The Environmental, Economic and Health Status of Water Resources in the U.S.-Mexico Border Region

Fifteenth Report of the Good Neighbor Environmental Board to the President and Congress of the United States

December 2012

GNEB
Environmental Advisors Across Borders

About the Board

The Good Neighbor Environmental Board was created in 1992 by the Enterprise for the Americas Initiative Act, Public Law 102-532. The purpose of the Board is to "advise the President and the Congress on the need for implementation of environmental and infrastructure projects (including projects that affect agriculture, rural development, and human nutrition) within the states of the United States contiguous to Mexico in order to improve the quality of life of persons residing on the United States side of the border."

The Board is charged with submitting an annual report to the President and the Congress. Management responsibilities for the Board were delegated to the Administrator of the U.S. Environmental Protection Agency by Executive Order 12916 on May 13, 1994.

The Board does not carry out border-region activities of its own, nor does it have a budget to fund border projects. Rather, its unique role is to serve as a nonpartisan advisor to the President and the Congress and recommend how the federal government can most effectively work with its many partners to improve conditions along the U.S.-Mexico border.

The Board operates under the provisions of the Federal Advisory Committee Act and membership on the Board is extremely diverse. By statute, the Board is composed of:

(1) "representatives from the United States Government, including a representative from the Department of Agriculture and representatives from other appropriate agencies;
(2) representatives from the governments of the States of Arizona, California, New Mexico, and Texas; and
(3) representatives from private organizations, including community development, academic, health, environmental, and other nongovernmental entities with experience on environmental and infrastructure problems along the southwest border."

The Board also includes representatives from tribal governments with lands in the border region.

The recommendations in this report do not necessarily reflect the official positions of the federal departments and agencies that are represented on the Board, nor does the mention of trade names, commercial products, or private companies constitute endorsement.

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Transmittal Letter to the President from the Chair of the Good Neighbor Environmental Board

President Barack Obama
Vice President Joseph Biden
Speaker John Boehner

On behalf of the Good Neighbor Environmental Board, your independent advisory committee on environment and infrastructure along the U.S. border with Mexico, I am submitting to you our 15th report, *The Environmental, Economic and Health Status of Water Resources in the U.S.-Mexico Border Region*.

Although the border region is facing a number of issues that require attention, and the Board has addressed water in previous reports, Board members determined it was imperative to focus again on this important topic given current climatic conditions, particularly the extensive drought within the region, and to offer insights and recommendations in the context of these current challenges. Compared to the United States as a whole, the population of the border region is younger, has lower levels of educational attainment, and has lower economic status than populations elsewhere. Of particular concern for this report and the United States is that, despite significant investments, rapid population growth, increasing water demand and the declining quality of water resources contribute to significant water and water infrastructure needs.

Water and wastewater infrastructure improvements can create or enhance economic opportunities in the region, but not all communities are able to afford such investments or receive the benefits they offer. In the U.S. border region, small rural communities, on and off tribal lands, tend to face the greatest needs. Many of these communities lack basic water and wastewater infrastructure services, or they require upgrades and replacement as well as the personnel and resources to manage the infrastructure they do have. Residents of communities with inadequate distribution and treatment systems may face chronic health problems and disease, many of which disproportionately affect young children, adolescents and the elderly.

The Good Neighbor Environmental Board recognizes that water issues in the U.S.-Mexico border region are complex and often contentious. Two major river systems, several smaller river systems, and more than 20 ground water basins span the border. Surface water resources were developed and institutional arrangements established to manage those resources before ground water resources were developed and governed, so there are few policies and institutions in place to govern ground water resources. The combined effects of inadequate infrastructure, lack of financial resources and gaps in authority, along with the need to share water supply during times of drought, present substantial challenges and require comprehensive solutions.

The Board, in the development of this report, and following a tradition that has been maintained since its inception, has been driven by its desire to work through consensus in constructing all of its recommendations. We hope that this report is useful to you and other U.S. government officials as we continue to think about how we can best achieve a healthier environment and a better quality of life for all of our citizens. We appreciate the opportunity to serve you and provide these recommendations and we respectfully request a response.

Very truly yours,

Diane E Austin

Diane Austin, Chair
Good Neighbor Environmental Board


WATE

CHAPTER 1

Context

The United States of America and Mexico share a 1,952 mile border, extending 100 km (62 miles) on each side of the political boundary, with a population of almost 14 million residents. It is a region that has a unique binational character and interdependence. Within this region, water resources increasingly are at risk, threatening the continued viability of human settlements and economic vitality. With regard to natural resources, economics, sociocultural and political concerns, energy, and physical infrastructure such as roads and housing, the decisions reached on one side of the international border have a clear, demonstrable impact on the other.

Understanding the context within which those decisions are made is key to addressing the issues that arise. Although the region includes bustling centers of commerce and stunning natural features, it also is marked in many places by severe poverty and degraded environmental conditions. In 1999, recognizing the importance of the border region to the entire country—and also the challenges it faces—former President Bill Clinton issued Executive Order 13122 establishing the Interagency Task Force on the Economic Development of the Southwest Border: "The purpose of the Task Force is to coordinate and better leverage existing Administration efforts for the Southwest Border, in concert with locally led efforts, in order to increase the living standards and the overall economic profile of the Southwest Border so that it may achieve the average of the nation."

A Border Environment Cooperation Commission (BECC) report describes the region as a "dynamic network of cultural, social, environmental and economic relationships between residents of both countries." Analyses conducted by the BECC[1] highlight the following U.S. Census Bureau statistics for 36 counties in the four border states (California: 1; Arizona: 4; New Mexico: 4; Texas: 27), not counting San Diego County, which is a strong outlier related to economic conditions:

- Twenty-three percent of persons are living below the poverty level (national average: 13.8%); 35 counties are below the national average.
- The average per capita income is $17,433 (national average: $27,334); 35 counties are below the national average.
- The average, median household income is $36,480 (national average: $51,914); all counties are below the national average.
- Individuals under the age of 18 or over the age of 65 average 41 percent of the population (national average: 37%); 33 counties are above the national average.
- Individuals of Hispanic or Latino origin average 68 percent of the population (national average: 16.7%); all counties are above the national average.
- Individuals over 25 years old who graduated high school average 70 percent of the population (national average: 80.7%); 32 counties are below the national average.
- The median value of owner-occupied housing units is $132,902 (national average: $188,400); 34 counties are below the national average.

The U.S.-Mexico Border Counties Coalition's 2006 report, *At the Crossroads: U.S./Mexico Border Counties in Transition*,[2] compared the U.S. border counties to the 50 states as if these counties were the 51st state of the United States, and found the following:

- Per capita income for the region (excluding San Diego, California) would rank 51st; however, personal income grew 41.4 percent compared to 29.3 percent for the nation.
- The region is second in incidence of tuberculosis and third in deaths due to hepatitis, which may be explained by exposure to unsanitary conditions existing on both sides of the border.
- As a 51st state, southwest border counties would rank last in access to health care professionals.
- Hospitals in border counties spend more than $800 million annually to provide emergency health care to uninsured populations. This is approximately 3 percent of all uncompensated costs in U.S. hospitals per year.

These general statistics clearly indicate a historically underserved region. An increase in population and demand for public services, as well as variability in natural resources, rapid urbanization and increasing costs associated with addressing these issues have compounded the need to deal with them in a systematic and mutually beneficial way. Despite the ongoing challenges, as will be documented in this report, the region abounds with examples of cooperation at the local, state, tribal and federal levels.

Although the border region is facing a number of issues that require attention, this 15th report of the Good Neighbor Environmental Board (GNEB or Board) focuses on water. The Board's 4th, 8th and 13th reports also addressed water, but Board members determined it was imperative to focus again on this important topic given current climatic conditions, particularly the extensive drought within the region, and to offer insights and recommendations in the context of these current challenges.

The Board's mission is "to advise the President and the Congress on the need for implementation of the environmental and infrastructure projects (including projects that affect agriculture, rural development and human nutrition) within the states of the United States contiguous to Mexico." It is hoped that the information contained in this report is relevant to individuals in all sectors who are concerned with water issues along the U.S.-Mexico border, and that it contributes to policy deliberations at local and state levels as well.

This report is focused on three broad areas: water supply, water quality and water treatment. Although the three are interrelated, each area is addressed in a separate chapter that highlights pressing issues and offers policy recommendations. In addition, specific examples are presented in case studies to highlight the complex realities associated with each area.

Overview of Key Concerns

As noted above, in comparison with other regions of the United States, and even the border states as a whole, the population of this region is younger, has lower levels of educational attainment, and has lower economic status than populations elsewhere. Of particular concern for this report and the United States is that the population has significant water and water infrastructure needs.

In the U.S. border region, small, rural communities, on and off tribal lands, tend to face the greatest needs. Although 90 percent of the region's population resides in urban centers, the remaining 10 percent represents more than 1.3 million people who are a vital part of the region and play a key role in agriculture, energy development and natural resources management. Many communities lacking some or all of the basic infrastructure services, such as clean water, wastewater treatment, solid waste collection, paved roads, drainage control and electricity, have been dubbed "colonias."[3]

Colonias emerge due to many factors, including urban renewal in border cities that can force residents outside the city limits to less expensive land parcels that lack infrastructure services. In the late 1980s, it came to light that hundreds of thousands of Texas residents in the border region lived in such unincorporated communities. Texas lawmakers enacted legislation to provide water and sewer service to colonia residents and to stop the proliferation of colonias, but the conditions persist.

More than 130 settlements in New Mexico, some of which are incorporated communities, have been officially designated as colonias. In Arizona, in addition to the term colonias, "wildcat subdivision" is used to describe similar informal communities that lack adequate infrastructure as a result of spontaneous development.

The contribution of hundreds of millions of local, state and federal dollars to colonias has led to significant improvements in the lives of thousands of colonia residents. A 2010 report by the Texas Secretary of State found that the number of colonias having access to potable water, paved access roads and operational wastewater disposal systems rose from 636 in 2006 to 891 in 2010 (serving a total population of more than 194,000 people).[3]

That same report by the Texas Secretary of State, however, found that 45,000 residents living in 350 colonias in the six largest border counties still lacked some basic services.[3] GNEB Board members have toured colonias in San Diego County, California, and Maverick and El Paso counties, Texas, in 2005, 2008 and 2012, respectively, and met with residents in New Mexico in 2011 to observe conditions and hear directly from colonia residents.

The Board recognizes that water issues in the U.S.-Mexico border region are complex and often contentious. For example, naturally occurring elements such as arsenic contaminate water supplies even where humans have not. In 2004, the BECC developed an *Economic*

Impact of Water and Wastewater Infrastructure Funding to Selected Border Communities[4] to determine the extent to which water and wastewater infrastructure improvements create or enhance economic opportunities in the community. In terms of infrastructure and well-being, the study projected that for the five communities studied, $1 million invested in water and wastewater infrastructure over 10 years resulted in the following overall community economic activity, including direct, indirect and induced impacts:

- $11.1 million in private sector investment;
- 221 new jobs created;
- $1.7 million in tax revenue; and
- $52.2 million in goods produced by the private sector.

A 2002 article by the U.S. Department of Agriculture (USDA)[5] reached similar conclusions; however, not all communities are able to afford such investments or are positioned to receive such benefits. Especially for isolated rural communities, the cost per person of providing centralized water and wastewater services can be prohibitive (see Case Study: Columbus, New Mexico – Puerto Palomas, Chihuahua). The combined effects of inadequate infrastructure, lack of financial resources and gaps in authority present substantial challenges and require comprehensive solutions. Other challenges include multiple water demands from residents, agricultural interests, industrial and commercial entities, as well as environmental conditions such as drought. In its prior reports on water, the Board has called for watershed-based analysis and management (4th report); the development of a more robust binational water database to provide a baseline for an integrated, 5-year, cross-border water planning process (8th report); and strengthening government institutions, research efforts and treaty instruments to establish firmer protections of transboundary aquifers based on binational participation (13th report). This 15th report draws on what was presented in those previous reports and is intended to clearly illustrate improvements, as well as where issues such as rapid population growth, increasing water demand and the declining quality of water resources continue to create challenges.

Case Study: **Columbus, New Mexico – Puerto Palomas, Chihuahua**

The neighboring communities of Columbus, New Mexico and Puerto Palomas, Chihuahua are 3 miles apart and share an aquifer that spans the international boundary. The aquifer, the Bolsón de los Muertos, is located in a hydrologic zone recharged by the Río Mimbres from the north and the Río Casas Grandes from the south. Potable water is supplied by deep wells (800 ft/264 m and more). Because there are no U.S.-Mexico agreements governing ground water, withdrawal from the aquifer is unregulated; the lowering of water tables due to insufficient recharge intensifies the concentrations of fluoride and arsenic in the aquifer.

Local topographic relief creates north-to-south flooding conditions from sheet runoff during storm events, overwhelming drainage systems on both sides of the international boundary. Residents believe that this has been intensified by building activities associated with the border security fence next to the port of entry; however, flooding occurred prior to construction of the U.S. border security infrastructure. To assure an equitable balance between national security and environmental impact, U.S. officials accounted for historical flooding challenges prior to and during border fence construction and addressed and quickly resolved flooding in the affected areas. Intense flooding in Puerto Palomas has led to the construction of a concrete masonry unit wall abutting the international boundary line in the Northwest sector of the town.

Both towns have faced challenging conditions for the disposal of wastewater and have limited revenues with which to provide physical infrastructure. Pollutants carried by floodwaters penetrate domestic well casings and, on occasion, have broken water mains, causing septic systems to overflow. Thus, there are public health risks associated with direct exposure to sewage and contamination of water sources, as well as the presence of naturally occurring minerals.

Both towns have attempted to respond to high levels of fluoride and arsenic by using reverse osmosis membrane technology—in the case of Puerto Palomas, providing water and central distribution sites where residents can fill containers, and more recently in Columbus, through the provision of centrally treated water in the village distribution system. With the aid of the U.S. Environmental Protection Agency (EPA) Project Development Assistance Program (PDAP) funds administered by the Border Environment Cooperation Commission (BECC), both towns have responded to wastewater issues through the rehabilitation and expansion of centralized collection and treatment systems for water and wastewater. Puerto Palomas also was certified by BECC and received an EPA Border Environment Infrastructure Fund (BEIF) grant administered by the North American Development Bank (NADB) for its wastewater system. Columbus received grants and loans from the U.S. Department of Agriculture's (USDA) Rural Development programs for both its water and wastewater systems.

Although the investments resulted in critical improvements to the water and wastewater systems of the two communities, the abiding issue is one of cost—the cost of repaying the portion of the loans for which the towns are responsible and the cost of ongoing maintenance. The improvements to the wastewater treatment system in Puerto Palomas were in excess of $5,180,000—a cost borne by EPA, the State of Chihuahua, the Municipio of Ascensión and the village of Puerto Palomas. At the time of certification by the BECC in 2000, the population of Puerto Palomas was estimated at around 9,000. Local residents calculate that this had diminished by about 50 percent in 2010, due to changing security conditions, and this included the loss of several local businesses and thus reduced the tax base below its already low level. In 2010, the cost for water and wastewater improvements in Columbus was more than $2,760,000, for a population of 1,430.[6] Although the water rates were increased to help pay the burden, the low average per household income of residents translates into a substantial burden (average per household income is $16,639 compared with a state average of $42,742; 53% of the local residents are beneath the poverty level compared to 18.1% of state residents).[7] Columbus officially is designated a colonia by U.S. state and federal authorities.

Residents in both communities have faced hardship in paying rates for water and sewer service, and there are dim prospects for economic improvement in the foreseeable future.

Water Supply (see Chapter 2)

With regard to water supply in the border region and throughout the U.S. West, surface water resources were developed and institutional arrangements established to manage those resources before ground water resources were developed and governed. Despite those arrangements, there still often are disagreements over how to share the surface water supply during times of drought, and there is a lack of attention in the arrangements to the environmental needs of rivers and bays. There are even fewer policies and institutions in place to govern ground water resources.[8] Key ground water concerns include depletion rates that exceed recharge rates; inadequate regulations that do not consider the multiple jurisdictions responsible for managing the resource; and public policies that lack long-term goals and often overlap.

Water Quality (see Chapter 3)

Water quality is important for all life and for the provision of environmental services. Water quality affects the health of wildlife habitats and biological diversity. In addition, it plays an important role in major sectors, such as tourism, manufacturing and agriculture, which are central to border economies. Drinking water quality is a primary determinant of public health and sanitation. Residents of communities with inadequate distribution and treatment systems may face chronic health problems and disease, many of which disproportionately affect young children, adolescents and the elderly.[9,10]

Both surface water and ground water contribute to water quality in the border region. Declining surface and ground water quality often stems from the inadequate or improper management of human, agricultural and industrial waste. Decreasing water availability due to competition among users and reduced precipitation also affects water quality. Among the critical factors affecting the border region's water quality are increasing salinity; runoff of pesticides, fertilizers and herbicides; industrial discharges; untreated residential effluent; and perhaps most importantly, inadequately treated wastewater that is discharged into stream and river systems, eventually entering ground water systems. This situation is complicated by cross-border flows of surface water and the lack of joint management of the more than 20 ground water basins that span the border and that are fed from upstream flow.

Water Treatment (see Chapter 4)

Water treatment, defined for this report as the treatment of drinking water and wastewater to meet applicable standards, is costly, and many communities struggle to construct and maintain water and wastewater treatment systems. Border communities require first-time services, infrastructure upgrades and replacement, and the personnel and resources to manage the infrastructure they have. Programs that can help ensure the continued operation of the existing infrastructure include enhanced operator training, enhanced pretreatment programs, asset management and programs to increase the financial, managerial and technical capacities of border utilities.

Water Governance

Managing the supply, quality and use of scarce border water resources is a complex challenge. Not only are rivers and aquifers shared between two countries, but the two major river systems, the Colorado and Rio Grande, originate outside of the border region. In places such as southern California, water originates in mountains far from the border and is transported hundreds of miles.

In Mexico, surface water and ground water are managed at the national level. In the United States, individual states have responsibilities for surface water management and jurisdiction over ground water management (and each state has different regulatory regimes). States administer water rights, set water quality standards (subject to U.S. Environmental Protection Agency [EPA] review), can develop large-scale water projects, and oversee water quality and quantity issues.

Binational Understandings and Treaties/ Agreements with Mexico

The water supply system in the four border states is comprised of two major river systems and includes 20 transboundary aquifers. Various commissions, agencies, districts and other entities have been established to help determine how scarce border water resources can be utilized optimally and their quality safeguarded. Some, such as the International Boundary and Water Commission (IBWC) whose precursor was created in 1889, are more than a century old while others, such as EPA (founded in 1970) and its counterpart the federal Mexican environment agency (founded in 1972; now the Secretaría de Medio Ambiente y Recursos Naturales [SEMARNAT]), are more recent. Overall, the institutional framework within the United States is more decentralized than that in Mexico.

The water supply system in the four border states is comprised of two major river systems and includes 20 transboundary aquifers.

The first treaty between the United States and Mexico regarding water resources was the Convention of 1906, which governed the international reach of the river between El Paso, Texas-Ciudad Juárez, Chihuahua and Fort Quitman, Texas. The treaty provided for the United States to deliver to Mexico 60,000 acre-feet per year of Rio Grande water for agricultural use. The allocation is reduced in the event of extraordinary drought. Less than 30 years later, the Convention of 1933 governed the joint construction, operation and maintenance (O&M) of the Rio Grande Rectification


Morelos Dam Downstream View

Project, which straightened, stabilized and shortened the river boundary in this area.

The Water Treaty of 1944 allocated the waters of the Colorado and Rio Grande Rivers between the two countries; provided for the construction of reclamation works on the main channel of the international reach of the Rio Grande; allowed the newly created IBWC to give preferential attention to the solution of border sanitation problems; and provided the IBWC with authority to apply and interpret the terms of the Treaty with the consent of the two governments. The IBWC's mission includes the O&M of Falcon and Amistad Dams on the Rio Grande; flood-control projects on the Rio Grande, Colorado and Tijuana Rivers; determination of the national ownership of the waters of the boundary rivers; water quality monitoring and salinity control; operation of international wastewater treatment plants; and mission-relevant studies and planning efforts.

The 1944 Water Treaty was created at a time when the annual supply of water from the Colorado River was estimated at 17.4 to more than 20 million acre-feet. The recent long-term drought in the Colorado River Basin has led the Lower Basin states in the United States (Lower Basin states are Arizona, Nevada and California; Upper Basin states are Wyoming, Utah, Colorado and New Mexico) to discuss voluntary reductions in the allocations they receive. In 2007, the Secretary of the Interior adopted guidelines to reduce allocations if Lake Mead reaches critically low elevations. The 1944 Water Treaty allows Mexico (on the Rio Grande) or the United States (on the Colorado River) to reduce its deliveries to the other country due to "extraordinary drought," a term not defined in the treaty, which continues to create complications. This may have profound implications for the future of irrigation and residential consumption of water if the current projections of continued drought and reduced stream flow in the region are realized.[11-13]

Binational agreements also establish mechanisms for addressing water quality. Signed in 1983 by the United States and Mexico, the Agreement for the Protection and Improvement of the Environment in the Border Area (La Paz Agreement) provides the foundation for cooperative environmental efforts. There have been several implementation programs of the La Paz Agreement, including the Integrated Border Environmental Plan for the U.S.-Mexican Border (known as the IBEP, 1992-1994) and the Border XXI program between 1996 and 2000 (a collaborative effort of EPA, USDA, U.S. Department of the Interior, U.S. Health and Human Services, Mexico's Secretariat of Environment, Natural Resources and Fisheries [SEMARNAP] and Secretariat of Health, and the U.S. and Mexican Sections of the IBWC).[14] From 2003 through August 8, 2012, the program operated as Border 2012.[15] Water quality was a main focus of the Border 2012 program and was addressed through the Water Policy Forum, Border 2012 Goal 1 (Reduce Water Contamination), and border infrastructure projects.[16] Border 2020 (the successor to Border 2012) will build on the prior programs with one of five central goals being to improve water quality and water infrastructure sustainability, and reduce exposure to contaminated water.[17]

U.S. Water Agreements Concerning Border Water Resources

The compacts, federal laws, court decisions and decrees, contracts and regulatory guidelines that establish how the Colorado River is used and managed are known collectively as the *Law of the River*. Within the United States, the Rio Grande and Colorado Rivers are governed by compacts that ensure deliveries of waters from those rivers to participating states within the United States. Compacts are overseen by Commissions with representatives of each state, chaired by a federal Commissioner.

The Colorado River Compact of 1922 defined the relationship between the Upper Basin states, where most of the river's water supply originates, and the Lower Basin states, and allocated 7.5 million acre-feet to each basin. The Boulder Canyon Project Act apportioned the Lower Basin's allocation among the States of Arizona, California and Nevada. The 1948 Upper Colorado River Basin Compact created the Upper Colorado River Commission and apportioned the Upper Basin's allocation among Colorado, New Mexico, Utah, Wyoming and the portion of Arizona that lies within the Upper Colorado Basin.

The Rio Grande Compact[18] was signed in 1938 and apportioned the waters of the Rio Grande above Fort Quitman, Texas, among Colorado, New Mexico and Texas. The Rio Grande Compact Commission establishes water delivery obligations and depletion entitlements for Colorado and New Mexico. Given the seasonal fluctuations in climate, compact accounting is conducted annually and provides for debits and credits to be carried over from year to year until extinguished under provisions of the Compact. Accrued credits or debits are an important element of the compact accounting and negotiations do not always lead to agreement.

Two additional commissions govern water allocations between Texas and New Mexico. The New Mexico-Texas Water Commission, formed as part of a 1991 settlement following a protracted dispute over water supplies in the El Paso/Las Cruces area, includes local governments, water utilities, irrigation districts and universities in El Paso County, Texas and southern New Mexico. The Commission last met in March 2006.[19] The Pecos River Compact Commission oversees the Pecos River Compact, which was established to provide for the equitable distribution of the waters of the Pecos River, a Rio Grande tributary, between New Mexico and Texas.

Additional laws and policies governing water supply include the Colorado River Basin Salinity Control Act of 1974, which addresses water quality by authorizing salinity control projects, including the Yuma Desalting Plant.

