THE EVALUATION OF THE IMPACT OF BASIC SANITATION INFRASTRUCTURE AT THE US-MEXICO BORDER

ID: 256

Author(s): Maria Elena **Giner** | Felipe Adrian **Vazquez** | Mario **Vazquez** | Tomas **Balarezo** | Ana **Cordova** |

Abstract

Since 1993 institutions such as the Border Environment Cooperation Commission (BECC), have addressed the asymmetries in basic sanitation at the US-Mexico border. The authors analyzed two groups of investments certified by BECC along the border (Valle de Juarez and Baja California). This was done using *ad-hoc* Results Measurement Methodology to determine how the $253.61 millions of US dollars invested in basic sanitation infrastructure impacted eight communities on the Mexican side of the border. The Impact Assessment process determines the impact on the area residents based on the use of the infrastructure. Results indicate that the infrastructure connected the target population to the existing sewer system thus reducing the potential of gastrointestinal diseases caused by exposure to open raw wastewater discharges.

Keyword(s): Basic sanitation; BECC; US-Mexico border; *ex post* assessment.

Introduction

More than 3000 km of border between Mexico and the United States is home to more than 11.8 million people (Parcher, 2008). The rapid expansion of urban areas has boomed since the signing of the North American Free Trade Agreement (NAFTA), increasing the creation of industrial and residential zones at a rate that surpasses the planning capacities of the border cities, especially on the Mexican side of the border (Wilder et al., 2013). This resulted in most Mexican border communities having a lack of wastewater treatment; approximately 75% of the population was not served (BECC,2007). In addition, this growth also affected the US side where, low-income, minority communities lacked municipal water and wastewater service. A 1995 Texas Water Development Board study estimates that 428 "colonias" with about 81,000 people are in need of potable water facilities and 1,1196 colonias with about 232,000 people need wastewater treatment facilities (FRBD 1996). Some concern had arisen from the additional evidence of contaminated drinking water in colonias along the border (VanDerslice 2011; Jepson 2012) including higher rates of gastro intestinal diseases and Hepatitis A.

Mexico and the US recognized that the lag in basic sanitation infrastructure would be further exacerbated with the increased economic and demographic pressure resulting from NAFTA. Consequently these untreated wastewater flows disposed of in the shared water bodies between the U.S. and Mexico posed a significant human health and environmental threat. This lead to the collaboration between federal authorities in both countries to address infrastructure gaps and create a funding program to assist communities in developing and implementing water and wastewater infrastructure. Long term benefits of proper sanitary infrastructure in border communities include public health improvements and increased opportunities for economic development. Furthermore, the elimination of wastewater overflows reduces odor and aquifer contamination (Hargrove et al., 2015) and attracts more industry and quality of life services to the region.

Since 1993, institutions like the BECC, U.S. and Mexican state agencies, United States Environmental Protection Agency, and Mexico's National Water Commission among others, have addressed the asymmetries in basic sanitation through the reduction and, in most cases, the eradication of the extended use of cesspools and non-compliant latrines in communities. Some of these areas had been identified as potential sources of contamination for shared water bodies used as potable water and its subsequent impact on the overall health of border communities (Flores-Margez et al., 2009; USEPA & SEMARNAT, 2011; BECC 2007; Lemos 2002).

The purpose of this work is to present a methodology developed by the authors to measure determine if wastewater projects meet the objective of providing health and environmental benefits to the intended population and communicate to stakeholders, partners and funding agencies the value created by the US and Mexico funding collaboration.

Scope of Work

The authors analyzed two groups of investments certified by BECC Board of Directors along the border (Valle de Juarez and Baja California) by *ad-hoc* Results Measurement Methodology to determine how the overall US$263.50M invested in basic sanitation infrastructure impacted eight communities on the Mexican side of the border. The Valle

de Juarez group includes the rural communities of Praxedis G. Guerrero, El Porvenir, Dr. Porfirio Parra, and Guadalupe as shown in Table No. 1:

Table No. 1. Summary of results from BECC/NADB intervention for selected communities in Valle de Juarez. Source: BECC 2016.

