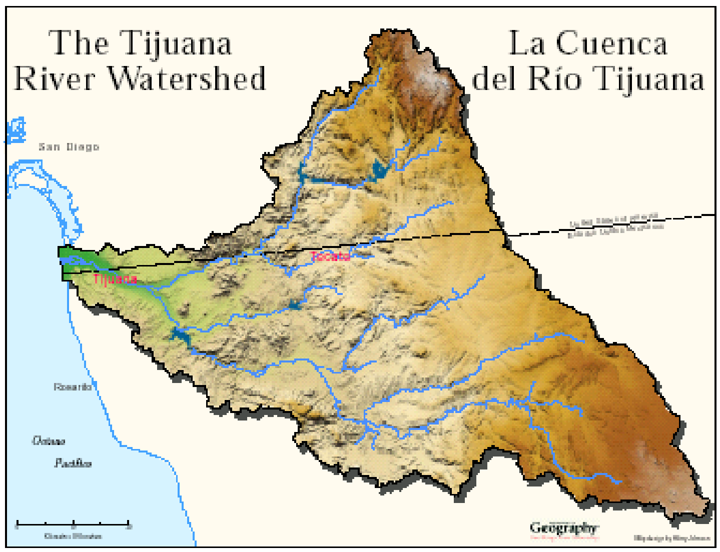
A Binational Vision for the Tijuana River Watershed

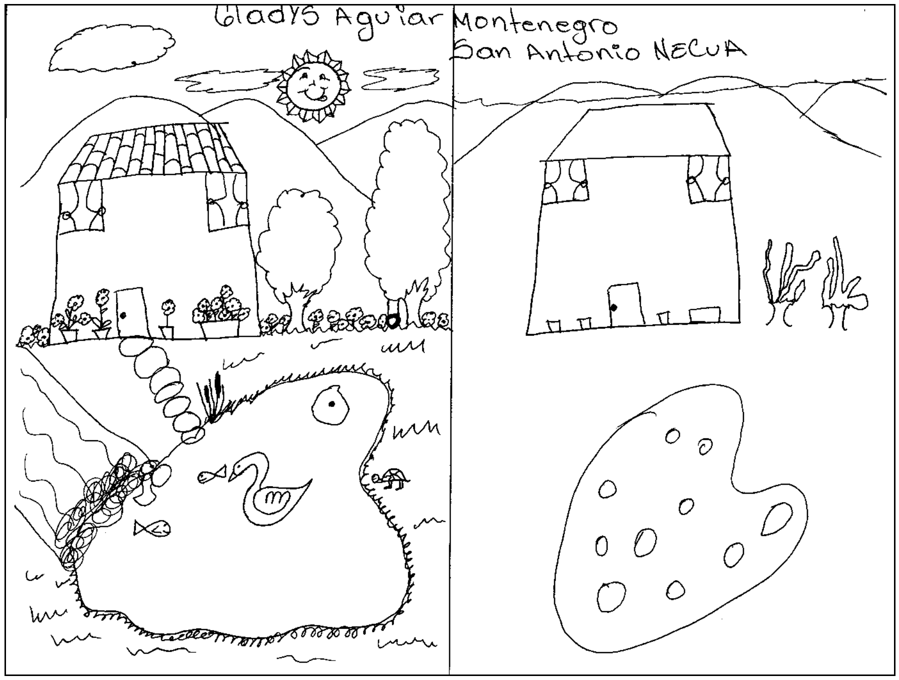


Prepared for the
Binational Watershed Advisory Council for the Tijuana River Watershed
by
the Institute for Regional Studies of the Californias and
the Department of Geography at
San Diego State University

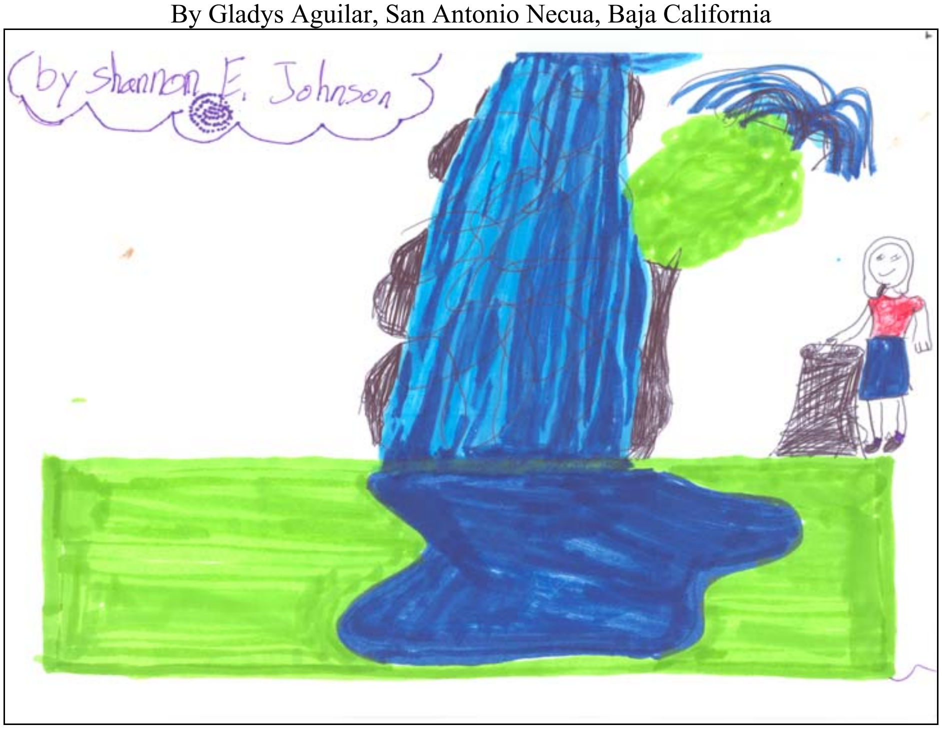
August 2005

With partial funding from the California State Water Resources Control Board,
the County of San Diego, and San Diego State University

Children's Vision of the TRW



The future TRW in a healthy state… and in an unhealthy state
By Gladys Aguilar, San Antonio Necua, Baja California



How people can help clean up the TRW waterways
by Shannon Johnson, Campo, California

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Executive vision statement for the Tijuana River Watershed

The stakeholders of the Tijuana River Watershed desire to meet the needs of the present while protecting resources for future generations; to create a balance between natural resource protection, economic development, and quality of life; to proactively manage local surface and groundwater for long-term sustainability; to protect, restore, and connect habitats; to create a strong economic base for sustainable development; and to create human communities that allow people to enjoy the unique cultural and natural landscapes and functions of the watershed.

Executive summary

The Tijuana River Watershed (TRW) lies across the U.S.-Mexican international boundary and is approximately 1,750 mi^2 (4,465 km^2) in area, with one-third in California and two-thirds in Baja California. The watershed is a place of natural and cultural beauty that is at risk from uncontrolled urbanization and infrastructure deficits. Growing human populations and land use changes have brought numerous environmental problems to the TRW region. These include:

- Decline in local groundwater quantity and further dependence on imported water
- Decline in quality of surface and groundwater for human use
- Increased erosion and flood dangers
- Increased air pollution
- Reduction in the amount of safe, open, and green areas for urban residents
- Decline in ecosystem health
- Increasing number of threatened and endangered plants and animals

In 2002 a binational team of researchers and practitioners, the Binational Watershed Advisory Council (BWAC), was convened to address these environmental challenges. The council identified stakeholders in the watershed who, in turn, participated in the development of this Binational Vision for the TRW, a snapshot of the current and desired conditions in the TRW. The stakeholders also helped to devise strategies and options for achieving that Vision.

The Vision document contains baseline data and trends for the major areas of concern identified by stakeholders: water, air, ecosystems and natural resources, waste, and socioeconomic issues. The following are brief descriptions of the issues in the watershed that will be discussed in detail in the body of this report.

Population growth

The watershed currently is home to about 1.4 million people; this figure is expected to double in 15 to 20 years.

Land use

Experts estimate that 90% of the land within the Municipality of Tijuana will eventually be developed. Tecate's industrial, commercial, and residential sectors are predicted to extend southward. The City of San Diego's urban footprint is predicted to expand southeast. New proposed border crossings at Tecate, Jacumba, and in East Otay Mesa (Otay II) would facilitate that southeast expansion. There is a growing concern that these three cities will merge into one megalopolis at the Otay corridor and choke off open space and wildlife corridors.

Water quantity and quality

Historically, the TRW's rivers ran with clean water, the ocean and wetlands were healthy, and groundwater was the main source of potable and irrigation water for the region. Today, imported water from the California Water Project and the Colorado River serves much of the area, and imported water use increases each year to meet a growing water demand. Surface and groundwater are scarce in the TRW, with variable rainfall that averages only 250 mm (10 in.) per year. Contamination of TRW aquifers and surface waters from sewage runoff, fertilizers, and pesticides is a concern. Polluted surface waters partly explain the high rates of gastrointestinal disease and hepatitis found in the TRW. Nitrogen and other contaminants found in the groundwater can also cause human health problems.

The Tijuana River flows into the Tijuana River Estuary in the United States and then into the Pacific Ocean. The water at the discharge point into the ocean contains some of the highest concentrations of suspended solids, Cadmium (Cd), Copper (Cu), Nickel (Ni), Lead (Pb), Zinc (Zn), and Polychlorinated Biphenyls (PCB) measured in Southern California. These heavy metals can bioaccumulate in people and animals, causing health problems.

In conjunction with the hilly topography and unplanned squatter settlements on slopes, the TRW precipitation pattern of dry weather much of the year and short, intense winter storms produces erosion, flooding, and landslides, especially during El Niño years. Floods in the 1980s and 1990s had devastating effects on natural habitat, structures, personal property, and transportation facilities in the Tijuana River Valley and adjacent watercourses. It is anticipated that flooding will continue to be problematic because of expanding impermeable areas that increase the speed and volume of runoff, lack of vegetation on hillsides to slow the flows, clogging of stream channels from sediment and trash, and inadequate municipal storm drainage systems.

