some who refused sewer service now want sewer service
		Household income	Mean and median monthly household income	Household incomes have risen but the same as in El Paso; would likely have been less without infrastructure
COMMUNITY DEVELOPMENT/ IMPROVEMENT	**Indirect**	Health care services	# clinics	Respondents believe have increased, but not confirmed
		Local businesses & jobs	#businesses, local jobs	Respondents believe have increased, but not confirmed
		Recreation space	# parks	Respondents believe have increased, but not confirmed
		Residential development	Land use conversion from agricultural to residential	4500 ha converted from agricultural to residential uses from 1995 to 2005
		Public safety	# fire hydrants	75 installed according to county specifications
		Other community improvements (paved streets, sidewalks, etc.)	Residents' perceptions	Respondents believe have increased, but not confirmed
		Quality of life	Residents' perceptions	93% of respondents expressed increase in quality of life

2. Conclusions Regarding the Process of the Assessment

We draw a number of conclusions from the retrospective HIA process that we enumerate below.

a) The timing of our household survey (November-December, 2016) made getting good results somewhat difficult. The weather was often inclement, daylight hours were reduced by switching from Daylight Savings Time, and the holidays resulted in poor response from door to door surveys and difficulty in getting participation.
b) The lack of important data available from BECC, LVWD, EPW, and TWDB provided constraints. For example, we had to estimate the actual number of connections that were provided; none of the funding agencies nor implementing agencies had these numbers.
c) Doing a retrospective HIA after the project had been completed for 15 years presented challenges in relying on people's memories and considering lack of data/records. However, conducting the assessment 15 years after the completion of the project allowed the impacts to be fully manifested. Enough time had passed to see significant benefits.

3. Recommendations

We provide a number of recommendations for some of the leading agencies and relevant stakeholders in this project.

For LVWD:

a) There are still significant needs in terms of water and sanitation infrastructure in the area. In particular, a number of individual households and even entire neighborhoods do not have sewer service. LVWD should make every effort to provide service to those still lacking water and sewer.
b) LVWD needs to keep better records of basic information about their service area such as number of service connections for water and sewer, fire hydrants, business connections, and numbers of people still lacking service, as examples.
c) LVWD needs to work more closely with relevant local governments such as City of Socorro and City of San Elizario to provide service. An example is that no one seems to know how many fire hydrants there are. City of Socorro told us to ask LVWD; LVWD told us to ask City of Socorro. Another example is that City of Socorro claims to be delaying paving of streets waiting on LVWD to provide water and/or sewer service, but also claims to have no knowledge of any plans of LVWD to provide such service.
d) LVWD needs to aggressively pursue funding to continue to provide service to those who need it.
e) Better strategic planning would be very beneficial to the customers and to the relevant local governments. Better planning is relevant to items # a, c, and d above.
f) Many residents complained to us about lack of storm water management. Temporary flooding and poor drainage in some areas are issues. There is an expectation that LVWD should address these problems. There is a county wide storm water management plan, developed by EPW, at the following website: www.epwu.org/stormwater/master_plan.html

For BECC:

a) There are still significant needs in terms of water and sanitation infrastructure in the area. In particular, a number of individual households and even entire neighborhoods do not

have sewer service. BECC should make every effort to provide technical and financial assistance to LVWD in providing water and sewer to those still without service.

b) This HIA was part of BECC's internal procedure to collect and review information related to certified and completed projects. As such it provides valuable results for BECC's internal use. BECC could benefit by also keeping better records of basic information about their assistance to local entities in providing water and sewer. BECC provided their planning documents, but had no documents on what was actually done under the EDAP project, since the implementation was funded mostly by other agencies.

c) For projects that BECC certifies and provides some assistance to, a better monitoring and evaluation process is needed. Baseline data/information should be collected/ documented before projects are implemented and then follow up to document impacts.

For Local Government (Socorro and San Elizario):

a) There are still significant needs in terms of water and sanitation infrastructure in the area. In particular, a number of individual households and even entire neighborhoods do not have sewer service. The local governments should work more closely with LVWD to plan for and provide service to those still lacking water and sewer.

b) The local governments need to keep better records of basic information about their services and the services related to water and sewer. Basic information like fire hydrants, paved streets, parks, and new businesses from the recent past compared to today were not available from the local governments that would have allowed some assessment of the benefits of water and sewer for the city.

c) The city governments need to work more closely with LVWD to improve and provide water and sewer service. An example is that no one seems to know how many fire hydrants there are. City of Socorro told us to ask LVWD; LVWD told us to ask City of Socorro. Another example is that City of Socorro claims to be delaying paving of streets waiting on LVWD to provide water and/or sewer service, but also claims to have no knowledge of any plans of LVWD to provide such service.

For the Residents of the LVWD Service Area:

a) Residents need to be more aggressive in terms of voicing their concerns to LVWD and to local government entities. Civic engagement is important to getting issues "on the table" for consideration and sometimes helpful to agencies like LVWD in obtaining funding to improve or provide more service.

For the Assessment Team at UTEP:

a) The early to mid-winter season is a bad time to try to do community-based participatory research and should be avoided in the future. Conducting such an HIA in the summer months might better connect people to the demands for water and the stresses associated with having inadequate supplies and quality of water for household uses.

b) The timeframe for this HIA was six months. A longer timeframe for such a complex HIA was needed to more fully examine all the secondary data and information, which was difficult to "dig out".

C. Dissemination Plan

We plan to distribute our final report and/or one page summaries to a number of stakeholders, decision makers, and funders of water and sanitation infrastructure. We list the groups with whom we will provide in-person briefings and to whom we will send reports and summaries below in Table 20.

Table 20. Summary of our dissemination plan

IN-PERSON BRIEFING	SEND REPORT	SEND SUMMARY
LVWD Staff	City of Socorro	Ayuda Inc.
LVWD Board	City of San Elizario	TAMU Colonias Program
County Judge Veronica Escobar	TCEQ – Austin El Paso	Bejar Estates (Summary of Bejar Survey)
BECC Staff	EPW	Sofia's Restaurant
State Sen. Rodriguez Staff	TWDB	Socorro Bakery
	EPA Border Office	Lincon Dairy
	USDA – RDA, Ft. Stockton	Rev. Ed Lucero
	EPISO/BI	Leaders from La Purisima Catholic Church
	TX Health & Human Services	Former Mayor of San Elizario
	PAHO	Members of Advisory Committee for EDAP Project
	Health Impact Project	

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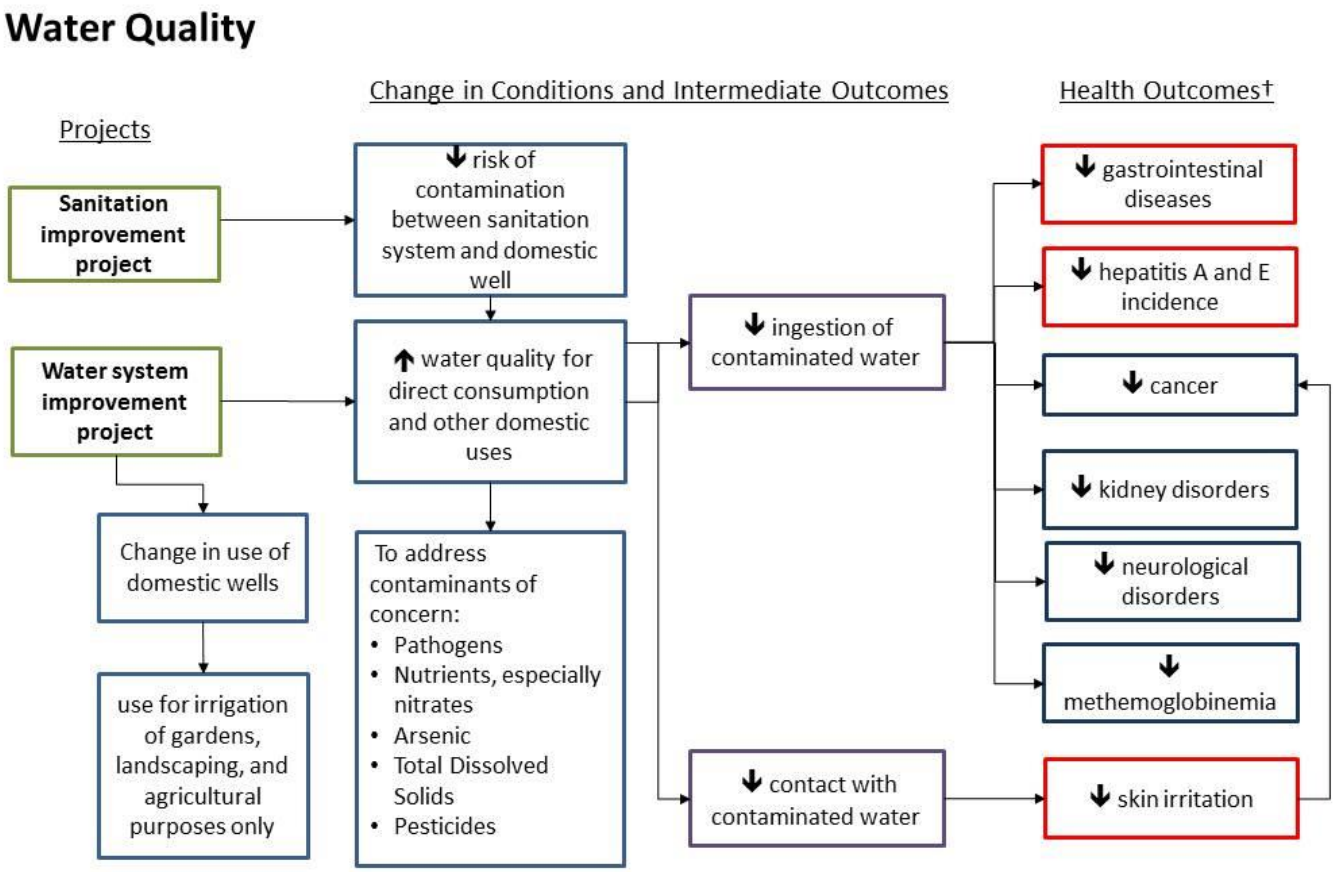
The survey team for Bejar Estates