Community	Main infrastructure elements (outputs)	Wastewater treatment coverage (outcomes)	Total investment in US$millions
Praxedis G. Guerrero	WWTP 15 L/s 22.3 km collectors	100%	$4.28
El Porvenir	WWTP 15 L/s 27.5 km collectors	100%	$2.27
Guadalupe	WWTP 18 L/s 37.0 km collectors	100%	$3.40
Dr. Porfirio Parra	WWTP 12 L/s 11.4 km collectors	100%	$2.00

In Baja California the assessment included the communities of Tijuana, Tecate, Rosarito and Mexicali as shown in Table No. 2.

Table No. 2. Summary results from the intervention from BECC/NADB in selected communities of Baja California. Source: BECC/NADB 2016

Community (Population projected for 2015)	Main infrastructure elements (improvements and new)(outputs)	Wastewater treatment coverage (outcomes)	Total investment in US$ millions
Tijuana (Pop. 1,722,348)	Two-WWTP 146 km collectors	97% (improved by 33%)	$92.66
Playas de Rosarito (Pop. 105,150)	WWTP 119.6 km collectors	100%	$18.83
Tecate (Pop. 11,098)	WWTP 43 km collectors	100%	$11.50
Mexicali (Pop. 1,025,743)	WWTP 63 km collectors	91% (improved by 10%)	$128.56

The certification of these projects by the BECC Board of Directors provided access to grant funding from both U.S. and Mexico's federal authorities needed to implement these projects. The certification process included working closely with the utilities in these communities over an extended period of time to ensure sustainable development and implementation of the infrastructure, which included elements of technical and financial feasibility, environmental compliance, public input and acceptance, and closeout after one year of operation. This approach was key in ensuring the success of the project, which resulted in residents connecting to the infrastructure built.

This investigation was conducted as a request by the BECC Board of Directors to analyze the impacts of wastewater infrastructure in the selected communities and was commissioned by BECC and the NADB including financial support to conduct field work such as surveys in Baja California, and to expand field work conducted by others in Valle de Juarez (increase the number of households surveyed and the type and number of survey questions).

Impact Assessment Methodology

An approach to assess the impact of certified projects and determine the extent to which projects are successful in meeting their fundamental objectives was developed. The impact assessment complements the *closeout process* (COP) that already has been in place to monitor the implementation of certified projects and to measure the extent to which physical targets are being met. The COP is conducted after one year of operation of the certified facilities and allows measuring results along the following components of the results chain: *Outputs* are measured to determine whether the facilities were constructed as certified in terms of their physical characteristics (i.e. dimensions, capacity, technology), schedule, costs and funding structure. *Outcomes,* defined as whether the infrastructure provides access to residents as anticipated and whether the level of service or penetration is being expanded and/or improved as planned.

The Impact Assessment (this paper) represents the next logical step in the measurement of results by shedding light onto whether the constructed project is indeed achieving the project's fundamental objective (i.e. having an impact), beyond the "physical" outputs and outcomes. For example, for a project consisting of the construction of wastewater collection and treatment, the COP will determine whether the project was built as certified (i.e. capacity, technology, km of collectors, etc.), whether it was done on schedule and budget, and how much of population now has access to wastewater treatment. As a complement to the COP, but after the COP is complete, the Impact Assessment determines the degree to which the population connects to the wastewater system, treats wastewater flows, eliminates cesspools and latrines, and implements internal plumbing within the household. Thus, fulfilling its fundamental objective of "Eliminate exposure to untreated or inadequately treated wastewater."

Case Study

In the case of the previously described projects the evaluation of the results was conducted using five main indicators: (1) increase in wastewater residential connections system; (2) overall reduction in the number of latrines and cesspools; (3) reduction of untreated wastewater flowing into international water bodies; (4) reduction in associated diseases and/or exposure to raw sewage and 5) increased quality of life. The challenge was to obtain baselines to compare before and after conditions within a reasonable schedule and budget that includes attainable fieldwork. In some instances, the data to document a certain indicator did not exist or was not in a useful format or required intensive labor or fieldwork beyond the scope of this work. Nevertheless, a large body of data was available from official sources such as census data (INEGI), health data (COFEPRIS), and hookups and project service area (water and wastewater utilities).