Ecosystems and natural resources

The flora and fauna of the TRW region are known internationally for their diversity and high levels of endemism (species found only in this area). The region contains many endangered and threatened species, such as bighorn sheep, the Arroyo toad, and several avian species. The watershed also contains endangered/threatened vegetation communities including coastal sage scrub and chaparral. Many of these plant and animal species are migratory and use habitats on both sides of the international boundary. Connecting these habitats is important for a species' survival.

Loss of biodiversity in the TRW regions is related to habitat fragmentation in vegetation. The main human causes of habitat loss are cattle ranching and farming, introduced exotic species that compete for resources, expanding urbanization, and extensive, dispersed rural development. Fragmentation of habitat can inhibit gene flow between populations of a species, and cause genetic problems that can contribute to extinction.

Healthy vegetated areas of the watershed should be protected. This can be achieved by designating open space preserves or natural protected areas in places, such as the Otay Corridor between Tijuana and Tecate, the upper watershed forests, the La Posta Corridor in the United States, and Joe Bill Canyon in Tecate.

Solid and hazardous waste

Trash accumulates in rivers and creeks, harming wildlife and polluting surface and groundwater. Landfills are inadequate in Mexico and recycling needs to be promoted on both sides of the border. Hazardous materials in the TRW include industrial waste, commercial waste, household waste, and biological waste that are sometimes illegally disposed of into the sewers or in canyons and arroyos. Proper treatment and disposal facilities for hazardous materials are not readily available in the Mexican portion of the TRW. Trash is sometimes burned, causing air pollution problems and health risks.

Air quality

Pollutants in the atmosphere impact the human population as well as flora and fauna in the TRW. The impacts can occur through direct inhalation of pollutants, deposition onto plants and soils, and absorption into streams, rivers, aquifers, and the nearshore marine environment. The major source of pollutants to the atmosphere within the TRW originates from human sources, such as vehicular congestion in urban areas and border crossings, heavy commercial trucking, dust from unpaved roads, burning trash, and industrial contamination.

Socioeconomic issues

The TRW is characterized by a rich cultural diversity and dynamic economic activity. However, socioeconomic issues of concern include rapid population growth, expanding industrialization, and uncontrolled urbanization over the past half century, especially in the Mexican portion. These processes have overwhelmed the ability of governments in Mexico to provide adequate urban infrastructure, affordable housing, parks and green areas, healthcare, and education. Rapid urbanization has damaged the natural environment and has contributed to the loss of historical and cultural resources. Although the regional economy has expanded significantly, job quality has not improved sufficiently, with large percentages of workers living in poverty.

In San Diego, the rapid population growth, economic expansion, urbanization and land use changes have caused habitat loss, fragmentation, and decreases of open space. Urban runoff and failure to maintain basic sewage infrastructure have impaired surface, groundwater, and marine waters of the TRW. Infrastructure improvements, such as transportation investment, the use of biotechnology, and smart growth which directs growth inward and upward is recommended to improve quality of life.

Consequences of inaction

Current policy and land use practices (residential, commercial, and industrial) have contributed to the social and environmental degradation of the TRW. Major policy changes are needed for the watershed. It is difficult to accurately predict the future. However, based on past trends and the opinion of experts, it is very likely that if no changes are made, the watershed will continue to be negatively impacted by human practices. Probable consequences of business as usual will be higher water costs, fewer natural resources, associated regional economic losses, and deteriorating quality of life. In addition, one may expect more species extinctions and a more degraded and unproductive environment, requiring importation of natural resources. For humans, a likely scenario will be the continued loss of cultural and recreational resources, a decline in quality of life, and social, political, and security problems on both sides of the border. As an alternative to inaction, the Research Team, the BWAC, stakeholders, and others have suggested some actions that can be taken in the watershed to help improve the future of the TRW.

Recommendations

Recommendations for meeting the goals identified by stakeholders in the process of developing the Vision are presented in Table 1:

Action	Implementation should begin			
	2004	2005	2006	2007
1. Identify important conservation areas for restoration and rehabilitation based on ecosystem function and threats	x			
2. Increase knowledge of the cultural characteristics of indigenous and other peoples of the watershed	x			
3. Protect sensitive habitat as well as cultural and historical areas	x			
4. Market sustainable tourism opportunities	x			
5. Binational planning for floods	x			
6. Evaluate and protect groundwater supplies	x			
7. Develop and implement watershed education programs and products for children and adults	x			
8. Connect conservation areas across the border		x		
9. Expand water reuse			x	
10. Facilitate cross-border vehicular traffic flow and reduce impacts in adjacent communities			x	
11. Develop an integrated waste management system with recycling components			x	
12. Develop a binational water quality monitoring system			x	
13. Develop point and non-point source water pollution prevention programs				x
14. Develop mechanisms for transborder watershed management				x

Table 1
Recommendations from the TRW stakeholders.

Introduction to watersheds

A watershed is an area of land where water, sediments, and dissolved materials drain into a common water body, such as a lake, river, or the ocean (

Fig. 1) (GNEB 2000). Watersheds include the precipitation catchment areas, the surface water drainage network, groundwater basins, and other elements, such as vegetation, soil, rocks, biological resources, wetlands, farms, cities, and additional human landscapes.

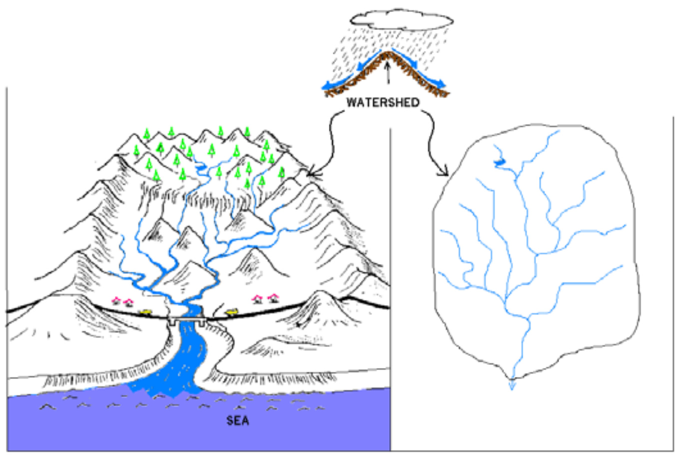


Fig. 1
Watershed diagram.
Source: (Zúñiga 2003).

Many interrelated ecological and human processes are involved in maintaining the health and economic benefits of a watershed. Some of these include climate, geology, soils, hydrology, animals, plants, and human communities (see Fig. 2).

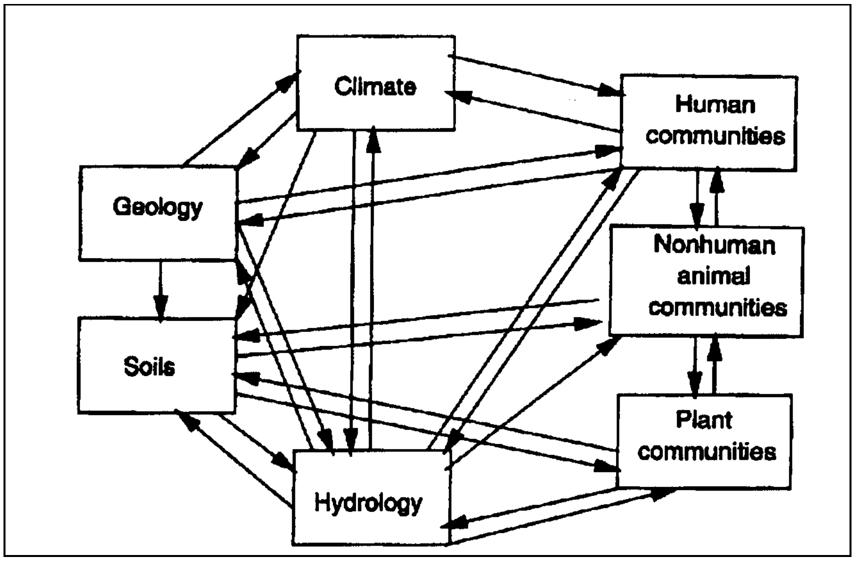


Fig. 2
Ecological and human interactions in a watershed.

A watershed vision provides a framework for harmonizing data and stakeholder inputs. A vision describes the past, present, and desired future conditions of a watershed. It is interdisciplinary and combines data from scientists, social scientists, practitioners, and watershed stakeholders. The visioning process encourages stakeholder participation, and has been shown to be a successful way of creating realistic and sustainable watershed management plans (Montgomery and Sullivan 1995).

A watershed vision typically asks the following questions (Table 2):

Questions	Steps
How does the landscape work?	Map the landscape (physical characteristics and underlying processes)
What is the history of the watershed?	Collect historical data and chart trends
What is the current condition?	Collect current data
What are the desired future states of the watershed?	Stakeholders meet to determine desired conditions
How can we meet stakeholder goals?	Develop prescriptions for meeting the desired conditions

Table 2
General questions and steps in a watershed visioning process.
Source: (Montgomery and Sullivan 1995).

Introduction to the Tijuana River Watershed

The Tijuana River Watershed (TRW) covers an area of 1,750 square miles (mi^2) or 4,430 square kilometers (km^2), with approximately one-third of the watershed in the United States, and two-thirds in Mexico (Wright, Ries and Winckell 1995). The watershed extends from the Laguna Mountains in the northeast, the Sierra Juárez Mountains in the south, to the Pacific Ocean in the west. In the San Diego portion of the TRW, 93% of the land falls under the jurisdiction of County of San Diego. In Mexico, almost all the TRW falls under the jurisdiction of the municipalities of Tijuana and Tecate, but a small part lies within the Municipality of Ensenada (Fig. 3).