Section V. Appendix

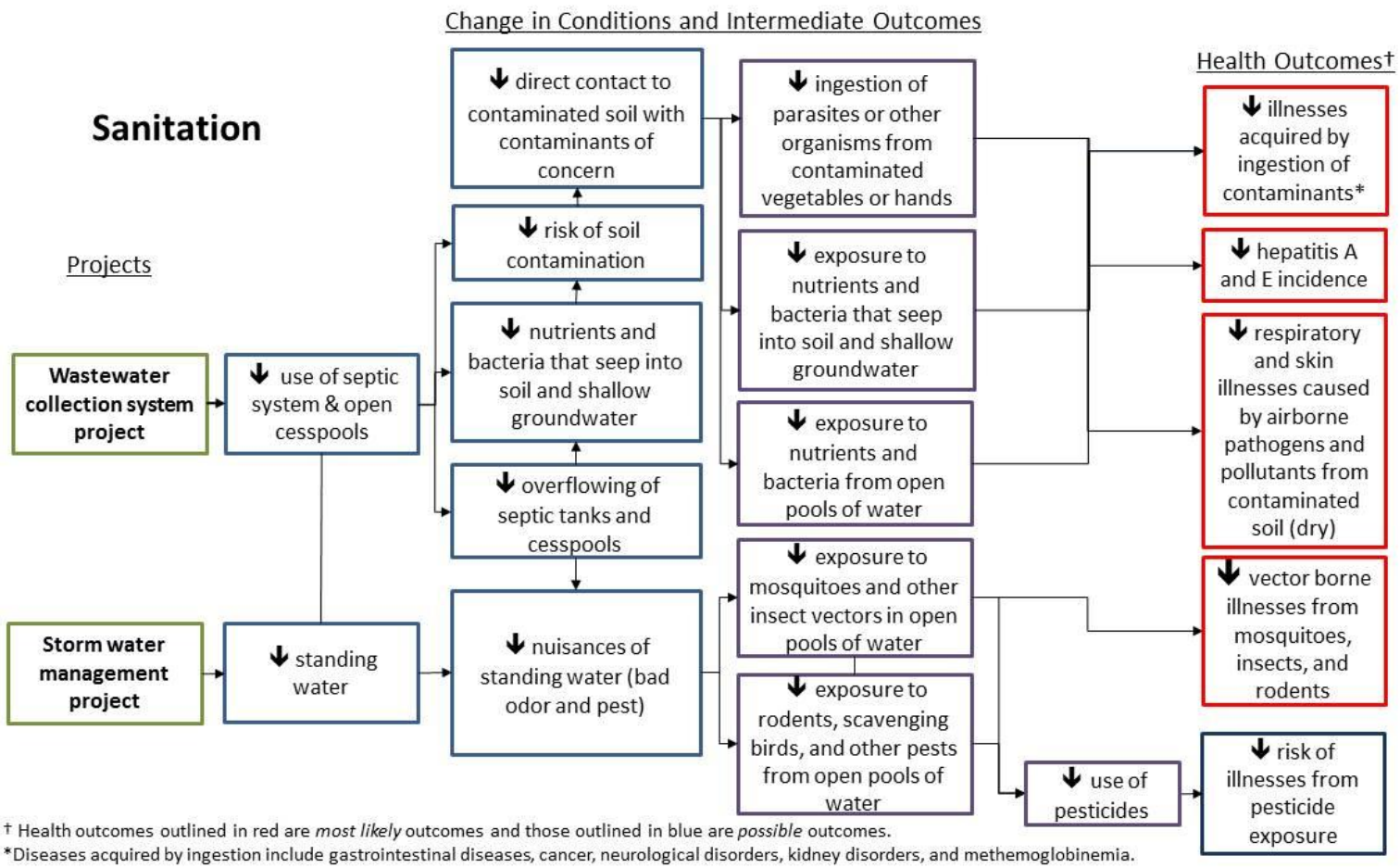
A. List of construction contracts for EDAP project

TWDB Project ID	Phase	CID	Description	Contractor	Construction start	End of Contract	Final Costs	Alternative Costs
10055	I	1	Phase I Water Ext Socorro	Border Precast	10/13/1992	3/16/1993	789,177.00	
10055	I	2	Phase I Master meters	NCT, Incorporated	2/9/1993	9/8/1993	324,302.00	
10055	I	3	Phase I Water Ext Surplus funds	Bradburry & Stamm Construction	4/25/1994	8/17/1994	367,558.00	
10055	I	Total	Totals from 3 CID's in Phase I -first time water service for 6 colonias	Total	10/13/1992	8/17/1994	1,481,037.00	
10055	I	Funding	Total TWDB Funding (grants and loans)	Funding	10/1/1991	10/13/1994	1,800,608.00	
10056	II	1	Phase II East Coll Sys	Danny Sander Construction, Inc.	12/17/1996	5/13/1998	3,154,246.00	
10056	II	2	Phase II East Int, LS (No.2)	Kenko dba McGrand	9/12/1996	3/4/1998	3,105,906.00	
10056	II	3	Phase II West Int, LS, Coll Sys (No.1)	Oscar Renda Contracting, Inc.	5/15/1996	1/15/1999	6,686,946.00	
10056	II	4	Phase II Water Ext	Accent Landscaping & Sprinkler	6/21/1995	2/12/1996	168,810.00	
10056	II	5	Phase II Purch Rodding Vacuum Truck	STM Equipment, Inc.	5/26/1998	3/25/1999	179,762.00	
10056	II	6	Phase II & III Sparks Hook ups	Rio Grande Valley, Inc.	9/27/1999	3/10/2001	307,932.00	
10056	II	7	Phase II & III Private WW Line Installations	Silverton Construction	5/1/2000	10/23/2001	611,629.00	
10056	II	Total	Totals from 7 CID's in Phase II -Improved water sercice and first time wastewater service for approximately 21 areas.	Total	6/21/1995	4/11/2003	14,215,231.00	
10056	II	Funding	Total TWDB Funding (grants and loans)	Funding	5/20/1993	6/1/1998	21,650,361.00	
10057	III	1	Phase III CE Common Water	Accent Landscaping & Sprinkler	12/26/1996	6/8/1998	866,868.00	866,869.16
10057	III	2	Phase III CAN & AS Common Pipeline W & WW	Gamey Companies, Inc.	12/1/1997	10/14/1999	8,890,672.00	8,890,672.40
10057	III	3	Phase III-CNBA Common Facilities W &WW	R.M. Wright Construction Company	1/17/1998	8/9/2000	2,259,382.00	
10057	III	4	Phase III-AS B Subdiv WW Collectors	Ortega Construction	10/8/1998	5/10/2000	2,135,892.00	
10057	III	5	Phase III-AN WW Int, LS #5 Proj A	Danny Sander Construction, Inc.	11/5/1988	1/13/2000	2,910,037.00	
10057	III	6	Phase III-AN&AS A Subdiv WW Collectors	NCT, Incorporated	8/25/1998	11/10/1999	2,449,877.00	
10057	III	7	Phase III-AW&AN B Common Water Lines	S.J. Louis Construction Inc.	10/22/1998	1/13/2000	1,571,339.00	1,573,373.64
10057	III	8	Phase III-CNBB Common Facilities W & WW	Triad Western Constructors, Inc.	2/23/1998	5/19/1999	1,321,436.00	
10057	III	9	Phase III -CN Water Line Cathodic System	Rio Grande Valley, Inc.	4/23/1998	10/7/1998	130,379.00	
10057	III	10	Phase III-CN Subdivision W & WW	C.F. Jordan	1/4/1999	7/12/2000	3,651,081.00	
10057	III	11	Phase III- CN Water Line Cathodic System	Corrpro Companies, Inc.	5/25/1999	1/13/2000	62,740.00	
10057	III	12	Phase III- B, CE&DS WW-A Lift Station (6,9,&10)	Southwest Contracting, Inc.	11/15/1999	3/6/2001	1,957,405.00	
10057	III	13	Phase III-B, WW, &W Trans Facilities	NCT, Incorporated	11/1/1999	4/4/2001	3,915,666.00	
10057	III	14	Phase III-CE Subdiv W & WW	C.F. Jordan	1/31/2000	11/5/2001	3,905,522.00	
10057	III	15	Phase III-B, CE &DS WW-B Int & FM	S.J. Louis Construction Inc.	11/1/1999	12/18/2001	4,286,330.00	
10057	III	16	Phase III-DS&DE WW-LS #11 & Common Water	Ortega Construction	3/5/2001	10/29/2002	3,569,930.00	3,456,580.50
10057	III	17	Phase III- DS & DE Collectors Las Azaleas	Danny Sander Construction, Inc.	10/30/2000	4/2/2002	4,349,572.00	
10057	III	Total	Totals from 17 CID's in Phase III-Improved water service and first time wastewater service for 18,820 residents in 19 colonias.		12/26/1996	5/19/2003	48,120,778.13	48,122,814.70
10057	III	Funding	Total TWDB Funding (grants and loans)	Funding	1/20/1994	11/20/2000	52,971,711.00	