Statistical and census data was available to the community level for all the selected communities. Consequently data for Valle de Juarez, where communities are small and the project addressed the entire community, the information was adequate. In the case of Tijuana, Mexicali, Tecate and Rosarito, the census from INEGI data needed additional disaggregation by means of Geographic Information System (GIS) tools (SPCT 2015) since some of the projects benefitted specific areas or sectors of the community. In the case of Valle de Juarez additional field data and surveys were obtained from Border 2020 projects (additional information on the program and some of the projects in USEPA 2013 and Flores-Márgez, et al., 2011). However, in the case of

the four Baja California communities the use of GIS tools allowed to create digital layers of all available data and an estimation of the impact on the areas served by the certified infrastructure (defined as project polygons of impact). In both cases fieldwork included household surveys that complemented official data and focused on the perception of impact at the residential level.

Results

All of the communities citied in this study received financial and technical support to build the basic infrastructure to reduce open discharge of untreated wastewater. The success of these projects is attributed to the close coordination the BECC had with the project sponsor during the planning and final design phase. This allowed for identification of potential obstacles early on such as land and right of away issues, operation and rate structure challenges, and facilitation of residential hookups. Consequently a more sustainable project was implemented where obstacles could be addressed early on. Additionally, the closeout report completed by BECC for these projects after one year of operation provided transparency in the use of public funds.

Valle de Juarez

The wastewater infrastructure projects (sewer lines and wastewater treatment plants) were certified in 2007 and their construction was completed between July 2009 and June 2010. An educational outreach campaign and interviews was conducted with local authorities as to the condition and operation of the new wastewater infrastructure.

The required baseline information prior to project implementation for the IA was gathered in 2008-2009 by UACJ, UTEP, COLEF and the Pan-American Health Organization (PAHO) with funding from Border 2012 and PAHO; also, a set of impact indicators were selected to be tested for the first time in this project. The final phase of the IA study was conducted after the project was implemented from 2012 to 2014 and the comprehensive report (2008-2014) was released on July 2014.

The implementation of the wastewater collection and treatment system (output) provided access to 100% of the population (outcome) within the community with wastewater service. The study completed by BECC reflects the impacts of the infrastructure implemented and include: (1)The percentage of households connected to the municipal wastewater system increased in the four studied communities to over 88%; (2) Consequently, the percentage of households with plumbing inside the house increased in the four studied communities; (3) The percentage of households with latrines and cesspools decreased in the four studied communities to almost 0%; and (4) 100% of the wastewater collected for all of the communities was not properly treated. Table No.3 summarizes the data collected as part of this study for the Valle de Juarez case study.

These rural communities have a strong association to agricultural activities. Until the wastewater treatment plants were put in place, all the raw wastewater was used for irrigation in the Valle de Juarez area and thus caused the exposure of agricultural workers to pathogens. It is suspected that field workers carried some of those pathogens to their homes. As a consequence of the elimination of open raw wastewater flowing through the community and into agricultural ditches, the wastewater collection and treatment facilities have eliminated the exposure to pathogens and infections.

Table No. 3. Summary of relevant data considered for the Valle de Juarez case study.

El Porvenir	2000 - Initial environmental conditions	2015 - Impacts (Projects by BECC/NADB)	Change
Population connected to the WW collection system	15%	97%	547%
Latrines	22%	3%	-86%
Cesspools	54%	0%	-100%
Population with WW treatment	0%	100%	100%
Flow of untreated raw WW (L/s)	10	0	–
Discharge points of raw WW adjacent to the community	1	Eliminated	–
Residents subject to exposure to raw WW during rainy season	100%	Eliminated	–

Praxedis G. Guerrero	2000 - Initial environmental conditions	2015 - Impacts (Projects by BECC/NADB)	Change
Population connected to the WW collection system	70%	95%	36%
Latrines	11%	0%	-100%
Cesspools	19%	3%	-84%
Population with WW treatment	0%	100%	100%
Flow of untreated raw WW (L/s)	8	0	–
Discharge points of raw WW adjacent to the community	2	Eliminated	–
Residents subject to exposure to raw WW during rainy season	100%	Eliminated	–

Guadalupe	2000 - Initial environmental conditions	2015 - Impacts (Projects by BECC/NADB)	Change
Population connected to the WW collection system	49%	88%	80%
Latrines	26%	8%	-69%
Cesspools	13%	13%	0%
Population with WW treatment	0%	100%	100%
Flow of untreated raw WW (L/s)	4	0	–
Discharge points of raw WW adjacent to the community	4	Eliminated	–
Homes exposed to raw WW in adjacent agriculture drain	30	0	–