Communities in the U.S. portion of the Tijuana River Basin include the incorporated cities of Imperial Beach and San Diego (including the communities of San Ysidro and Otay Mesa), Campo, Barrett Junction, Portreo, Pine Valley, Morena Village, Buckman Springs, Boulder Oaks, Tierra del Sol, and Tecate (United States). Kumeyaay Indian reservations include Campo, Manzanita, and portions of the La Posta and Cuyapaipe lands. Mexican cities include Tijuana and Tecate, and the communities of Valle de Las Palmas, Nueva Colonia Hindú, Carmen Serdán, Vallecitos, Santa Verónica, Nejí, El Hongo, San Luis, and Terrazas del Valle. Mexican indigenous communities include San José de Tecate, Juntas de Nejí, Aguaje de la Tuna and Peña Blanca. These are not officially recognized as communities by the Mexican government, with the exception of Juntas de Nejí.

The eastern part of the watershed encompasses mountain ranges with altitudes reaching 1,900 m (6,233 ft), and an average precipitation of 250 mm (10 in.) (CNA 1995; Ojeda Revah 2000). The major tributaries in the TRW are the Cottonwood Creek-Río Alamar system and the Río Las Palmas system. The TRW is characterized by steep, hilly terrain and a Mediterranean climate. Vegetation cover is dominated by chaparral and coastal sage scrub, along with wetlands (vernal pools and riparian zones) and oaks and conifers in the mountains. Temperatures range between 8 to 18 degrees Celsius (46.4 and 64.4 degrees Fahrenheit) (Fig. 4) and precipitation amounts range from 150 to 650 mm (5.91 to 25.59 in.) per year (Aguado 2005).

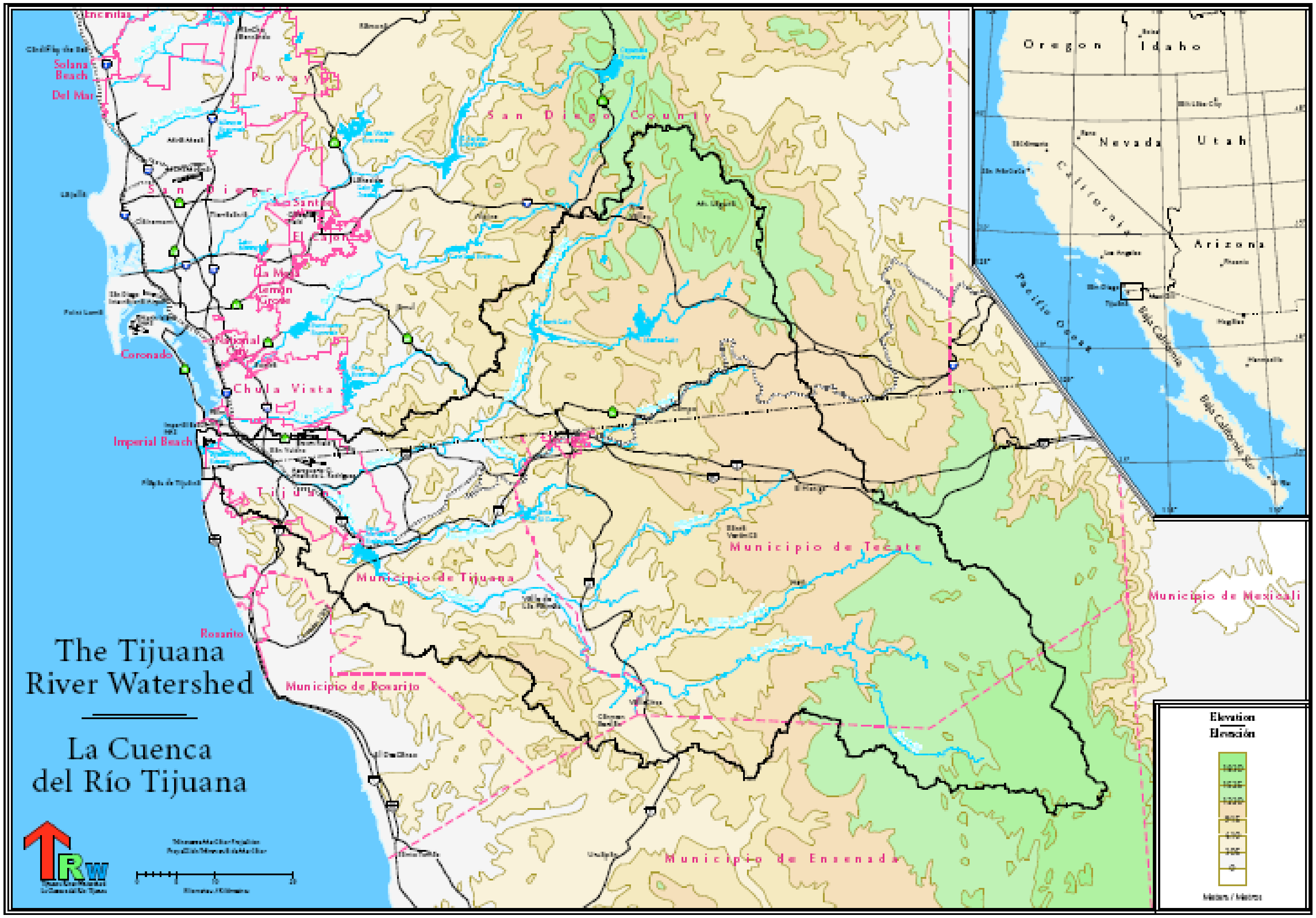


Fig. 3
County and municipality boundaries in the TRW.
Source: Geography Dept., SDSU.

In terms of human activity, the western section of the watershed demonstrates rapid economic growth, urbanization, and population expansion in Tijuana, San Diego, and adjacent cities. The eastern end of the basin remains lightly developed, although dispersed rural development is increasing in the United States and Mexico. The TRW has numerous aquifers that provide local drinking water. Water storage includes the Rodríguez and Carrizo Reservoirs in Baja California, and the Morena and Barrett reservoirs in California. The Carrizo Reservoir is the terminal for the Colorado River water brought over the mountains via the Colorado River aqueduct. The other reservoirs store runoff from local precipitation.

The most pressing environmental and cultural issues identified in the watershed include rapid population growth, uncontrolled urbanization, increasing demand for water, flood control, poor water quality, and the loss of important animal and plant species and habitats. Cultural issues include the preservation of important indigenous, historical, and archeological resources. There is also a growing concern about decreasing quality of life in the TRW related to environmental and cultural degradation, and other issues, such as traffic congestion, loss of recreational areas, public safety, crime, and poverty.

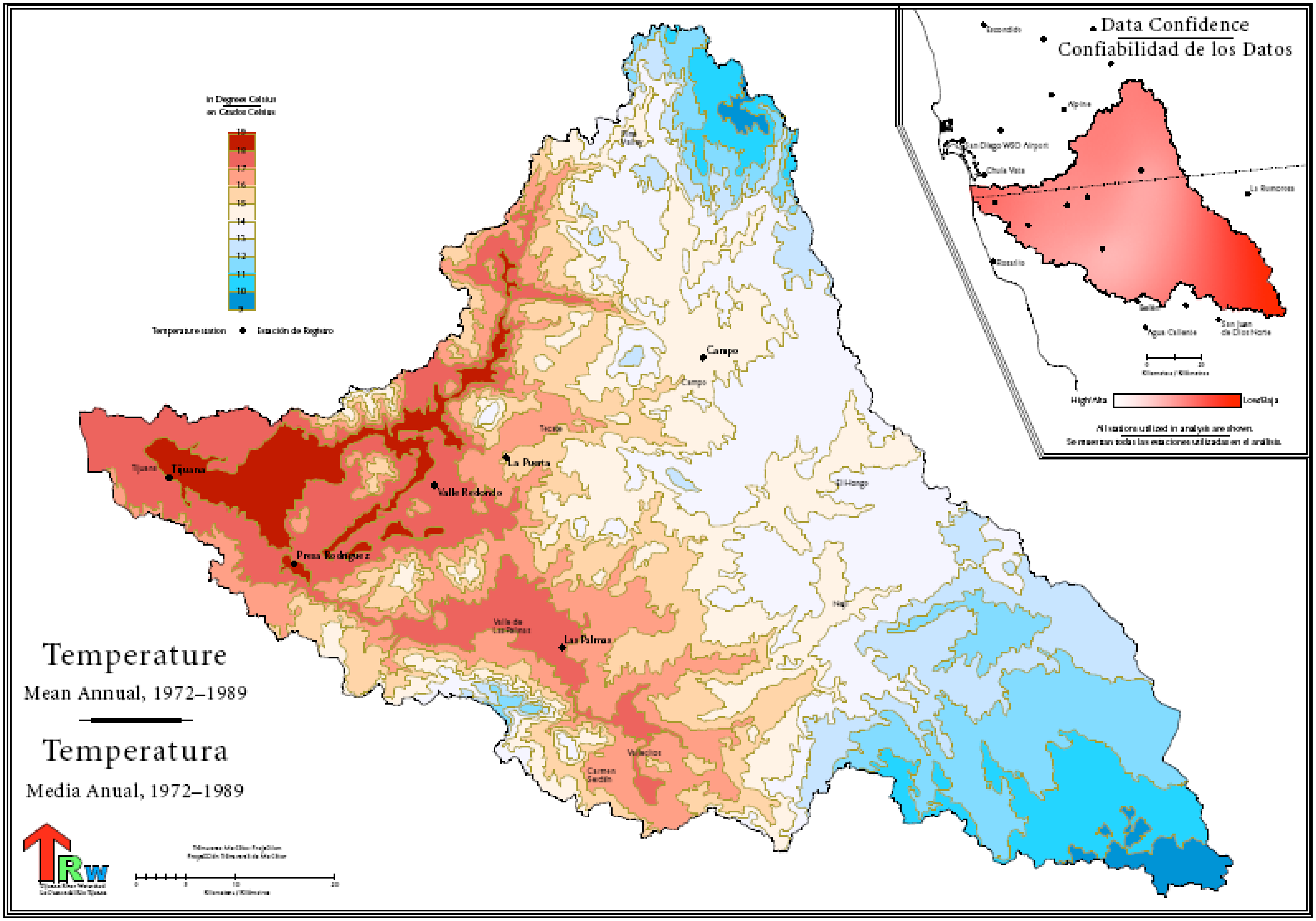


Fig. 4
Temperature.
Source (SDSU and COLEF 2005).