B. Pathway Diagrams

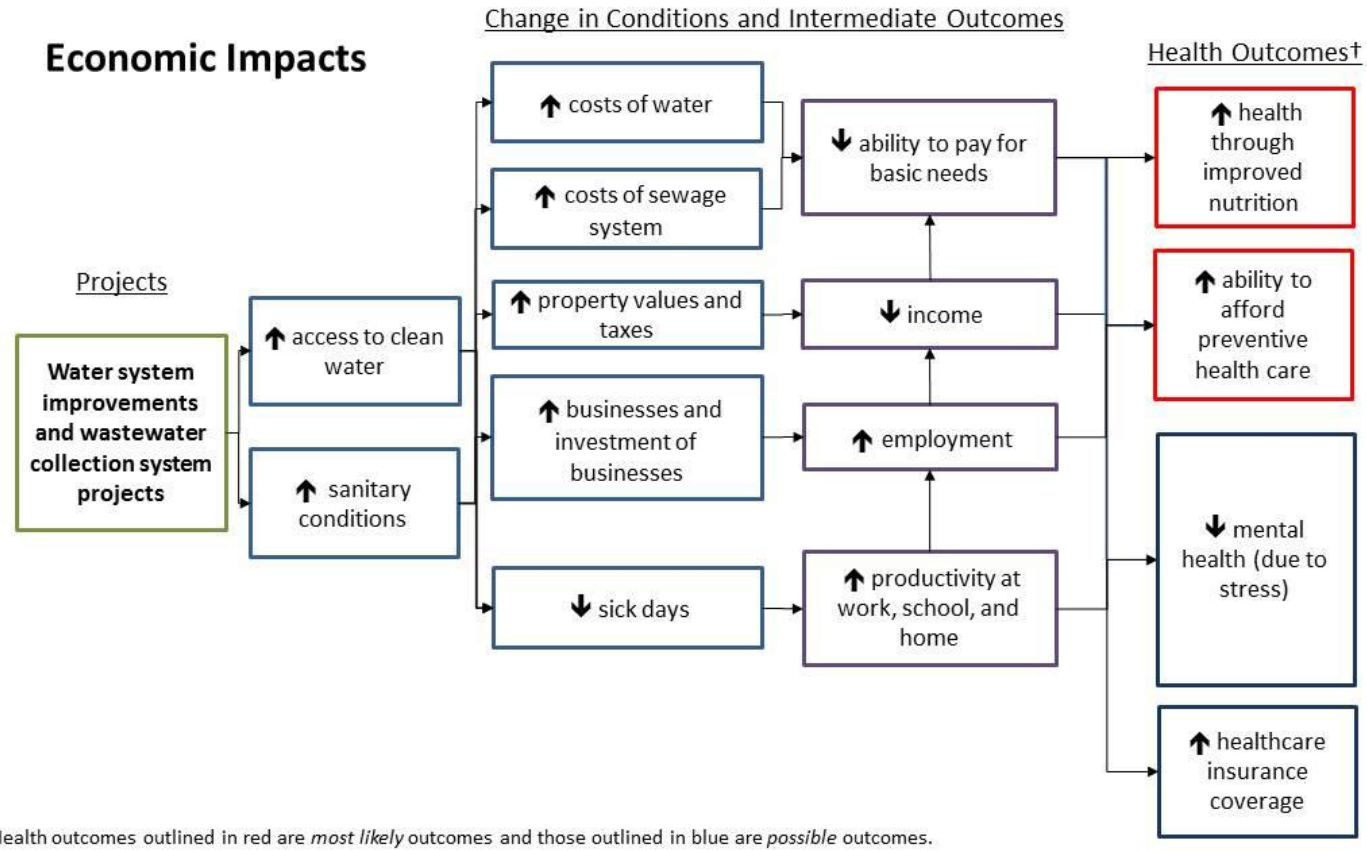


† Health outcomes outlined in red are *most likely* outcomes and those outlined in blue are *possible* outcomes.



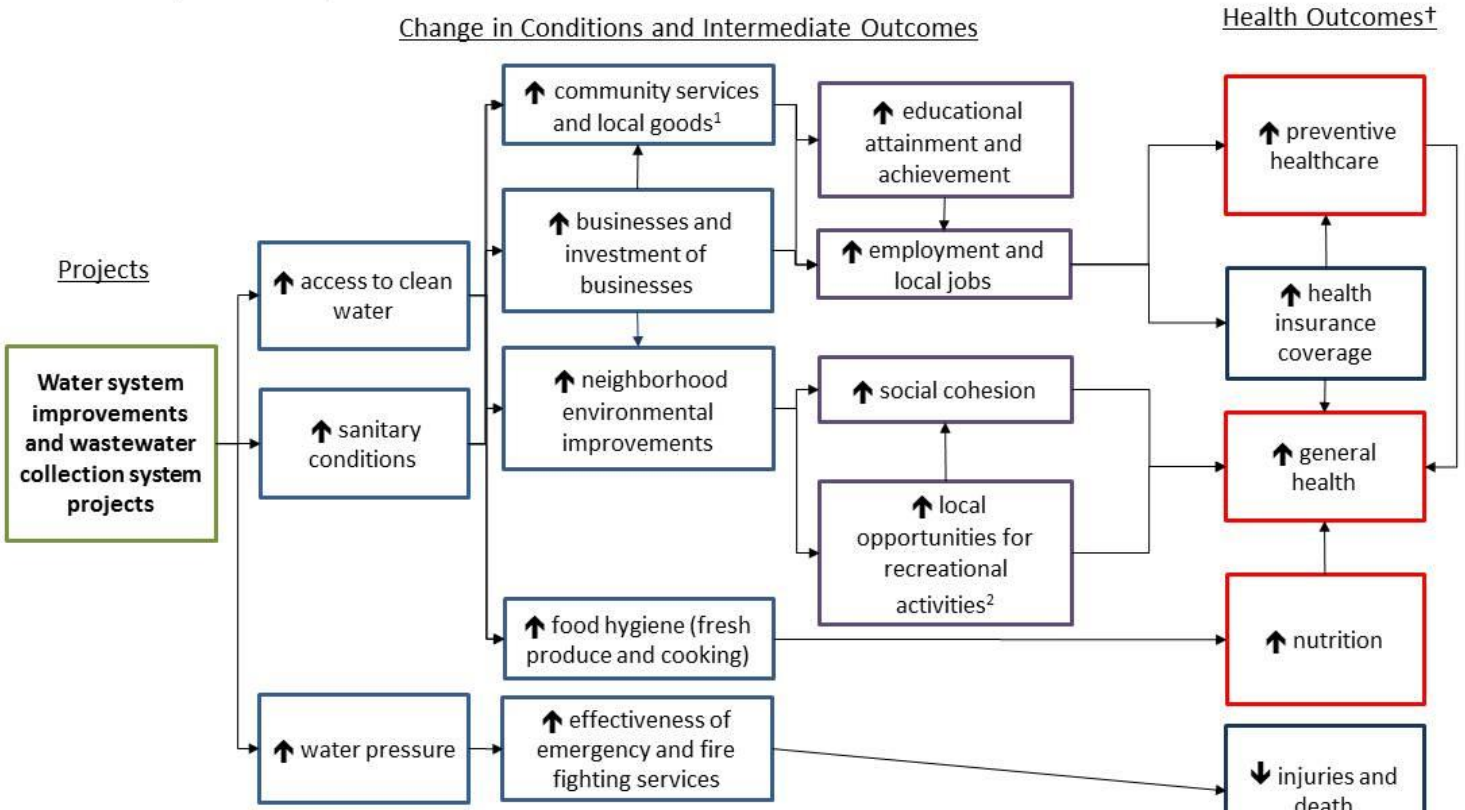
† Health outcomes outlined in red are *most likely* outcomes and those outlined in blue are *possible* outcomes.
*Diseases acquired by ingestion include gastrointestinal diseases, cancer, neurological disorders, kidney disorders, and methemoglobinemia.