Dr. Porfirio Parra	2000 - Initial environmental conditions	2015 - Impacts (Projects by BECC/NADB)	Change
Population connected to the WW collection system	78%	95%	22%
Latrines	5%	0%	-100%
Cesspools	14%	4%	-71%
Population with WW treatment	0%	100%	100%
Flow of untreated raw WW (L/s)	4	0	–
Discharge points of raw WW adjacent to the community	9	Eliminated	–
Homes exposed to raw WW in adjacent agriculture drain	80	0	–

Baja California

In the case of Baja California almost all the targeted communities did not follow any urban planning and experience rapid growth due to migration from southern Mexico in search of employment and quality of life opportunities. The technical information provided by the local utilities, as well as the information generated in the COP of the wastewater collection and treatment projects was collected, classified, georeferenced and analyzed. Surveys of public opinion for 3,409 households were designed, pilot-tested and applied in the urban areas benefited by projects in Tecate, Playas de Rosarito and Tijuana. The implementation of the wastewater collection and treatment system (output) provided access to the population (outcome) within the community with wastewater service. Some of the impacts of the infrastructure implemented and include: (1) Sanitation conditions in the cities of Tijuana, Rosarito, Tecate, and Mexicali, measured as coverage of services for the collection and treatment of wastewater, significantly improved between the years 2000 and 2015; (2) infrastructure projects implemented by the BECC and North American Development Bank were an important catalyst for this achievement (3) The percentage of households with latrines and cesspools decreased significantly in the four studied communities; (4) The decrease in the incidence of gastrointestinal diseases was significant in three of four communities studied ranging from 16% to 33%; (5) Opinion surveys showed a high degree of satisfaction with the operation of the utility (87%+) as well as a perception of well-being

associated with the implemented project (90%). Table No.4, 5, 6 and 7 summarize the specific data collected for the four communities selected in Baja California.

Table No. 4. Summary of data for polygons of intervention and citywide in Tijuana

Tijuana WW System	Initial conditions	Impacts	Change
City-wide (Projects by BECC/NADB & Others)	Yr. 2000	Yr. 2015	%
Population (inhabitants, - INEGI)	1,210,520	1,722,348	42%
Population connected to the WW collection system	77%	91%	18%
Existing wastewater domestic hookups	266,762	488,250	83%
Wastewater treatment coverage	73%	97%	33%
Gastrointestinal diseases rate (/100000)	444	320	-28%
Flow of untreated raw wastewater (L/s)	627	0	—
Project Polygons (Projects by BECC/NADB)	Yr. 2000	Yr. 2015	%
Residents within the project polygons	19,450	46,581	139%
Population connected to the WW collection system	0%	90%	90%
Latrines	89%	10%	-89%
Cesspools	11%	1%	-90%
Population with wastewater treatment	0%	100%	100%
Flow of untreated raw wastewater (L/s)	95	0	—
Discharge points of raw wastewater to the community	Multiple	Eliminated	—
Risk of residents exposure to raw WW in rainy season	100%	Eliminated	—
Satisfaction with utility service	No base-line info	91%	—
Project related well-being perception		95%	—

Table No. 5. Summary of data for polygons of intervention and citywide in Playas de Rosarito

Playas de Rosarito WW System	Initial conditions	Impacts	Change
City-wide (Projects by BECC/NADB & Others)	Yr. 2000	Yr. 2015	%
Population (inhabitants, - INEGI)	63,420	105,150	66%
Population connected to the WW collection system	45%	65%	44%
Existing wastewater domestic hookups	8,493	32,191	279%
Wastewater treatment coverage (in compliance)	36%	100%	178%
Gastrointestinal diseases rate (/100000)	392	329	-16%
Flow of untreated raw wastewater (L/s)	36	0	—
Project Polygons (Projects by BECC/NADB)	Yr. 2000	Yr. 2015	%
Residents within the project polygons	7,255	20,042	176%
Population connected to the WW collection system	0%	79%	79%
Latrines	89%	18%	-79%
Cesspools	11%	3%	-74%
Population with wastewater treatment	0%	100%	100%
Flow of untreated raw wastewater (L/s)	41	0	—
Discharge points of raw WW to the Pacific Ocean	Multiple	Eliminated	—
Risk of residents exposure to raw WW in rainy season	100%	Eliminated	—
Satisfaction with utility service	No base-line info	89%	—
Project related well-being perception		91%	—