The TRW Binational Vision Project

The TRW Binational Vision Project was headed by a core team of researchers at San Diego State University (SDSU),[1] along with colleagues from El COLEF and the Secretaría de Fomento Agropecuario and the Universidad Autónoma de Baja California (UABC). The Research Team provided basic research, Web page development, and stakeholder coordination, along with day-to-day support for the project. The Research Team convened the Binational Watershed Advisory Council (BWAC) early in the project to provide overall direction to the Vision effort and to serve as the link to the diverse stakeholders of the TRW. A list of the members of the Research Team, BWAC, and their responsibilities can be found in Appendix 1. A description of stakeholder organizations and their responsibilities are outlined in Appendix 2.

The Binational Vision for the TRW presented here contains stakeholders' views about the desired state for the watershed in the near and distant future and recommends strategies and alternatives for achieving that Vision. Much of the data and analysis on historical and projected trends presented here had been collected previously and analyzed outside of the scope of this visioning project. This document serves to inform stakeholders and provide guidelines for decision makers, and provides a snapshot of the state of the TRW as it is viewed by stakeholders today.

Description of the visioning process

The general process for the Vision project followed these steps (Fig. 5):

[1] The Institute for Regional Studies of the Californias and the Department of Geography at San Diego State University. Funding sources for the project and associated research include the California State Water Resources Control Board, the County of San Diego, San Diego State University, and the William and Flora Hewlett Foundation.

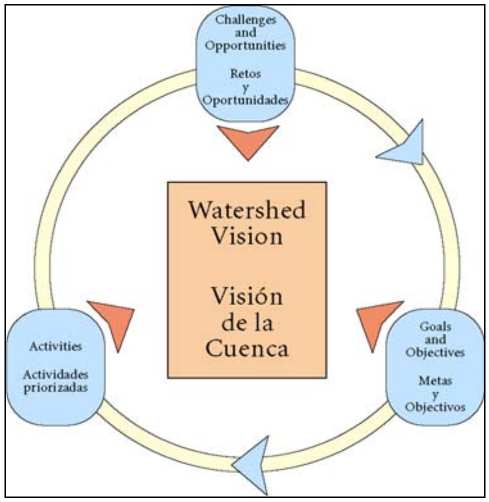


Fig. 5
General visioning process.

Definitions

- Challenges are conditions that degrade the watershed
- Opportunities are conditions that occur or that can be created to halt degradation
- Goals are broad statements of the desired state or condition
- Objectives break down the goals into actions
- Activities are specific actions—where and when—and lead to the realization of the goals

The stakeholders and BWAC first outlined the major challenges, opportunities, goals, and objectives in the TRW. From this exercise the Research Team established the five critical resource areas for the TRW: water, ecosystems and natural resource areas, air, waste, and socioeconomic issues. Stakeholders then formulated specific actions to meet the goals for the TRW, and described "where and when" the actions should take place. A table of these recommendations can be found at the end of each section of this document.

Project time line

The project proceeded according to the following general time line (Fig. 6):

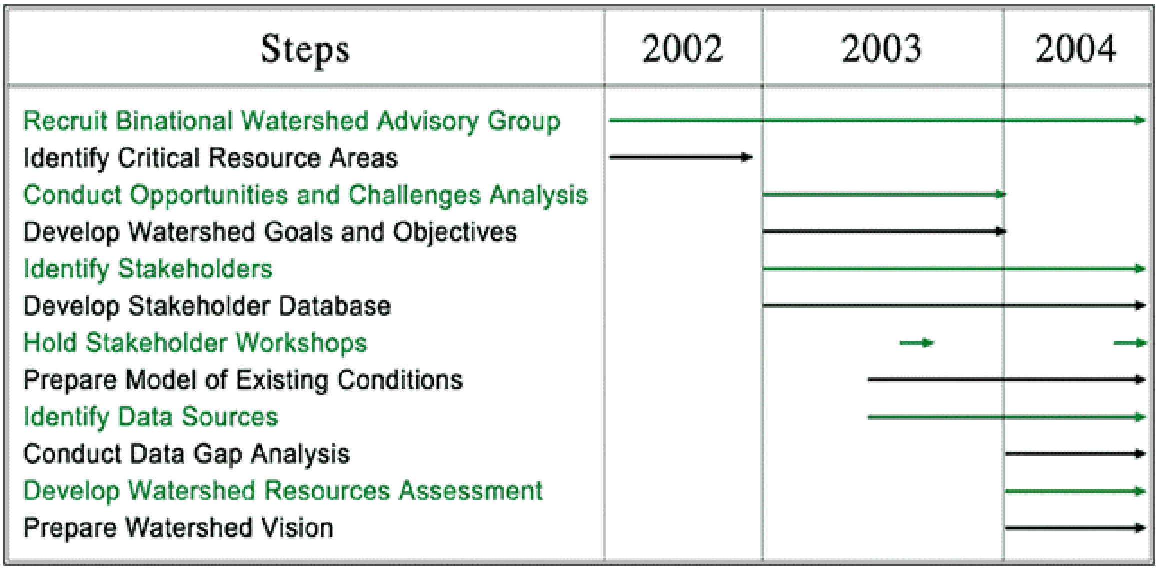


Fig. 6
General time line for the Binational Vision Project.

Description of stakeholder meetings

Approximately 60 BWAC members meet quarterly to discuss the components of the Vision project. In 2003, the BWAC identified major challenges and opportunities for the watershed. The Vision Research Team sketched out the goals and objectives for the watershed, which were first reviewed and revised by BWAC, and then critiqued by a wider group of stakeholders at public meetings.

One hundred and fifty-five (155) TRW stakeholders, or interested persons, were convened in September and October of 2003 to help develop a Binational Vision for the TRW. Three of the meetings were held in Imperial Beach, Campo, and Tecate, and two meetings took place in Tijuana, for a total of five meetings. Each meeting included participants from both sides of the border and from the entire TRW region including Ensenada. One-half of the participants were contacted in person through outreach efforts in the field, while the remaining participants were stakeholders suggested by BWAC members and contacted through mail, phone, email, and fax (see Appendix 2 for participants and meeting dates). The meetings included diverse sectors, such as landowners, water resource managers, natural resource managers, academics, indigenous groups, cattle ranchers, agricultural interests, industry, the public sector, businesses, and so forth. Efforts by outreach coordinators[2] were critical in making sure that adequate numbers and types of stakeholders participated at the public meetings.

[2] Michael Wilken (CUNA), Juan Ramón Sánchez (CUNA), Victor Zambrano (IRSC-SDSU), and Katherine Comer (IRSC-SDSU)

The format of the 2003 stakeholder meetings was as follows:

1. *Sign-in sheets*. At the registration table, participants were presented with a list of issues and asked to assign a value to each, ranging from one (lowest priority) to five (highest priority). The issues were: water quality, air quality, ecosystem health, solid and hazardous waste, and socioeconomic conditions.
2. *Introduction to the TRW*. A power point presentation then outlined the major TRW challenges, opportunities, and goals that the BWAC had identified
3. *Worksheets.* Each participant next filled out a worksheet identifying actions that could resolve some of the issues in the watershed.
4. *Working groups*. Participants were divided into small working groups for water, ecosystem health, air, waste, and socioeconomic issues. They discussed their results and decided on major actions for their resource area. Leaders presented the results of each working group to the larger group.
5. *Votes.* At the end of the meeting, each participant voted with stickers for his or her five priority actions from the list of major actions identified by all groups at their meeting. This exercise enabled the Research Team to prioritize the actions according to the number of votes.

Stakeholder input

Stakeholder input into this Vision document came from the five stakeholder meetings held in September and October of 2003, as well as from BWAC members during the quarterly meetings. The 266 proposed actions from the five stakeholder meetings are included in Appendix 4 of this report.

The Vision Research Team ranked the results of the five stakeholder meetings in several ways. First, the votes for each of the actions proposed were tallied and then divided by the total number of votes cast at the meeting. This gave a percentage vote for each action at each meeting. The ten highest prioritized actions for each meeting were reported in a newsletter to stakeholders in January 2004 to provide feedback to participants and to inform other interested parties.

Second, the actions, along with their percentage vote, were combined within the five general resource areas: air, water, ecosystems and natural resources, socioeconomic conditions, and waste. The actions for each resource area that received the highest percentage votes across all meetings are reported in a table at the end of each section in this document. Combining the recommendations by resource area gives managers and decision makers an better idea about what actions were important for the TRW as a whole.

Finally, the actions and percentage votes for the five resource areas and the five meetings were combined (see Appendix 4). The reported percentages are a ratio of the number of votes cast for an action divided by the total number of votes at each meeting. This provides decision makers an idea of priority actions from stakeholders for the whole watershed, regardless of resource area or meeting location. One assumption was that the more people who voted for an action, the higher the priority, therefore the more urgent the need for immediate action. After adding several actions identified from experts and the literature, the highest prioritized actions for the TRW are presented in the "Time line" section of this document. Strategies for implementing the time line are included.

The following chapters provide baseline data, historical trends, and projected trends for the physical geography and the six resource areas of concern in the TRW—water quantity, water quality, air quality, ecosystems and natural resources, solid and hazardous waste, and socioeconomic issues. At the end of each section, the reader can find recommendations for addressing some of the challenges in the TRW.