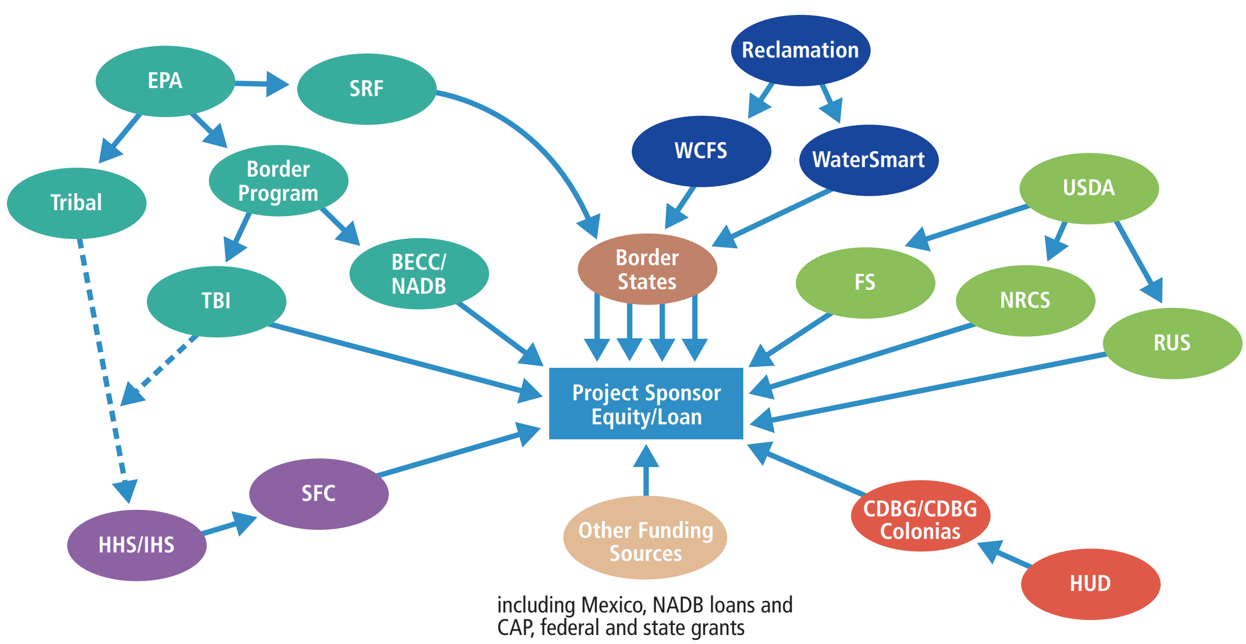
Financial Resources

Maintaining both water supply and quality requires significant financial investment. Any efforts to improve living conditions and meet the increased demand on public services are enhanced by public financial investment. Resources for managing water supply, as well as watershed protection and conservation programs, are discussed in greater detail in Chapter 2. During the last several years, the ability for the public sector to finance infrastructure projects and make the necessary investments has been affected by the U.S. recession. In the past, small communities typically sought grant assistance to make their capital investments; however, lower revenues to municipal and state governments have increased the challenges of funding public infrastructure projects.

Financing in the border region will continue to be addressed in a way that recognizes the differences in how Mexico and the United States approach the issues. In Mexico, local financing options primarily are limited to federal apportionments; however, the opportunity for market financing has potential through numerous private-sector financial institutions. In the United States, myriad financing options are available to municipal and state governments, whether it is grant or debt financing (public or private).

Border communities and states are eligible for the resources available to any U.S. entities, such as the State Revolving Funds (SRFs), and a number of special programs, as shown in **Figure 1**, provide resources to them, including grants to assist communities that cannot afford loans. At the community level, the options available depend on whether or not the community is incorporated, and whether or not it is located on tribal land. Although U.S. tribes are eligible for Border Environment Infrastructure Fund (BEIF) financing, for example, the BEIF also works in partnership with the tribes to provide resources through the Tribal Border Infrastructure program.

Figure 1. Programs That Provide Resources to Border Communities



BECC/NADB – Border Environment Cooperation Commission/North American Development Bank
CAP – Community Assistance Program
CDBG – Community Development Block Grant
EPA – U.S. Environmental Protection Agency
FS – Forest Service
HHS/IHS – Department of Health and Human Services/Indian Health Service
HUD – Department of Housing and Urban Development
NRCS – Natural Resources Conservation Service
RUS – Rural Utilities Service
SMART – Sustain and Mange America's Resources for Tomorrow
SRF – State Revolving Fund
TBI – Tribal Border Infrastructure
USDA – U.S. Department of Agriculture
WCFS – Water Conservation Field Services and Water

The North American Development Bank (NADB)

The North American Development Bank (NADB) and its sister institution, the BECC, were created under the auspices of the North American Free Trade Agreement (NAFTA) to address environmental infrastructure issues in the U.S.-Mexico border region. NADB was created with an initial investment of $450 million, divided in equal parts between the U.S. and Mexican governments, and receives additional funding through the BEIF, as described above. It is authorized to serve communities in the U.S.-Mexico border region, from the Gulf of Mexico to the Pacific Ocean (100 km and 300 km from the U.S. and Mexico borders, respectively). Under its charter, NADB is authorized to finance projects that will prevent, control or reduce environmental pollutants or contaminants; improve the drinking water supply, or protect flora and fauna, so as to improve human health; promote sustainable development; or contribute to a higher quality of life. In this context, NADB may finance projects, including but not limited to water, waste management, clean and renewable energy, air quality, industrial and hazardous waste, and energy efficiency. In addition, under its charter, NADB is authorized to make loans to both public and private sector borrowers operating within the United States and Mexico. Any project, regardless of community size or project cost, is eligible for financing and other forms of assistance from NADB, if it meets certain eligibility criteria.

NADB has financed an estimated $1.326 billion in environmental infrastructure projects through loans and EPA BEIF grants.

Through its loan program, NADB finances a portion of the capital costs of projects. In addition to its loan program, NADB also provides and administers grant financing to help make environmental infrastructure projects more affordable for border communities. The Community Assistance Program (CAP), funded with NADB-retained earnings, attempts to offset the reduction in BEIF funding and offers grant financing to support the implementation of projects sponsored by public entities in all environmental sectors eligible for NADB financing.[20] In 2012, 11 projects (four U.S. and seven Mexican) were selected to receive funding that will exceed $4.25 million.[21] NADB is limited, however, in the amount that it can set aside each year by the size of its lending portfolio and the need to maintain financial prudence.

To date, NADB has financed an estimated $1.326 billion in environmental infrastructure projects through loans and EPA-funded BEIF grants.[22] As noted, however, the population of the border region and its infrastructure needs continue to grow. In addition, existing infrastructure continues to age and requires replacement.

Several potential options for expanding NADB's reach include subsidized lending, a revolving loan fund and refinancing of debt. NADB funds its lending with proceeds of debt that it issues in the open capital markets. Although NADB maintains a high credit rating (Moody's, AAA; S&P, AA+), it has capital costs. It also must cover the additional requirements of its operations, reserves and CAP funding from its interest earnings. Therefore, NADB must receive assistance to provide lower interest rates to the creditors. As interest rates have decreased in the last two decades, finance officers in all types of entities, public and private, have sought to refinance their debt to provide savings in cash flows that allow them to invest in either operations or capital needs.

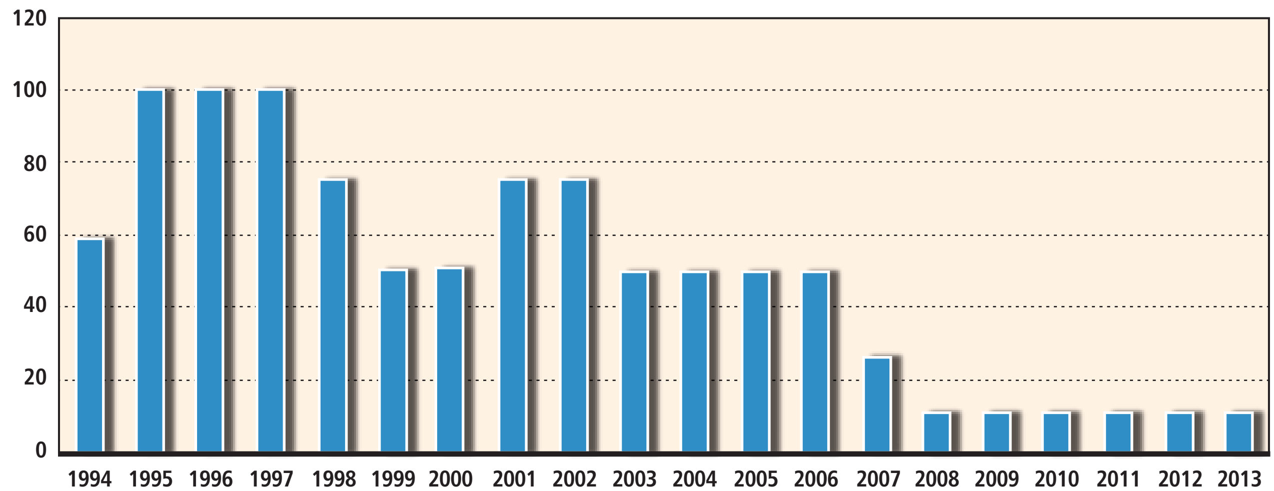
The U.S. Environmental Protection Agency (EPA)

In 1997, EPA began providing funding to the U.S.-Mexico Border Water Infrastructure program, supporting technical and financial assistance from the BECC Project Development Assistance Program (PDAP) during project planning and design, and construction financing and oversight by NADB through its BEIF. The PDAP is available for public water and wastewater infrastructure projects identified for funding opportunities through a program-specific prioritization process.

Wastewater Treatment Facility View

Indian Health Service

Figure 2. U.S. Appropriations to U.S.-Mexico Border Infrastructure Program



Source: BECC Development Assistance Programs Fact Sheet, June 2012.

The BEIF offers grant financing exclusively for the implementation of high-priority municipal drinking water and wastewater infrastructure projects located within 100 km of the U.S.-Mexico border. The BEIF has been particularly important in providing affordable financing, including a blend of grants and loans to projects in Mexico. With leveraged funding from the Mexican government, primarily in the form of grants, it has provided for major infrastructure projects in Tijuana, Mexicali, Nogales, Ciudad Juárez, Nuevo Laredo and Matamoros. These projects have had highly positive impacts on border ecology. Decreased federal funding, as shown in **Figure 2**, has limited the BEIF's potential.

Due to a lack of data, it is difficult to estimate the need for financing for border water and water infrastructure projects. The BECC uses two approaches. First, the cost of *eligible* applications is compared to what is actually funded, which is shown in **Figure 3**. In 2011 to 2012, BECC-NADB received applications for about $800 million, yet BEIF had only $10 million available for appropriation. Of the 200 eligible projects, only 28 were selected to receive funds during the initial award process. Second, the BECC estimates the costs of replacing all decentralized infrastructure in the U.S. border region with centralized infrastructure. Based on that approach, unmet border financing needs are estimated at $9.928 billion.

Funding through EPA's Border Water Infrastructure program does not support supply projects and is limited to drinking water quality and wastewater collection and treatment projects. The Drinking Water State Revolving Fund (DWSRF),[23] however, offers some drinking water supply project assistance. Eligible DWSRF projects include storage reservoirs and reservoir repair, rainwater harvesting, water conservation, well drilling, supply conveyance and source water protection. DWSRF funding also has decreased in 2012.

EPA's Tribal Border Infrastructure (TBI) program funds high-priority projects submitted by tribes whose reservations meet certain criteria. Projects are selected through a competitive process; the last request for proposals for this program was issued in 2010. EPA's Clean Water Indian Set Aside (CWISA) program funds high-priority projects by utilizing data from the Indian Health Service's (IHS) Sanitation Deficiency System (SDS; see section on Department of Health and Human Services-Indian Health Service).

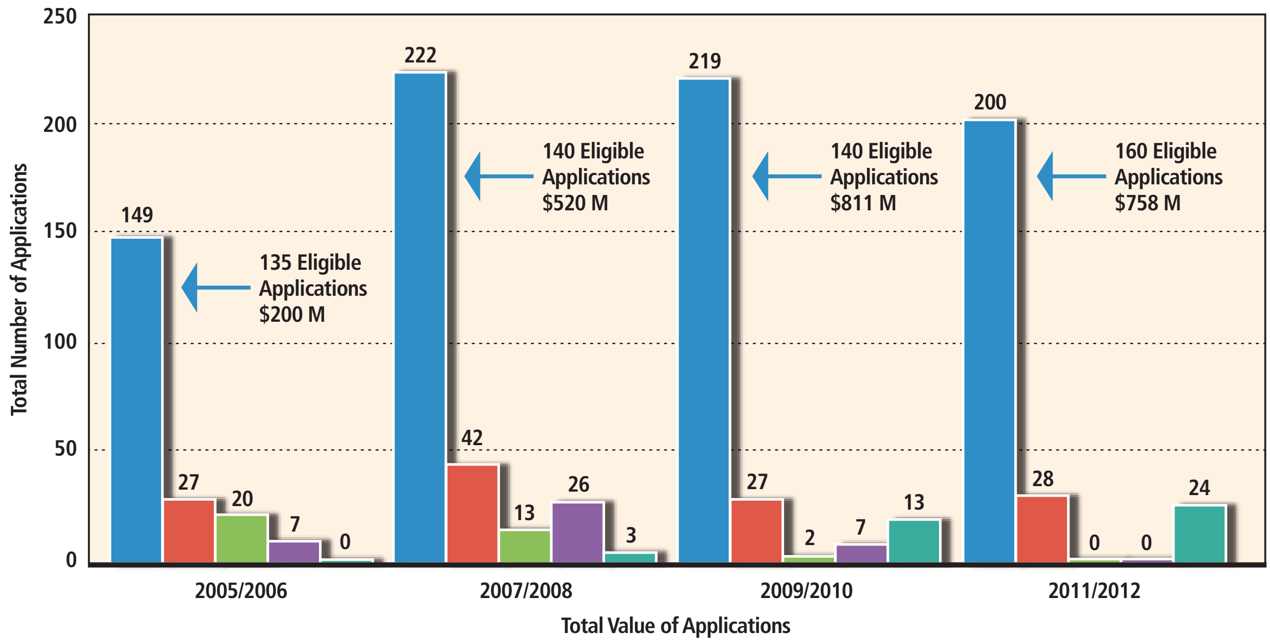
U.S. Department of Agriculture (USDA)

The USDA plays a critical role in protecting and sustaining the nation's water supply by providing expert research and science-based knowledge, tools and resources to farmers, ranchers, consumers, educators and others working on and affected by water issues.

The USDA Natural Resources Conservation Service (NRCS)[24] increases the productivity and quality of water on agricultural lands through a series of conservation programs. In May 2012, NRCS announced a new Water Quality Initiative committed to improving impaired waterways in Arizona. NRCS will make financial and technical assistance from its Environmental Quality Incentives Program (EQIP) available to eligible farmers and ranchers in the San Pedro watershed in Cochise County. Other grant and cost-share programs include Agricultural Management Assistance (AMA), Conservation Innovation Grants (CIG) and the National Integrated Drought Information System (NIDIS), among others. This assistance will help producers implement conservation practices that will reduce agricultural return flows into the river watersheds through irrigation water management and improved irrigation systems.

NRCS conducts Colorado River Basin Salinity Control activities primarily under the authorities of EQIP in the upper watershed.

Figure 3. Application Requests for Funds from BECC-NADB



	Received	Projects Selected	Certified	By-Passed	Under Development
2005/2006	$1030 M	$141 M	$163 M	N/A	0
2007/2008	$673 M	$252 M	$107 M	N/A	$8 M
2009/2010	$1130 M	$249 M	$9 M	N/A	$62 M
2011/2012	$794 M	$193 M	TBD	N/A	$176 M

Source: BECC Development Assistance Programs Fact Sheet, June 2012.

NRCS also offers assistance to private landowners, including Native American tribes, to reduce salt mobilization and transport to the Colorado River and its tributaries.

USDA's Rural Utilities Service (RUS) provides water and waste disposal facilities and services to low income, rural communities whose residents face significant health risks. Funds have been set aside for eligible projects that benefit members of Federally Recognized Native American tribes and colonias. Water and waste disposal systems can obtain grants for up to 100 percent of the cost to construct basic drinking water, sanitary sewer, solid waste disposal and storm drainage systems to serve the residents of colonias. For example, USDA's Rural Development RUS has funded and co-funded border water infrastructure projects such as the Avenue B and C Colonia in Yuma County, Arizona.[25]

There are several Water and Environmental Programs (WEP) such as the SEARCH Grant program and the Emergency Community Water Assistance Grants (ECWAG), which are not available exclusively to colonias but are often a very good fit for these communities. Also within WEP, Congress has traditionally, via legislation, mandated funds to benefit federally recognized Native American tribes. In past years, this generally has been funded at approximately $16 million. These grants can fund 100 percent of project costs but are limited to $1 million per project.

The 2008 Farm Bill included provisions for Substantially Underserved Trust Areas (SUTA) and gave the RUS new tools to finance improvements in water and sewer infrastructure in underserved tribal communities. The USDA partners with EPA and BEIF for research and development on nearly all rural water infrastructure projects that it funds.

Additionally, the grants provided to EPA's PDAP, administered by BECC, have allowed facility planning and environmental clearance to be obtained, facilitating the approval of construction funds from the USDA program. This program also provides an analysis of what the community can afford by using a blend of grants and low interest loans based on the affordability of infrastructure (typically the blend is 10% loan and 90% grant).

Department of Housing and Urban Development (HUD)

Since 1974, HUD has administered the Community Development Block Grant (CDBG) program to provide communities across the United States with resources to address a wide range of unique community development needs. The CDBG program provides annual grants on a formula basis to local governments and states. The National Affordable Housing Act of 1990, section 916, required Texas, New Mexico, Arizona and California to set aside 10 percent of their FY 1991 CDBG funds to meet the needs of residents in colonias relating to water, sewage and housing. For subsequent years, HUD was directed to set the level (up to 10%) for each of the border states. With one exception, HUD has required Texas, New Mexico and Arizona annually to set aside 10 percent of their CDBG funds for colonias, while California has set aside between 2 and 5 percent of its CDBG funds during those years.

The lack of stable funding and capacity among organizations serving the colonias has been recognized as a major barrier in the effectiveness of federal programs. The Border Community Capital Initiative ("Border Initiative") is a recent collaborative effort among three federal agencies—HUD, the Department of the Treasury Community Development Financial Institutions Fund and USDA Rural Development—aimed at overcoming that barrier.[26] The Border Initiative's goal is to assist local financial institutions in improving their capacity to raise capital, increase lending and boost investment in affordable housing, business lending and community facilities in the chronically underserved and undercapitalized U.S.-Mexico border region. Specifically, it will provide direct investment and technical assistance to community development lending and investing institutions that focus on affordable housing, small business and community facilities to benefit the residents of colonias. Although the program is small, it will offer up to $200,000 to nonprofit and/or tribal financial institutions serving colonias for such projects.

Department of Health and Human Services (HHS) – Indian Health Service (IHS)

The Division of Sanitation Facilities Construction (SFC) within IHS administers a nationwide SFC program that is responsible for delivering environmental engineering services and sanitation facilities to American Indians. The IHS established the SDS as part of a larger database called the Sanitation Tracking and Reporting System (STARS).[27] The SDS is an inventory of the sanitation deficiencies, including water, sewer and solid waste of Native American homes and communities. Within the border region, IHS area offices serve Native American individuals, families, communities and health programs, with the exception of two Texas tribes, which have no area office service.

IHS offices, in consultation with the tribes in their areas, identify sanitation deficiencies, update them annually in the SDS, and report them to Congress as required by the Indian Health Care Improvement Act[27] for the purposes of determining infrastructure funding per the Clean Water Act of 1977.[28] The IHS evaluates all of the needs reported by each tribe and determines which needs can be corrected by projects or project phases that meet the current eligibility policies of the program. The IHS also determines project feasibility. Projects that exceed the agency's maximum per home cost are deemed infeasible, but still are reported on SDS. The list represents one of the largest efforts undertaken by any federal agency to catalog infrastructure needs in Native American country. EPA uses this list to implement the CWISA program and award infrastructure funds for wastewater-only projects.

Bureau of Reclamation

The Bureau of Reclamation,[29] an agency of the U.S. Department of the Interior, has a number of projects or initiatives that have supported water supply projects in the U.S.-Mexico border region. One such effort is the Water Conservation Field Services Program, which includes:

- Development of improved irrigation scheduling for freshwater conservation in pecan fields of El Paso County, Texas (see Case Study: The City of El Paso, Texas).
- Modernization of the Elephant Butte Irrigation District irrigation management system in New Mexico through installation of new software for more timely and precise water decision making.
- Measurement of excess irrigation water to help irrigators reduce inefficiencies in the Imperial Irrigation District, California, through the Tailwater Education program.
- Promotion of water conservation in the Yuma Irrigation District, Arizona, by upgrading to more efficient pumps to promote water conservation.
- Demonstration of an automated surface irrigation system that uses data on soil moisture and inflow measurements with computer models to optimize shutoff times for irrigators and reduce surface runoff (University of California, El Centro Extension).

Vegetable field and irrigation equipment

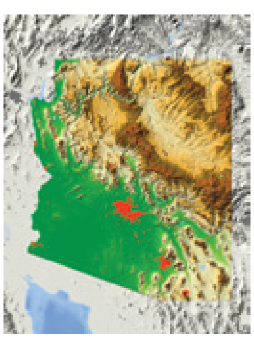
- Development of soil suitability guidelines for irrigating with water of elevated salinity in El Paso, Texas, to assist users of reclaimed water.

Since 2010, the Bureau of Reclamation has funded 13 Sustain and Manage America's Resources for Tomorrow (WaterSMART) grants in close proximity to the U.S.-Mexico border. In total, these grants are expected to save more than 6,500 acre-feet of water annually at a combined federal cost share of more than $3.5 million. The grants cover a variety of projects and activities, including retrofitting irrigation district check gate structures to increase efficiency, lining or enclosing irrigation canals, installing digital control systems to improve accuracy of measurements, and effluent reuse.

The San Diego Area Water Reclamation program is authorized under Title XVI of P.L. 102-575 to receive up to $172,590,000 in federal funding, or 25 percent of the total project cost (with 75% of the project cost to be provided by non-federal project sponsors). As of September 2011, this program is 58 percent complete, and it features construction of water reclamation plants and related infrastructure. The use of reclaimed water in southern California results in decreased dependency on potable imported water, including water from the Colorado River, an important source to both the United States and Mexico.

Water Management in the Four U.S. Border States

The four U.S. border states differ in their approaches to water management. Arizona, California and New Mexico manage surface water quantity and quality in separate state agencies. Texas, by contrast, manages water quality and quantity within the same agency but conducts water planning in a different agency. Texas and California treat ground water withdrawal as a private property right and do not regulate it (although Texas does allow for regulation of ground water in ground water conservation districts), and Arizona and New Mexico, in response to disputes and threats of depletion, established legal mechanisms to do so. Arizona, California and Texas also have delegated authority from EPA to implement the National Pollutant Discharge Elimination System program and regulate water reclamation.[30] All four states receive resources from the SRF.



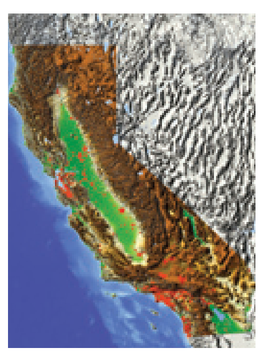
Arizona

The Arizona Department of Water Resources (ADWR) was established in 1980 to administer the provisions of the Arizona Groundwater Management Code. ADWR also negotiates with external political entities to protect Arizona's Colorado River water supply, oversees the use of surface and ground water resources under state jurisdiction, and represents Arizona in discussions and negotiations of water rights with the U.S. federal government and Native American tribes. ADWR collects and analyzes data on water levels and water quality characteristics in support of these activities. The Department also inspects dams and participates in flood control planning and floodplain management to prevent property damage, personal injury and loss of life.

The Arizona Water Banking Authority (AWBA or Water Bank) was established to increase utilization of the state's Colorado River entitlement and develop long-term storage credits for Arizona. It "banks" unused Colorado River water to be used in times of shortage for Arizona. These water supplies benefit municipal, industrial and Native American users along the Colorado River.

The Arizona Department of Environmental Quality (ADEQ) Water Quality Division is responsible for protecting and enhancing public health and the environment by ensuring safe drinking water and reducing the impact of pollutants discharged to surface and ground water. Responsibilities of the Division include investigating complaints and violations of Arizona's water quality laws, issuing permits to protect from point sources of pollution, and regulating wastewater discharge and treatment. The ADEQ Office of Border Environmental Protection was established to address transboundary issues that impact Arizona's environment and its citizens.[31] The Office focuses on improving water quality in Arizona border communities through collaboration with programs such as the U.S.-Mexico Border 2020 Environmental program, the Arizona-Mexico Commission and the Border Governors Conference.

Arizona manages the resources in its SRF through the Water Infrastructure Finance Authority (WIFA), an independent state agency authorized to finance drinking water, wastewater, wastewater reclamation and other water quality facilities and projects. WIFA offers borrowers below-market interest on loans, flexible funding timelines, no mandatory loan amounts, and financial incentives for "green" projects. WIFA also offers a planning and design grant program to prepare water and wastewater facilities for project construction.