Table No. 6. Summary of data for polygons of intervention and citywide in Tecate

Tecate WW System	Initial conditions	Impacts	Change
City-wide (Projects by BECC/NADB & Others)	Yr. 2000	Yr. 2015	%
Population (inhabitants, - INEGI)	77,795	111,098	43%
Population connected to the WW collection system	84%	96%	14%
Existing wastewater domestic hookups	16,454	27,710	68%
Wastewater treatment coverage (in compliance)	0%	100%	100%
Gastrointestinal diseases rate (/100000)	526	632	20%
Flow of untreated raw wastewater (L/s)	200	0	—
Project Polygons (Projects by BECC/NADB)	Yr. 2000	Yr. 2015	%
Residents within the project polygons	9,580	14,995	57%
Population connected to the WW collection system	0%	94%	94.0%
Latrines	68%	6%	-91%
Cesspools	32%	0%	-100%
Population with wastewater treatment	0%	100%	100%
Flow of untreated raw wastewater (L/s)	31	0	—
Discharge points of raw wastewater to the Río Tecate	Multiple	Eliminated	—
Risk of residents exposure to raw WW in rainy season	100%	Eliminated	—
Satisfaction with utility service	No base-line info	92%	—
Project related well-being perception		94%	—

Table No. 7. Summary of data for polygons of intervention and citywide in Mexicali

Mexicali WW System	Initial conditions	Impacts	Change
City-wide (Projects by BECC/NADB & Others)	Yr. 2000	Yr. 2015	%
Population (inhabitants, - INEGI)	764,602	1,025,743	34%
Population connected to the WW collection system	83%	95%	14%
Existing wastewater domestic hookups	162,682	488,250	200%
Wastewater treatment coverage	91%	100%	10%
Gastrointestinal diseases rate (/100000)	289	193	-33%
Flow of untreated raw wastewater (L/s)	115	0	—
Project Polygons (Projects by BECC/NADB)	Yr. 2000	Yr. 2015	%
Residents within the project polygons	34,454	50,560	47%
Population connected to the WW collection system	0%	98%	98.3%
Latrines	29%	1%	-96%
Cesspools	71%	0%	-99%
Population with wastewater treatment	0%	100%	100%
Flow of untreated raw wastewater (L/s)	103	0	—
Discharge points of raw wastewater to the Río Nuevo	Multiple	Eliminated	—
Risk of residents exposure to raw WW in rainy season	100%	Eliminated	—
Satisfaction with utility service	No base-line info	87%	—
Project related well-being perception		90%	—

Conclusions

Results indicate that the BECC mandate of improving human health and the environment had been fulfilled and that communities had been serviced as expected by the promoters. Additionally, projects met the fundamental environmental objective of providing access to service, and demonstrate that residents utilized infrastructure and benefitted from improved quality of life and in the overall sanitation of the community. The surveys in all cases show a perception of improvement after the interventions (survey data is available from the authors).

The Results Measurement Framework proved to be a useful tool in determining the actual impact of sanitary infrastructure in support of the objective effect of financial investment beyond the merely cost per capita analysis, which not always reflects the hidden costs of health and quality of life. Particularly, when more than one financial

institution is involved the results of the impact assessment offer additional transparency to stakeholders. In most cases funds from USEPA, CONAGUA, NADB and the respective states were combined in different proportions to finance the infrastructure.
The proper planning with local and federal authorities combined with the use of funds for technical assistance (mostly from BECC) appear to be the formula to incentivize the flow of funds to assist socio-economically challenged communities. Bi-national cooperation among US and Mexican agencies were successful in producing the financial and technical resources needed by small and sometimes marginalized communities to acquire levels of sanitation above the national average.

References

Aspen Institute, T., 2000. El Medio Ambiente y la Economía en la Frontera entre México y Estados Unidos: Llamamiento a la Acción, Queenstown, MD, USA. Available at: http://www.aspeninstitute.org/sites/default/files/content/docs/ee/mexrep-sp.pdf.