Topography

The watershed increases in elevation from sea level at the mouth of the Tijuana River in the west, to more than 1,944 m (6,378 ft) and 1,800 m (5,900 ft) in the northeast and southeast mountains, respectively (Fig. 7). Many parts of the TRW have been steeply eroded, particularly near the major stream valleys which can have slopes in excess of 25%. Gently sloping land (slopes of less than 10%) is found in the bottoms of the major stream valleys, such as the Tijuana River and the Río de las Palmas, the tops of the marine terraces in the west, and the uplands of the east-central and southeastern sections. Mountain peaks from west to east are (Wright 2005):

- Colorado Peak (500 m or 1,640 ft)
- Otay Mountain (1,087 m or 3,566 ft)
- San Isidro Peak (840 m or 2,638 ft)
- El Carmelo Peak (880 m or 2,887 ft)
- Gaskill Peak (1,169 m or 3,835 ft)
- Tecate Peak-Cerro Cuchumá (1,184 m or 3,885 ft)
- Grande Peak (900 m or 2,953 ft)
- Gordo Dos Peak (1,040 m or 3,412 ft)
- Corte Madera Mountain (1,419 m or 4,656 ft)
- Morena Butte (1,195 m or 3,920 ft)
- San Javier Peak (1,200 m or 3,937 ft)
- Los Monos Peak (1,100 m or 3,609 ft)
- Peña Blanca Peak (1,200 m or 3,937 ft)
- La Hiedra Peak (1,020 m or 3,346 ft)
- Gill Peak (1,125 m or 3,691 ft)
- Nejí Peak (1,360 m or 4,462 ft)
- Cuyapaipe Peak (1,944 m or 6,378 ft)
- La Sierrita Range (1,580 m or 5,184 ft)
- San Pedro Peak (1,800 m or 5,906 ft)

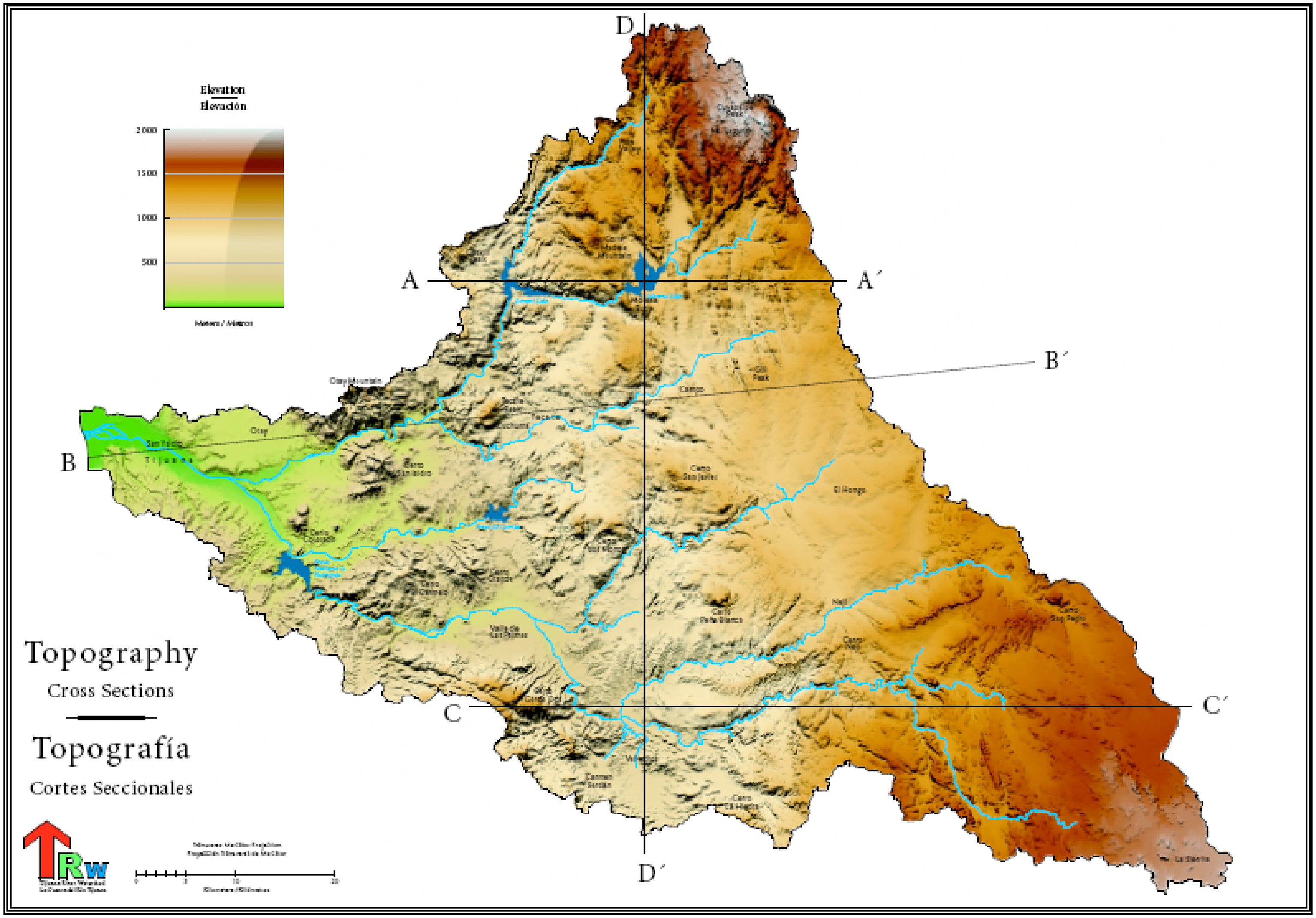


Fig. 7
Shaded relief.
Source (SDSU and COLEF 2005).

Precipitation

The TRW exhibits a Mediterranean seasonal precipitation pattern in which the majority of precipitation occurs from October through March, with summers being particularly dry. Rain gauge stations record precipitation from 200 mm (8 in.) to nearly 1,100 mm (43 in.) per year (Fig. 8). Cold air masses move across the Pacific Ocean or southward along the coast from the Gulf of Alaska, causing cooler seasons in the winter, with the possibility of snow at the higher elevations. Precipitation in the late summer occasionally arrives in the form of late-stage tropical storms off the coast of southern Baja California. Although these precipitation events normally yield low rainfall amounts, they can occasionally produce flash floods, especially during El Niño periodic storm seasons (Aguado 2005).

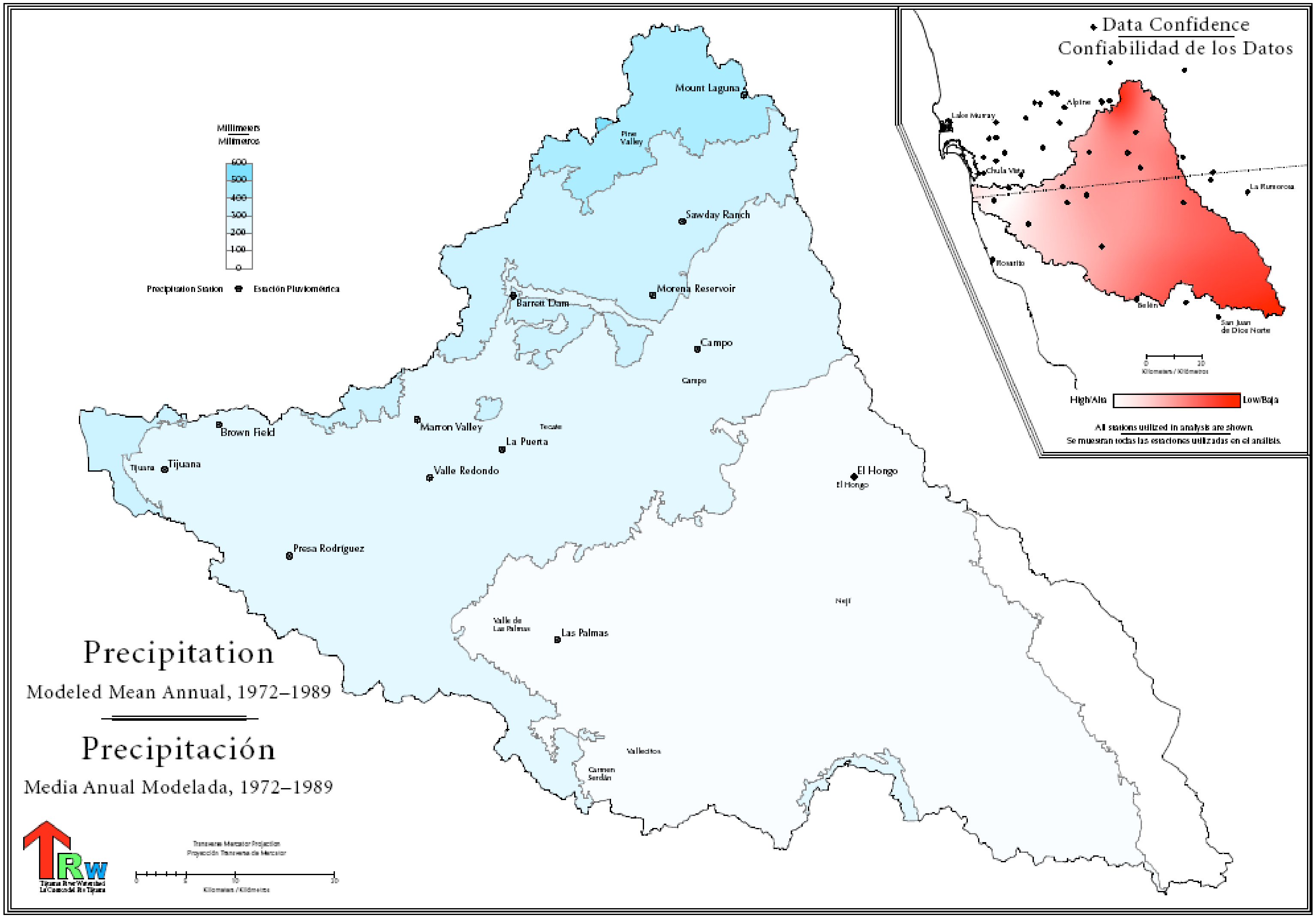


Fig. 8
Precipitation in the TRW.
Source: (SDSU and COLEF 2005).

Population

Of the approximate 1.4 million people who live in the TRW, around 97% reside within the Mexican portion of the watershed (INEGI 2004; U.S. Census Bureau 2004).