California

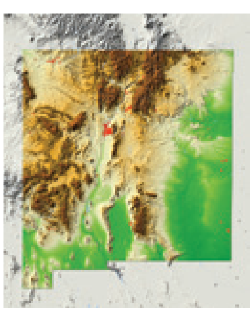
California's Department of Water Resources (DWR), within the state's Natural Resources Agency, has broad powers to study, plan and implement projects to meet California's water needs and manage its water resources. DWR operates and maintains the California Water Project, provides dam safety and flood control services, assists local water districts in water management and conservation activities, and promotes recreational opportunities. DWR also administers water bonds that provide financial assistance for various water projects.

The California Department of Public Health, Office of Drinking Water has many responsibilities, including the regulation and improvement of public water systems, promotion of information on water recycling and conservation, provision of funding opportunities for water system improvements, and other activities.

The California Environmental Protection Agency (Cal/EPA) oversees all state boards, departments and offices that are charged by state law to protect specific areas of the environment and/or regulate specific activities. Within Cal/EPA, the State Water Resources Control Board (State Water Board) has responsibility for statewide water quality policy and protection of both surface and ground waters. It also oversees surface water rights and can adjudicate ground water issues.

The State Water Board oversees nine state Regional Water Quality Control Boards (Regional Water Boards), which are charged with the protection of water quality and carrying out regional water quality control programs. The State Water Board's Division of Financial Assistance (DFA) administers the implementation of the Water Board's financial assistance programs, such as the SRF, including loans and grants to fund water projects. DFA also administers the Water Recycling program and the State's Wastewater Treatment Plant Operator Certification program.[32]

The California-Baja California Border Environmental program is a collaborative effort of Cal/EPA, other California state agencies, Baja California and Tribal Nations located along the border region. California has cooperative environmental agreements with Mexico, one of which covered the development and implementation of industrial wastewater monitoring and pretreatment along the California-Mexico border.[33]



New Mexico

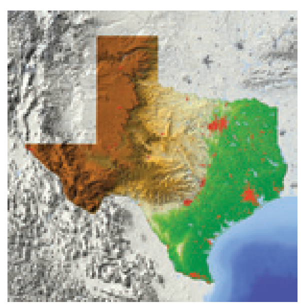
The New Mexico Interstate Stream Commission and New Mexico Office of the State Engineer are companion agencies charged with administering the state's water resources. They have responsibility for the supervision, measurement, appropriation and distribution of nearly all surface and ground water in New Mexico, including streams and rivers that cross state boundaries.

The New Mexico Environment Department (NMED) promotes a safe, clean and productive environment throughout the state. The NMED is comprised of five sections, one of which is the Water and Waste Management Division, which primarily addresses water quality issues. The New Mexico Office of Natural Resources Trustee represents the state's interest in the recovery of damages incurred by natural resources on state land under two federal statutes, the Water Pollution Control Act and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

The New Mexico Water Quality Control Commission is the state water pollution control agency that oversees state compliance with the wellhead protection and sole source aquifer programs of the federal Safe Drinking Water Act.

The Water Trust Board recommends water projects, including water delivery to end users, implementation of federal Endangered Species Act collaborative programs, and water recycling and conservation programs, among others.[34,35] Funding may be provided in the form of grants or loans from the Water Project Fund, which receives appropriations from the state legislature.

The NMED Border Environmental Justice Liaison works with New Mexico border communities and serves as the main point of contact for Border 2020. Subcommittees along the border address water issues, one having supported efforts such as the development of a geographic information systems (GIS) mapping tool for the Mimbres Basin,[36] and the *Roadmap - A Draft Model for Collaborative Operation of Transboundary Watersheds* proposal.[37]



Texas

The Texas Commission on Environmental Quality (TCEQ) is the state's official environmental agency. It oversees water rights and sets state water quality standards to protect public health, recreation and aquatic life. Interstate compacts are managed by the TCEQ as well. It also has broad oversight for surface water and ground water quality, as well as for safe drinking water management and enforcement. More recently, TCEQ has been charged by the Texas Legislature with establishing minimum environmental flows[38] for Texas' major rivers and bays. Chaired by the TCEQ, the Texas Groundwater Protection Committee coordinates ground water quality protection activities among state agencies and the Texas Association of Groundwater Districts. The Committee also documents ground water contamination in its annual Joint Groundwater Monitoring and Contamination Report.

The Texas Water Development Board (TWDB) is responsible for developing a State Water Plan through regional water planning groups. It also conducts research on aquifers, water availability and environmental flow needs, as well as periodic surveys of ground water use. The TWDB also works with 16 Groundwater

Management Areas to establish future desired conditions and the volume of water that will be available for future use. Other responsibilities include providing technical and financial assistance, such as administering the Drinking Water State Revolving Fund for Texas. TWDB also administers the Economically Distressed Areas Program (EDAP), which provides water and wastewater funding for colonia programs in Texas.

The rural nature of many tribal communities creates special challenges for those seeking to provide water and wastewater services.

The Texas Parks and Wildlife Department (TPWD) monitors water quality with an emphasis on protecting the health of aquatic life and its habitat. It also is responsible for wetlands protection and for investigating fish kills or any other instances of pollution that harm or threaten wildlife.

The Texas State Soil and Water Conservation Board is responsible for controlling and reducing state agricultural nonpoint source and water pollution. It administers federal grants for projects that control agricultural nonpoint sources of water pollution, such as fertilizer runoff.

Water Resources and U.S. Border Tribes

The U.S.-Mexico border region is home to 26 U.S. federally recognized Native American tribes, ranging in size from 9 to 17,000 members, and to indigenous communities in Mexico. Persistent water-related issues face the communities on both sides of the international boundary, including safe drinking water and proper wastewater treatment and disposal, as well as particular forms of pollution such as the ammonium perchlorate that was identified as a concern in the GNEB's 8th report.

The rural nature of many tribal communities creates special challenges for those seeking to provide water and wastewater services. To address gaps in service, tribes can access resources from EPA as well as the IHS, as noted above. Beyond these, there are a number of programs that support agricultural production and other forms of land conservation management that give special recognition to the position of tribes. Other programs provide information that can be used by tribes, such as the Pollutant Release and Transfer Register, which provides county-level analysis of toxic releases by type and by producer, and the Causal Analysis/Diagnosis Decision Information System (CADDIS), which tracks the causes and effects of pollution in water resources.

Tribes participate in border environmental programs, such as Border 2020, through their offices of environmental protection and management. Where possible, the tribes share information and resources, and those with greater infrastructure support those tribes without such infrastructure. A representative of the Tohono O'odham Nation, for example, has served as coordinator of border activities for all of the Arizona border tribes. Of concern to the border tribes, however, is the low level of support that they received from Border 2012.[39] Although they are eligible to receive funding from the BEIF, tribes have not submitted proposals through that program, working instead with EPA through the Tribal Border Infrastructure program. From 2006 to 2010, that program received 44 proposals totaling $28.7 million. During that time only $4.3 million was available, which provided funding for only 14 tribes.[39]

Interdependence in U.S. Governing Bodies

In addition to the political divisions described above, regional and local governments also play a role in U.S. water management. As noted, border communities access public financial support through both state and federal agencies. Local entities involved in water management may include irrigation districts and soil and water conservation districts, publicly regulated utilities such as public water supply systems, and domestic water users. The responsibilities of supply planning and regulation often overlap.

An example of this overlap is ground water extraction for natural gas, which can negatively affect the environment (e.g., fish) and farmers. Over-allocation to agricultural customers can lead to low river flows and sediment accumulation, which reduces the size of the river channel and can result in catastrophic flooding during storms.

Tensions regarding water along the border have been amplified by many factors, such as dramatic increases in population, periodic drought in some of the major basins, the absence of legal frameworks governing ground water, and disagreements interpreting compact or international agreement surface water requirements. In recent years, conflict has arisen over a variety of issues, including transboundary sanitation problems and water deliveries to Mexico and U.S. users during drought. In some cases, these conflicts have led to litigation. Successful management requires working across physical, social and political

Aerial landscape of tailing ponds for mineral waste boundaries with integrated watershed and basin-wide management, which is emerging in U.S. border states.

Integrated management of water for use in economic and energy development, public health, food production and environmental conservation depends on the application of appropriate frameworks that recognize relationships among uses. Frameworks include conceptual models that identify key attributes of water resources, such as basin water volume budgets, reservoir capacities and natural flood regimes, and link them to both user groups and usage. Relationships among users then can be identified, including the timing of water needs and usage rates. The emerging field of ecosystem services also can contribute to gaining an understanding of natural flow variation and species needs and other basin management needs.

A key requirement of successful integrated management is the availability of reliable and consistent data. The 8th report highlighted the need for data collection efforts, and some progress has been made; however, inadequate or missing data increases the potential for misunderstanding and hinders collaboration.

Critical Issues in 2012

As already noted, water has been the topic of several prior GNEB reports, but the Board decided to focus its attention on water supply, quality and treatment because of the need to highlight water problems in the region. The above sections have addressed the tremendous need for financial resources within border communities. The following sections summarize some additional critical issues.

Rapid Urbanization

The 10 states along the U.S.-Mexico border have experienced substantial population growth in the past 50 years, growing from a population of just more than 33 million in 1960 to nearly 90 million in 2010.[40] Almost 14 million of those residents live within the border region. In the six Mexican states alone (Baja California, Sonora, Chihuahua, Coahuila, Nuevo Leon and Tamaulipas), the population has grown from 5.5 million in 1960 to 19.9 million in 2010.[40] That constitutes nearly a quadrupling of the population in 50 years. The northern parts of Mexico, especially those closest to the international border, grew with the development of cross-border trade, including establishment of the Maquiladora program. This program allows for the duty-free importation of U.S. manufacturing parts and components into Mexico. Following assembly of the manufactured parts, the finished product(s) are delivered back to the United States. The maquiladora industry increased the demand for labor in the border region, attracting hundreds of thousands of people seeking employment, mostly to urban centers. The growth in population has greatly exceeded the expansion of supporting infrastructure and services.

Much of the increase in population on the U.S. side of the border has been driven by the tremendous growth on the Mexican side. In addition, within the United States, a warm climate and new employment opportunities, including defense, high technology, construction and agribusiness, have drawn residents from the rust belt to the south and southwest. The four U.S. border states have been among the fastest growing in the country in the past 50 years, especially in the major metropolitan areas, like El Paso, Texas; Las Cruces, New Mexico; Tucson, Arizona; and San Diego, California. This trend also is true for newly emerging metropolitan areas, such as along the Lower Rio Grande Valley of Texas in the cities of McAllen, Harlingen and Brownsville.

This population growth has led to a continued increase in demand for water for residential, commercial and industrial use even with the implementation of water conservation measures. This growth of water demand in some cases has led to conflicts between urban and agricultural water users because many of these areas also are heavily irrigated for agricultural use. Finally, the widespread urbanization has disrupted natural flows and aquifer recharge while increasing impervious cover, leading to local impacts such as flooding.

Flooding

Dramatic storm events can produce flood conditions that can overwhelm local catchment and diversion systems and lead to extreme stormwater and sediment runoff conditions that flood communities on both sides of the border. This flooding can compromise the buffers between residential water resources and domestic waste disposal in shallow well areas.

Energy and Water

There is a close nexus between energy production and use and demand for water. Water loss in a distribution system requires additional pumping and therefore increases energy costs. Water and wastewater utilities tend to be the single largest energy consumers in any community, and their energy bills represent the second largest expense. The GNEB 14th report also noted the potential for the development of renewable energy resources to consume large quantities of water. As electricity generators install larger capacity infrastructure and expand service delivery, the permitting process that governs water release, water withdrawals, water storage and heat loading also must be updated to address the increase in load and the eventual effluent.

Of special concern along the Texas border, specifically in the counties of Dimmitt, Edwards, Frio, LaSalle, Maverick, McMullen, Webb and Zavala, has been the recent rapid expansion of shale gas development. By all measures—permits, drilling starts and gas production—activity has increased exponentially since 2010. This is exemplified by 1,010 drilling permits being issued in 2010, 2,826 issued in 2011, and 1,452 issued between January and April of 2012 for the Eagle Ford shale.[41] Although recent studies suggest that the total amount of water utilized for hydraulic fracturing ("fracking") wells for oil and gas development is still relatively small compared to agricultural and municipal water use in the region, the local impacts on aquifers and surface water use can be significant and represent a new water demand in the area. Studies suggest that a single "frack" job in the Eagle Ford shale in Texas can require between 6 and 8 million gallons of water.[42,43]

The U.S. Geological Survey (USGS) does not have an active, extensive ground water level monitoring network near the U.S.-Mexico border in Texas. Adding such a network of ground water level monitoring in these counties would be extremely beneficial due to the recent oil and gas exploration activities there. As an example, there has been a recent increase in the use of ground water associated with oil and gas exploration and production in Maverick and Webb counties, in particular associated with the Carrizo Wilcox and Yegua Jackson aquifers. Yet, relatively few data are available in these counties. These counties also lack ground water conservation districts. Data from USGS wells in nearby Dimmitt County indicate declining ground water levels in the Carrizo Wilcox. The magnitude of the water use associated with oil and gas production – coupled with existing agricultural and industrial needs – could have dramatic impacts on ground water resources in the areas that currently are not monitored or understood. By enhancing data collection in those areas, the USGS could add to the information presently being used by stakeholders, local ground water conservation districts and the Texas Water Development Board in their water planning processes.

Climate

As of October 2012, most of the U.S.-Mexico border region is experiencing drought conditions.[44] Long-term climate models for the region predict increased temperatures, decreasing precipitation and shifting of rainfall patterns in coming years. These factors, combined with the potential for reduced snowpack within the basins of rivers that traverse the border region, may contribute to decreased stream flows as well. These conditions can be monitored with the NIDIS.[45] For example, low precipitation and above-normal temperatures meant that by March 2012, less than 50 percent of the average snowpack remained from 1981 levels in the Sangre de Cristo Mountains, the location of the headwaters of the Rio Grande.[46,47] Local concern over the intensity of natural events, particularly temperature fluctuation and precipitation, has increased over the last decade.[48,49]

Increasing drought conditions with unpredictable rainfall patterns

Rising temperatures mean greater evaporation of water into the atmosphere, increased runoff and a shift in precipitation from snowfall to rainfall, resulting in less water for storage in reservoirs.[50] Seasonal weather patterns that previously supported reliable rainfall seasons, the reliable snowpack, and sufficiently gentle rainfall that allowed for more percolation into the soil, less runoff and lower sediment loads have changed in ways that require greater planning by local communities.[51,52]

Continued shortfalls can result in competition among users, the potential for greater public health risks from insect- and fungal-based diseases, reduced recharge of ground water systems and lessened environmental flows, habitat loss, and increased nonpoint source pollution. A recent study focused on climate change in the Arizona-Sonora border region cited aging or inadequate water-delivery infrastructure, over-allocation of water resources within the region, and the location of poor neighborhoods in flood-prone areas or other at-risk areas as key factors increasing the vulnerability of urban water users.[53]

Water Conservation

Water conservation is an integral component to enhancing and prolonging the supply of surface and ground water in any part of the United States. This is particularly vital in the border region, given the arid nature of much of the border, scarce resources and the great demands on water, especially in the agricultural and municipal sectors. Some water conservation projects, specifically in the agricultural sector, can produce significant water savings and help address water supply obligations (see Case Study: Coachella Valley Water District – Coachella Canal Lining Project). The following are some agricultural water conservation practices:

- Concrete lining of earthen canals;
- Replacement of canals with pipelines; and
- Use of improved systems of irrigation (e.g., drip irrigation).

Water conservation is an effective strategy for managing municipal water as well, and conservation practices can be passive, incorporating more efficient appliances or technologies

Case Study: **Coachella Valley Water District – Coachella Canal Lining Project**

Designed to conserve 30,850 acre-feet of water that is lost annually through seepage from the canals, the Coachella Canal Lining Project will line about 35 miles of the Coachella Canal and help California stay within its annual 4.4 million acre-feet per year (AFY) constraint under the Colorado River Compact. It also will assist the federal government in implementing the San Luis Rey Indian Water Rights Settlement Act, which settles water rights claims for the stakeholders in San Diego County, California.

The project proposal was evaluated by the Bureau of Reclamation and by the Coachella Valley Water District, the federal and state leads, respectively. Project alternatives were evaluated through environmental impact assessments. The key environmental mitigation strategies for this project included ensuring Salt Creek receives 623 AFY, large mammal mitigation strategies, revegetation of the riparian habitat, restoration of 352 acre-feet to desert dry wash, the creation of a 17-acre marsh, 50 acres of freshwater pond and fisheries mitigations, and transporting fish into the new canal.

The canal has 1,300 cubic feet per second capacity. The project uses concrete lining and covers about 35 miles of the canal.

The original contract for this project was $71.2 million with a final contract cost of about $88 million. Project construction was completed in 2006, and that November, the newly lined portion of the canal was put into service. A total of $120 million was spent on this project, which included construction and environmental expenditures. The environmental mitigations continue, including water supply development, marsh creation, the 50-acre fish pond, and other strategies described in the environmental analyses, and are nearing completion.[56]

such as low-flow shower heads, or involve education, regulation or programs to reduce water use. Examples of municipal water conservation include:

- Xeriscaping, a way to save water by using creative landscaping that replaces high water use plants and grass with landscaping that requires little or no watering;
- Irrigating less;
- Installing low-flow shower heads and toilets; and
- Implementing practices in cities to locate and address water loss in the distribution system.

Municipal water conservation has additional benefits, such as greater energy savings. For example, in recognizing these benefits, the City of Tucson, Arizona, currently offers cost-match incentives for installation of active and passive rainwater harvesting features on private property, with rebates of up to $2,000 available.[54] In addition, Tucson has adopted a Rainwater Harvesting Ordinance that requires new commercial facilities to meet 50 percent of their landscape water demands using harvested rainwater achieved through implementation of a site water harvesting plan. Since its adoption in 2008, the Commercial Rainwater Harvesting Ordinance has received attention as a model for cities and communities across the United States that are considering similar ordinances.[55]

New Policy and Management Initiatives

In the face of the many challenges associated with water resources in the border region, new policy and management initiatives are emerging. For example, in 2010, the Colorado River Joint Cooperative Process was formalized in Minute No. 317, *Conceptual Framework for U.S.-Mexico Discussions on Colorado River Cooperative Actions* (a Minute is a binding agreement of the IBWC, United States and Mexico, intended to implement a boundary or water treaty). That Minute commits the United States and Mexico, through the IBWC, to work with stakeholders to address potential areas of cooperation, including water conservation, identification of new water sources, improvement of hydraulic and hydrologic system operations, and identification of water for environmental purposes. The goal is to conclude an IBWC Minute for a comprehensive package of joint cooperative actions to benefit both countries.

Outline of the Remainder of the Report

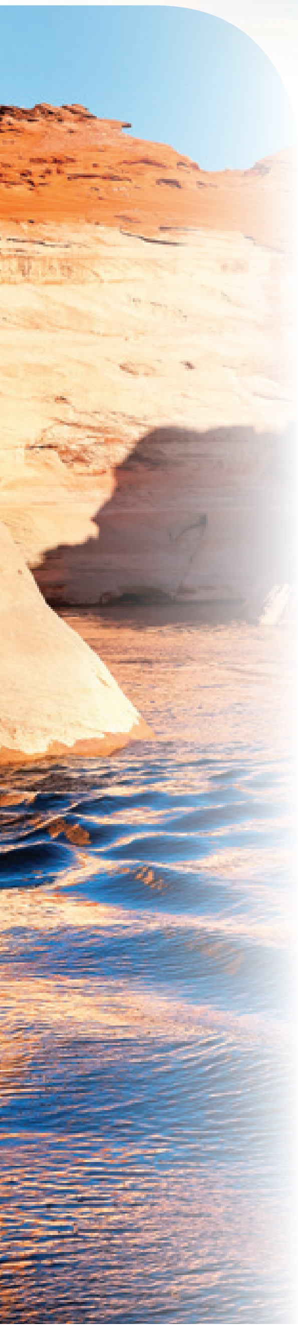
The information provided in this chapter sets the background against which U.S.-Mexico border water and water infrastructure issues will be discussed. Chapter 2 covers water supply, describing existing infrastructure and programs that support border water supply projects, current and projected water supply shortages, and the unique challenges of working in transboundary watersheds and basins. Chapter 3 addresses water quality, discussing the importance of water quality, management and regulation of border water resources, and threats to those resources. Chapter 4 describes water treatment, focusing on both drinking and wastewater. Chapter 5 begins with a summary of the principal findings and recommendations of previous GNEB reports on water, and concludes with a list of recommendations.

The 1,952 mile U.S.-Mexico border includes thousands of communities, some lying in floodplains where surface and ground water are in regular contact with one another and others hundreds of feet atop the nearest aquifer. In many ways, each community faces its own unique challenges and has developed distinct strategies for addressing them. At the same time, the border communities share many characteristics. It is impossible in a report such as this to discuss each situation or circumstance; therefore, the report focuses on broad patterns, using case studies in each chapter to illustrate how those patterns are experienced in actual communities, programs and institutions.

CHAPTER 2

Water Supply

Ensuring that border communities and ecosystems have an adequate water supply is critical to the future well-being and economic growth of the region. Along the U.S.-Mexico border—which includes vast areas of desert, heavily utilized surface water and ground water resources, and water sources that are shared by two nations—water management issues are paramount. This chapter discusses the existing water supply infrastructure in U.S. border communities, federal programs that support border water supply projects, current and projected water supply shortages, and the unique challenges of working in transboundary watersheds. This chapter will highlight regions where local residents and leaders or state water planners have identified particular concerns about future water supply. Although the Good Neighbor Environmental Board (GNEB or Board) considered and finds merit in various water supply alternatives, such as expansion of water reclamation activities, gray water reuse and rainwater harvesting, it does not explore those types of activities in this report because the federal role often is limited.



Border Water Supply System

The Water Supply System in the four border states is comprised of two perennial river systems, the Colorado and Rio Grande, several smaller river systems, and 20 transboundary aquifers.

Surface Water System

The Colorado River and Rio Grande watersheds are the principal rivers supplying water to the border. In addition, the State of California has a major transboundary transfer of water to the San Diego area from the Sierra Nevada Mountains. Other border river watersheds include the Tijuana, New, Santa Cruz and San Pedro.

As shown in **Figure 4**, spanning parts of Arizona, California, Colorado, New Mexico, Nevada, Utah and Wyoming, the Colorado River Basin is one of the most critical sources of water in the western United States. **Figure 5** shows that the natural water supply of the Basin is highly variable year to year. The ability to capture water Basin-wide during years when supply is greater than demand made it possible to meet most of the resource needs throughout the 20th century and into the 21st. The water supply is managed by a system of dams and water conveyance projects that provide flood control and river regulation, help meet water demands, generate hydropower, enhance ecosystems for a variety of species, and offer innumerable recreation opportunities.

The operations of these projects are guided by the series of federal laws, court decisions and decrees, contracts, an international treaty with Mexico, and regulatory procedures collectively known as the "Law of the River." One of the most recent elements added to this "law" is the *2007 Interim Guidelines for Coordinated Operations of Lake Powell and Lake Mead* (see Chapter 1).

These operational guidelines, in place through 2026, address the operations of these two reservoirs through a full range of situations, including drought and low reservoir conditions. They also establish measures for addressing shortages in the Lower Basin, including a process for the Basin states to consult about further measures if Lake Mead's elevation reaches a critical level. Mexico water deliveries set by the 1944 U.S.-Mexico Treaty are not impacted by these guidelines.

The Secretary of the Interior, acting through the Bureau of Reclamation, is the Watermaster for the Lower

Figure 4. Colorado River Hydrologic Basin

Source: Colorado River Basin Water Supply and Demand Study, 2011.

Figure 5. Moisture Sources to the Colorado River Basin

Source: U.S. Department of the Interior. U.S. Geological Survey Fact Sheet 2004-3062, Version 2, August 2004.

Colorado River from Lee Ferry, Arizona, to the southerly international border with Mexico. As Watermaster, the Secretary is authorized to manage and operate the Lower Basin of the Colorado River under the "Law of the River." In managing water issues, the Secretary collaborates with the Lower Division States of Arizona, California and Nevada; the Republic of Mexico (through the International Boundary and Water Commission [IBWC]); water and power utilities; and many stakeholders representing agricultural, economic, environmental and other interests.

The San Pedro River flows north from Cananea, Sonora to the Sierra Vista-Fort Huachuca area in Arizona, and supports a highly diverse riparian community that is a National Conservation Area on the U.S. side of the border. The Santa Cruz River, located in the Ambos Nogales region, begins in Arizona, flows south into Sonora, and then returns northward into Arizona; along the river is the Nogales International Wastewater Treatment Plant, which produces effluent that dominates water for approximately 20 km downstream.[57]

The Rio Grande Basin provides water for irrigation, households, the environment and recreational uses in Colorado, New Mexico and Texas, as well as Mexico, as shown in **Figure 6**.[58] Above El Paso, Texas, flow in the Rio Grande is controlled largely by releases from Caballo Reservoir located below Elephant Butte Dam. Downstream from El Paso to Fort Quitman, flow consists mainly of treated municipal wastewater, irrigation return flow and stormwater runoff.