Economic Impacts



† Health outcomes outlined in red are *most likely* outcomes and those outlined in blue are *possible* outcomes.

Community Development

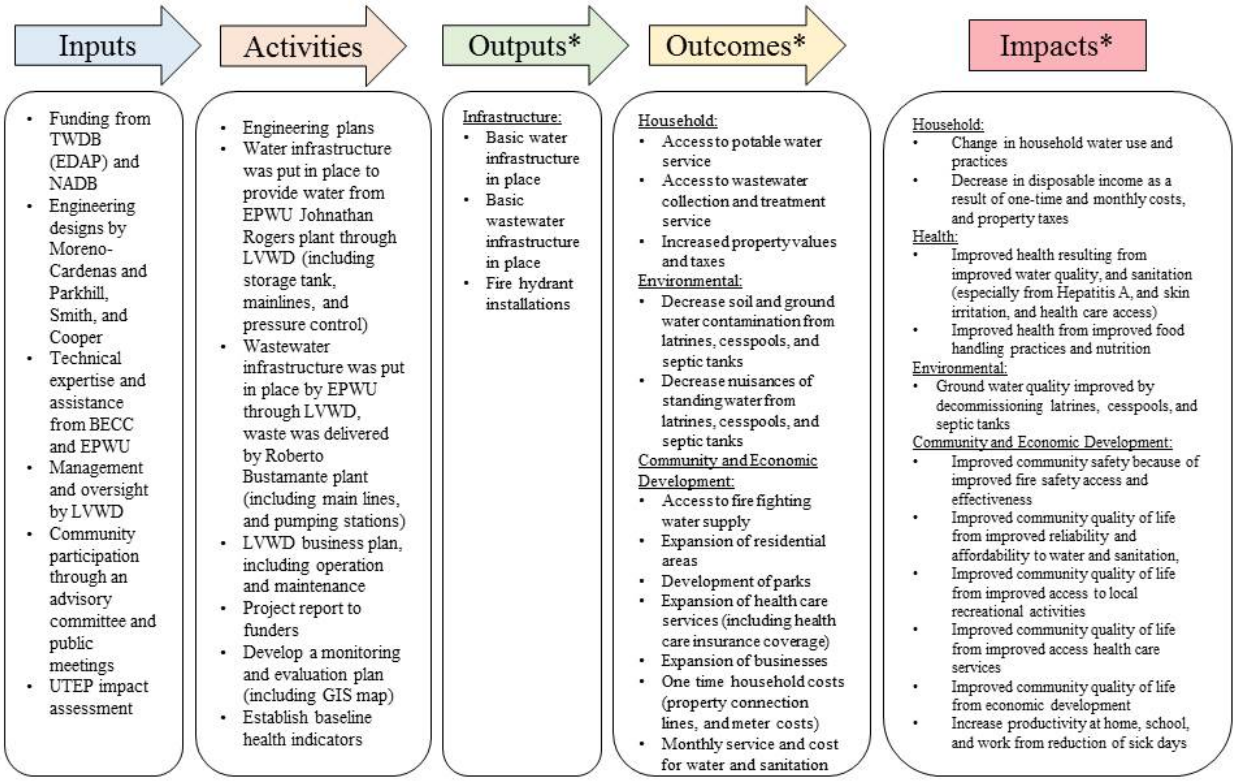


† Health outcomes outlined in red are *most likely* outcomes and those outlined in blue are *possible* outcomes.
[1] Community services include: schools, health clinics, pharmacies, grocery stores, and business services.
[2] Opportunities created through community centers and parks.

C. Logic Model

Logic Model for the Water and Sanitation Infrastructure Project in Socorro and San Elizario, TX

Situation: Residents depend on shallow domestic wells for water and septic tanks for sanitation. Water was contaminated by poorly managed/septic tanks. Incidence of Hepatitis A and Gastrointestinal disease was high.



D. Literature Review

Water Quality Issues in Socorro/San Elizario Community in El Paso County
Amit Raysoni, Graduate Research Assistant, CERM/UTEP

The U.S.-Mexico border, which runs approximately 2000 miles long, separates two nations that share many common features, cultural heritage, language, and social norms. One of the important features of this border region, from Tijuana (Baja California)/San Diego (California) to Brownsville (Texas)/Matamoros (Tamaulipas) is the existence of '*colonias'.* Colonias are basically unincorporated and economically disadvantaged communities and majority of the people living in it are of Hispanic/Latino descent. Figure 1 below showcases the U.S.-Mexico border region as per the La Paz agreement of 1983 (Border Health, 2016).

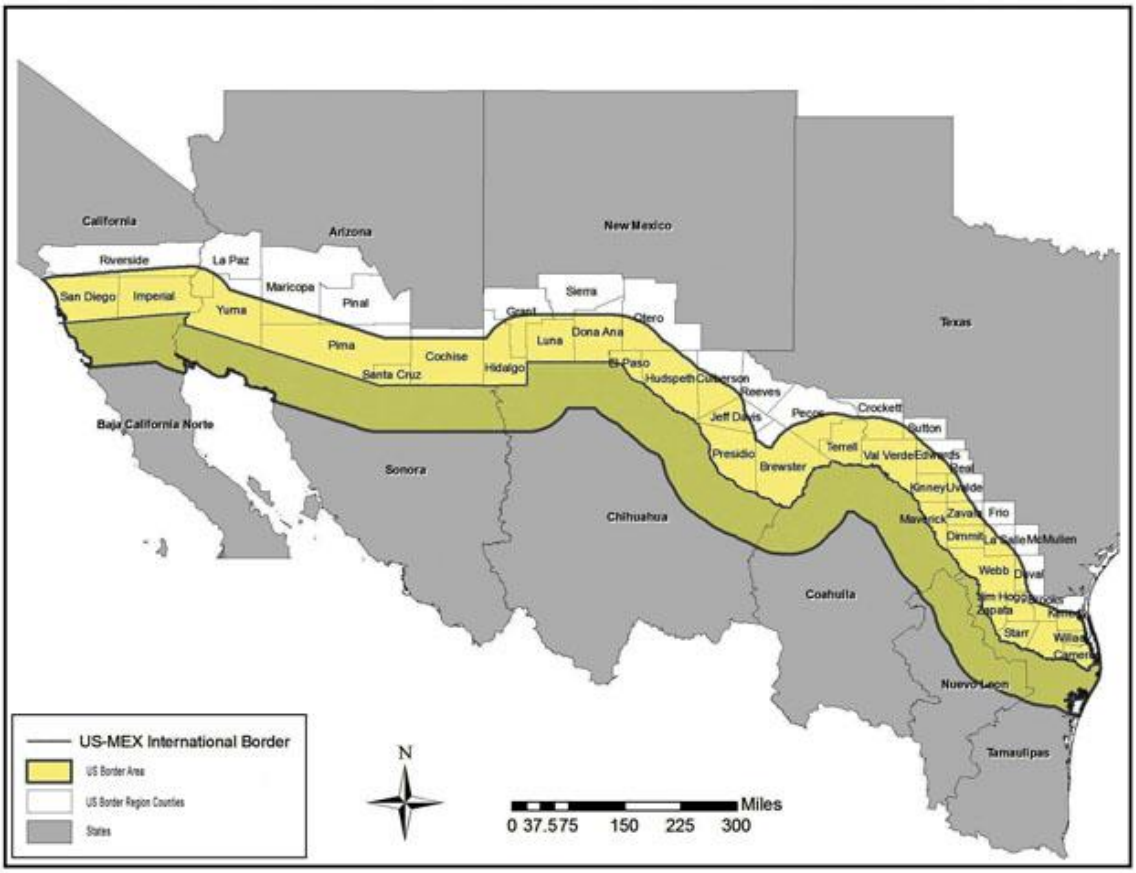


Figure 1: U.S.-Mexico Border

The United States Department of Housing and Urban Development defines a colonia as a community within 150 miles of the U.S./Mexico border that lacks one or more of the following features of healthy living:

- Potable water supply
- Adequate sewage system
- Paved roads
- Decent, safe, and sanitary housing.

In the state of Texas alone, approximately 400, 000 persons live in the more than 2,294 colonias (Anders et al., 2010). An estimated 64.4% of all residents and 85% of residents under the age of 18 are born in the United States. Many residents of these colonias live in trailers or self-built

houses and lack basic services such as drainage, paving, and street lighting (Mier, 2008; Ward, 1999). After the passage of NAFTA, numerous maquiladoras that produce finished goods also dot the landscape of this border region, albeit all on the Mexican side. The presence of the unregulated colonias, untreated or improperly treated sewage, regulated or unregulated industrial discharge from these maquiladoras are a potent recipe for environmental contamination – especially the water bodies in this region (Mendoza et al., 2004).