TRW estimated population (2000)—1.4 million
Mexico (municipalities of Tecate and Tijuana)—more than 1,277,795
United States (nine census tracts and the Campo Indian Reservation)—more than 43,963

Population trends

Tijuana is the fastest growing city in the watershed. Historical data document a population increase in the Municipality of Tijuana from 250 persons in 1900 to 1.2 million persons in 2000. Tecate's 1960 municipal population was 6,588 and the 2000 municipal population was 77,796 (Table 3 and Fig. 9). Population growth in these border cities is driven mainly by immigration from the interior of Mexico. The migrants are attracted by plentiful and relatively well-paying jobs in the *maquiladora* (assembly) industry and by accessibility to the United States for jobs and goods. The Vision Research Team selected census tracks that fell within, or largely within, the watershed boundaries to calculate a population of 43,963 for the U.S. portion of the TRW in 2000, an increase of 13,000 from 1990 (U.S. Census Bureau 2004). The total population of the municipalities of Tijuana and Tecate from 2000 was derived from the Mexican census. This total excludes the few TRW residents who live within the boundaries of the Municipality of Ensenada and includes the Playas de Tijuana neighborhood which lies partially outside of the TRW. There is likely undercounting of some rural populations and the transient population.

The population of the watershed is expected to double by 2030 (Fig. 10). Rapid urbanization and industrial growth in the San Diego, Tijuana, and Tecate area will continue to spread south and eastward (Fig. 11). Of particular concern is the possible physical merging of Tijuana and Tecate over time. Uncontrolled population growth, urbanization, and lack of infrastructure exacerbate other issues, such as water and sewage infrastructure deficits, poor water quality, habitat fragmentation, and declining quality of life. If Tijuana and Tecate merge, urban structures will choke off the natural corridor from Otay Mountain to the southeast of Tijuana. This corridor is important for migratory species that cross the border to forage for food and breed as well as plant species that are linked across the border.

Año	Baja California	Tijuana	Porcentaje
1900	42,245	250	0.6%
1950	226,965	60,000	26.4%
1990	1,660,855	747,381	45.0%
1995	2,108,118	989,287	46.9%
2000	2,487,700	,212,232	48.7%

Fuente: Estadísticas Históricas de México e INEGI.

Table 3
Population of Tijuana and Baja California from 1900 to 2000.
Source: (INEGI 2004).

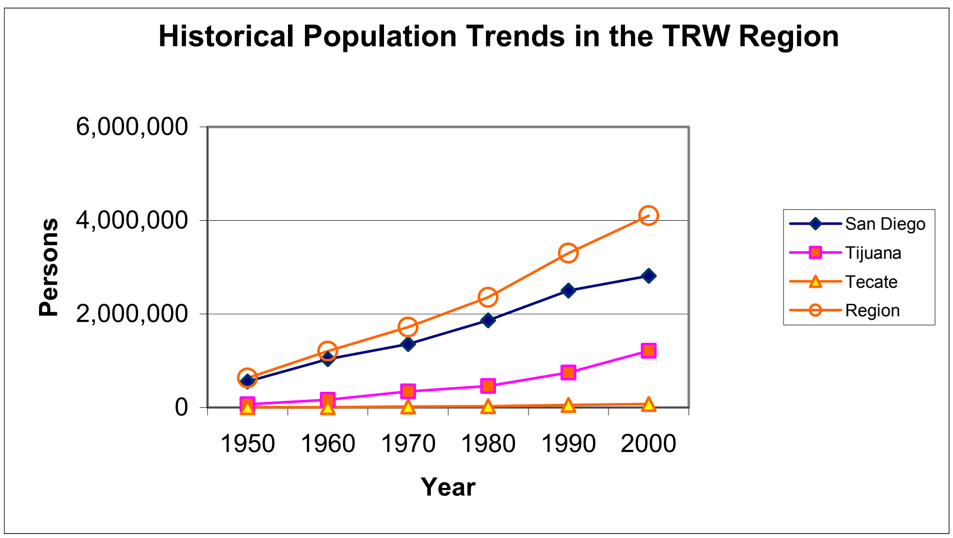


Fig. 9
Historical Population Trends in the TRW region.
Source: (INEGI 2004).

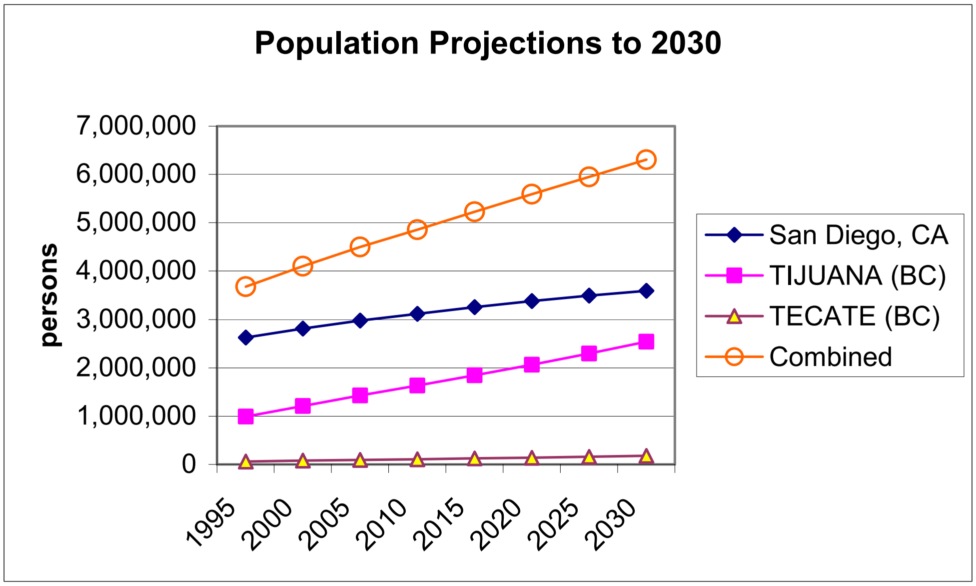


Fig. 10
Population projections to 2030.
Source: (Peach and Williams 2003).

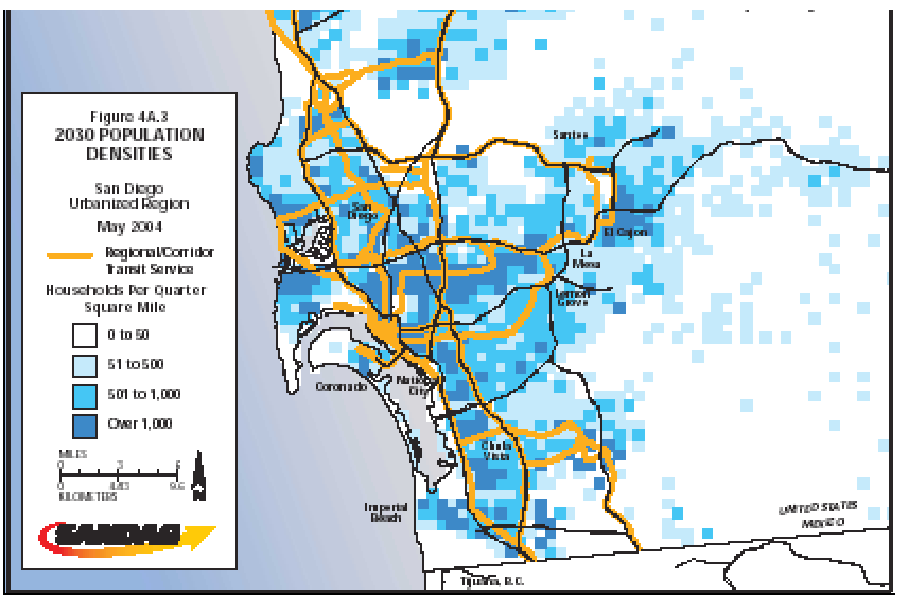


Fig. 11
Population density projections for the year 2030 for San Diego County.
Source: (San Diego Association of Governments 2004).

San Diego County's population is expected to increase from 2.91 million in 2002 to 3.05 million in 2030. Tecate's population is expected to increase from 77,796 in 2000 to 117,273 by 2030. Tijuana's population is expected to reach 2.54 million in 2030, up from around 1.30 million in 2000 (Peach and Williams 2003).

Population data gaps

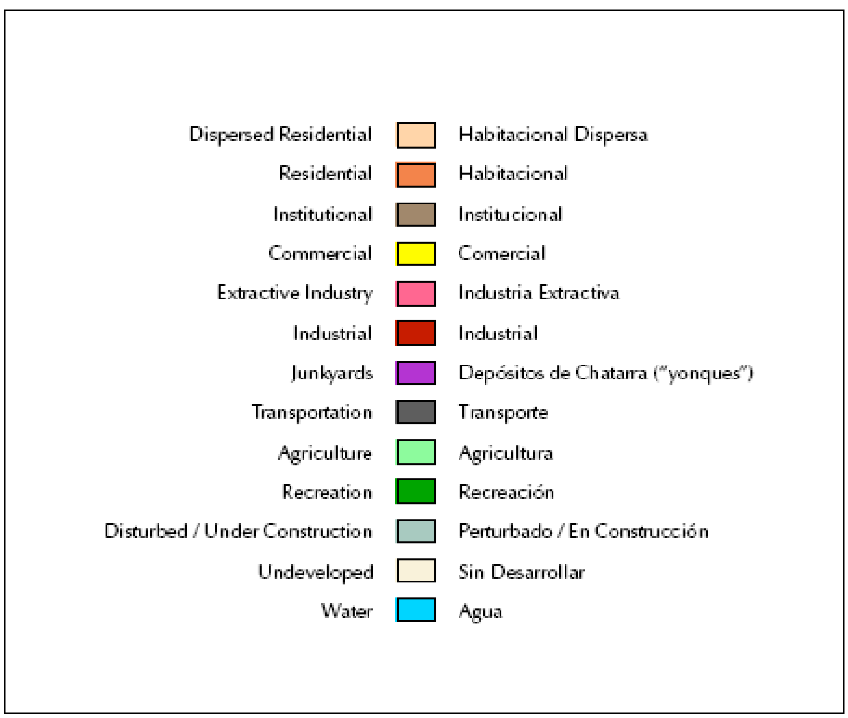
Both the United States and Mexico have problems with census undercounts. Typically, the United States has problems counting urban populations while Mexico undercounts rural areas, reporting households and estimating the number of residents. Also, Mexico does not census federal zones along the international boundary, coast, or rivers. Mexico is taking steps to address these issues with the next census in 2010.