FRBD, 1996. Texas Colonias: A thumbnail sketch of the conditions, issues,chalanges and opportunities, Dallas, Texas. Available at: http://gato-docs.its.txstate.edu/jcr:f5da7029-3156-44ab-8633-40749d4a6ae2/Texas Colonias.pdf.

(BECC), Border Environmental Cooperation Commission, 2007. US Appropriations to US-Mexico Border Program, Ciudad Juarez, Mexico. Available at: http://www.becc.org/uploads/files/white_paper_analysis_of_us-mex_border_program.pdf.

COCEF/BDAN, 2016, “Evaluación del Impacto de los proyectos de infraestructura de saneamiento de la COCEF y el BDAN en comunidades del estado de Baja California”, Comisión de Cooperación Ecológica Fronteriza, Ciudad Juárez, México, 50 pp. Available at: http://www.cocef.org/desarrollo-de-capacidades/publicaciones-e-informes/

(BECC) Border Environmental Cooperation Commission, 2016. *Evaluación del Impacto de la infraestructura de saneamiento básico en Comunidades del Valle de Juárez, Chih. 2013-2014*. Available at: http://www.cocef.org/desarrollo-de-capacidades/publicaciones-e-informes/p2

Flores-Margez, J.P. et al., 2009. *Microbial Pathogens in Tap Water at Rural Communities of North México. In Urban water management, issues and opportunities*. Chicago, IL: University Council on Water Resources, pp. 5–12. Available at: www.ucowr.siu.edu.

Flores-Márgez, P., Ramírez-López, A. & Hurtado-Jimenéz, R., 2011. Un Valle Olvidado en México : *Acciones Educativas y Diagnostico Epidemiológico*, Saarbrucken, Germany: Académica Española. LAP Lambert Academic Publishing.

Hargrove, W.L., Juárez-Carillo, P.M. & Korc, M., 2015. Healthy vinton: A health impact assessment focused on water and sanitation in a small rural town on the U.S.-Mexico border. International Journal of Environmental Research and Public Health, 12(4), pp.3864–3888.

Jepson, W., 2012. Claiming Space, Claiming Water: Contested Legal Geographies of Water in South Texas. Annals of the Association of American Geographers, 102(3), pp.614–631. Available at: http://www.tandfonline.com/doi/abs/10.1080/00045608.2011.641897.

Lemos, M.C. et al., 2002. Public – Private Partnerships as Catalysts for Community-Based Water Infrastructure Development: The Border WaterWorks Program in Texas and New Mexico Colonias. Environment and Planning C: Government and Policy, 20(2), pp.281–295. Available at: http://journals.sagepub.com/doi/10.1068/c12w.

Parcher, J.W., 2008, *U.S.-Mexico Border Geographic Information System: U.S. Geological Survey Fact Sheet 2008–3069*, 4 p. Available at: https://pubs.usgs.gov/fs/2008/3069/.

SPCT (2015): Evaluación de impacto de las obras principales de saneamiento en las ciudades de tijuana, rosarito, tecate y mexicali, baja california. Estudio realizado para COCEF/BDAN, Ciudad Juárez, Chih. Coordinated by Luis Cervera and Alfonso Cortez. Available upon request to T. Balarezo at tbalarezo@cocef.org.

USEPA & SEMARNAT, 2011. Border 2012: U.S. - Mexico Environmental Program, State of the Border Region Indicators Report 2010,

USEPA 2013. Border 2012: Accomplishment Report (2010-2012). Available at: https://www.epa.gov/sites/production/files/documents/b2012closeout_eng.pdf.

VanDerslice, J., 2011. Drinking Water Infrastructure and Environmental Disparities: Evidence and Methodological Considerations. American Journal of Public Health, 101(S1), pp.S109–S114. Available at: http://ajph.aphapublications.org/doi/10.2105/AJPH.2011.300189.

Wilder, M. et al., 2013. Climate Change and U . S . -Mexico Border Communities. In G. Garfin et al., eds. *Assessment of Climate Change in the Southwest United States: A Report Prepared for the National Climate Assessment*. Washington DC: Island Press, pp. 340–384