For example, the Rio-Grande, or the Rio Bravo as it is called in Mexico, is the natural boundary between the U.S. and Mexico from El Paso/Ciudad Juarez to Brownsville/Matamoros. The headwaters of this once mighty river are in the Rockies of the Colorado and it meanders its way through hundreds of miles and finally meets the Gulf of Mexico at Brownsville. For the Paso del Norte region, which comprises of the cities of El Paso, TX, Ciudad Juarez, MX, and Sunland Park, NM, the Rio Grande river is a major watershed. The major groundwater reservoirs for this arid region are the Hueco Bolson and the Mesilla Bolson. The Hueco Bolson is a major source of water for both El Paso, Texas, and Ciudad Juarez, Chihuahua. Most of the water for the city of Las Cruces, NM is sourced through the Mesilla Bolson (Li et al., 2005). The Rio Grande is the lifeline of this border region; however, it has lost its pristine and uniqueness due to the gargantuan demand of its water by the industries, agricultural activities, and human consumption (IBWC, 1998). This has led to the Rio Grande becoming a reservoir for infectious micro-organisms and toxic pollutants. This problem is compounded by the chemical and biological contamination of the ground water due to improperly installed and lackadaisical maintenance of the septic tanks, landfills, injection wells, irrigation and animal wastes runoffs (Singh, 1992).

The water borne diseases that could be attributed to unclean drinking water in this region are cholera, amoebiasis, Hepatitis A, salmonellosis, shigellosis, ascariasis, giardiasis, and other inflectional diseases. In the colonias, the major infections of interest are Hepatitis A, cholera, salmonellosis, dysentery (Mendoza et al., 2004). In addition to the problems enlisted above regarding the contamination of the water bodies, potential contamination from wells dug shallow in the colonias, poor hygiene, low socio-economic status, and low educational levels also contributed to the overall problems associated with water contamination (TNRCC, 1994).

Figure 2 below is an example of the various point and area sources of water contamination into the Rio Grande river in the Paso del Norte region (Mendoza et al., 2004). Mendoza and colleagues tested levels of microbial contamination and chemical toxicity in the Rio Grande river along the 112 km segment from Sunland Park, NM to Fort Hancock, TX. Their findings indicated the presence of *H. pylori* at all the testing sites along this stretch of the river. In addition, their results also showed a greater variability in the number of fecal coliforms on a month- to- month basis with severe implications for the health of the citizens on both sides of the international border.

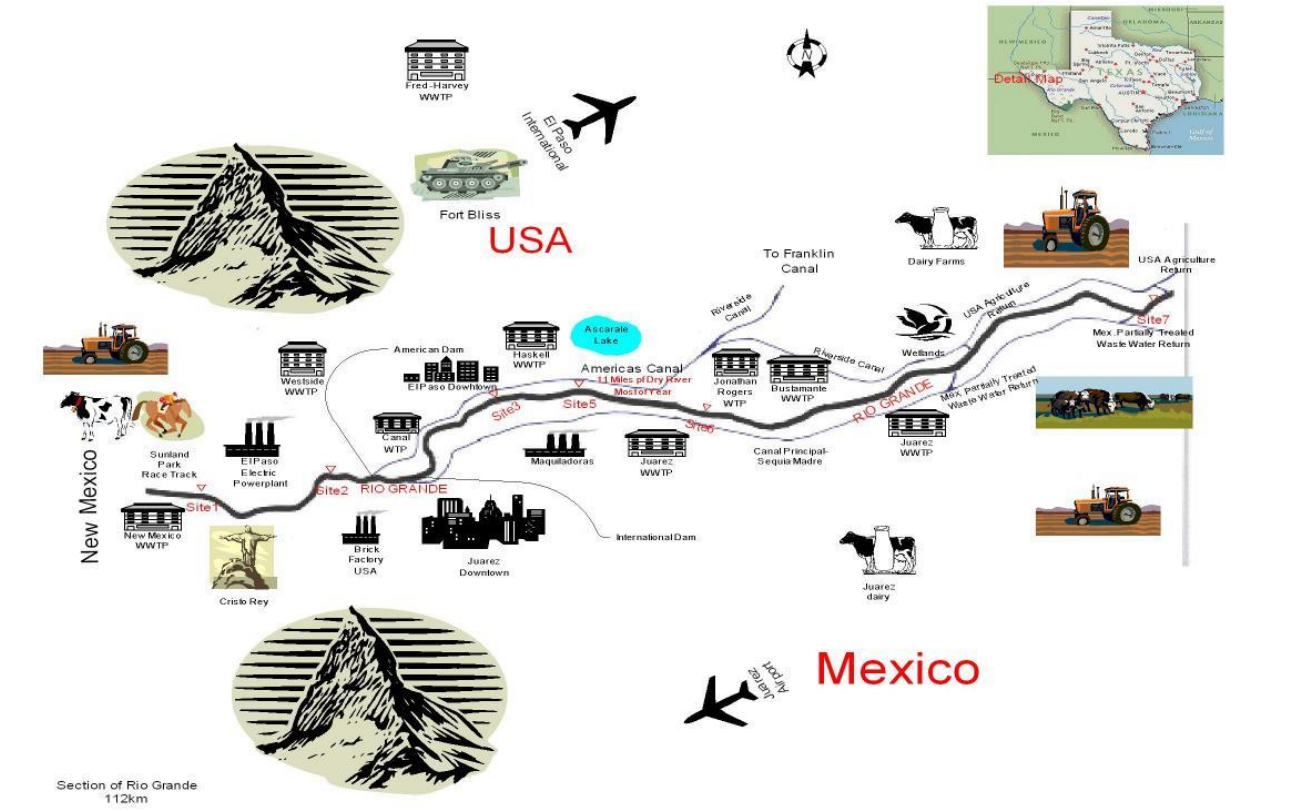


Figure 2: Point and area sources of contamination into the Rio Grande river in the Paso del Norte region (Source: Mendoza et al., 2004).

This review focuses on the community of San Elizario, TX, which has a population of approximately 11000 residents (Anders et al. 2008). This town is located approximately twenty miles southeast of El Paso. Prior to 1987, the town lack basic health and sanitation facilities (Sawyer JA, 1989). The town was instituted as municipality in 1986 and the process of connecting the community members to the grid – with sewerage and water facilities was initiated.

Historically, this town has been plagued with infections associated with water borne diseases. A study conducted by Redlinger and colleagues documented the presence of H. *pylori* antibodies in 21% of children between the ages of four to seven in an elementary school cohort comprising of 365 school children (Redlinger et al., 1999). During the study period, approximately 50% of the population did not have access to piped water and 86% used septic tanks for sewage purposes.

A study pertaining to Hepatitis A infection was also conducted by Redlinger and colleagues in the same study area from January to June 1996 (Reglinger et al., 1997). This infection is caused by the hepatitis A virus and is transmitted predominantly through the fecal-oral route. In addition, this transmission is highly correlated with low socio-economic status (SES) and insalubrious sanitary conditions (Mast and Alter, 1993). 16.9% of the 561 children studied in this research tested positive for total anti-hepatis A virus and one student tested positive for IgM anti-

hepatitis A virus. Half of the study did not have access to municipal water supply and only 2.7% lives in homes connected to the municipal sewer system. 87.5% of the households had septic tanks; however, 25% did not have a leach field.

Sawyer and co-researchers had conducted a study in the late eighties assessing Hepatitis rates in this community (Sawyer et al., 1989). Prevalence of the IgG antibody to Hepatitis A virus was measured in 282 residents. Their findings showed that one third of 8 year old children, 60% of 12 year olds, and over 90% of those over age 30 tested positive to the antibodies for Hepatitis A. During this study period, 74% of the households used drinking water wells, 26% had connections to drinking water lines from El Paso. 98% of the drinking water wells were, however, contaminated by sewage (Sawyer et al., 1989).

Another study investigating bacterial populations in the groundwater in the El Paso County showed contamination by fecal coliforms and other pathogens (Mroz et al., 1994). The researchers sampled 73 domestic wells in this study. 13 wells were contaminated by fecal coliforms, whereas other wells contained a variety of bacterial genera with severe implications for public health.

Findings from these studies accentuate the importance of cleaning drinking water and sewerage facilities for the people in this border region. In contrast to the conditions existing in San Elizario thirty years ago, the number of people with access to clean drinking water and sewerage facilities is increasing. The Lower Valley Water District (LVWD), which came into being in 1986, has been steadfast in applying for local, state, and federal grants to provide clean piped drinking water to the residents of Socorro and San Elizario. Plans were also conceived to construct a water and wastewater system. Consequently, proposals were submitted to the Texas Water Development Board (TWDB), which committed funds for the Socorro wastewater system from their State Water Pollution Control Revolving Fund (SRF) program. In 1992, the LVWD decided to incorporate seven additional subdivisions to the wastewater project proposed in the 1989 Socorro Facilities Engineering Plan.