The Pecos and Devils Rivers in Texas are the principal U.S. tributaries of the Rio Grande. Both of these rivers flow into Amistad Reservoir on the Rio Grande, which is located upstream of Del Rio, Texas, and Ciudad Acuña, Coahuila. The Pecos River flows southward through eastern New Mexico, where it is impounded by Red Bluff Reservoir at the Texas-New Mexico border. In Mexico, major tributaries include the Conchos River, which flows to the Rio Grande at Presidio, Texas, and Ojinaga, Chihuahua; the Salado River, which flows into Falcon Lake downstream from Laredo, Texas, and Nuevo Laredo, Tamaulipas; and the San Juan River, which enters the Rio Grande in the Lower Rio Grande Valley of Texas and Tamaulipas.

Below Falcon Dam, the Rio Grande Basin tapers to a relatively narrow band bordering the Rio Grande and varying in width from 10 to 30 miles as it forms a delta. In Hidalgo and Cameron counties, Texas, at the extreme lower end of the Basin, the river is confined between levees and the Basin is generally less than a few miles in width. This system of levees and the associated drainage channels were constructed by the United States and Mexico to control flooding of the extensive agricultural and urbanized areas along the river in the Lower Rio Grande Valley.[59]

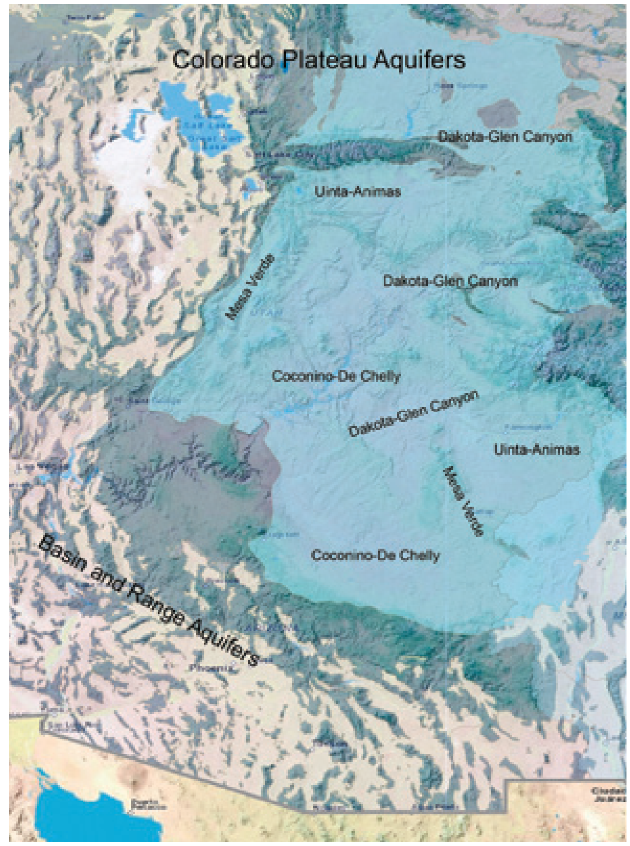
Groundwater System

Data on ground water systems can be difficult to acquire. In 2006, the U.S.-Mexico Transboundary Aquifer Assessment Act authorized funds for, and directed the establishment of, a program to study transboundary aquifers between the two countries.

Figure 6. Rio Grande Basin

Source: International Boundary and Water Commission.

Figure 7. Colorado Plateau Aquifers



Source: International Boundary and Water Commission.

Figure 7 shows that the major ground water aquifers in the Colorado River are the Colorado Plateau aquifers. They are the Uinta-Animas, Mesaverde, Dakota-Glen Canyon and the Coconino-De Chelly aquifers. The lower Colorado River is comprised of the Basin-Range Basin-fill aquifers that are unconsolidated sand and gravel aquifers.

- *Uinta-Animas Aquifer:* In the San Juan Basin, water recharges this aquifer in the higher altitude areas that nearly encircle the Basin. During 1985, about 28,000 acre-feet of ground water was withdrawn from the aquifer.

- *Mesaverde Aquifer:* Ground water discharges from the aquifer directly to streams, springs and seeps by upward movement through confining layers and into overlying aquifers, or by withdrawal from wells. The natural discharge areas generally are along streams and rivers, including the Colorado River.

- *Dakota-Glen Canyon Aquifer:* The potentiometric surface for this aquifer has been defined for much of the northern part of the aquifer. Ground water flow directions inferred from the potentiometric surface indicate several, major recharge areas. Ground water flow in this aquifer is toward major discharge areas along several rivers.

- *Coconino-De Chelly Aquifer:* The aquifer is recharged in several areas, but discharges mainly to the Colorado and Green Rivers. Water in this aquifer generally flows northwestward toward a discharge area near the mouth of the Little Colorado River. In the Grand Canyon, a series of springs issuing from the Mississippian Redwall Limestone discharges water derived in part from this aquifer. Fractures and solution channels in the Redwall Limestone and the rocks separating the Redwall Limestone from the Coconino Sandstone provide conduits for the ground water. Similar processes affect the ground water flow system elsewhere in the vicinity of the Grand Canyon.

The U.S. government gave the Upper San Pedro Partnership the task of achieving a sustainable yield of the regional aquifer by 2011.[60] A particular water management challenge for the Santa Cruz Aquifer is its shallow microbasins, located mainly in the most heavily used parts of the aquifer, which experience annual water level changes of up to 15 meters, resulting in limited ground water storage capacity.[60]

Figure 8 shows that the major ground water systems east of the Colorado River Basin along the U.S.-Mexico border are the Mimbres Basin, and the Mesilla Bolson, Hueco Bolson, Edwards-Trinity and Gulf Coast Aquifers.

Case Study: **The Transboundary Aquifer Assessment Program (TAAP)**

The United States and Mexico share water resources from several basins that span the international border; however, there is no treaty regarding the management of ground water from shared aquifers. To expand knowledge about these water resources systems, a binational collaborative effort has been under way to evaluate priority aquifers in the border region. Scientists from both countries have been working together to share data and knowledge, and thereby develop an enhanced integrated understanding of the aquifer systems' current and projected future conditions. Such collaboration is important because it ultimately can prevent undesirable outcomes, such as ground water depletion, elimination of streamflow or threats to riparian ecosystems and water quality.

In 2006, the U.S. Congress passed, and the President signed into law, the U.S.-Mexico Transboundary Aquifer Assessment Act (U.S. Public Law 109-448). The Act authorized $50 million over 10 years and directed the Secretary of the Interior to establish a program to study transboundary aquifers between the two countries. The TAAP is a joint effort of the U.S. Geological Survey (USGS) and the States of Arizona, New Mexico and Texas, through their universities' Water Resources Research Institutes (WRRIs).

Mexico's collaboration in the program was formalized in 2009, through a Joint Report signed by U.S. and Mexico Principal Engineers of the International Boundary and Water Commission (IBWC). The IBWC is providing the framework for U.S.-Mexico coordination and dialogue to implement the studies. Key participants from Mexico include the National Water Commission (CONAGUA), the Mexican Geological Service and the University of Sonora's Department of Geology.

A total of four priority aquifers were identified initially in the U.S. federal legislation. Two of the priority aquifers, the Hueco Bolson and the Mesilla, are located in the general vicinity of the El Paso-Ciudad Juárez border region. For a variety of reasons, activities in this region were focused on the Mesilla/Conejos-Médanos Aquifer at the New Mexico-West Texas-Chihuahua border. At the Arizona-Sonora border, binational scientific assessment and stakeholder efforts have been under way for the other two legislatively identified priority aquifers, the San Pedro River Basin and the Santa Cruz River Basin Aquifers. The aquifer assessments address various scientific considerations such as geology, geophysics, hydrology, water quality, water demands and other essential aquifer characteristics.

The IBWC's Joint Report, Regarding the Joint Cooperative Process for the TAAP, summarizes details of the program, such as roles and responsibilities, funding, adherence to the boundary and water treaties, and procedures for use of information that is obtained through the TAAP process.

The USGS and the WRRIs prepared an interim report to Congress in 2012, as required by the enabling legislation. U.S. and Mexico studies of the Mesilla Basin/Conejos Médanos Aquifer were completed in 2011. Collaborative work has progressed on the study of the two Arizona-Sonora aquifers with binational scientific reports projected for completion in early 2013.

The TAAP was funded through line-item appropriations in the U.S. Department of the Interior's budget in fiscal years (FY) 2008-2010 for a total of $2 million to support work in all of the priority aquifers. No U.S. funding was provided in FY 2011-2012. The Mexican government has financed studies that were performed for the TAAP in Mexican territory. Although Mexico's National Water Commission has indicated a willingness to support continued work on the program, binational activities will cease in 2013, unless the United States dedicates matching funds.

- *Mimbres Basin:* Bounded by the Continental Divide and the Lower Rio Grande Basin, this basin extends south into northern Chihuahua. The only perennial stream reach in the basin is the Mimbres River, which becomes ephemeral by the time it reaches the City of Deming, New Mexico.

- *Mesilla Bolson Aquifer:* This aquifer lies in the Rio Grande Valley near El Paso, Texas, and extends into New Mexico where it is used primarily for agricultural and municipal supply.[61] The Rio Grande flows through the Mesilla Basin, forming a floodplain 60 miles long and several hundred feet to 5 miles wide.[62]

- *Hueco Bolson Aquifer:* Extending east of the Franklin Mountains in El Paso County, Texas, this aquifer is bounded by the Hueco Mountains, the Diablo Plateau and the Quitman Mountains. The aquifer also travels a short distance north into New Mexico and south into Mexico. The Hueco Bolson, along with the Mesilla Bolson Aquifer, provides much of the municipal water supply for the City of El Paso, depending on the time of year and availability of Rio Grande water.[61]

- *Edwards-Trinity Aquifer:* This aquifer extends from Central to West Texas. Springs issuing from the aquifer form the headwaters of several eastward and southerly flowing rivers. Aquifer thickness is as much as 1,000 feet. All known water wells produce water from the Salmon Peak and McKnight formations. San Felipe Springs in Val Verde County issues from the Edwards and is the primary municipal supply source for Del Rio, Texas.[63]

- *Gulf Coast Aquifer:* This aquifer exists in an irregular band along the Texas coast from the Texas-Louisiana border and into Mexico. Historically this Aquifer has been used to supply water in Cameron, Hidalgo, Jim Hogg, eastern Starr and southeastern Webb counties. The aquifer is brackish in many areas, although there are significant quantities of ground water available. Water levels have remained relatively stable over the years.[59]

Understanding and Managing Border Water Supply

Developing and maintaining adequate water supply in the border region requires both physical and institutional infrastructure. The former includes a complex system of dams/reservoirs, treatment plants, pumping stations, canals and other distribution infrastructure. In this report, distribution infrastructure also

Figure 8. Rio Grande and Coastal Aquifers

Source: International Boundary and Water Commission.

includes policies and plans, as well as the organizations and staff needed to carry them out.

Water is critical for environmental flows that sustain ecosystems and support animal populations upon which people's livelihoods and well-being depend. Environmental flows have been defined by an international group of experts as the "quantity, timing and quality of water flows required to sustain freshwater and estuarine ecosystems and the human livelihood and well-being that depend on these ecosystems."[64] Managing for environmental flows is intended to address a broader range of purposes than management focused strictly on water supply, energy, recreation or flood control, as shown in **Table 1**. Water managers sometimes attempt to adjust the quantity, timing and quality of environmental flows to accommodate human uses while also maintaining the essential processes required to support healthy river ecosystems. In the border region, establishing environmental flow programs requires binational, multi-sector collaboration and commitments. Such programs depend on up-to-date data on a variety of environmental conditions and a transparent process for sharing them.

Even with proper planning, increased demand for water in the border region, coupled with environmental factors such as drought, has strained the water supply. One effort to better understand future water supply and demand under different scenarios is the Colorado River Basin Water Supply and Demand Study.[65]

Key to planning and management is the availability of reliable and consistent data related to raw water transmission and storage, water treatment and distribution, wastewater conveyance and treatment, flood control and drainage, coastal water management, and the measurement/monitoring of precipitation, water quantity and water quality (surface and ground water). Such data are severely limited in the U.S.-Mexico border region. The GNEB has recognized this gap and elaborated on specific data needs in its prior reports. The 8th GNEB report, *Water Resources Management on the U.S.-Mexico Border-Region,* included as the second recommendation: Develop and sign formal U.S.-Mexico border region water resources data agreements. Such agreements should support the collection, analysis and sharing of compatible data across a wide range of uses so that border region water resources can be managed more effectively.[66]

Various U.S. federal entities, including the U.S. Geological Survey (USGS), the U.S. Section of the IBWC (USIBWC), the National Oceanic and Atmospheric Administration (NOAA),

Table 1. Example of Human Benefits Supported by Environmental Flows

Service Category	Service Provided	Environmental Flow Component/Indicator
Production	Vegetables/fruit	Floodplain inundation; Flows supporting riparian inundation
	Medicinal plants	Floodplain inundation; Flows supporting riparian inundation
Regulation	Flood mitigation	Floodplain inundation; Flows supporting riparian inundation
	Prevention of saltwater intrusion	Instream flow regime
Information	Recreation and tourism	Site specific
	Biodiversity conservation	Natural flow regime
Life Support	Previously healthy ecosystems	Natural flow regime

Source: Modified from Richter, B. D. (2010). Re-thinking environmental flows: From allocations and reserves to sustainability boundaries. *River Research and Applications,* 26:1052.

Case Study: Colorado River Basin Water Supply and Demand Study[65]

The Bureau of Reclamation of the U.S. Department of the Interior currently is conducting a Colorado River Basin Water Supply and Demand Study to assess future water supply and demand imbalances during the next 50 years, and develop and evaluate opportunities for resolving these imbalances. The study began in January 2010, and soon will be completed. The purpose of the study is to inform planning and to provide technical information for future studies and activities, rather than providing information to be used directly in decision making.

The historical Colorado River water supply is highly variable, but there is a definite increasing trend in water use. The study attempts to determine what the water supply versus use trend will look like during the next 50 years. There are many factors that can affect this outcome, including storage capacity, hydropower capacity, demand alterations and population changes, among others. These challenges require innovative and creative solutions.

There are four study phases: (1) water supply assessment, (2) water demand assessment, (3) system reliability analysis, and (4) development and evaluation of opportunities. The first two phases interrelate in that approaches and scenarios involving supply and demand must be identified. Outcomes from phase three can indicate the locations of large imbalances and assist in the development of opportunities in phase four. For phase one, there are different scenarios to project water supply that take into account multiple climate change scenarios and a paleoclimatology tree ring method that allows the observation of water supply in the Basin from 1,200 years ago to assist in forecasting future water supply. For phase two, there are four scenarios being studied: (1) current projected, which examines the current patterns (i.e., "business as usual") and the projected outcomes; (2) slow growth, which anticipates slow growth based on economic efficiency; (3) rapid growth, which observes the possible outcomes from an economic resurgence; and (4) enhanced environment, which examines the possible outcomes given expanded environmental awareness and stewardship.

The base concept of phase three is to understand baseline reliability. Following this, the state of the system will be simulated for the next 50 years with and without various options/strategies. Phase four must include a broad range of options and strategies. More than 140 options were submitted by the public regarding water management, and there are four broad categories that encompass the majority of these options: increase water supply, reduce water demand, modify operations, and governance and implementation. The researchers will package the various options and develop and evaluate representative options.

and the U.S. Environmental Protection Agency (EPA); state agencies; and numerous county, city and local entities manage the measuring and monitoring of water resources in the U.S.-Mexico border region. This measuring and monitoring provides information that helps water managers and the public understand climate trends, the ecological health of rivers, public health impacts, national ownership of waters, water deliveries to agricultural and municipal users, unauthorized withdrawals, flood control, long-term aquifer trends for both supply and quality, and surface water-ground water interactions, among others. Even with a broad range of activity already under way, **Table 2** shows a number of needs identified by the GNEB.

Table 2. U.S.-Mexico Border Water Measurement and Monitoring Needs

Agency/Program	Need	Reason	Additional Information
National Streamflow Information Program (NSIP); USGS	14 gauges in the Rio Grande Basin Border counties.	Achievement of the five critical federal needs for the NSIP network.[67]	N/A
USIBWC	Improve gauging station network.	Gauging network is used to account for the national ownership of waters of the boundary rivers in accordance with the water treaties between the United States and Mexico, and for flood control.	IBWC operates and maintains more than 60 gauging stations on the Rio Grande, Colorado River and tributaries, with each Section of the Commission in charge of the stations in its country. Most stations use satellite telemetry to provide near real-time flow data.
U.S.-Mexico Border Governors Conference	IBWC and Mexico's National Water Commission (CONAGUA) provide timely information to state and local governments when reservoir management policies are changed.	Implementation of appropriate safety measures.[68]	N/A
USIBWC	RiverWare and Aquarius modeling software.	Modernize dated water accounting procedures, making the IBWC water accounting more efficient and transparent.	In 2011, the USIBWC made a significant investment by purchasing equipment, software and training. It also secured replacement components for the aging telemetry network and invested in new bank-operated technologies, such as Hornet Plus cableways and remote-controlled boats, to allow stream measurement to be conducted safely from the U.S. bank. In addition, the USIBWC secured a commercially available hydro-database management solution that will revolutionize the processing of Commission water quantity and quality data.

Table 2. U.S.-Mexico Border Water Measurement and Monitoring Needs (continued)

Agency/Program	Need	Reason	Additional Information
USGS; National Weather Service (NWS)	More dense surface water data collection network.	To provide information regarding floods.	The USGS has been working with the NWS to identify communities with needs that have not yet been successful in securing funding to support enhanced local data collection networks. The NWS maintains a list of potential sites where additional flood information is needed or requested by local communities.
National Park Service (NPS)	Additional stream gauging data collection.	To meet its needs near Big Bend National Park at sites along the Pecos and Devils Rivers in Texas and at three sites along the Rio Grande.	N/A
USGS	Extensive ground water level monitoring network near the U.S. border in Texas.	Beneficial due to recent oil and gas exploration activities near the border that may deplete water supplies.	N/A
USGS; NWS; TX Department of Transportation; City of El Paso, TX	Funding for the proposed expansion of the current rain gauge data collection network of one site in the El Paso area.	Project has been discussed for 4 years without being funded.	N/A

Water Supply Challenges

Current or Projected Shortages and Impacts

Each of the four U.S. border states has engaged in long-term water planning to some extent, although their methodologies vary. State plans provide projections for future water supply and demand, as well as provide insights into the relationship between water supply and economic issues, indicating how lack of a reliable long-term water supply can inhibit development. These plans also demonstrate that a commitment to ensuring that future generations have access to water requires a suite of approaches, from conservation to new infrastructure development. Though the state plans tend to focus on human needs, there is growing recognition in the border region of the importance of environmental flows as well. The following regions are highlighted because state water planners have identified particular concerns about future water supply.

The 1980 Arizona Groundwater Act identified and designated five Active Management Areas (AMAs) that rely heavily on mined ground water. The Act also identified and designated two Irrigation Non-expansion Areas (INAs) within which restrictions are placed on increasing the number of irrigated acres. The Santa Cruz and Tucson AMAs include portions of the border region near Nogales and Tucson, and in those areas developers must demonstrate an adequate water supply for 100 years before new development can be permitted. Arizona also has authorized counties outside of AMAs to require developers of new subdivisions to demonstrate access to an adequate water supply. In the border region, Yuma and Cochise counties have adopted this policy. Most of the Douglas Basin was designated as the Douglas INA, and it has been determined that there is insufficient ground water to provide a reasonably safe supply for irrigation. The Douglas Basin has been severely over-drafted since the late 1940s, and a decline in water levels in wells has been observed.[69]

The Arizona Department of Water Resources also has conducted surveys of water providers to get their perceptions of water issues in their region. A 2004 survey of water providers in the Lower Colorado River and Southeastern Planning Areas[70] identified the following as moderate or major concerns:

- Inadequate storage capacity to meet peak demand.
- Inadequate well capacity to meet peak demand.
- Inadequate water supplies to meet current demand.
- Inadequate water supplies to meet future demand.
- Infrastructure in need of replacement.
- Inadequate capital to pay for infrastructure improvements.
- Drought-related water supply problems.

The 2009 California Water Plan Update for the South Coast, which includes coastal regions of California from the Los Angeles area to the Mexican border, projects significant increases in water demand. Taking into consideration the current trend analysis in the report (one of three possible scenarios analyzed), urban water demand could increase by 1.645 million acre-feet by 2050 and agricultural demand would drop by 320,000 acre-feet.

For California's Colorado River region, which includes the eastern portion of San Diego County (a border county), all of Imperial County (a border county) and portions of two non-border counties, urban demand shows an increase of

1.15 million acre-feet while agricultural water demand is expected to decrease by 850,000 acre-feet due to a reduction of irrigated acreage and conservation.

According to the New Mexico Lower Rio Grande Regional Water Plan (2003), demand is projected to increase from 495,000 acre-feet in 2000 to a range of 519,000 to 572,000 acre-feet by 2040. The Water Plan notes that "if ground water development expands much above the current levels, the Rio Grande will not be able to continue replenishing the ground water and this will result in ground water mining in the Rincon Valley and Mesilla Basins. Because the river cannot be isolated from the Rincon Valley and Mesilla Basins, it will continue to replenish the basins, which in effect robs the river of water. This is water that should be in-stream flow for local agricultural users as well as meeting compact delivery obligations to Texas users and Mexican Treaty water users."[71]

The Water Plan also notes that the Mesilla and Hueco Bolson aquifers are shared by New Mexico, Texas and Mexico, which generates uncertainty related to long-term management and viability of the aquifers, especially because there has been significant usage by Texas and Mexico. The report expresses concern about the poor long-term viability of the Hueco Bolson, both due to water supply and water quality problems. It should be noted, however, that El Paso Water Utilities performed a peer-reviewed study in 2004 that concluded "with continued reliance on surface water when it is available along with continued conservation, there is an adequate supply of fresh ground water for 70 years or more."[72]

The Water for Texas 2012 State Water Plan (for Far West Texas, Region E), which has most of its population centered in El Paso, Texas, has identified an additional 226,569 acre-feet per year of water needed by 2060. Conservation is projected to account for 50 percent of the additional volume, and the plan indicated that an investment of $842 million is required for strategies to provide additional water. The plan also notes significant unmet irrigation needs in this desert region.

In Region M, the Lower Rio Grande Valley of South Texas, the State Water Plan identifies a need for an additional water supply of 609,906 acre-feet per year by 2060, requiring an investment of more than $2 billion. Agriculture accounted for 93 percent of the region's total water needs in 2010, but the management regime prioritizes municipal and industrial water uses over irrigation. The report notes that no economically feasible strategies have been identified to meet a significant portion of the region's irrigation needs. Possible strategies include acquisition of water rights through purchase, desalination of seawater and brackish ground water, irrigation conveyance system conservation, and construction of storage weirs on the Rio Grande.

More detailed approaches to assessing water needs and availability[73] are being developed to meet the greater range of users and complexity of water use. Measures of consumptive use, instead of ground and surface water withdrawals, can be used to evaluate farm efficiency efforts and the potential for urban gray water reuse. To address the seasonal nature of water needs, monthly (instead of annual) assessments of availability and use can be conducted.[74] Even though complex, environmental flows (see above) can be developed and tested to support environmental resources, recreational values, flood protection, and public and environmental health. The Texas Legislature took the first step in addressing environmental flows in 2007, when it passed House Bill 3 and Senate Bill 3, which require the Texas Commission on Environmental Quality (TCEQ) to adopt environmental flow standards for the river basin and bay systems in the state.

Case Study: **Environmental Flows in Texas**[75-77]

In 2007, the Texas Legislature passed House Bill 3 and Senate Bill 3 (SB 3), which referred to the environmental flow process in Texas. SB 3 specifically was related to the development, management and preservation of the water resources of the state. SB 3 established a nine-member Environmental Flows Advisory Group from Texas. This group then appointed the Statewide Science Advisory Committee (which has the objective to provide advice) and the Basin and Bay Area Stakeholder Committees (which represent many interests, including agriculture, cities, industry, environment and so forth). Each stakeholder committee appoints an Expert Science Team for its environmental system.

According to the schedule established by SB 3, the Expert Science Team was given 1 year to develop an environmental flow regime analysis and recommend environmental flow regimes. The stakeholder committees then would have 6 months to review and develop recommendations to submit to the Texas Commission on Environmental Quality (TCEQ).