In addition to undercounting problems, the census tracts in both countries do not coincide with the natural boundaries of the TRW. In order to address the population data gaps, the following are data and analysis are needed:

- A spatial population model that depicts historical, current, and projected population densities within the boundaries of the TRW
- Census methods that are comparable across the border and do not exclude rural areas or undercount

Land use

Most of the land in the watershed (58%) was undeveloped in 1994, with 14% in agricultural production, and 9% classified as urban. Grazing of cattle and goats occurs in the undeveloped parts, and has impacted the land for centuries, causing compaction of soils, degraded vegetation, and increased runoff (Minnich and Vizcaino 1998). Extraction (mining) of sand and clay for pottery and bricks occurs in Tijuana and Tecate, a practice that contributes to the erosion of stream banks and subsequent flooding and sedimentation problems. Actions by the Dirección General de Ecología del Estado de Baja California (DGE) in 1994 have tried to curb illegal sand mining. The construction of vacation "ranchettes" in rural areas in the eastern section of the watershed, along with "bedroom communities" closer to the cities, are occupying large plots of land. Large lot sizes, as opposed to urban "smart planning" (building inward and upward in existing communities), continue to fragment important habitat and consume open space in the TRW (Fig. 12).



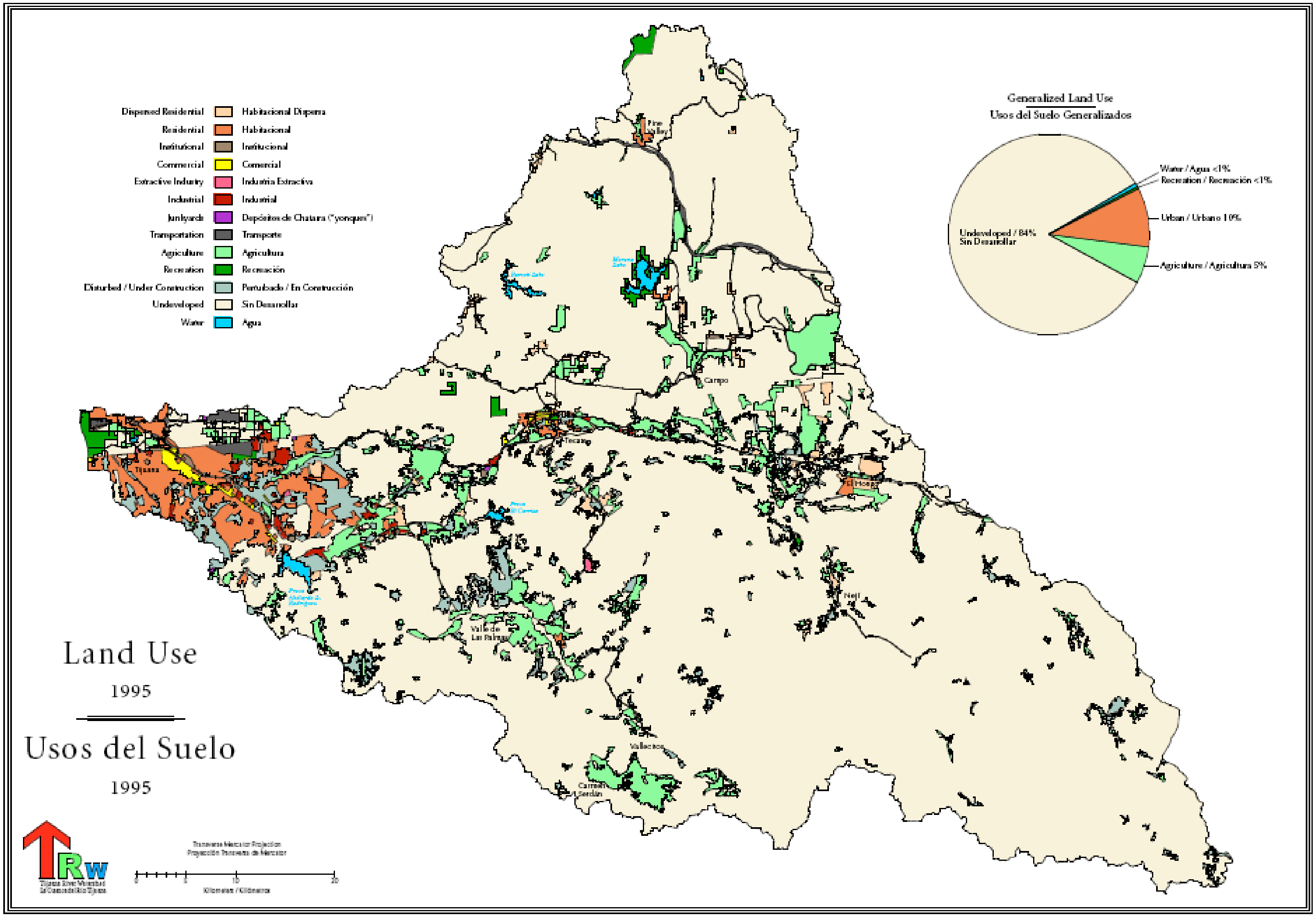


Fig. 12
Land use.
Source: (SDSU and COLEF 2005).

Land use trends

The developed area of Tijuana consumes approximately 25% of the Municipality of Tijuana. About 90% of urban Tijuana is contained within the TRW boundaries. Fig. 13 shows the expansion of Tijuana toward the southeast from 1956 to1994. In the late 1990s, new areas of commercial and services activity, such as Villa Fontana and El Florido, developed toward the east and southeast of the city.

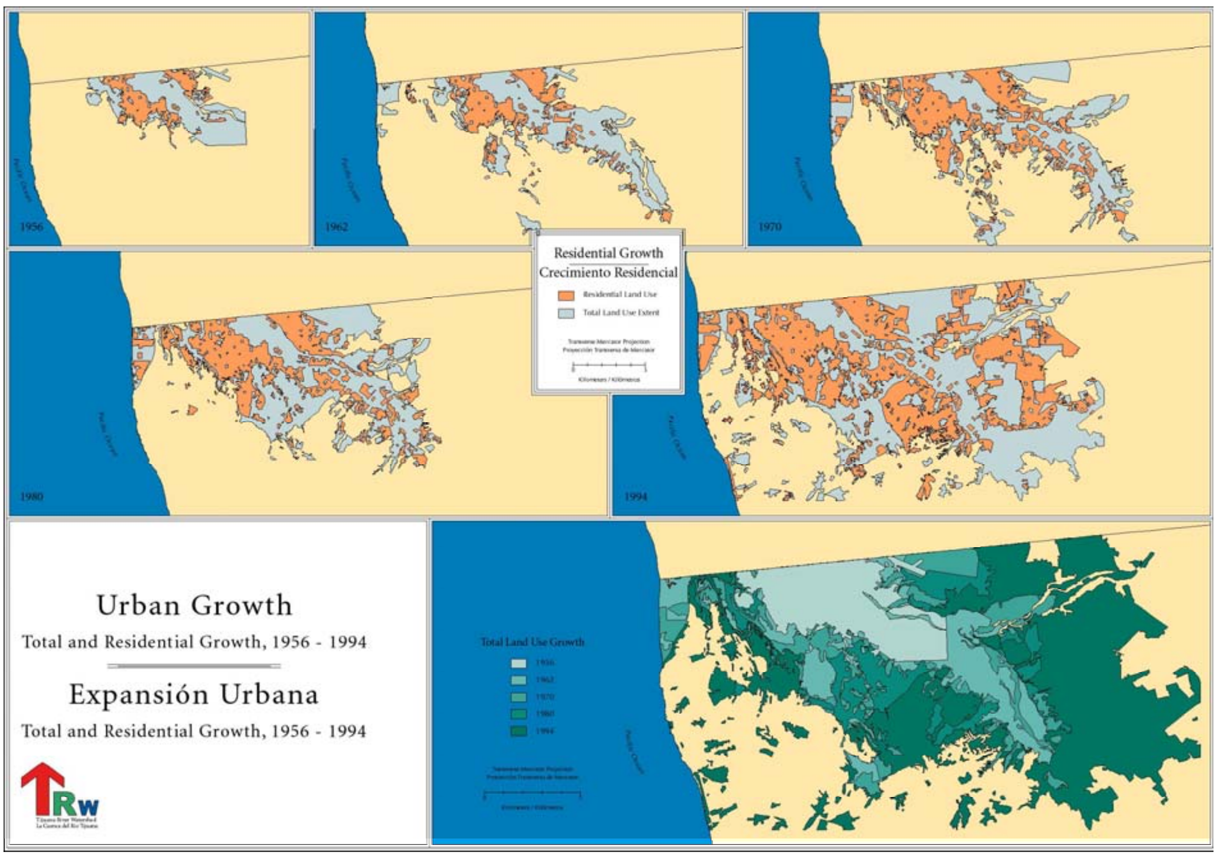


Fig. 13
Historical expansion of Tijuana 1956 to 1994.
Source: (SDSU and COLEF 2005).

An important transportation project, Corredor Tijuana-Rosarito 2000, is under construction. The project is building a major highway and related infrastructure from south Playas de Rosarito around the southeast part of Tijuana to connect with the new international border crossing at East Otay Mesa. One goal of the Corredor is consolidation of economic activity and infrastructure that will encourage development in more appropriate areas of Tijuana (see Fig. 14) (CESPT 2002).