Phase II consisted of the construction of a wastewater collection system and a water supply for the portion of the city of Socorro. Phase III consisted of the construction of a wastewater system for the remaining portion of the city of Socorro and the portion of San Elizario. The design period was changed from 2010 to 2015, and it was estimated that the system would serve 70,599 people or 15,000 connections by the year 2015. The total cost associated with the various stages of the project was $81.4 million. Also, it was planned that the water supply would be provided from a combination of both surface water and ground water sources. The wastewater system proposed for the project was a gravity flow system.

It was recommended that the provisions of clean drinking water and sewerage facilities would help address public health problems associated with poor and non –conventional sewage disposal methods such as cesspools, pit-privies, and ineffective septic tank/drainfield systems. Finally, the implementation of this project would be in compliance with the said international treaties between United States and Mexico. This project also, in essence, addressed the issues of environmental injustices in this border region (VanDerslice, 2011). Majority of the people in the Socorro/San Elizario community are of Hispanic descent and lack of access to clean drinking water and sewerage facilities is a major health disparity issue.

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E. List of Key Informants

Agency/Organization/Role
1. Former LVWD Steering Committee member for BECC EDAP Projects 2. AYUDA Inc. (Promotores de salud/Community Health Workers) 3. Sofia's Restaurant 4. Former Mayor of Socorro, Water for Children Committee, and former LVWD Steering Committee member for BECC EDAP Steering Committee 5. City of San Elizario, Mayor 6. City of Socorro, City Manager 7. Texas A&M Colonias Program, Health Promoter 8. City of Socorro-Planning and Zoning Department 9. Longtime resident-City of Socorro 10. Kellogg Clinics, UTEP College of Health Sciences, Former Program Director 11. EPISO, Co-Chair, and former priest at La Purisima Catholic Church 12. Licon Dairy 13. San Elizario Bakery and former farmer 14. EPISO former members, former SISD teacher, La Purisima Catholic Church, and longtime City of Socorro residents

F. List of interview questions for key informants

1) Tell me about your agency, business, or organization and who it serves.

2) How long have you been in your position?

3) Are you aware of the water and sanitation infrastructure project that was completed in San Elizario and Socorro in 2001? If so, in what way were you familiar with the project?

4) Before 2001, most residents and businesses in this area either had their own domestic well or hauled water for household use, and relied on septic tanks for sanitation. What do you think has been the impact of providing water and sanitation service to these communities?

5) How do you think the improved infrastructure impacted public health for residents in this area?

6) How did the infrastructure project impact the residents' ability to have a garden/grow their own food?

7) How did the infrastructure project impact economic development in the area?

8) How do you think the improved infrastructure impacted land values in the area?

9) How do you think the improved infrastructure impacted the following community services/conditions?

   Fire safety

   Recreational parks

   Health care services

   Restaurants

   Environmental quality

10) Who do you think benefited the most from the improved infrastructure?

11) Is there anything you want to add that we did not address already?

12) Do you have a recommendation as to other individuals who we should talk to?

G. Household survey

SECTION I: GENERAL HOUSEHOLD DATA

1. Gender	a. Male ( )	b. Female ( )
2. Age	_____ yrs.	
3. Home street address and zip code		
4. Number of persons living in the home		
5. How many years have you lived in your current home?		
6. Type of home	a. Single family house b. Condo / apartment (collective housing) c. Other type (specify):_____	
7. Is your home currently connected to the LVWD water system? If yes, since when?	Circle answer: Yes No I don't know _____ or I don't remember/don't know	
8. Is your home connected to the LVWD sewer system? If yes, since when? If no, do you have a septic tank?	Circle answer: Yes No I don't know _____ or I don't remember/don't know Yes No	
9. From the following choices, please point to the range of your household income.	___ $10,000 or less ___ $11,000 to $20,000 ___ $21,000 to $30,000 ___ $31,000 to $40,000 ___ $41,000 to $60,000 ___ $61,000 to $80,000 ___ More than $80,000 ___ Don't know; don't remember	

SECTION II: WATER SERVICE

10. Do you know or remember the conditions and your practices with respect to water before connecting to LVWD water service?

    a. Yes, continue with questions
    b. No, or I have always been connected to LVWD, skip to Question 17

11. Before connecting to LVWD (2001), what was the primary source of water in your home?
    ___Hauled water by family
    ___Hauled water by a service
    ___Purchased bottled water
    ___Well on property
    Other:_____

12. If you depended on hauled water before, do you remember how much you spent on hauled water per trip, and then how many trips you make per month or week?

    a. $_____per trip ____# of trips per week or month (circle one)
    b. Did not hauled water

13. Did you have plumbing inside your house before connecting to LVWD?
    a. Yes
    b. No
    c. I do not know

14. At that time, did you drink the tap water or bottled water?
    a. Tap water
    b. Bottled water
    c. Both
    d. Other:_____

15. At that time, did you wash fruits and vegetables, and cook with tap water or bottled water?
    a. Tap water
    b. Bottled water
    c. Both
    d. Other:_____

16. Before connecting to LVWD was the water in your household ever discolored, taste bad or have an odor?
    a. Yes, describe:_____
    b. No
    c. I do not remember

17. Compared with the period before 2001, what is your degree of satisfaction with the water service that you currently receive?

    a. Satisfied (continue and skip question 19)
    b. Somewhat satisfied (continue and skip question 19)
    c. Dissatisfied (skip to question 19)

18. If satisfied or somewhat satisfied, are you satisfied with the water service for the following reasons?

a.	It has improved health at home	Yes	No	I don't know
b.	It has saved us money	Yes	No	I don't know
c.	Water pressure has improved	Yes	No	I don't know

d. We use more water now than before because we are able to use more water for nonessentials like watering plants and landscaping Yes No I don't know
e. It is more reliable Yes No I don't know
f. Other (please specify):_____

19. If dissatisfied, are you dissatisfied with the water service for the following reasons?
    a. Costs are too high Yes No I don't know
    b. Bad customer service Yes No I don't know
    c. Water pressure is too high Yes No I don't know
    d. Service is frequently interrupted for repairs/maintenance Yes No I don't know
    e. Water tastes bad Yes No I don't know
    f. Other (please specify):_____

20. Today, do you drink tap water or bottled water?
    a. Tap water
    b. Bottled water
    c. Both
    d. Other:_____

21. Today, do you wash fruits and vegetables and cook with tap water or bottled water?
    a. Tap water
    b. Bottled water
    c. Both
    d. Other:_____

22. If you currently use bottled water, how much do you currently spend on bottled water per month?

    $_____ per month

23. Today, is the tap water in your household ever discolored, taste bad or have an odor?
    a. Yes, describe:_____
    b. No
    c. I do not know

24. Has water service provided by LVWD ever interrupted in your home by the provider for maintenance, repair, or construction? If yes, for how long?
    a. Yes, for how long_____
    b. No
    c. I do not know

25. How satisfied are you with the water pressure now?
    ___Not satisfied
    ___Sometimes unsatisfied
    ___Neutral
    ___Sometimes satisfied
    ___Very satisfied

26. How much do you trust the quality of your tap water?

    ___Not very much
    ___Somewhat
    ___Neutral
    ___Sometimes

___Very much

SECTION III. SANITATION SERVICE

For this section only, if you are connected to LVWD for sewer service answer Questions #32 through 35. If not answer Questions #27-31.

27. If you have a septic tank, what year was it constructed?

28. Do you have a certificate of compliance from the county for your septic tank or has it ever been inspected?
    a. Yes
    b. No
    c. I don't know

29. How often is your septic tank pumped out or cleaned? How much does it cost to have it pumped out?
    a. Indicate how often_____ and costs $_____
    b. Never has been pumped out or cleaned

30. How often is there a wet area or free standing water near your septic tank or drainage field?
    a. Very often
    b. Sometimes
    c. Never
    d. I don't know
31. Have you ever received information on how to manage or maintain your septic tank?
    a. Yes
    b. No

32. If you are connected to LVWD for sewer service, what is your degree of satisfaction with the service that you currently receive?

    a. Satisfied (continue and skip question 34)
    b. Somewhat satisfied (continue and skip question 34)
    c. Unsatisfied (skip to question 34)

33. If satisfied or somewhat satisfied, are you satisfied with the sewer service for the following reasons?

    a. It has improved hygiene at home Yes No I don't know
    b. It has saved money Yes No I don't know
    c. It has reduced or eliminated leaks and spills of wastewater Yes No I don't know
    d. It has improved wastewater treatment Yes No I don't know
    e. It has reduced the pollution of rivers, streams, and wells Yes No I don't know
    f. Other (please specify):_____

34. If dissatisfied, are you dissatisfied with the sewer service for the following reasons?
    a. Need to expand the sewer system Yes No I don't know
    b. Cost of connection and sewer service Yes No I don't know
    c. Bad customer service related to sewage leaks Yes No I don't know
    d. Pollution of rivers, streams, and wells Yes No I don't know
    e. Other (please specify):_____

35. How would you rate the maintenance service to the sanitary sewer system of your neighborhood?
a. Very Good b. Good c. Regular Average d. Bad e. Very Bad d. I don't know

SECTION IV. IMPACTS OF WATER AND SANITATION INFRASTRUCTURE

36. Before your house was connected to LVWD, did you or any member of your household experience any of the following health conditions (check all that apply):

( ) Frequent ailments of the stomach-intestine (diarrhea, nausea, vomiting, gastritis)
( ) Stomach infections: Salmonella, E. coli, cholera, dysentery, H. pylori
( ) Hepatitis A, E
( ) Skin problems in any part of the body (rash, itchy, redness, dryness)
( ) Strange feelings in fingers, arms or legs such as numbness, cramping, or tingling
( ) Any type of cancer
( ) Illnesses borne by mosquitoes, rodents, insects, or other pests (like West Nile virus, for example)
( ) Blue-baby syndrome (called methemoglobinemia)-happens to babies less than 6 months of age with bluish or slate-gray on the skin, lips, or nailbeds
( ) Any other health condition? Please specify:
( ) No health conditions, skip to question #38.