After submission of recommendations to the TCEQ, each stakeholder committee and Expert Science Team must develop a work plan. As of August 3, 2012, three stakeholder groups had submitted work plans. The TCEQ examines the recommendations and work plans, and considers them in context of the Texas Water Code, Section 11.147(b)(1)–(10).

For implementation of the rulemaking requirements of SB 3, the TCEQ will conduct three separate rulemakings for different regions. For the Rio Grande, the Rio Grande estuary and the Lower Laguna Madre, the rulemaking is scheduled to be adopted by September 2013. The various Rio Grande committees established pursuant to SB 3 have been meeting since 2011.

SB 3 is an adaptive management process. The TCEQ may alter an environmental flow standard or environment flow set-aside through a rulemaking by following a schedule set by the Commission. The TCEQ may not alter a standard more than once every 10 years unless the work plan for that area allows it. Information on group activities and progress in all of the basins is available at the TCEQ website.

Case Study: **Impact of Off-Reservation Water Use on Tribal Land**

Note: This recent case study highlights the complexities affecting water supply involved in an off-reservation impact that depleted tribal water. Because this case currently is in litigation, names and details will not be disclosed in this account.

A community drinking water system adjacent to a Native American Reservation had a permit from the state to provide water to its community residents. The drinking water operator decided to sell water for a construction project off-reservation at a location of considerable distance from both the water system and the Native American Reservation. The construction project demanded several hundred thousand gallons of water per day for construction. The tremendous use of water depleted wells on the reservation (as well as those of nearby off-reservation residents), affecting public drinking water system wells, as well as private domestic wells.

The tribe and off-reservation residents appealed to the water system operator and owner to cease excessive pumping that was depleting water resources, but the operator continued to sell water to the construction project. The tribe and other residents appealed to the county. The county investigated and issued an order for the water company to cease pumping and selling water. The water company ignored the order to cease and continued to deplete the surrounding wells.

Off-reservation residents appealed to the tribal government and stated their belief that the tribal government had more authority than off-reservation residents to get the water company to cease pumping. Due to the proximity to the border of both the reservation and the water company that was pumping water, domestic wells and public water systems on both sides of the border were affected by this excessive pumping. The tribal government appealed to the Bureau of Indian Affairs (BIA), the U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (the proponent of the construction project).

The Environmental Assessment for the construction project had not specified where water would be obtained for construction. All the federal agencies to which the tribe appealed claimed that they had no authority to become involved or to remedy the situation. The tribe was informed that it had no authority in tribal court to issue a cease and desist order to the water company because the water company was not located on the reservation, even though its actions were affecting reservation residents. The tribe was advised that its only recourse was to request an injunction in federal court, at great expense to the tribe, and with no guarantee that the water pumping would be curtailed.

The county issued several cease orders to the water company but did not succeed in halting the sale of water. The wells on the reservation became severely depleted, and the tribe had to supplement residents' drinking water at an expense to the tribe. Tribal businesses also suffered a loss of water and had to purchase water off-reservation to keep their businesses operating.

Many tribal communities have suffered severe water loss from similar situations. If a project is permitted to proceed with construction under a Categorical Exclusion or an Environmental Assessment, there is no process for a tribe to comment on the proposed project to insist that the proponent of the project identify the water sources to be used for construction, or to request a limit on the amount of water that can be depleted during construction. The outcome of the litigation currently is pending. Tribes are researching options to determine a better recourse in the future should a similar situation occur.

Although tribal communities face many of the same issues regarding water supply, there are some unique issues affecting tribes. Most Native American Reservations, especially on the U.S.-Mexico border, are located in rural and remote areas. Many are in desert ecosystems or in harsh, rocky mountainous areas. Most of these reservation communities lack the financial resources to provide adequate infrastructure to manage water resources. Myriad laws and regulations affect water and water rights in these areas, and are complicated by issues related to "checkerboard" reservations where tribal land is interspersed with privately owned land. All federal laws relating to water quality and supply apply to Native American Reservations. Water rights, however, are governed by state law. A tribe may be a delegated authority over water on its reservation if the tribe has enacted ordinances and regulations that adequately protect water.

Water Supply Infrastructure Deficiencies

The critical nature of water supply infrastructure as a key determinant of economic growth and population sustainability is perhaps as acute in the southwestern U.S. border region as anywhere in the United States. There is a clear consensus that, despite efforts to address gaps, the region faces a substantial deficit in investment in such infrastructure. According to some measures, California owes its position as the world's 9th largest economy to the water supply infrastructure investments it has made over the past 150 years. Likewise, the burgeoning economies and the development of thriving agricultural sectors in the other U.S. border states would not have been possible without the legacy of investment in dams, canals, wells and other water storage and conveyance infrastructure throughout the region. Viewed from a population sustainability perspective, Jo Ellen Darcy, a senior official at the U.S. Army Corps of Engineers, observed at the World Water Forum in Marseille, France in March 2012, that without such investment, the population of Los Angeles County would be nearer to 100,000 rather than the 18 million who currently reside there. At the same time, water needs are dynamic and impacted by the very population and economic growth that previous investment in the sector has enabled. Additionally, other factors such as the decay of decades-old infrastructure make a substantial infrastructure deficit discernible.

The American Society of Civil Engineers (ASCE) estimated in its 2009 state-level "report card" series that the four U.S. border states would face a drinking water infrastructure requirement of more than $65 billion over the subsequent 20-year period. The study considered dams/reservoirs, treatment plants, pumping stations and other distribution infrastructure.

In late 2011, focusing exclusively on the region located within the 100 km strip of territory north of the border that constitutes its U.S. mandate, the Border Environment Cooperation Commission (BECC) assessed drinking water investment requirements at $2.01 billion. The BECC analysis considered the costs associated with providing access to centralized water supply sources for currently unserved or underserved populations of nearly 272,000 people. **Table 3** summarizes these estimated requirements, presented by each state's border region and water and wastewater needs (see Chapter 4 for additional information).

Many residents in U.S. border counties continue to lack access to adequate drinking water and wastewater services, primarily in rural communities where they rely on onsite systems. Given that many onsite systems lack adequate maintenance or water quality testing, resources may be needed either to connect the residents to a centralized municipal or utility system or to improve the onsite systems. A particular concern and investment priority is with households that have connections to centralized water but not centralized wastewater service as shown in **Table 4**. Residents in these households are likely to live near urbanized areas because they receive water, and the gap in wastewater service means an increased risk of exposure to untreated or inadequately treated wastewater, influenced by the following:

- Residents connected to centralized water systems tend to be higher water users creating a greater burden on wastewater disposal methods, especially individual onsite systems.

Monitoring the New River, Calexico

- Areas served by centralized water systems are typically characterized by higher density development, resulting in insufficient space for adequate leach field operation.
- High water tables and/or poor soil conditions are typical in the border region and influence risks related to over-saturated leach fields.

Table 3. Access to Centralized Municipal Services – U.S. Needs and Investment Estimates

State	# of Counties	Drinking Water (DW)-Unserved	Estimated Investment-DW	Wastewater (WW)-Unserved	Estimated Investment-WW	Total Estimated Investment
California	2	38,864	$287.6 M	70,803	$849.6 M	$1.14 B
Arizona	4	133,491	$987.8 M	138,359	$1.67 B	$2.65 B
New Mexico	5	11,826	$87.5 M	38,669	$464.0 M	$551.5 B
Texas	25	87,377	$646.6 M	289,609	$3.48 B	$4.12 B
Total U.S. Border Region	**36**	**271,558**	**$2.01 B**	**537,440**	**$6.45 B**	**$8.46 B**

Source: BECC Needs Assessments, incorporating data from the U.S. Census Bureau; EPA EnviroFacts; Clean Water Needs Survey; state, city and county websites; direct contact with sector authorities, and connections and project data from BECC-NADB.

Table 4. Connections With Centralized Water Service and Without Centralized Wastewater Service

State	# of Counties	Drinking Water Connections	Wastewater Connections	% Coverage	Total Estimated Investment
California	2	1,154,181	1,122,242	97%	**$383.3 M**
Arizona	4	465,534	460,666	99%	**$58 M**
New Mexico	5	69,613	42,770	61%	**$322.1 M**
Texas	25	728,192	525,960	72%	**$2.4 B**
Total U.S. Border Region	**36**	**2,417,520**	**2,151,638**	**89%**	**$3.2 B**

Source: BECC Needs Assessments, incorporating data from the U.S. Census Bureau; EPA EnviroFacts; Clean Water Needs Survey; state, city and county websites; direct contact with sector authorities, and connections and project data from BECC-NADB.

Managing Water Supply Through Improved Management and Conservation

Border water supply challenges will require a multifaceted approach, incorporating the construction of new infrastructure but also improved management and conservation of existing resources. Agriculture is a major water user, and efforts to better manage and conserve water used in irrigation can have major benefits. An example of this is when, in 2008, the U.S. and Mexican governments, working through the IBWC, agreed to release more than $80 million in grants to improve infrastructure and irrigation practices in response to flow reduction from the Conchos River. This affected not only Mexican farmers but also those working downstream along the Rio Grande. These grants were released via the BECC-North American Development Bank (NADB) and were directed to the Delicias Irrigation District in Chihuahua and several U.S. irrigation districts so that more water would be available downstream. Two approaches to reducing water use in agriculture are better timing of irrigation and lining of canals.

Conservation is a critical element of municipal water supply management as well. Throughout the border region, cities and towns are taking steps to reduce water use by changing rate structures, offering incentives and providing outreach and education.

In addition to improvements in the efficiency of water use both for the end user and the water systems themselves, many communities throughout the United States also have begun to better incorporate drought management into their short- and long-term plans. The recent drought-like conditions throughout much of the Southwest highlighted the inadequacy of existing drought management policies and the need to significantly improve response strategies before the next inevitable drought.

In Texas, most water suppliers are required to develop drought contingency plans, but these plans often are ineffective or without tangible, actionable steps. The most important drought management tool is a strong water conservation program, which also leads to more effective drought responses.

In addition to year-long water conservation programs, however, drought management plans often involve water restrictions, depending on climactic and water supply availability conditions. Thus, with proper input and stakeholder participation, water suppliers can impose restrictions on lawn watering, irrigation schedules or other such activities. A properly vetted drought contingency plan helps avoid protracted legal battles or political uncertainty concerning water delivery.

Solar Array at San Benito Water Treatment Plant

Case Study: **Development of Improved Irrigation Scheduling for Freshwater Conservation in Pecan Fields of El Paso County**

Pecan production is a major economic activity in southern New Mexico and Texas. In 2009, New Mexico ranked first in value of pecan production with approximately $133 million in net sales.[78] In recent years, the number of pecan groves in the New Mexico-Texas border area near El Paso, Texas, has increased significantly; pecan production in New Mexico increased 63 percent between 2008 and 2009.

Pecan trees, however, need more water per acre than most other crops. Conserving water in pecan fields can reduce greatly the overall water consumption of the El Paso County Water Improvement District #1. Currently, flood irrigation used by most pecan growers in El Paso County not only flushes nutrients out of the root zone but also uses large quantities of water. Because most of the soils have an elevated salt content, they require flood irrigation.

Texas A&M University is working with the pecan growers to reduce water consumption by installing moisture sensors in the pecan groves and irrigating the fields only when water is needed by the trees. The university has received a grant of $64,700 from the Water Conservation Field Services program of the Bureau of Reclamation to evaluate the best moisture sensors and method to determine the water requirements of the pecan trees. Texas A&M University has provided an additional $65,000 in funding for the project. Readings from the sensors will be transmitted wirelessly to farmers' computers and the university data collectors.

At the conclusion of the program, Texas A&M University will deliver a final report to the Bureau of Reclamation describing the methodology for determining a better process for irrigating pecan groves. Further, Texas A&M University will work with the Pecan Growers Association and others to conduct seminars with pecan growers in the area to disseminate the information.

Case Study: **Agricultural Water Conservation Demonstration Initiative**[79]

Harlingen Irrigation District Cameron County # 1 (District) in the Lower Rio Grande Valley of Texas developed an Agricultural Water Conservation Demonstration Initiative to illustrate how the District could save water.

Established in May 1914, the District covers 38,000 acres within Cameron County. The Rio Grande serves as the only water source in the area. Average annual water diversion is 52,000 acre-feet per year for irrigation and 15,000 acre-feet per year for municipal and domestic use. The District reports an estimated water delivery efficiency of about 80 percent.

The Rio Grande Valley suffered unprecedented water shortages in the late 1990s. These shortages were exacerbated by Mexico's deficit in water deliveries to the United States under the 1944 Water Treaty, drier than normal weather conditions, and booming urbanization trends, making water conservation a priority. Lower Rio Grande water districts sought state and federal assistance for water conservation projects and received funding for the Lower Rio Grande Valley Water Conservation program and the 2025 Western Water Initiative Challenge Grant, as well as the Agricultural Water Conservation Demonstration Initiative. The latter was a BECC priority area and the District's project was certified for $3.56 million; 50 percent of its total funding came from NADB, and the remainder came mostly from the District, with about 10 percent from the State of Texas.

The Water Conservation program had two main accomplishments: installation of canal lining and a pipeline, and meters and telemetry advances. The Water Initiative Challenge Grant helped establish nine flow-metering bridges with remote telemetry units to assist farm deliveries. The Agricultural Water Conservation Demonstration Initiative brought together multiple participants from the area and provided many helpful technologies and system improvements to achieve higher rates of water conservation. These improvements included a variable speed pump, metering technologies, semi-automated calibration tanks, Internet-based information for real-time flows, surge and automated surface irrigation, and a water user accounting system. The Texas Water Resources Institute of the Texas A&M University found that, according to the Economic and Conservation Evaluation of Capital Renovation Projects for the Harlingen Irrigation District, the initiative would create estimated water savings of 13,092 acre-feet per year, on an average annual basis.

The next steps for the Lower Rio Grande Valley include a continued push for district-wide conservation improvements. The conservation programs will seek to continue to improve and expand the telemetry system and seek funds for canal rehabilitation projects, as well as for the development of low-cost level measurement devices, low-cost automatic canal control gates, and telemetry-supported soil moisture measurement devices. The total water savings from the entire project, once completed, are expected to be about 138,000 acre-feet per year.

Case Study: **The City of El Paso, Texas**

El Paso, Texas, instituted aggressive water conservation strategies to decrease water use. In 1990, El Paso was using 183 gallons per person per day (expressed as gallons per capita per day).[80] By 2008, however, it had reduced this to 137 gallons per capita per day,[81] a decrease of 33 percent. El Paso accomplished this through an aggressive water conservation and education program, including incentivizing people to xeriscape their yards, providing low-flow shower heads and low-flow toilets, developing a city water conservation ordinance, encouraging residents to report water waste, and promoting public awareness. During the summer of 2012, El Paso used 500 million gallons less than the amount used during the same period in 2011.[82]

CHAPTER 3

Water Quality

As noted in Chapter 1, the Good Neighbor Environmental Board (GNEB or Board) has addressed water quality in its 4th, 8th and 13th reports. Good water quality is vital to the health of human communities and ecosystems. This chapter seeks to update the information from prior reports, noting both improvements and remaining challenges. Following a description of the nature and scale of water quality issues in the U.S.-Mexico border region, four case studies are presented to illustrate the ways in which they are manifest at a watershed scale. This is important because truly improving water quality for the long-term depends on treatment of the entire hydrologic system, rather than short-term responses in a particular location, because contamination is cumulative as water moves downstream.

Importance of Water Quality

Water quality, and its effects on the well-being of human communities and ecosystems, is determined not only by geographical proximity. Impacts on waters from their points of origin down to their terminal points are cumulative. This means that downstream locations are affected by all of the activity upstream, including that affecting all the tributaries within the watershed or basin.[85] Additionally, water quality issues are compounded by the fact that hydrologic systems span the border.

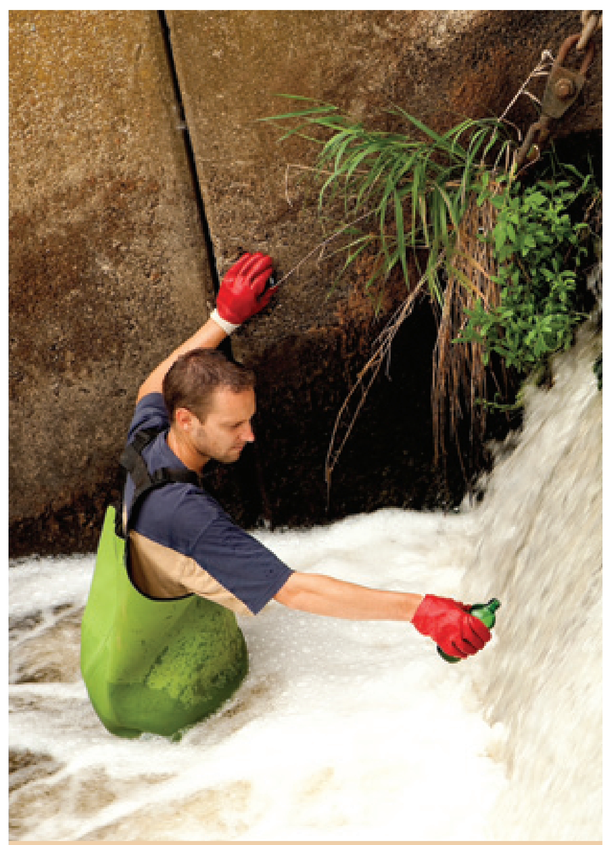
Water quality has had a profound impact on human health throughout history. Bacteria and parasites in water have caused outbreaks of infectious water-related diseases such as cholera, typhoid, dysentery and hepatitis. Additionally, chemical contaminants such as nitrates and arsenic can lead to chronic disease.

Implications for Public Health

For decades there has been recognition of the challenges facing communities with inadequate infrastructure in the border region. Although these communities offer affordable home sites for people with limited incomes, some are located close to shallow sources of water, and many were established within floodplains, and they often pose health risks due to the potential contamination of insufficiently protected shallow wells. During storm events, sewage and septage (the waste in septic tanks) may overflow into well housings and affect ground water and surface water quality.

Outside of the major incorporated municipalities, many communities in the border region obtain their drinking water from local wells. Some of these wells are in excess of 800 to 1,000 feet deep and can contain harmful concentrations of minerals such as arsenic and fluoride that occur at such depths. Additionally, some water sources contain radioactive compounds.[84] Both ground and surface waters also may be contaminated by the highly toxic byproducts of industrial activity where industrial effluent has been insufficiently treated to protect public health.

Even within communities where some residents benefit from centralized services, independent of whether they are located in urban or rural areas, the populations most threatened by waterborne diseases are the economically disadvantaged. Because they typically receive water intermittently, regardless of the method of delivery (piped systems, water tank trucks or hand hauling), economically disadvantaged households must obtain



Taking water samples for environmental research adequate quantities of water when it is available, and then store it in containers for subsequent use when the delivery system is inoperative or unavailable, increasing the risk of contamination.

Although the public health aspects of the lack of clean water for household use are widely recognized, and these include vulnerability to pathogens such as bacteria, protozoa and viruses,[85,86] the effect of contaminated irrigation water is not as apparent. Vegetables that are grown with water that has been in contact with raw sewage can carry infectious diseases such as hepatitis, dysentery and cholera. Domestic sewage also can contribute to interactions of pharmaceutical compounds with bacteria, the latter then developing resistance to medical interventions.[87-89] Where raw foods are transported across the international boundary via informal markets, health risks are difficult to track, resulting in a public health profile in the border region that does not meet the standards of a regulated marketplace.[90]

Additional threats to public health stem from water-related vector-borne diseases such as arboviral encephalitis (that which is carried by mosquitoes and ticks) and hantaviruses. Poorly controlled water sources, including stagnant and organically charged waters, can facilitate the spread of gastrointestinal pathogens, such as *Giardia lamblia*, *Campylobacter* sp., *Vibrio cholerae* and Hepatitis A and E viruses. In addition, the region has seen the emergence of several new vector-borne diseases that are associated with declining moisture regimes. For example, in 2010, Arizona, New Mexico, Texas and California accounted for 55 percent of all cases of arboviral neuro-invasive diseases in the United States.[91-93]

Implications for Ecosystems

Vibrant ecosystems play a critical role in the overall health and well-being of both urban and rural populations. When people are not in daily contact with surrounding natural systems, they may not recognize how directly dependent they are on them. The water resources contained in streams, reservoirs, lakes and underground aquifers are essential to support wildlife, agriculture and recreational opportunities, in addition to residential, commercial and industrial activity. Compromised water quality affects all of these uses.

In addition to gathering data on known contaminants, the U.S. Geological Survey (USGS) has been studying emerging contaminants (hormones, wastewater compounds, pharmaceuticals and personal care products) in border watersheds. For example, studies conducted by the USGS Border Environmental Health Initiative in both the San Pedro and Santa Cruz River Basins, both of which are dependent on effluent, aim to better understand the links between these contaminants and ecosystem health. After collecting and analyzing water, soil, plants, birds, fish and aquatic insects in the Santa Cruz River Basin, researchers detected a number of compounds at levels of concern.[94] The USGS also has initiated a study of surface-to-ground water transport of emerging contaminants at Tumacacori National Historical Park, which includes portions of the Santa Cruz River.

Implications for Economic Opportunity

Water quality also is of critical, though often unrecognized, importance to border economies. A study of the relationship between water quality and economic opportunity in Texas noted that "a sound natural environment is essential…for maintaining…a strong state economy. Healthy aquatic ecosystems conserve biodiversity and support many industries, including recreation, tourism, commercial fishing, transportation and water supply."[95]

Water Quality Concerns in the Border Region

Concerns about water quality in the border region are both acknowledged and widespread. As shown in **Table 5**, the most consistent data come from surface water analysis, as the binational water agreements concern only surface water. For example, recent data from the Santa Cruz River in Arizona suggest that water quality has improved with respect to ammonia, nitrate and biological oxygen demand (BOD) concentrations. There are indications of new measures, however, that exceed safe concentration limits, including both total and dissolved cadmium, other metals and sporadic bacterial excursions. Contamination of ground and surface water may come from industrial and sewage treatment facilities, stormwater runoff, drainage, seepage and other sources. Point source pollution in the border region may be identified from production facilities, waste sites and by industry.[96]

In addition to contaminants entering water bodies at specific points, nonpoint source pollution affects drinking water, recreation, fisheries and other wildlife as shown in **Figure 9**, and includes:

- Excess fertilizers, herbicides and insecticides from agricultural lands and residential areas;
- Oil, grease and toxic chemicals from urban runoff (e.g., paved/unpaved road systems) and energy production;

Table 5. Examples of Impairments/Pollutants in Transboundary Watersheds

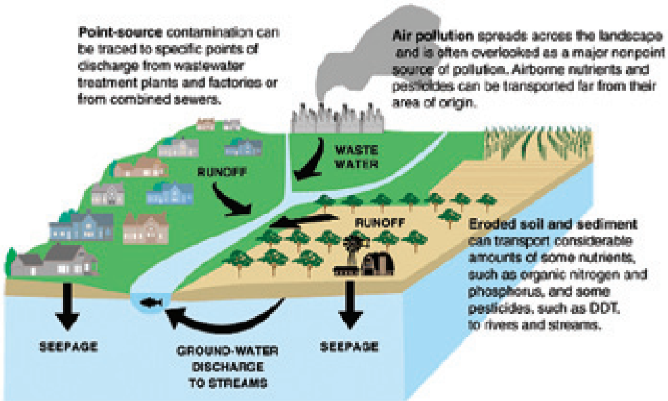
Pollutants/Impairments	Water Bodies With Impairment	Impacts
Aluminum	Burn Lake, NM	Aquatic Life
Ammonia	Nogales Wash, AZ	Aquatic Life, Wildlife, Public Health
Arsenic	Salton Sea, CA	Public Health, Aquatic Life
Bacteria	Alamo and New Rivers, Salton Sea, CA; Nogales Wash and Potrero Creek, AZ; Arroyo Colorado Tidal, Arroyo Colorado Above Tidal, Rio Grande Above and Below Amistad Reservoir, Rio Grande Below Falcon Reservoir and Rio Grande Below Riverside Diversion Dam, Laguna Madre and Gulf of Mexico, TX; Mimbres River, NM; Pacific Ocean, CA; Tijuana Estuary, CA; Tijuana River, CA	Aquatic Life, Wildlife, Public Health
Boron	Gila River, AZ	
Chloride	Rio Grande Above Amistad Reservoir and Rio Grande Below Riverside Diversion Dam, TX	Water Quality (general use)
Chlorine	Nogales Wash and Potrero Creek, AZ	Aquatic Life, Wildlife, Public Health
Copper	New River, CA; Nogales Wash and San Pedro River, AZ	Aquatic Life, Wildlife, Public Health
Escherichia coli	San Pedro River, AZ	Aquatic Life, Wildlife, Public Health
Low Dissolved Oxygen	New River, CA; Potrero Creek and Painted Rock Borrow Pit Lake, AZ; Arroyo Colorado Tidal and Laguna Madre, TX; Bear Canyon Reservoir, NM; Tijuana River, CA	Aquatic Life, Wildlife, Public Health
Mercury in edible tissue	Alamo and New Rivers, CA; Parker Canyon Lake, AZ; Arroyo Colorado Tidal, Arroyo Colorado Above Tidal and Gulf of Mexico, TX; Bear Canyon Reservoir, NM	Aquatic Life, Wildlife, Public Health
Nutrients	New River and Salton Sea, CA; Bear Canyon Reservoir and Mimbres River, NM; Barrett Lake, CA; Morena Reservoir, CA; Tijuana Estuary, CA; Tijuana River, CA	Aquatic Life, Wildlife
PCBs in edible tissue	Alamo and New Rivers, CA; Arroyo Colorado Tidal and Arroyo Colorado Above Tidal, TX; Pacific Ocean (Imperial Pier), CA	Aquatic Life, Wildlife, Public Health
Pesticides	Alamo and New Rivers, Salton Sea, CA; Painted Rock Borrow Pit Lake, AZ; Arroyo Colorado Tidal, TX; Tijuana Estuary, CA; Tijuana River, CA	Public Health, Aquatic Life, Wildlife
Salinity	Salton Sea, CA	Aquatic Life
Sedimentation/Siltation	Alamo and New Rivers, CA; Tijuana Estuary, CA; Tijuana River, CA	Aquatic Life, Wildlife, Public Health
Selenium	Alamo and New Rivers, Salton Sea, CA; Colorado River and Gila River, AZ; Cottonwood Creek, CA; Tecate Creek, CA; Tijuana River, CA	Aquatic Life, Wildlife, Public Health
Sulfate	Rio Grande Above Amistad Reservoir, TX	Water Quality (general use)
Temperature	Mimbres River, NM	Aquatic Life
Total Dissolved Solids	Rio Grande Above Amistad Reservoir and Rio Grande Below Riverside Diversion Dam, TX	Water Quality (general use)
Toxicity	New River, CA; Tijuana River, CA	Aquatic Life, Wildlife, Public Health
Trash	New River, CA; Tijuana Estuary, CA; Tijuana River, CA	Aquatic Life, Wildlife, Public Health
Zinc	New River, CA	Aquatic Life, Wildlife

Source: Final California 2010 Integrated Report(303(d) List/305(b) Report. http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml

- Sediment from improperly managed construction sites, crop and forest lands, and eroding stream banks;
- Salt from irrigation practices and acid drainage from abandoned mines;
- Bacteria and nutrients from livestock, pet wastes and faulty septic systems;
- Atmospheric deposition and hydromodification such as channelization, installation of dams, and streambank and shoreline erosion; and
- Ash, soil and debris from forest fires.[97]

Nonpoint source pollution is more difficult to identify because it occurs in a broad, transboundary landscape where monitoring is technically difficult and expensive. The effects can include subtle contamination of drinking water sources provided to human communities by both private and public water systems; this appears to be a particular problem in areas with widely distributed water systems serving agricultural households that are located near irrigation canals.[98] In acknowledging such risks, the U.S. federal government has enacted protective regulations, although they do not apply to all consumers.[99] In forested areas, fuels treatment (e.g., thinning and removal of wood) has the benefit of indirectly protecting water quality by reducing the

Figure 9. Water Body Pollution Sources



Source: The U.S. Geological Survey Water Science School (http://ga.water.usgs.gov/edu/waterquality.html).

number of catastrophic wildfires and therefore nonpoint source pollution, as well as directly protecting communities from fire.