37. Have any of these health conditions continued after connecting to LVWD? If so, which ones?
Yes, like:_____ b. No

38. Do you believe that water and sanitation service has benefitted your community?
a. Yes b. No
If yes, is it in the following way?
a. Improved fire safety by providing fire hydrants Yes No I don't know
b. Allowed development of new parks for recreation Yes No I don't know
c. Allowed development of health care services to locate in the community
Yes No I don't know
d. Expanded local businesses such as restaurants, grocery stores, and other retail stores
Yes No I don't know
e. Other; Please specify:

39. Do you believe that water and sanitation services impacted your disposable household income?
a. Yes b. No
If yes, is it in the following way?
a. Increased monthly costs of water; if so, how much? _____ Yes No I don't know
b. Increased monthly costs for sanitation; if so how much? _____ Yes No I don't know
c. Increased property values, if so how much? _____ Yes No I don't know
d. Increased property taxes, if so, how much? _____ Yes No I don't know
e. Improved local job opportunities Yes No I don't know
f. Other; Please specify:

40. Do you believe that water and sanitation services impacted economic development in your community?
a. Yes b. No
If yes, is it in the following way?
a. More businesses moved to the area Yes No I don't know
b. Improved local shopping Yes No I don't know

c. More residential development Yes No I don't know
d. Other: Please specify:

41. What is the change you see in your quality of life with the water and sanitation infrastructure in your neighborhood?
    a. It improved a lot
    b. Moderately improved
    c. It improved slightly
    d. Still the same
    e. Got worse

    In what ways? _____

42. Do you believe that water and sanitation services impacted the environment in your community?
    a. Yes b. No

If yes, is it in the following way?
a. Reduced groundwater contamination Yes No I don't know
b. Reduced contamination of the river Yes No I don't know
c. Reduced vector borne diseases (West Nile virus for example from mosquitoes) Yes No I don't know
d. Increased water recycling and reuse Yes No I don't know
e. Other: Please specify:

43. Did you change or make improvements to your home after water and sewer infrastructure were provided?
    a. Yes
    b. No

44. Were other public services provided in your community after the water and sewer infrastructure were provided (such as paved roads, street lights, sidewalks, etc.)?
    a. Yes, what kind?_____
    b. No

H. Sanitation Survey for Bejar Estates

1. Today's Date:	2. Gender: ( ) Male ( ) Female	3. Age: _____ yrs.
4. Property street address, city, and zip code:		
5. Number of persons living in the home: _____	6. How many years have you lived in your current home? _____yrs.	
7. Property description: ( ) Single family house ( ) Condo/apartment/collective housing ( ) Restaurant ( ) Other:_____		
8. Is your property currently connected to the LVWD water system? a. ( ) Yes ( ) No ( ) I don't know b. If yes, since when?_____yrs.		
9. Is your property connected to the LVWD sewer system? a. ( ) Yes ( ) No ( ) I don't know b. If yes, since when?_____yrs. If no, do you have a septic tank? ( ) Yes ( ) No		
10. Are you currently charged for sewer on your water bill by Lower Valley Water District? ( ) Yes ( ) No If yes, how much?_____monthly		
11. From the following choices, please select the range of your household income. ( ) $10,000 or less ( ) $11,000 to $20,000 ( ) $21,000 to $30,000 ( ) $31,000 to $40,000 ( ) $41,000 to $60,000 ( ) $61,000 to $80,000 ( ) More than $80,000 ( ) I don't know		
12. What year was your septic tank constructed? _____year		
13. Do you have a certificate of compliance from the county for your septic tank or has it ever been inspected? ( ) Yes ( ) No ( ) I don't know		
14. How often is your septic tank pumped out or cleaned? How much does it cost to have it pumped out? a. Indicate how often_____ and costs $_____ ( ) Never has been pumped out or cleaned		
15. How often is there a wet area or free standing water near your septic tank or drainage field? ( ) Very often ( ) Sometimes ( ) Never ( ) I don't know		
16. Do you flood irrigate your property with water from the canal? ( ) Yes ( ) No		
17. Have you ever received information on how to manage or maintain your septic tank? ( ) Yes ( ) No		
18. Have you or any member of your household experience any of the following health conditions (check all that apply): ( ) Frequent ailments of the stomach-intestine (diarrhea, nausea, vomiting, gastritis) ( ) Stomach infections or bleeding ulcers ( ) Hepatitis A, E ( ) Illnesses borne by mosquitoes, rodents, insects, or other pests (like West Nile virus, for a. example) ( ) Any other health condition? Please specify:		

I. Sources for secondary data

Data/Information Description	Source
2013-2016 Food Handling Establishments in area codes 79927 and 79849	City of El Paso. Food Inspection Data. Available at http://legacy.elpasotexas.gov/foodscores/establishment_inspection.asp.
1999 and 2016 LVWD customer sewer line installation costs (per foot)	Lower Valley Water District. Engineering Department. Document copy.
EDAP Wastewater Projects	Lower Valley Water District. Engineering Department. Document copy.
1975-2001 EDAP Residential and Commercial Connections	Lower Valley Water District. Engineering Department. GIS file.
1985, 2003, & 2016 Estimated Pop. Lacking piped potable water and sewer service over the past 30 years	El Paso Water. Communications and Marketing Manager. Email communication.
2016-2017 water and wastewater whole sale rates to LVWD	El Paso Water. Chief Financial Officer. Phone communication on 3/19/2017.
1995-2015 County and State Health Data on Notifiable Diseases	Centers for Disease Control and Prevention [CDC]. 2015. Overview of Water-related Diseases and Contaminants in Private Wells. Access on Feb 02 2017. Available at https://www.cdc.gov/healthywater/drinking/private/wells/diseases.html. City of El Paso. Epidemiology Notifiable Conditions Reports. 2016. Available at https://www.elpasotexas.gov/public-health/programs/epidemiology. Texas Department of State Health Services [TDSHS]. 2017. Texas Annual Reports (statistics, disease data). Available at https://www.dshs.texas.gov/idcu/Data/Annual/. U.S. Census Bureau. Population and Housing Unit Estimates [datasets]. Available at https://www.census.gov/programs-surveys/popest/data/data-sets.2010.html.
2000-2015 Population Estimates, El Paso County, City of Socorro, and City of San Elizario	U.S. Census Bureau. Population and Housing Unit Estimates [datasets]. Available at https://www.census.gov/programs-surveys/popest/data/data-sets.2010.html.
2016 Population Estimates, El Paso County	U.S. Census Bureau. Population and Housing Unit Estimates [datasets]. Available at https://www.census.gov/programs-surveys/popest/data/data-sets.html
1999-2014 County Death Records	CDC Wonder Detailed Mortality Database. Available at https://wonder.cdc.gov/.

2002 & 2012 Business and Industry, City of Socorro, and City of San Elizario	US Census Bureau. American Fact Finder. 2002 & 2012 Economic Census. Available at https://factfinder.census.gov
2017 Fire Hydrants, LVWD service area	Lower Valley Water District. GIS Department. Excel files. Email communication.
2000 & 2016 LVWD Water and Wastewater Connections	Lower Valley Water District. GIS Department. Excel files. Email communication.
1996-2003 EDAP related funded water and wastewater installations and construction costs	Texas Water Development Board. Public Information Coordinator. Document copies.
1992-2011 Land Cover Changes in Lower Valley	Multi-Resolution Land Characteristics Consortium (MRLC).National Land Cover Database (NCLD). Available at https://www.mrlc.gov/nlcd2011.php.
1998-2001 EPISO Press Releases	El Paso Interreligious Sponsoring Organization. Industrial Areas Foundation. Document copies.
2000 & 2015 Household and Economic Demographics for Socorro and San Elizario	U.S. Census. American Fact Finder. Census 2000 Summary. Available at https://factfinder.census.gov. U.S. Census Bureau. American Fact Finder. 2015. American Community Survey 5 year estimates, 2011-2015. Available at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.
2016 LVWD water and sewer customer bill	Lower Valley Water District. GIS Department. 2017. Excel files. Email communication.
2016 EPU Water and sewer customer bill	El Paso Water. 2017-2018 Budget reports. Selected Financial and Statistical Data. Available at http://www.epwu.org/public_information/financial_reports.html.
1985 El Paso County Population Estimate	Texas State Library and Archives Commission. Population Estimates of Texas Counties, 1985-89. Available at https://www.tsl.texas.gov/ref/abouttx/popcnty85-89.html.