The factors described in the previous chapters that are affecting water supply, from drought to increased ground water extraction, also affect water quality. For example, as seen in the Chapter 1 Case Study, in the Palomas-Columbus region at the New Mexico-Chihuahua border, arsenic and fluoride concentrations have increased in ground water as water quantity in the aquifers has decreased. Combined with more stringent drinking water standards (the arsenic drinking water standard, for example, was lowered from 50 parts per billion (ppb) to 10 ppb in 2001, with enforcement of the new standard beginning in 2006), the resulting changes have meant that many community water systems are out of compliance with federal law. Standard responses to these problems include expensive system upgrades and continued operation and maintenance (O&M) costs that many communities cannot afford.

Border tribes also face particular challenges in assuring drinking water quality for their communities. As described in Chapters 1 and 2, they have been affected by cross-border flows, the characteristics of deep-well water quality (such as the persistent problem of ammonium perchlorate and arsenic) and reduced funding. U.S. federally recognized Native American tribes must adopt federal water quality standards on their reservations that are at least as stringent as those of the U.S. federal government, although they are not subject to local or state laws or regulations.[100] Tribes have the authority to establish water quality standards more stringent than those of the U.S. federal government although no border tribes have exercised that right.[101]

After the change in the drinking water standard for arsenic, about one-half of the wells on the Tohono O'odham Nation (TON) did not meet the new standard in 2012. In the past, the TON has received support from the Border Environment Infrastructure Fund (BEIF) to address arsenic issues, but those funds have diminished. The TON has addressed the non-compliance problem by asking for exemptions for particular wells and by combining water from more than one system to achieve dilution, thereby reducing the concentration of arsenic to below the standard.[102] Researchers from Arizona State University recently received a Border 2012 grant to conduct field and laboratory work and to begin developing technologies to address the arsenic problem. In general, in response to the decreasing federal financial support to address tribal water quality issues, Native American nations have had to redirect their limited resources from other budget categories[103] and develop innovative cooperative programs with the U.S. states in which they are located.[104-106]

As noted in Chapter 1, current changes in weather patterns also affect the management of water resources. As noted above, drought reduces the volume of water, thereby increasing the concentration of contaminants. At the other extreme, dramatic storm events can produce flood conditions that can overwhelm local catchment and diversion systems, thus creating extreme stormwater runoff conditions that flood communities on both sides of the border and compromise the buffering between residential water resources and domestic waste disposal in areas with shallow wells. As in any region, there also is the prospect of compromised security for public water systems through sabotage or other kinds of disruption.

Water Quality Management and Regulation of the Resource

As described in Chapter 1, federal, state, tribal and local governments have developed policies and established programs to manage and protect water quality in the border region. Cooperative efforts among U.S. entities and with Mexico have been accomplished; however, pollutants from point and nonpoint sources in the United States and Mexico still are entering shared waterways. This problem, along with inadequately treated drinking water, is impacting the health of border residents as well as degrading environmental quality.

Border tribes also face particular challenges in assuring drinking water quality for their communities.

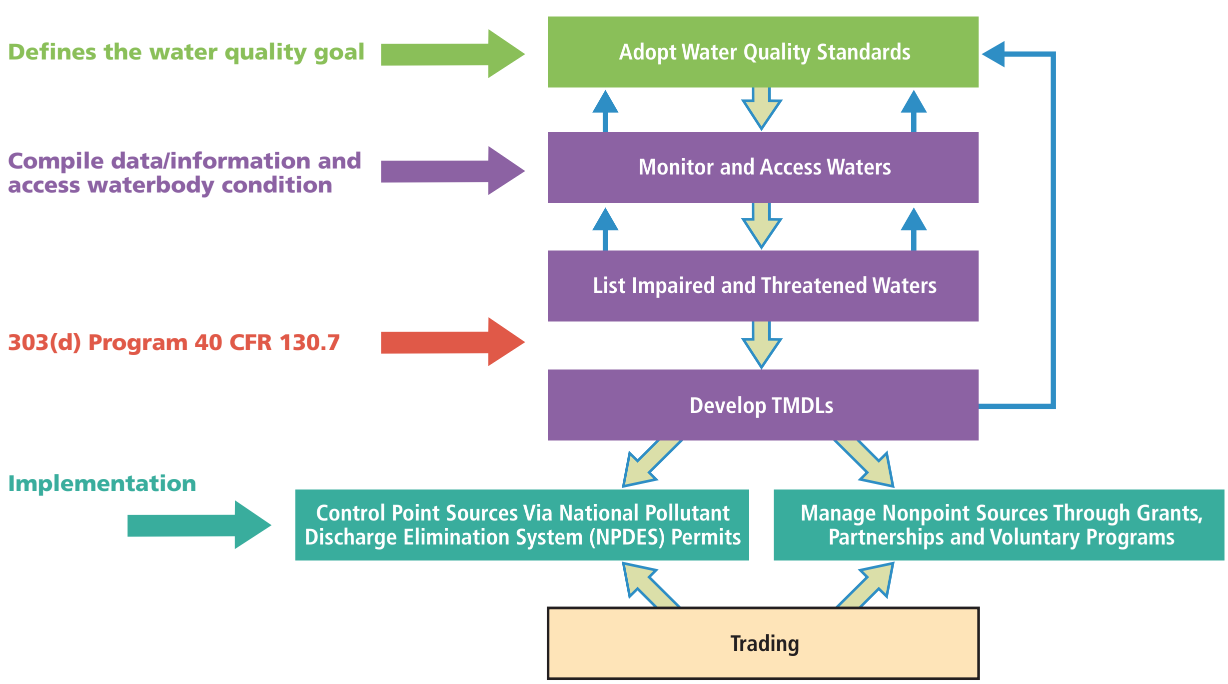
U.S. federal legislation has led to the development of water quality monitoring and protection programs aimed at both surface and ground water. For example, the U.S. Environmental Protection Agency (EPA) administers the Source Water Assessment and Protection program, building on prior Wellhead Protection program efforts to protect ground water.[107] A healthy watershed provides high-quality upstream flows that recharge wells and riparian areas as well as pesticide-free buffer zones, called refugia, which are critical for suppressing the expansion of pesticide-resistance genes and organisms.[108] Maintaining safe drinking water supplies begins with a source water assessment to delineate or map the land area that could contribute water and pollutants to the water supply. Water protection programs then are tailored to a state's or tribe's water resources and drinking water priorities using the approach shown in **Figure 10**. Section 106 of the Clean Water Act authorizes EPA to provide federal assistance to states (including territories, the District of Columbia and Native American tribes) and interstate agencies to establish and implement ongoing water pollution control programs. Pollution control programs include prevention and control measures such as permitting, development of water quality standards and total maximum daily loads (TMDL), surveillance, ambient water quality monitoring, and enforcement; advice and assistance to local agencies; and the provision of training and public information.[109]

The 1987 amendments to the Clean Water Act established the Clean Water State Revolving Fund (CWSRF) to fund water quality protection projects, including nonpoint source, watershed protection or restoration, and estuary management projects, as well as more traditional municipal wastewater treatment projects. The 1987 amendments also established the Section 319 Nonpoint Source Management program to provide federal leadership in helping focus state and local nonpoint source efforts. Grant monies to states, territories and tribes support a wide variety of activities, including technical assistance, education and training, technology transfer, demonstration projects and monitoring to assess the success of specific nonpoint source implementation projects. The four border states have used clean water loans to address water infrastructure needs in their border communities.

The Safe Drinking Water Act established programs specifically for the protection and management of drinking water. The 1996 amendments to the Act established the Drinking Water State Revolving Fund (DWSRF) to make funds available for financing drinking water infrastructure improvements, including the installation of new water treatment facilities and upgrading aging systems (see Chapters 1 and 4). The DWSRF focuses on small and disadvantaged communities and programs that encourage pollution prevention as a tool for ensuring safe drinking water. Other programs address the supervision of public water systems and underground injection wells.

EPA's Targeted Watershed Grants program was initiated in 2002 to encourage successful community-based approaches and management techniques to protect and restore the nation's waters. Any governmental or nonprofit non-governmental entity is eligible to receive a grant under this program, and inter-jurisdictional watershed partnerships are encouraged. Through these grants, EPA expects to see the return of native fish species and increased recreational opportunities, and to discover innovative solutions to improving and sustaining water quality. Between 2003 and 2007, the Targeted Watershed Grants Program supported a project along the Arizona-Sonora border to coordinate basin-wide restoration, monitoring and policy efforts targeting the Santa Cruz River in Arizona and Sonora.[110] The collaborative endeavor was led by the Sonoran Institute and brought together federal, state and local government agencies; non-governmental organizations (NGOs); academic institutions; and local ranchers and developers from both sides of the border.

Figure 10. Water Quality-Based Approach of the Clean Water Act



Source: EPA, Water: Total Maximum Daily Loads (303d). Retrieved from http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/intro.cfm#tmdlfitcwa.


Colorado River at Quechan Tribal Reservation

EPA also has a number of programs that provide assistance in protecting wetlands, and border communities from San Diego, California through Brownsville, Texas, have accessed those grants for projects to conduct assessments, map riparian vegetation, and implement control measures.[111] In response to the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000, EPA has established programs to improve water quality testing at beaches and to help beach managers better inform the public of water quality problems. To support its beach water quality monitoring program, for example, in 2012, the San Diego County Department of Environmental Health received $25K (6%) of its funding from the U.S. federal government through the BEACH program, $300K (74%) from the state and $83K (20%) from the county. Departmental staff work closely with NGOs on the program as well.

One of the most serious water quality concerns in the border region comes from the interaction of human sources with natural phenomena. The desert rivers and aquifers of the southwest borderlands tend towards high natural salinity. High levels exist where salts present in soils are mobilized and transported by the movement of ground water, leaching and biological activity, leading to their accumulation (see Case Study in Chapter 2: Development of Improved Irrigation Scheduling for Freshwater Conservation in Pecan Fields of El Paso County). The mobilization and transport of salts are exacerbated by land clearing and human activities. Although this is particularly true of the Colorado River system,[112] it also is true of the Rio Grande system.[113]

Agricultural return flows are a main cause of elevated salinity levels that affect both U.S. and Mexican water users and require monitoring by farmers and domestic water users to ensure that the water is suitable for crop production and municipal uses. In the Lower Rio Grande Valley, the El Morillo Drain in Tamaulipas, Mexico, is the subject of International Boundary and Water Commission (IBWC) Minutes 269 and 282. It contains highly saline irrigation return flows that are diverted from the Rio Grande. When the pumps for the El Morillo Drain fail or are inoperable, these highly saline waters enter the Rio Grande and jeopardize the ability of U.S. farmers to use Rio Grande water to irrigate crops—salinity levels can become high enough to kill crops. To respond to the elevated salinity levels, the IBWC developed the Morillo Drain project—a channel that prevents saline irrigation return flows from a Mexican irrigation district from entering the Rio Grande by bypassing these flows into a Mexican canal that discharges into the Gulf of Mexico. The Morillo Drain project is funded by the U.S. and Mexican federal governments and Texas irrigators. Despite the Morillo Drain project, however, in 2011, the Rio Grande Watermaster of the Texas Commission on Environmental Quality (TCEQ) had to release a total of 78,000 acre-feet of Texas water stored behind Falcon Dam to dilute the Rio Grande salinity to useable levels. Higher salinity levels are being recorded upstream of the Morillo Project. Therefore, the IBWC is undertaking an analysis of water quality from Falcon Dam to the Gulf of Mexico to determine if different sources of salinity are developing. Although problems still occur, significant improvements have been made to the Morillo Drain infrastructure in 2011 and 2012, including pumping plant upgrades and clearing of debris and sediment from channels and culverts to improve reliable operation of the system. As part of this effort, O&M responsibilities were transferred from the Mexican National Water Commission (CONAGUA) to the Mexican Section of the IBWC in late 2011.

On the Colorado River, the two countries employed a similar approach in the Wellton-Mohawk Irrigation District, bypassing saline flows from the United States and into the Wellton-Mohawk Drain. This Drain conveys these saline waters to the Santa Clara Slough in Mexico. The bypass ensures that the salinity of Colorado River water that the United States delivers to Mexico is similar to that received by U.S. users. Further upstream, the U.S. federal government, in partnership with individual water users and water districts throughout the basin, has made considerable effort in recent decades to reduce salinity loading into the river by some 1.2 million tons per year. The Colorado River Basin Salinity Control Act of 1974 authorized the planning and execution of successful salinity control measures, including improving irrigation practices such as by lining canals and ditches to reduce percolation of salinity from farm fields into the Colorado River, and improving flood irrigation systems or providing sprinklers.[114]

Best Practices

In the border region water is scarce, highly regulated and vital to its communities for their quality of life, economic, ecological and human health. The border region shares the same complex interactivity among the atmosphere, landscape, surface water, ground water, human activities and aquatic health that impact water quality in other regions, but with the significant difference that it shares an international border with Mexico. The political geography of this shared fundamental resource significantly alters the planning environment in which water and watersheds are managed along the border. Ultimately, water quality is an outcome that is linked intrinsically to land use, discharge and stormwater policies and practices in the watershed or basin. Though much more remains to be done, the GNEB identified pockets of progress along the border where best practices currently are being implemented using collaborative, watershed-based or basin-wide approaches with local, state, regional and international partners. These efforts are laying the ground work for conservation, monitoring for impacts and planning for recovery.

Data Collection and Monitoring

The geography, growing population and natural environment in the border region place continuing stress on water resources. This requires an integrated response to support human settlements of the future, affecting land use choices, hydrography, water use patterns and economic strategies. Information that can highlight both spatial and temporal aspects of vulnerability to water shortages and contamination can be especially useful in, for example, developing local and regional water resource plans and long-run economic development plans, identifying infrastructure and investment needs, and highlighting communities and ecosystem resources most at risk.[115]

Since 2000, the GNEB has re-iterated in multiple reports (4th, 8th and 13th) its support for watershed-based or basin-wide approaches that are integrated and stakeholder driven, the development of binational data protocols, and the expansion of data sharing, analysis and monitoring infrastructure (surface, ground and aquifers) along the border's entire length, from its eastern most extent in Brownsville, Texas, to its westernmost extent in Imperial Beach, California. In the 8th GNEB report, the Board commented that these approaches are "…absolutely essential if the sustainable management of U.S.-Mexico border water resources is to be achieved."[66]

Several important initiatives have begun in recent years, including a cross-border water data sharing program in the Paso del Norte area in support of watershed restoration,[116] as well as water flow and quality management plans that have been developed collaboratively by researchers from Texas, New Mexico and Chihuahua[117] (see also *Roadmap - A Draft Model for Collaborative Operation of Transboundary Watersheds*[118]).

The following case studies illustrate the watershed-based approach to water quality analysis and mitigation. The case study of the Texas Clean Rivers Program focuses on partnerships for water quality monitoring. The Colorado River Basin Water Quality Control Board addresses water quality through establishing and implementing limits on TMDL of pollutants. The case study of the Tijuana River Valley Recovery Team illustrates an applied strategy to restore the health of the water resources in southern California. The final case study explains how conservation efforts at the landscape scale involving multiple watersheds draw upon partnerships with multiple agencies and across international boundaries.

Identifying and Implementing Pollution Limits

Once information about water quality is made available, it is important that actions are taken to eliminate or reduce contaminants. With the appropriate enforcement mechanisms in place, active stakeholder participation can be crucial for finding and adopting approaches that achieve results. Because of the cumulative nature of many contaminants, watershed-based or basin-wide approaches are critical.

Case Study: **Monitoring for Impacts: The Texas Clean Rivers Program (for the Rio Grande Basin)**

There are 1,255 miles of river and 91 monitoring stations located along the Texas portion of the Rio Grande that is the southern border of the United States. The Texas Clean Rivers Program (CRP), a federal-state partnership between the Texas Commission on Environmental Quality (TCEQ) and the U.S. Section of the International Boundary and Water Commission (USIBWC), is responsible for collecting water quality data throughout the Texas portion of the Rio Grande Basin. The CRP is a state fee-funded program for water quality monitoring, assessment and public outreach, and aims to maintain and improve the quality of water within each river basin in Texas. The CRP works with a host of partners (state and local government agencies, non-governmental organizations [NGOs] and academic institutions) to monitor, collect and analyze water samples from the upper, middle and lower Rio Grande in Texas. With these data, the partners are able to identify and evaluate water quality issues, establish priorities for corrective actions, and work to implement those actions. In addition to routine monitoring and assessment, shared through its annual report and its 5-year basin reports, the program also conducts special studies to investigate changes in stream characteristics. These science-based efforts are complemented by outreach activities, environmental education, service learning projects and public meetings. Water quality data are analyzed based on the designated use of a particular river segment to determine if the applicable water quality standards are being met. The major water quality issues for the Rio Grande Basin in Texas are bacteria (as shown in Figure 11), nutrients, salts, depressed dissolved oxygen (as shown in Figure 12), fish kills, illegal discharging, trash and exotic species.[119]

Figure 11. 2010-2012 Bacterial Impairments

Source: Grijalva, L. USIBWC Texas Clean Rivers Program for the Rio Grande (PowerPoint presentation), June 28, 2012.

Figure 12. 2010-2012 Dissolved Oxygen and Salinity Impairments

Source: Grijalva, L. USIBWC Texas Clean Rivers Program for the Rio Grande (PowerPoint presentation), June 28, 2012.

Case Study: Colorado River Basin Water Quality Control Board and Imperial Valley Farm Bureau: A Cooperative Approach for Implementation of Pollutant Limits[120]

The Salton Sea Watershed contains five of the six impaired surface waters listed on the Clean Water Act 303(d) list of the Colorado River Basin Regional Water Quality Control Board (WQC Board).[121] Water quality is impacted primarily by nonpoint source pollutants, such as sediment from irrigated agriculture in the Imperial Valley. For the region, agriculture is a billion dollar industry and is an important source of winter vegetables, such as winter greens, sold throughout the United States. These impairments require the development and implementation of total maximum daily loads (TMDLs), which provide the basis for strategies to improve and protect a region's water quality.

The WQC Board overcame its initial adversarial beginnings with the TMDL process by adopting a watershed-based management approach that focused on watershed analysis, prioritizing water quality issues, coordinating regulatory programs, and allowing for significant public participation and cooperation to develop and implement solutions. Key to the process' success was the creation of a Technical Advisory Committee that involved those most likely to be impacted by the TMDLs in their development in identifying and recommending best management practices (BMPs) for compliance.[122] The WQC Board designated a liaison to support the Committee's work as a facilitator and communicator among the Committee, the Board and the Imperial County Farm Bureau, a cooperating agency in TMDL development. The Farm Bureau's Voluntary Compliance program also has been an important contributor to the region's success by using the Farm Bureau, not regulators, in assisting the farmers to self-determine and implement BMPs tailored toward the impairments and to include them in On-Farm Water Quality Improvement Plans.

This approach has been met with significant success. The WQC Board has adopted TMDLs for the New River, Alamo River and Imperial Valley Drain, as well as a Valley-wide standard for silt. A TMDL implementation plan is in place, and monitoring data are showing a significant decrease in suspended solids for the Alamo and New Rivers.[123]

Restoration and Recovery Within Watersheds and Basins

Along the border, impaired water basins and ecosystems require long-term, collaborative solutions that take into account the varied resources, capacities and needs of stakeholders and managers.

As these case studies indicate, addressing water quality requires analysis and action on a broad, geographical scale based on realities within given watersheds. Furthermore, successfully mitigating contamination requires ongoing cooperation between private and public agencies and across international boundaries.

To promote restoration and recovery of waters, federal agencies from both countries have worked to match sampling and analytic procedures for water salinity of the Colorado River. A binational technical group, including the IBWC, the U.S. Bureau of Reclamation, and Mexico's National Water Commission completed a technical report on a study of the sampling and

Case Study: Reaching Across Borders – Landscape-Scale Conservation in the Big Bend-Rio Bravo Region[124]

In the border region, landscape-scale conservation (which typically involves multiple watersheds) necessitates transboundary cooperation and collaboration. This certainly is true of conservation efforts under way in the Big Bend/Rio Bravo Region of the northern Chihuahuan Desert—an area that encompasses more than 300 miles of the Rio Grande and many secondary watersheds, as well as nearly 3 million acres of public and private land dedicated to conservation efforts. Watershed conservation efforts in the Alamito, Tornillo and Terlingua creeks are showing promising results, including enhancement and restoration in stream, riparian and grassland habitats, and plans for a partial dam removal in Alamito Creek. Efforts to re-establish the endangered Rio Grande silvery minnow in the Big Bend reach of the Rio Grande also are showing signs of success. Landscape-scale planning is improving coordination for identifying and accomplishing shared conservation goals between the two countries, as well as between public land managers and private landowners. By working with the U.S. Fish and Wildlife Service's (USFWS) Partners for Fish and Wildlife Program and Texas Parks and Wildlife Department's Landowner Incentive program, private landowners are implementing habitat restoration activities in prioritized watersheds adjacent to protected lands.

In 2010, President Barack Obama and former President Felipe Calderon issued a joint statement for agencies in their countries to use their respective national processes to designate the Big Bend-Rio Bravo region as "a natural area of binational interest." Since then, two major binational forums have been established to support strategic implementation and coordination of transboundary landscape conservation in the region. Together, these groups are working to create a transboundary landscape conservation strategy for the Big Bend-Rio Bravo Region.

The Big Bend Conservation Cooperative is a local grassroots partnership of more than 30 organizations with leadership from the USFWS, National Park Service, U.S. Geological Survey, and Texas Parks and Wildlife Department. This group is building on successful cooperative projects to create a cooperative program focused on coordinating science and monitoring in an adaptive management framework to inform, directly and efficiently, conservation actions and improve the efficacy and efficiency of their implementation. The group also is developing a climate action plan for the region.

Related to and integrated with the Big Bend Conservation Cooperative, the Big Bend-Rio Bravo Initiative is being jointly led by the U.S. Department of the Interior and Mexican Secretariat of Environment and Natural Resources (SEMARNAT) with participation from multiple agencies in the United States and Mexico to improve binational coordination for conservation efforts in the region. This group produced the "Action Plan for the Big Bend/Rio Bravo Protected Area" in 2011. The plan contains 12 specific transboundary conservation goals focused on implementing conservation actions, connecting people with nature, and encouraging sustainable, conservation-based economic activities in local communities; it currently is being implemented by natural resource managers and scientists on both sides of the border. The Action Plan provides a framework to focus research, monitoring, restoration and conservation priorities, including the re-opening of a local Port of Entry, restoration of the Rio Grande, invasive species control, fire management and local community and visitor engagement in conservation practices.

Case Study: **Ready for Action – Watershed-Based Approaches for Restoration and Recovery: The Tijuana River Valley Recovery Team**[125]

The Tijuana River Valley and its estuary spans two countries and has two faces. The first is as an ecologically significant area that is home to a National Wildlife Refuge, National Estuarine Research Reserve, and the California State Park, San Diego County Regional Park. The Tijuana River culminates in the largest and least developed estuary in southern California, which is considered by the United Nations as a "wetland of international importance," and provides habitat to more than 370 species of birds. Its second face is as a significantly challenged natural resource that balances and is impacted by the complexity of land uses and land use policies on both sides of the border. The 1,700 square mile transboundary watershed originates in Mexico and flows northward to the United States. Stormwater flows bring trash, high concentrations of urban, agricultural and industrial pollutants and a large volume of sediment from highly erosive soils in the upper watershed's floodplain—the 8 square mile Tijuana River Valley and its associated estuary.

Until recently, up to 13 million gallons per day of untreated sewage crossed the border via the Tijuana River, resulting in beach closures year-round in the United States. To address inadequate sewage treatment, the U.S. Environmental Protection Agency (EPA) and the International Boundary and Water Commission (IBWC) invested nearly $400 million in infrastructure to collect and treat Tijuana's wastewater. In addition, a Mexican utility has made substantial expenditures to provide more than 90 percent of Tijuana with wastewater services.[126, 127]

Although these investments resolved the contamination problems of the river during dry weather, rain events can produce high stormwater runoff that concentrates trash and other urban, agricultural and industrial pollutants in the river and its tributaries with threats to ecological, recreational and economic resources. Additionally, the soils in the watershed are highly susceptible to erosion, especially when disturbed; due to urbanization, even moderate storms can bring significant flows of sediment downstream.

Excessive sediment also suffocates the vegetation and eliminates natural ecosystem functions such as coastal erosion control and pollutant removal. During a single storm event in 2005, 18 acres of wetlands in the Tijuana River National Estuarine Research Reserve were buried with sediment. Restoration of these wetlands costs more than $400,000 per acre. Rapid population growth and development within the watershed has meant greater costs for sediment removal by the City of San Diego and the State of California, with total costs tripling to $3 million and increasing from $38,000 in 2004 to $2.5 million in 2009 to remove sediment.[128]

Because sediment is listed as a pollutant causing impairment in the Tijuana River and Estuary on California's 303(d) list, the San Diego Regional Water Quality Control (WQC) Board for the State of California is tasked with addressing the sediment loads on the U.S. side of the border. In response, the WQC Board formed the Tijuana River Valley Recovery Team, a group of 30 local, state and federal agencies. The original intent of the Board was that through the formation of the Recovery Team, U.S.-side infrastructure collection of sediment and trash could be designed and funded. The Board gave the City and County of San Diego, and other landowners in the area, the choice to either participate in the Team's meetings or to face cleanup and abatement fines. The Board also funded the URS Corporation to provide cost estimates for the foreseen sediment basins and trash screens.

Preliminary hydrology and hydraulic studies of the watershed by URS suggested that most of the proposed U.S.-side infrastructure would be prohibitively expensive to construct and operate, so the Team eventually decided to try to look for solutions in Mexico. A few members of the Recovery Team started participating in Tijuana Watershed Task Force Border 2012 meetings with Mexican local, state and federal agencies. The Border 2012 program provided more than $500,000 since 2004 for projects in Tijuana to reduce trash and sediment. The program also paid for translation services for meetings between members of the Recovery Team and Tijuana officials. In addition, the Recovery Team has been involved in a new binational "watershed initiative" recently created by IBWC. The IBWC intends to sign a Minute to address the trash and sediment problem.

Both the IBWC and The Tijuana River Valley Recovery Team have expressed interest in supporting the new EPA-Mexican Secretariat of Environment and Natural Resources (SEMARNAT) Border 2020 program, which identifies the Tijuana River Watershed as one of four high-priority watersheds in the border region. If well managed, these multiple agencies, workgroups and programs will align to avoid redundancies and maximize leveraging opportunities. It is hoped also that, via the total maximum daily loads program, a mechanism is established for U.S.-side landowners to fund source control projects in Mexico so that their investment has more significant and long-term results.[129]

The day the Rio Grande Silvery Minnow was reintroduced into the wild (December 16, 2008) at Big Bend National Park.

Source: Raymond Skiles, National Park Service.

analytical procedures used by the United States and Mexico. The study was conducted in 2006-2007 after discrepancies were noted in the U.S. and Mexican methodologies. The technical group has remained active, and in 2012, it made site visits to laboratories in both countries and continued third-party laboratory analysis.

Personnel from the IBWC, the National Weather Service, TCEQ and CONAGUA have been meeting to discuss means to improve data exchange among the agencies, including ways to automate the reservoir and precipitation information gathered and distributed by CONAGUA, which manages upstream reservoirs on Mexican tributaries to the Rio Grande. CONAGUA has provided information about how to locate on its Web pages the daily bulletins containing precipitation observations and reservoir levels and discharges. The group has discussed the development of a data warehouse hosted by the U.S. Section of the IBWC, which would allow agencies in both countries to place and retrieve data.

CHAPTER 4

Water Treatment

Water treatment in this report is defined as the treatment of drinking water and wastewater to meet applicable standards. In the United States this usually means state standards, and all four U.S. border states have obtained delegation from the U.S. Environmental Protection Agency (EPA) under the Safe Drinking Water Act and the Clean Water Act (as noted previously in Chapter 1, EPA must approve and review state surface water quality standards). In Mexico, drinking water and wastewater treatment plants, which are operated at the state and local level, must meet federal standards set by the Mexican National Water Commission (CONAGUA).

Communities across the United States have found it difficult to keep up with the challenges of providing adequate water and wastewater treatment. Emerging contaminants in source water from the chemical, health and beauty care industries are putting new stresses on water treatment facilities (see Chapter 3). Wastewater treatment facilities are being asked to meet tighter standards on nutrients and toxicity. The costs associated with these changes have proven to be particularly heavy for small, rural and economically disadvantaged communities, such as colonias (see Chapter 1), which lack the institutional capacity and economic critical mass to support these requirements. The cost of operating a conventional activated sludge wastewater treatment plant has increased from $4 per million gallons per day (MGD) in 2003 and 2004 to around $11-12 per MGD today.[130] Staffing and operating costs have risen correspondingly.

There are several factors that make water treatment in the border region unique. The area has high rates of poverty, and a population that is growing rapidly and is highly mobile. Much of the border region experiences harsh, arid conditions, punctuated by seasonal heavy rainfall, and must rely on source waters of compromised quality due to high total dissolved solids (TDS), arsenic, fluoride and other natural contaminants (see Chapter 3) and, in the United States, the impacts of untreated or poorly treated domestic and industrial wastewater coming across the border from Mexico. Additionally, the region must contend with the large volume of people moving back and forth across the border every day.

Even where border residents have access to centralized wastewater and drinking water systems (see Chapter 2), new regulations can require costly systems upgrades. As discussed in Chapters 1 and 3, arsenic and other elements contaminate water and require the costly adoption of more stringent drinking water standards. Local municipalities and water districts are entering collaborative agreements with public and private lenders; however, the recent addition of Davis-Bacon wage requirements to the State Revolving Fund (SRF) program can increase project costs, making SRF loans less attractive.

Despite the documented need for basic water and wastewater services, current grant funding is not at previous levels, which leaves many border communities with fewer water and wastewater services than the rest of the country. Throughout the border region, the need for infrastructure upgrade and replacement, as well as first time services, is well documented, as is the increasing shortage of financial assistance from traditional federal and state resources. What has been

Wastewater plant

Wastewater 2

documented less well is the border region deficit in management of the existing infrastructure. Many border communities have difficulty attracting qualified operators for their utilities. Border communities often have underfunded administrative staffs, making them unable to manage the utilities or their assets. Given the current funding realities and the unlikelihood of any near-term changes, now is an optimal time to re-evaluate and possibly re-prioritize border infrastructure needs. Programs are needed that will ensure the endurance of the existing infrastructure through enhanced operator training, enhanced pretreatment programs, asset management and programs to increase the financial, managerial and technical capacities of border utilities.

Various case studies are included in this chapter to illustrate border water treatment issues. They demonstrate the complexities of water treatment in a binational setting.

Infrastructure Status and Needs

Although the Border Environment Cooperation Commission (BECC)-North American Development Bank (NADB) has diversified and begun working in new sectors such as renewable energy and energy efficiency, the vast majority of the projects certified and financed continue to be in the water sector. (See Chapter 1 for a discussion on the resources contributed towards water projects and programs.) Such projects have led to significant improvements in public health and the environment over the past 15 years. Wastewater collection and treatment has increased from 21 to 82 percent in Mexico's border communities. Additionally, a reduction in discharges by more than 350 MGD has had a significant impact on downstream U.S. communities.

Even with the significant achievements, great needs for water and wastewater services still exist in the border region. The Good Neighbor Environmental Board (GNEB or Board) previously identified two issues for immediate priority: (1) provision of freshwater for human populations and for ecosystem protection and (2) prevention of contamination of ground and surface sources of water.[131]

Drinking Water

Although most border communities have adequate drinking water, there remain many areas of the border where the quality and availability of potable drinking water continues to be a major concern. Factors that affect the provisioning of drinking water are described in Chapters 1 through 3 and include greater cost of regulation compliance, lack of potable water, and issues related to drought.

Small communities and small public water systems that lack some or all of the financial, managerial or technical capacity to ensure continued treatment of drinking water to meet Safe Drinking Water Act standards present a major concern. The challenges faced by small systems are illustrated in the border region by the case of Anthony, New Mexico.

Efforts to avoid upfront costs often lead to greater expenses later. Unlike the Anthony Water and Sanitation District, many small communities cannot afford the capital costs associated with centralized reverse osmosis treatment systems. Also, they lack the institutional knowledge to operate reverse osmosis systems. For removing arsenic, these communities typically select adsorptive media treatment systems to meet the 10 ppb limit because of relatively lower capital costs and ease of operation. Adsorptive media systems typically have high life-cycle costs due to media replacement, which accounts for 79 percent of the total operation and maintenance (O&M) cost.[132] O&M for adsorptive media systems also is affected by source water quality and limited arsenic-adsorptive capacities. Further arsenic mitigation assistance is needed to achieve compliance.

Wastewater

Water quality in the border region varies widely, both for surface and ground water, but often is generalized as bad or poor. The region still is characterized by cross-border flows of inadequately treated wastewater, affecting streams, lakes, reservoirs, wetlands and the near-shore marine environment. Wastewater treatment has improved over the past 15 years due in part to projects certified by the BECC and financed by EPA through the Border Environment Infrastructure Fund (BEIF) and funded by other state and federal agencies on both sides of the border. Nevertheless, surface water

Case Study: **Water Improvements Project in Anthony, New Mexico**

Located within the southern portion of Doña Ana County, New Mexico, the drinking water in the town of Anthony (population 8,388) was found in recent years to have elevated concentrations of nitrate and arsenic. In 2004, the New Mexico Environment Department (NMED) conducted testing and found one of the seven wells to be out of compliance for nitrate. Results of a 2008 analysis by NMED found arsenic violations ranging from 11.8 to 16.6 parts per billion (ppb) in four of the seven district wells, exceeding the U.S. Environmental Protection Agency (EPA) maximum contaminant level (MCL) for drinking water of 10 ppb (the standard was lowered in 2001 and enforcement began in 2006; see Chapter 3). As a result, the Anthony Water and Sanitation District was cited for violations and required to treat the well water prior to distribution to avoid the health risks associated with human intake of arsenic via drinking water.

Health statistics show a relatively high number of cases per year in Doña Ana County of cancers that are sometimes associated with arsenic contamination. Non-cancer effects include thickening and discoloration of the skin, stomach pain, nausea, vomiting, diarrhea, numbness in hands and feet, partial paralysis and blindness. Long-term exposure has been linked to cancer of the bladder, lungs, skin, kidneys, nasal passages, liver and prostate. Arsenic also can cross the placenta and increase the likelihood of fetal exposure.

Reducing arsenic concentrations required rehabilitation of three existing wells and the new construction/installation of a reverse osmosis unit with a capacity of 600 gallons per minute. The cost of the project was $8.8 million and benefitted 3,100 connections. North American Development Bank (NADB)-Border Environment Infrastructure Fund (BEIF) construction assistance in the form of a grant covered $2.8 million (37.1%) of the total cost. In its first year, the costs for operation and maintenance (O&M) of this system were about $300K. Projected costs by its sixth year of operation are expected to increase to nearly $375K.[133] Other sources of funding for this project included loan and grant mechanisms from both the New Mexico Finance Authority (NMFA) and Rural Development of the U.S. Department of Agriculture (USDA) at 14.2 and 54.1 percent of the total cost, respectively.[134]

The implementation of this project will provide sufficient, high-quality water to meet the needs of the community. It should be noted that many communities on the border have faced high costs associated with compliance with new regulations, and not all have been able to secure loans and grants to pay for expensive improvements needed to meet the more stringent regulatory standards.[135]

quality still is a concern in many areas, and transboundary flows, of both surface waters and ground water, present a unique challenge to U.S. border communities.

A good example of the complexity of transboundary flows that affect surface water quality, including wetlands and the near-shore marine environment, is the case of the Tijuana River. In this complex case, presented in Chapter 3, water from the binational Tijuana watershed in Mexico, including stormwater, has affected the sensitive Tijuana River estuary and state park in the United States, as well as ocean water quality in Imperial Beach, California.

Infrastructure Funding

Following the passage of the Clean Water Act, the U.S. federal government provided infrastructure funding through its national Construction Grants program. This program helped communities throughout the United States meet infrastructure needs. In 1989, the Construction Grants program was replaced with the SRFs. It now has been more than 20 years since the close of Construction Grants and much of the infrastructure built with those grants is in need of upgrade or replacement. Border communities in particular have had difficulty meeting their infrastructure needs, with or without SRF assistance.

For this reason, EPA's Border Water Infrastructure Program (BWIP) began offering construction grants to border communities through the Project Development Assistance Program (PDAP) and BEIF in 1997. Over the past 5 years, BWIP, which is managed by NADB, has seen its annual operating budget shrink by 90 percent (from $50 million per year to $5 million). As noted in prior GNEB reports and Chapter 1 of this report, the BEIF received $100 million per year in the 1990s. The BWIP biennial projects solicitation has demonstrated repeatedly that infrastructure needs in the border outstrip available funds by hundreds of millions of dollars.

Working to Address Untreated or Inadequately Treated Wastewater to Improve Water Quality in Binational Waters

As discussed and highlighted previously in this report, watersheds that cross political jurisdictions can share water infrastructure. Where those watersheds cross the U.S.-Mexico border, wastewater treatment plants may receive sewage and discharges generated by residential, commercial and industrial users located across political boundaries. In addition, wastewater treatment facilities located in both the United States and Mexico discharge treated effluent across political boundaries. This makes O&M of these plants dependent on the policies and practices of both countries. The rapid growth of industry and population in Mexico's northern border region has brought this issue into focus as it relates to the quality of shared water resources.

One such example is the case of Ambos Nogales (Nogales, Sonora and Nogales, Arizona).

Case Study: **Resolving a Binational Water Quality Issue—the Nuevo Laredo Wastewater Treatment Plant**

In the late 1980s, the poor water quality of the Rio Grande was gaining attention from nearby populations because the river exceeded both Mexican and U.S. standards for bacteria and other contaminants. Residents on the U.S. side of the border pointed to inadequately treated industrial and domestic sewage that entered the river from the Mexican side of the border.[136] Texas residents in Laredo expressed concerns about an estimated 21 to 27 million gallons of raw sewage entering the Rio Grande in Nuevo Laredo from 31 discharge points each day.[137]

The United States and Mexico agreed to solve the problem through a collection and treatment system, including a wastewater treatment plant with secondary treatment of sewage. The formal development of a wastewater treatment plant in Nuevo Laredo began after the two sections of the International Boundary and Water Commission (IBWC), the United States and Mexico, signed Minute 279 in 1989.[138] The plant officially was dedicated in 1996, with a total project cost of $60 million.[139] Although the plant was built in Mexico, the United States shared the cost with the State of Texas alone contributing $2 million after the legislature appropriated funds. The final installment of $500,000 from Texas was not provided to the IBWC until July 2000, when Texas was assured that operation and maintenance (O&M) for the plant was adequate.[140] A ceremony recognizing final project completion was held in September 2000.[140]

Over the next few years, tests found that even though the discharge from the plant met water quality standards, deterioration and reduced capacity of the collection lines meant that not all sewage in the lines was getting to the treatment plant before entering the river. On July 30, 2004, the Border Environment Cooperation Commission (BECC) certified a new project, entitled "Improvements to the Water and Sewer System in Nuevo Laredo, Tamaulipas," to tie in the extra lines. Sponsored by Nuevo Laredo's Water and Wastewater Utility (Comisión Municipal de Agua Potable y Alcantarillado de Nuevo Laredo [COMAPA]), the project consisted of rehabilitating the sewer system, constructing a new treatment plant, and expanding and rehabilitating the water distribution system, as well as separating stormwater and wastewater lines. The total cost was $57.7 million, with about 40 percent of the funding coming from the U.S. Environmental Protection Agency's (EPA) Border Environment Infrastructure Fund (BEIF) and North American Development Bank (NADB) loans.[141]

The BECC stated binational benefits would include:

1. "The elimination of wastewater discharges to the Rio Grande caused by the deterioration of the mainline of the sewage collection system. This will result in environmental benefits for both countries.
2. A more efficient and rational use of water as proposed by this project evidences the willingness of Mexican authorities, especially those of Nuevo Laredo, to abide by water distribution agreements between Mexico and the United States.
3. Investments will be made in water projects to increase water use efficiency by reducing per capita water use and making a more rational use of the scarce volume of water obtained from the Rio Grande.
4. Institutional capacity building actions will provide for increased operation and commercial efficiency of COMAPA, creating a comprehensive water culture to achieve the city's sustainable development."[141]

To further eliminate wastewater discharging into the river, in June 2006, the joint BECC-NADB Board certified another major project for Nuevo Laredo. This $44 million project will build a new storm drainage system of six stormwater collectors and a stormwater channel. As of March 31, 2012, one of the stormwater collectors had been completed.[142]

The Nuevo Laredo project illustrates how cooperation between the United States and Mexico through the assistance of EPA, IBWC, BECC-NADB, and the involvement of the State of Texas, has helped resolve a binational water quality discharge issue.[143]

Raw sewage mixed with stormwater and treated with chlorine tablets flows past sandbags in the Nogales Wash used as a bypass for the dilapidated International Outfall Interceptor (IOI). The bypass of sewage into the Nogales Wash in Arizona was undertaken to facilitate repairs of the IOI at the border with Mexico. A dam designed to divert flows back into the IOI was breached by stormwater. Wastewater mixed with stormwater and flowed in an unlined channel as far north as the Santa Cruz River in Rio Rico, 8 miles north of this site (October 28, 2010).

Damaged section of 24" diameter sewer pipe removed at the De Concini Port of Entry. The scour of the wastewater infrastructure in Arizona resulted from the introduction of sediment in Nogales, Sonora. This location is at manhole 1 in Arizona, immediately downstream of the border with Mexico (October 28, 2010).

Source: Hans Huth, Arizona Department of Environmental Quality, Office of Border Environmental Protection.

Case Study: **Ambos Nogales**

Note: Due to ongoing litigation involving local, state and federal agencies, certain information related to this case study has been omitted.

The two cities that make up Ambos Nogales (Spanish for "both Nogales") are located 65 miles south of Tucson, Arizona, in the upper Santa Cruz River watershed. In Nogales, Sonora, Mexico's 2010 census recorded a population of about 220,000 with a growth rate of 3.2 percent.[1] In Nogales, Arizona, the U.S. 2010 census population was 20,837, less than 10 percent of the population of its sister city to the south.[2] The rapid growth of industry and population in Mexico's northern border region has placed increased pressure on wastewater and stormwater infrastructure shared by both countries.[3] The City of Nogales, Arizona, is seeking federal responsibility of border infrastructure where impairments are recognized as originating in Mexico.

Nogales, Arizona, is an example of a U.S. border city that shares infrastructure with Mexico. International Boundary and Water Commission (IBWC) Minute 276 allows Mexico to deliver up to 9.9 MGD of its wastewater to the Nogales International Wastewater Treatment Plant (NIWTP) in Rio Rico, Arizona.[4] This volume received from Mexico represents the majority (77%) of the wastewater treated at the plant, and the IBWC, U.S. Section, receives reimbursement from Mexico for a portion of the operation and maintenance (O&M) costs of the NIWTP.[5] When the NIWTP was relocated to its present site in 1972 at the request of the City of Nogales, Arizona, construction costs were borne by the U.S. and Mexican governments and the City of Nogales, Arizona. The city reimburses the IBWC for a portion of the O&M at the NIWTP.[6]

The International Outfall Interceptor (IOI) is the main conveyance that transfers sewage to the NIWTP. Although this infrastructure is binational, different regulatory standards for stormwater management and industrial discharges in Sonora create stresses on the infrastructure and ambient water quality in the binational watershed. Resulting challenges for the Arizona border communities are:

1. Construction and O&M issues in Sonora have resulted in multiple cross-border sanitary sewer overflows (SSOs) that affect the Nogales Wash in Arizona. Although the incidence of SSOs has decreased significantly in proportion to binational investments in Sonoran infrastructure, the SSOs continue, often as a result of a lack of infrastructure management (e.g., recent road/bridge construction).
2. U.S. federal agencies have recognized that the IOI is seriously compromised and that the primary cause of wear is scour due to Sonoran wastewater carrying heavy sediment loads. Combined (sanitary sewer and stormwater) practices in Sonora contribute to sediment-related scour in the IOI. Sediment scour has undermined the integrity of the IOI in certain places, putting border communities at risk.
3. The Nogales Wash is the main stormwater conveyance for the Ambos Nogales watershed. A section of the Nogales Wash surveyed by the U.S. Army Corps of Engineers (Corps) in 2007 indicated that the concrete bottom of the channel had lost half of its thickness.[7] In 2008, the Corps concluded that the "performance [of the box section] under current imposed loads is very unpredictable and a hazardous condition" due to scour associated with stormwater.[8] Past failures of the wash have resulted in at least one significant disruption to international railroad commerce.[9]
4. Sections of the IOI are located under the engineered portion of the Nogales Wash in Arizona. Historic failures of the Nogales Wash panels have increased the risk of a rupture of the IOI.[9, 10] A breach of the IOI would result in a major sewer spill impacting Arizona and the Santa Cruz River in the United States.

- In response to these challenges, the U.S. federal government has spent millions of dollars in the last several years to support the community in addressing these challenges in a variety of ways, including:
- Repaired damaged sections of the Nogales Wash following emergency operations.
- Sealed joints in the concrete channel of the Nogales Wash to extend their life and to reduce the likelihood of damage to the IOI.
- Under emergency conditions, repaired a damaged section of the IOI at the international border.
- Installed a flood warning system in Nogales, Sonora.
- Provided chlorine to Mexico for disinfection of SSOs in the Nogales Wash before they arrive in the United States.
- Prepared a scope of work for a study to assess and design upgrades to the IOI.
- Appropriated $750K in matching funds to plan, design and construct improvements to the IOI, (appropriations have not been spent because matching funds have not been provided).
- Convened binational pretreatment meetings and published pretreatment reports discussing efforts to control industrial discharges into the sewer systems in Ambos Nogales.