J. Water and Wastewater Related Health Conditions, Texas and El Paso County, 1995-2015

Year	Pop. Estimates		Disease	*Amebiasis*		*Campylobacteriosis*		*Hepatitis A (acute)*		*Salmonellosis*	
	Texas	*El Paso*		*Texas*	*El Paso*	*Texas*	*El Paso*	*Texas*	*El Paso*	*Texas*	*El Paso*
1995	18958559	653310	*Cases*	118	14	118	14	3001	397	2363	111
			IR [a]	0.6	2.1	0.6	2.1	15.8	60.8	12.5	17.0
1996	19340145	655575	*Cases*	130	7	897	44	3460	228	2800	199
			IR	0.7	1.1	4.6	6.7	17.9	34.8	14.5	30.4
1997[b]	19740120	664216	*Cases*	153	7	981	37	4511	165	2793	141
			IR	0.8	1.1	5.0	5.6	22.9	24.8	14.1	21.2
1998	20157330	670422	*Cases*	75	1	881	35	3538	128	3401	111
			IR	0.4	0.1	4.4	5.2	17.6	19.1	16.9	16.6
1999[c]	20558022	674630	*Cases*	37	2	1153	26	2516	37	2198	55
			IR	0.2	0.3	5.6	3.9	12.2	5.5	10.7	8.2
2000	20944499	681729	*Cases*	37	N/A	1237	N/A	1937	33	2941	N/A
			IR	0.2		5.9		9.2	4.8	14.0	
2001	21319622	689163	*Cases*	34	N/A	1109	N/A	1154	14	2819	N/A
			IR	0.2		5.2		5.4	2.0	13.2	
2002	21690325	696446	*Cases*	104	N/A	822	N/A	960	N/A	2332	N/A
			IR	0.5		3.8		4.4		10.8	
2003	22030931	705200	*Cases*	201	N/A	1218	N/A	613	N/A	3868	N/A
			IR	0.9		5.5		2.8		17.6	
2004	22394023	717652	*Cases*	314	0	1264	32	624	25	2665	68
			IR	1.4	0.0	5.6	4.5	2.8	3.5	11.9	9.5
2005	22778123	728095	*Cases*	135	0	816	20	461	37	3145	70
			IR	0.6	0.0	3.6	2.7	2.0	5.1	13.8	9.6
2006	23359580	744795	*Cases*	204	6	1075	43	330	20	3060	100
			IR	0.9	0.8	4.6	5.8	1.4	2.7	13.1	13.4
2007[d]	23831983	755578	*Cases*	434	4	1690	42	264	16	3534	117
			IR	1.8	0.5	7.1	5.6	1.1	2.1	14.8	15.5
2008	24309039	769930	*Cases*	336	1	1441	24	259	14	5583	123
			IR	1.4	0.1	5.9	3.1	1.1	1.8	23.0	16.0
2009	24801761	786759	*Cases*	244	2	1617	13	184	8	3964	125
			IR	1.0	0.3	6.5	1.7	0.7	1.0	16.0	15.9
2010	25244363	803638	*Cases*	200	2	2001	37	139	6	4929	141
			IR	0.8	0.2	7.9	4.6	0.6	0.7	19.5	17.5
2011	25654464	820015	*Cases*	112	1	1741	38	138	3	5218	97
			IR	0.4	0.1	6.8	4.6	0.5	0.4	20.3	11.8
2012	26089741	831864	*Cases*	148	1	2390	45	134	2	4990	99
			IR	0.6	0.1	9.2	5.4	0.5	0.2	19.1	11.9
2013	26500674	832457	*Cases*	183	4	2640	52	109	3	4946	120
			IR	0.7	0.5	10.0	6.2	0.4	0.4	18.7	14.4
2014[e]	26979078	835545	*Cases*	189	3	2589	58	123	2	5145	136
			IR	0.7	0.4	9.6	6.9	0.5	0.2	19.1	16.3
2015	27469114	835593	*Cases*	206	4	3944	72	147	2	5727	167
			IR	0.7	0.5	14.4	8.6	0.5	0.2	20.8	20.0

[a] Incidence rates are based on projected census data obtained from U.S. Census Bureau, IR=cases per 100,000 population

[b] 1997 Hepatitis A vaccine became available

[c] 1999 Hepatitis A vaccination required by law to children in daycare and schools

[d] 2007 E Coli was aggregated into category STEC

[e] 2014 E. Coli is aggregated with Shiga Toxin-Producing STEC, and Hepatitis A is aggregated with Hepatitis E acute

[f] Cholera includes all vibriosis

K. Fact sheet summarizing the results and conclusions of our HIA

HEALTH IMPACT ASSESSMENT

The Lower Valley Water District (LVWD)

El Paso County, Tx.,

WATER AND WASTEWATER PROJECT

(certified in 1998 / project completion in 2003)

Objective

Assess the health and quality of life impacts of water and wastewater services provided through Lower Valley Water District project completed in 2003, using the tools of HIA, as defined by WHO.

Context

- The population of Socorro and San Elizario was 22,995 and 4,385, respectively, from 1990 Census.
- Before (the water & wastewater project) 2003, residents and businesses in San Elizario and Socorro were mostly dependent on private domestic wells for water and septic tanks for sanitation.
- Inadequately designed and constructed on-site treatment systems led to contaminated shallow wells in the area. Studies by UTEP (1988) and the CDC (1992) found that 100% and 30% of wells tested, respectively, were bacteriologically contaminated.
- EP County Health Department (1992) reported high rates of Hepatitis A (3x the national average) and shigella dysentery (3x the national average) in the area. And, a study by UTSA Health Sciences Center (1988) found that 90% of San Elizario residents sampled had been infected with Hepatitis A before reaching the age of 35.

General Characteristics and Cost of the Project

Cost	$98 million	Funding Sources	EPA, TWDB, USDA
Implemented	1995 - 2005	13,729 connections	Benefiting 55,729 people
Water Infrastructure	Purchase of existing infrastructure, 3 million gal ground storage tank, 25 MGD added pumping capacity, approximately 265,000 lineal feet of water line from 6-inch to 24-inches		
Wastewater Infrastructure	Construction of 8 sewer lift stations, approximately 650,000 lineal feet of collection line, main collectors and force main, ranging from 8-inch to 42-inches		

The Assessment

- Interviewed 11 key informants
- Survey of 100 households from a total of 223 who had lived in the same home for >25 yrs
- Review of secondary data related to health, economic, and quality of life impacts

Results

Household Survey

Water & Sanitation, Before & After

- Before the infrastructure project, 32% of residents obtained water through some combination of hauled water, domestic wells, and bottled water. 15% depended on hauled water only, and 8% depended on domestic wells only. For those who hauled water, 64% of them hauled water more than once per week. 100% of residents depended on septic tanks for sanitation.
- After the infrastructure project, 100% of residents had piped water, and 93% of residents connected to sewer.
- Today from the survey, 93% of residents are satisfied with water service, and 89% are satisfied with the sewer service.

Self-Reported Health Conditions, Before & After

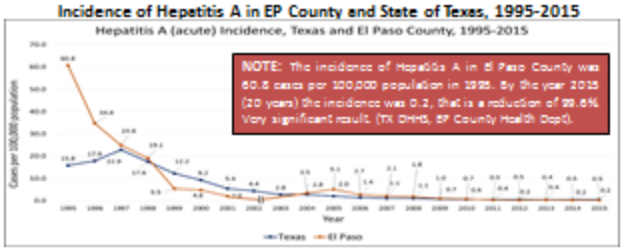
	Before	After
Skin problems (rash, itchy, dry)	22%	9%
Neuropathy (numbness, cramping, tingling)	10%	4%
Gastrointestinal illness (diarrhea, nausea, gastritis)	9%	3%
Stomach infections (salmonella, cholera, H. pylori)	1%	0%

Economic, Community Development, Quality of Life, Before & After

- 93% of the respondents believe that water and sewer benefitted the community through expanded health care services, local businesses, parks and recreation, and improved fire safety.
- 88% of residents believe quality of life has improved.

Secondary Data

Incidence of Hepatitis A in EP County and State of Texas, 1995-2015



Community Development and Economic Impact

- Property values increased by 41% in Socorro and 23% in San Elizario between 2000 and 2010 (American Fact Finder). The average is 20% in El Paso County after first time water service (EPW).
- 4500 ha of agricultural land were converted to residential use (from Landsat imagery).