Several immediate needs include:

1. The last evaluation of the Nogales Wash was conducted by the Corps in 2008. A re-evaluation is needed that considers options for increasing flow capacity and identification of new areas with dilapidation; failure to do so poses risks to public health and disruption of international commerce.
2. The entire IOI requires evaluation and repair to minimize the inflow and infiltration that is damaging the treatment performance of the NIWTP.
3. Repair and/or relocation of the IOI from the Nogales Wash is needed to prevent rupture and the ensuing public health threats.

Continued and enhanced attention to these needs, while protecting new investments in infrastructure, will require new and innovative coordination among local, state and federal governments in the United States and Mexico. This collaboration can include studies of specific examples of cross-border surface water contamination and the development of actions to address them. Associated strategies already have been exercised by Arizona, yielding positive results as outlined in a 2011 report prepared for the Arizona Mexico Commission. As the Ambos Nogales case study illustrates, the management of border wastewater infrastructure requires proactive U.S. federal government engagement that includes the participation of all binational stakeholders in shared watersheds.

Protecting Infrastructure Investments to Maintain Water Quality in U.S. and Binational Waters

Water and wastewater treatment facilities are costly and only part of an overall program designed to protect and maintain water quality in border water systems. Pretreatment programs remove harmful pollutants from wastewater discharged by commercial and industrial facilities before it enters the wastewater collection system to protect the systems, the wastewater treatment plant, the receiving water and the resulting sludge. In addition, proper O&M of wastewater treatment plants, including periodic training on O&M and compliance assurance, help protect investments in water and wastewater infrastructure. Along the U.S.-Mexico border, collaborative program design, training and compliance checks may involve federal, state, tribal and local partners from both sides of the border.

Case Study: **The New River**

The New River originates in the Mexicali Valley, about 13 miles south of the City of Mexicali, Mexico, enters the United States by the West Port of Entry in the City of Calexico, California, and then empties into the Salton Sea, California's largest inland lake.[144] The New River sub-watershed drains about 175,000 acres from Imperial Valley and 300,000 acres from the Mexicali Valley, Mexico, which includes the metropolitan area of Mexicali—a city with a population of 1,000,000 people.[144]

The New River began to be widely recognized for significant water pollution problems in the 1950s, primarily because of the odor of raw sewage.[144] Pollution sources have included untreated municipal sewage from Mexicali, industrial discharges, effluent from municipal wastewater treatment plants, and agricultural irrigation runoff on both sides of the border.[144] By the 1970s and 1980s, the sewage pipes in Mexicali were dilapidated and collapsing and the existing wastewater treatment facilities lacked the necessary treatment capacity to handle the sewage generated in Mexicali. The problem was magnified by insufficient institutional capacity. For example, sewage collectors were not routinely maintained, treatment plants were not sufficiently staffed, and there was no pretreatment program in place. All of these shortcomings resulted in routine bypasses and discharges of 10-15 millions of gallons per day (MGD) of raw sewage into the New River. Consequently, the New River acquired the dubious reputation of being one of the most polluted rivers in the United States, with many of the pollutants posing a serious threat to public health and contributing to the degradation of the Salton Sea. Since the 1990s, significant binational efforts have been undertaken to improve water quality conditions in the New River as it enters the United States.

In the case of New River pollution from Mexico, pollution prevention and managing pollution at the sources made economic and policy sense. Following project certification from the Border Environment Cooperation Commission (BECC) and completion of a financing plan by the North American Development Bank (NADB), a series of sewer infrastructure projects began to be implemented in 1998 to improve water quality of the New River as it enters the United States.[145] In 1992, International Boundary and Water Commission (IBWC) Minute 288 established a long-term sanitation strategy for the New River water quality problems at the International Boundary, and divided the sanitation projects into Immediate Repairs (i.e., "emergency fixes"), the Mexicali I, and the Mexicali II projects.[146]

The Immediate Repairs Project addressed critical deficiencies in existing facilities, including rehabilitating and replacing lift and pump stations, relining and replacing collection lines, and dredging wastewater treatment plant lagoons. The Border Environment Infrastructure Fund (BEIF) contributed $4.2 million to the Immediate Repairs Project, which cost more than $7.6 million in total. The Mexican match provided $3.4 million.[147] Additionally, the U.S. Environmental Protection Agency (EPA) contributed about $6 million to planning activities leading to the Immediate Repairs Project, Mexicali I and Mexicali II projects.[148] The subsequent Mexicali I Project, certified in 1998, consisted of 19 components to improve the collection and treatment of wastewater in the fully developed Mexicali I area. BEIF funds contributed $20.6 million to the total project cost of $55 million. The Mexicali II Project, comprised of the "Las Arenitas" wastewater treatment plant situated in an uninhabited area 16 miles (26 km) south of Mexicali, was certified in September 2003 with a total project cost of $30 million. Construction of the plant was completed in 2007.[148] Currently, further enhancements to the Las Arenitas Plant include engineered wetlands that are being constructed to treat the wastewater treatment plant effluent prior to discharge into the Hardy River.

Overall, EPA contributed nearly one-half of the $98.6 million cost of the Mexicali wastewater projects,[148] and the Mexican government contributed the remainder of the funds. Already, these projects are serving an estimated 635,000 people in Mexicali, and have resulted in the treatment of approximately 40 MGD of raw sewage that were discharged routinely into the New River. Once it was built, however, it was crucial that the infrastructure be properly operated and maintained to protect the investment and ensure that the quality of the river significantly improved. The Mexicali water/wastewater utility (Comisión Estatal de Servicios Públicos de Mexicali [CESPM]) owns and operates the sewage infrastructure and has enhanced substantially its institutional capacity ever since the projects began to be implemented. CESPM has achieved this by:

1. Staffing its wastewater treatment plants with qualified personnel.
2. Periodically conducting surveillance and testing of the sewage collectors to ensure pretreatment programs are working and that the infrastructure, personnel and the environment are protected.
3. Building an analytical laboratory at the new wastewater treatment plant (WWTP) for process control and to ensure compliance with its discharge permits.
4. Increasing accountability and transparency by making readily available to the public the plants' discharge quality and compliance data.
5. Providing stand-by portable generators and pumping equipment to prevent and minimize bypasses of raw sewage into the river.
6. Providing ongoing training and professional development of personnel.

All of these have been crucial in protecting the U.S. investment and have contributed to a substantial overall improvement of the quality of the New River as it enters the United States.

Although there remains much to be done to ensure the New River meets its water quality standards, water quality data collected by the California Regional Water Quality Control (WQC) Board, Colorado River Basin, indicate that the levels of decomposable organic matter polluting the river decreased by nearly 30,000 pounds per day—an overall pollution load reduction of nearly 70 percent. The projects and their proper operation and maintenance (O&M) also are credited with the removal and treatment of the municipal raw sewage that contributed to the river's dubious reputation. The data of the WQC Board and the U.S. Section of the IBWC (USIBWC) also indicate that the levels of pathogen-indicator organisms in the New River at the U.S. border and the amount of phosphates adversely affecting the Salton Sea have decreased substantially following project completion and implementation. Fecal coliform levels can be variable but overall levels have dropped by more than 80 percent.

The bilateral agreement to the North American Free Trade Agreement (NAFTA) that created the BECC and NADB provides for financing opportunities to develop and implement structural controls to address pollution of binational water bodies all across the border, including New River pollution in Mexico. The State of California and the State of Baja California actively participated in the BECC certification program to develop and implement sanitation projects for the Mexicali I and Mexicali II service areas and by extension, address New River pollution from Mexico.

Binational Technical Committee meetings hosted by USIBWC are held on a frequent basis to discuss environmental issues affecting both countries, monitor progress of projects along the New River, and tour the region to observe the issues still affecting water quality. Industrial pollutants are being addressed by the government agencies in the region, namely the Mexican National Water Commission (CONAGUA), by implementing industrial pretreatment programs, such as PROSANEAR, by working with the regulated community to raise awareness of the issues, and by participating in binational meetings to provide updates on current projects and introduce future projects.

CHAPTER 5

Review and Recommendations

Review of Recommendations from Prior GNEB Reports on Water

In its 8th report (2005), *Water Resources Management on the U.S.-Mexico Border*, the Good Neighbor Environmental Board (GNEB or Board) identified numerous challenges of working in international watersheds. Those challenges remain in 2012. As the 8th report noted, "Effective management of water resources is less than straightforward virtually everywhere, but in the U.S.-Mexico border region, it might be said that the task is particularly challenging. An arid climate, the presence of poverty, rapid population growth, aging infrastructure, an international border, and laws in both countries that were put into place in earlier times under different circumstances are just a few of the potential roadblocks."

In 2005, the GNEB identified a number of water supply barriers related to working in international watersheds along the U.S.-Mexico border, which are summarized here:

- ***Lack of a management framework for ground water.*** No legal regimes or institutions currently exist for managing water quality, supply or pumping of aquifers that cross the border, and existing U.S.-Mexico water treaties do not regulate the distribution of ground water between the two countries.

- ***Binational funding challenges***. Demand for water infrastructure on the border has greatly exceeded the available funding.

- ***Different legal and institutional frameworks.*** In both the United States and Mexico, the federal government establishes and can enforce laws related to water quality. In Mexico, the federal government manages water rights while in the United States, the states have this responsibility.

- ***Data collection and management challenges.*** Data gaps exist on water quantity and quality, especially ground water. There also are different methods and units of measurement used in compiling and expressing data, which makes comparison difficult, both within the United States and internationally. Another barrier is inaccessibility of data. Different water user sectors, such as industry and residential, may be reluctant to share data across the border for fear of losing their current water shares to other water users due to different national or local water priorities. The issue of sovereignty also may contribute to a reluctance to share data between the two nations, as well as shortage of resources that can make it difficult to transfer the information.

- ***"Piecemeal" implementation of watershed or basin-wide projects.*** Water management at the U.S.-Mexico border would benefit from an institutionalized, basin-wide approach.

Recent Progress and Ongoing Concerns

To address the identified barriers, the GNEB 8th Report proposed a number of "Next Steps" that are recapped below. Although some progress has been made, concerns remain in all of the proposed areas.

Promote binational sharing of information about transboundary aquifers. Devote more resources to data collection, especially ground water data. The Transboundary Aquifer Assessment Act authorized $50 million over 10 years and directed the Secretary of the Interior to establish a program to study transboundary aquifers between the United States and Mexico. Substantial actions have been taken towards this end; however, the program has been funded to date for a total of $2 million (no funding was provided in fiscal year [FY] 2011-2012). The Mexican government, however, has financed and completed studies in Mexican territory (see Chapter 2).

Restore the annual Border Environment Infrastructure Fund (BEIF) at $100 million to help meet the needs for border water and wastewater infrastructure. In FY 2007-2012, the Border Water Infrastructure Program (BWIP) operating budget has declined from $50 million to $5 million.

Encourage the North American Development Bank (NADB) to develop additional lending vehicles. As of August 2012, NADB had a total of $600.6 million in outstanding loans and loan commitments, and had an additional $661 million in grant disbursements and commitments.[149] Although NADB utilized a Low Interest Rate Lending Facility (LIRF) in the past, the tool was not sustainable as a sole alternative lending vehicle and has long been inactive. As NADB does not anticipate transacting any LIRF loans in the near future, it should consider other types of alternative lending mechanisms/assistance (see Chapter 1).

Fully exploit current institutional missions and the current legal framework. The 8th Report cited as an example the change in policy that allowed the Border Environment Cooperation Commission (BECC)-NADB to support projects within 300 km of the U.S. border in Mexico, three times more than the 100 km that was allowed previously.

Develop binational data protocols and apply them. Build capacity and trust, ensure that surface and ground water data along the U.S.-Mexico border are made available quickly after collection and Quality Assurance. Establish an annual U.S.-Mexico Water Quality Data Exchange. Improve data exchange and transparency for large watersheds covering multiple states and jurisdictions. The International Boundary and Water Commission (IBWC) has been working on the development of a Geographic Information System for the border region to prepare and provide information using consistent databases pertaining to natural resources, basins, rivers, demarcation of the international boundary, and other topics. U.S. agencies, including the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (EPA), with the Mexican National Water Commission (CONAGUA) and the National Institute of Statistics and Geography (INEGI) from Mexico, are participating in the dissemination and exchange of data, as well as the development of a network to distribute information. Water quality and quantity data already have been uploaded into the system and will be available through an Internet Web portal in 2012. Federal agencies from both countries also have worked to harmonize sampling and analytic procedures used to determine the salinity of waters of the Colorado River.

Enhance binational watershed planning. Increase institutional support for local planning efforts in smaller watersheds. Advances in watershed planning have been made in specific communities. The USGS has been working with the IBWC on a project in the Santa Cruz Watershed at the Arizona-Sonora border. The effort included the transfer to Mexico of weather monitoring and stream gauge equipment provided by the USGS to monitor conditions in Mexican headwaters. The equipment is part of a collaborative effort to jointly monitor, track and develop strategies for mitigation of floods and associated damage. The Tijuana River Valley Recovery Team, which includes participants from government agencies in Mexico and the United States, completed its recovery strategy document at the San Diego, California-Tijuana, Baja California border (see Chapter 3, Case Study: Ready for Action – Watershed-Based Approaches for Restoration and Recovery: The Tijuana River Valley Recovery Team). The document recommends construction of sediment basins and trash capture devices in the United States and Mexico, improvement of cross-border communication, and environmental restoration activities.

In addition to its recommendations in prior reports, the GNEB recommended addressing the continued impacts of nonpoint source pollution in watersheds in its May 2009 letter. California has begun by funding watershed planning efforts and establishing total maximum daily loads (TMDL) limits and regulations.

Recommendations of the 15th Report

I. Increase Collaboration and Coordination

Where specific water sanitation and quantity issues arise involving binational water bodies, the GNEB recommends that the U.S. federal government convene groups that include the government of Mexico, stakeholders in Mexico, border states, tribal and local governments, and citizens to solve these problems**.**

I.A. Concerning Management and Planning, the GNEB recommends:

- The **U.S. federal government** enhance binational watershed planning and increase institutional support and technical assistance for local planning efforts in smaller watersheds.

- The **U.S. Department of the Interior**, **U.S. Department of Agriculture (USDA)**, **U.S. Section of the IBWC (USIBWC)** and **the U.S. Environmental Protection Agency (EPA)** continue to take a cooperative binational approach to watershed level management. This includes the USIBWC continuing to lead discussions with Mexico on finding common areas for the sustainable management of shared water resources, including protection of the quality of life and the environment in both countries.

- The **U.S. Department of the Interior** continue to provide institutional support to the Colorado River Basin Water Supply and Demand Study and other efforts to gain information for better management of border watersheds and water bodies, and then ensure that the solutions examined and adopted in such studies include those that promote healthy river flows in the Lower Basin. This would include dissemination by the U.S. Department of the Interior of results of the Colorado River Basin Water Supply and Demand Study to stakeholders in other border watersheds.

- The **U.S. federal natural resource agencies** and the **IBWC** develop metrics and models for environmental flows for use in water planning to obtain lessons learned for potential use in other border watersheds, recognizing the sovereignty of U.S. states regarding water rights. The information that is needed includes analysis of the range of flow characteristics, such as peak flow and monthly flow variation, and base flows to support planning for allocations, wildlife habitat needs, recreation and treatment capacity.

The USIBWC should continue to lead discussions with Mexico on finding common areas for the sustainable management of shared water resources.

- The **USIBWC** continue to facilitate binational, multi-stakeholder efforts to improve water quality in binational water bodies.

- The **U.S. federal government** continue to develop and implement programs that assist utilities, municipalities and industrial and agricultural interests to achieve water conservation objectives. The U.S. federal government should make these programs functional at multiple scales, for example, by integrating basin-level initiatives with on-farm technical assistance.

- The **BECC** and **NADB** continue to assist applicants to develop water conservation efforts, including those to be implemented in times of drought, through their technical assistance and other programs, and **EPA** continue to incorporate water and energy conservation actions into its cooperative agreements with the BECC-NADB.

- U.S. federal agencies, particularly the **USIBWC**, **Bureau of Land Management**, **Bureau of Reclamation**, **National Oceanic and Atmospheric Administration (NOAA)**, **U.S. Fish and Wildlife Service (USFWS)** and **U.S. Forest Service**, continue to provide coordinated institutional support for water and drought management along the border, including assisting planners in developing future-use scenarios based on environmental limitations and historical drought conditions.

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- **EPA** and the **IBWC** work to strengthen partnerships with Mexico to improve pretreatment of wastewater discharges in shared watersheds, as well as to manage stormwater and nonpoint source discharges from municipalities.

- **EPA** and **the Indian Health Service (IHS)** continue to assist tribes in building capacity to develop greater recognition and regulatory authority over tribal waters.

- **EPA**, as stipulated in Minute 304,[150] continue to ensure that state and municipal governments participate in pertinent project planning and development meetings, and that EPA allow state and municipal governments to participate in the annual Minute 304 meetings with the IBWC and CONAGUA.

I.B. Concerning Data Acquisition and Sharing, the GNEB recommends:

- U.S. federal agencies within the **U.S. Department of the Interior** and the **USDA** develop and sign formal U.S.-Mexico border region water resources data agreements that will support the collection, analysis and sharing of compatible surface and ground water data across a wide range of uses to promote transparency, increase data utility and help ensure that border water resources are managed effectively.

- U.S. federal agencies, such as the **USGS**, **Bureau of Reclamation** and **USFWS**, as well as Mexican stakeholders and tribal partners, should participate in U.S. state environmental flow reviews. Where no U.S. state environmental flow review or process is occurring, these federal agencies should convene basin-wide analyses of environmental flows that are developed with Mexican, state and tribal partners to help identify the quantity, timing and quality of flows and beneficiaries of these ecosystem services. These analyses should be shared with U.S. state environmental flow reviews when and if they occur.

- More resources be made available to **local ground water conservation districts, state agencies** and the **USGS** to enhance the coordination and data collection activities currently under way. The additional data collected will enhance the understanding of the effects of an increase in ground water pumping on ground water levels near the U.S.-Mexico border in Texas, especially in counties like Webb and Maverick that lack local ground water conservation districts and have experienced significant recent oil and gas exploration activities.

II. Reduce Discharge into Border Water Bodies

The GNEB recommends:

- The **USDA Natural Resources Conservation Service (NRCS)** and **Bureau of Land Management** identify and encourage land use practices that reduce sediment entering border water bodies.
- The **NRCS** address, in consultation with states, the control of nitrate contamination of surface and ground water in the border region.
- The **U.S. Department of Energy** work in concert with **EPA** and the **U.S. Department of Commerce** to update permitting processes for electricity generators that are expanding their capacity and services, and to provide technical support to assist these generators in implementing suitable practices.
- The **IBWC**, **EPA** and **U.S. state and municipal environmental agencies** facilitate sharing of industrial pre-treatment programs with Mexican federal, state and local water agencies.
- The **Water Policy Group of the Border 2020 program** encourage measures to protect shared infrastructure and the environment in binational watersheds.
- The **Border 2020 Water and Waste Groups** work to protect border watersheds through improved management of waste on both sides of the border.
- The **U.S. federal government** develop and/or implement models to estimate nutrient load and transport that informs the efficacy of sediment conservation practices.

III. Improve Drinking and Wastewater Infrastructure

The GNEB recommends:

- The **U.S. federal government** continue to assist in building institutional capacity on both sides of the border to ensure reliable operation and maintenance of municipal wastewater treatment facilities and collection systems, through resources such as NADB's Utility Management Institute. In addition, the government expand NADB's Operator Training Pilot program in Mexico that incorporates best practices from both the American Water Works Association and National Sewerage Association.
- The **U.S. federal government** work with Mexico to repair and replace border infrastructure to separate wastewater from stormwater, and provide emergency backup power to provide redundancy and reliability to border treatment plants.
- The **IBWC** and **EPA** work to raise stakeholder awareness of the impacts of inadequate wastewater management on binational watersheds and, through the study of specific examples of transboundary surface water contamination, support appropriate and consistent management of wastewater infrastructure, including conveyances, to ensure protection of our shared water resources.

IV. Address Financial Needs

The GNEB recommends:

- The **BECC** and **NADB** continue to provide funding for water management and planning, specifically for water conservation and drought management efforts.
- The **U.S. federal government** devote more resources to data collection, especially of ground water data, including fulfilling its commitment to the Transboundary Aquifer Assessment Program (TAAP).
- The **BECC-NADB** and relevant agencies increase opportunities for economically disadvantaged border communities to obtain funding through grants, cost-share agreements and low-interest loans, supported by financial, managerial and technical assistance. Additional attention must be given to small and rural drinking water service areas unable to meet the challenges of treating water to meet new standards for arsenic, fluoride and uranium.
- The **Joint Board of Directors of the BECC and NADB** consider additional lending vehicles, such as subsidized lending, revolving loan funds and the ability to refinance debt.

Appendices

Glossary of Acronyms and Abbreviations

ADEQ	Arizona Department of Environmental Quality
ADWR	Arizona Department of Water Resources
AFY	acre-feet per year
AMA	Active Management Area
ASCE	American Society of Civil Engineers
AWBA	Arizona Water Banking Authority
BEACH	Beaches Environmental Assessment and Coastal Health (Act)
BECC	Border Environment Cooperation Commission
BEIF	Border Environment Infrastructure Fund
BIA	Bureau of Indian Affairs
BMP	best management practices
BOD	biological oxygen demand
Border Initiative	Border Community Capital Initiative
BWIP	Border Water Infrastructure Program (EPA)
CADDIS	Causal Analysis/Diagnosis Decision Information System
Cal/EPA	California Environmental Protection Agency
CAP	Community Assistance Program
CDBG	Community Development Block Grant
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CESPM	Comisión Estatal de Servicios Públicos de Mexicali
CIG	Conservation Innovation Grants
COMAPA	Comisión Municipal de Agua Potable y Alcantarillado de Nuevo Laredo
CONAGUA	National Water Commission (Mexico)
Corps	U.S. Army Corps of Engineers
CRP	Clean Rivers Program (Texas)
CWISA	Clean Water Indian Set Aside program (EPA)
CWSRF	Clean Water State Revolving Fund
DFA	Division of Financial Assistance
DWR	Department of Water Resources (California)
DWSRF	Drinking Water State Revolving Fund
ECWAG	Emergency Community Water Assistance Grants
EDAP	Economically Distressed Areas Program
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
Fracking	hydraulic fracturing
FS	Forest Service
FY	fiscal year
GIS	geographic information system
GNEB	Good Neighbor Environmental Board
HHS	U.S. Department of Health and Human Services
HUD	U.S. Department of Housing and Urban Development
IBEP	Integrated Border Environmental Plan for the U.S.-Mexican Border
IBWC	International Boundary and Water Commission
IHS	Indian Health Service
INA	Irrigation Non-expansion Area
INEGI	El Instituto Nacional de Estadística, Geografía e Informática
IOI	International Outfall Interceptor
La Paz Agreement	Agreement for the Protection and Improvement of the Environment in the Border Area
LIRF	Low Interest Rate Lending Facility
MCL	maximum contaminant limit
MGD	million gallons per day
NADB	North American Development Bank
NAFTA	North American Free Trade Agreement
NGO	non-governmental organization
NIDIS	National Integrated Drought Information System
NIWTP	Nogales International Wastewater Treatment Plant
NMED	New Mexico Environment Department
NMFA	New Mexico Finance Authority
NOAA	U.S. National Oceanic and Atmospheric Administration
NPS	U.S. National Park Service
NRCS	U.S. National Resources Conservation Service
NSIP	National Streamflow Information Program
NWS	U.S. National Weather Service
O&M	operation and maintenance
PDAP	Project Development Assistance Program (BECC)
ppb	parts per billion
Regional Water Board	Regional Water Quality Control Board
RUS	Rural Utilities Service
SB 3	Senate Bill 3
SDS	Sanitation Deficiency System
SFC	Division of Sanitation Facilities Construction
SEMARNAT	Secretaría del Medio Ambiente y Recursos Naturales
SEMARNAP	Secretaría del Medio Ambiente, Recursos Naturales y Pesca
SRF	State Revolving Fund
SSO	sanitary sewer overflow
STARS	Sanitation Tracking and Reporting System
State Water Board	State Water Resources Control Board (California)
SUTA	Substantially Underserved Trust Areas
TAAP	Transboundary Aquifer Assessment Program
TBI	Tribal Border Infrastructure
TCEQ	Texas Commission on Environmental Quality
TDS	total dissolved solids
TMDL	total maximum daily load
TON	Tohono O'odham Nation
TPWD	Texas Parks and Wildlife Department
TWDB	Texas Water Development Board
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USIBWC	United States Section of the IBWC
WaterSMART	Sustain and Manage America's Resources for Tomorrow
WCFS	Water Conservation Field Services and Water
WEP	Water and Environmental Programs (USDA)
WIFA	Water Infrastructure Finance Authority (Arizona)
WQC Board	Colorado River Basin Regional Water Quality Control Board
WRRI	Water Resources Research Institute
WWTP	wastewater treatment plant

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