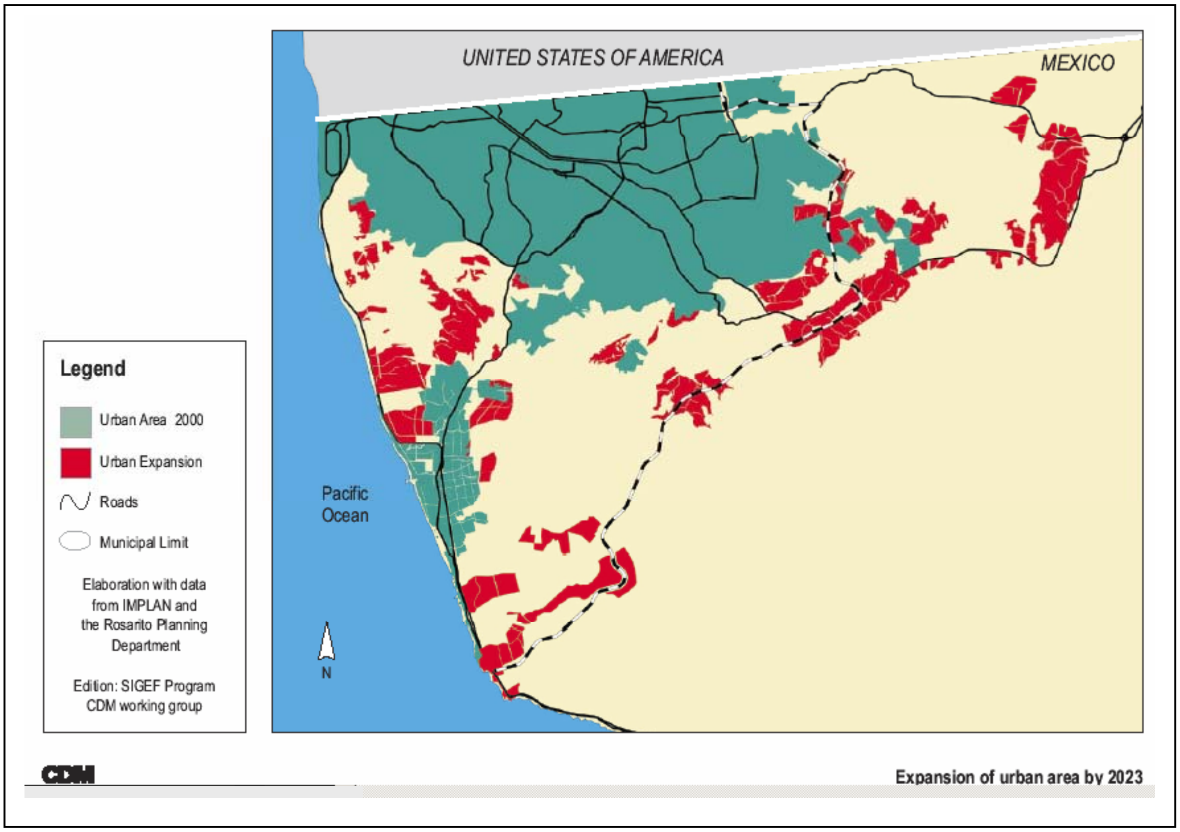


Fig. 14
Projected urban expansion of Tijuana and Rosarito to 2023 and the Corredor Tijuana 2000.
Source (CESPT 2002).

Future land use expansion for the entire TRW has not yet been modeled. However, urban growth in San Diego County will likely affect the TRW in terms of cross-border traffic, environmental impacts, water consumption, habitat fragmentation, and so forth. In May 2003 the San Diego Association of Governments (SANDAG) published the San Diego-Baja California Planned Land Use/*Propuesta de Usos Del Suelo* Map in May 2003 (Fig. 15) which covers the TRW. Planned land use for the Municipalities of Tijuana and Tecate can be found in the *planes municipales de desarrollo urbano, los programas de centro de población,* and *programas parciales*. Once the plans are approved by the governor's office and the municipalities, they are published in the Periódico Oficial del Estado de Baja California. A land use plan for the Alamar River was developed in 1999 by Tijuana's Municipal Planning Agency, IMPlan, and calls for moderate development while protecting the environment (IMPlan 1999).

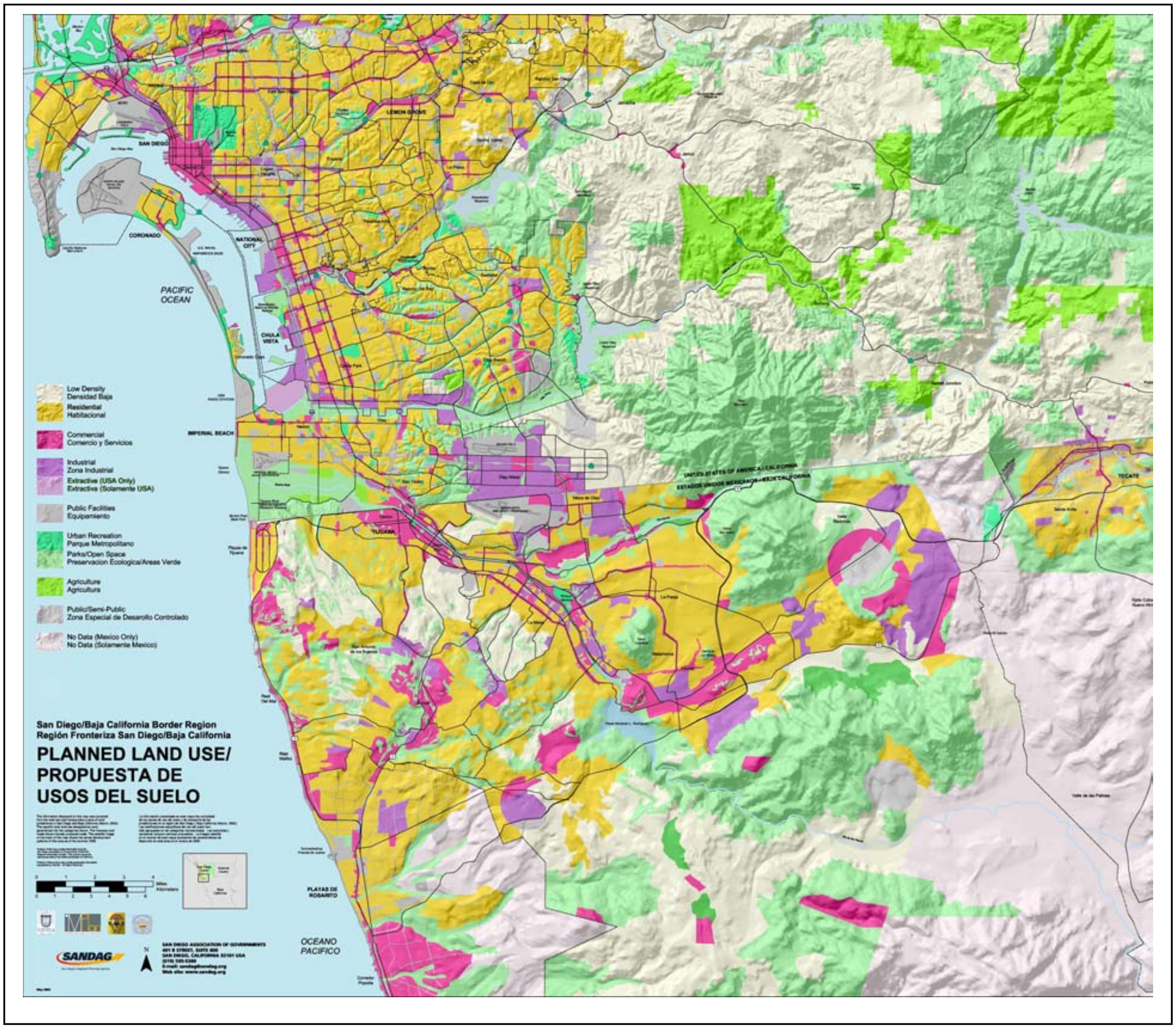


Fig. 15
San Diego-Baja California planned land use, May 2003.
Source: SANDAG 2004.

Land use data

Land use data are based on 1994 aerial photographs and satellite imagery (Fig. 12) (SDSU and COLEF 2005).

Land use data gap

There are difficulties combining Mexican and U.S. maps and statistics because different data collection methods and land use categories are used. The San Diego-Tijuana Border Area Planning Atlas pioneered data harmonization for part of the TRW at the urban interface from

Otay Mountain to the Pacific Ocean (IRSC 2000). In the 1994 TRW land use map, the use of the term "undeveloped" also includes protected lands. There should be a separate class in the land use legend of the TRW map titled "preserved" that would include national forests, parks, forest preserves, open space preserves, and others. The addition of this land use class will significantly alter the interpretation of land use patterns. In order to address the data gap for land use, the following are suggested:

- An updated land use map with current (post-1994) data
- A new land use category called "protected areas"
- A spatial land use projection model within the boundaries of the TRW

Water quantity

Hydrology

Due to Mediterranean-semiarid climatic conditions, stream flow is mostly intermittent, with maximum flows occurring from November through April. Mexico's National Water Commission (CNA) defines 37 hydraulic regions in Mexico (CNA 1995). The TRW is the largest basin in Hydraulic Region One, with an annual runoff of 67.30 million cubic meters (m^3) or 54,861 acre-feet (acre-ft).[3]

Two major drainage networks form the TRW. The major tributaries in the TRW are (1) the Cottonwood Creek-Río Alamar system comprised of the Río Alamar, lower Cottonwood, upper Cottonwood, Campo, Pine, and Tecate Creeks; and (2) the Río Las Palmas system, comprised of the Río Las Palmas, El Florido, the Río Seco, La Ciénega, Las Calabazas, Las Canoas, and El Beltrán Creeks. Further downstream, the Río Las Palmas and the Cottonwood-Alamar systems join to form the Tijuana River. The Tijuana River is mostly channelized from that point to the international border. At the international border, the Tijuana River flows into the Tijuana River Valley and finally to the Tijuana Estuary at Imperial Beach, Ca., where it discharges into the Pacific Ocean (Fig. 16) (Wright 2005).

The California Regional Water Quality Control Board (CARWQCB), San Diego, designates beneficial uses and associated water quality objectives for inland surface waters, coastal waters, reservoirs and lakes, and groundwater in San Diego County (Regional Water Quality Control Board 1994). Beneficial uses describe existing or potential value of water, such as recreational value, ecological value, or drinking water supply. Table 4 lists beneficial uses identified by the CARWQCB for the U.S. portion the TRW.

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[3] 3An acre-foot of water is approximately 325,851 gallons, enough to sustain the needs of approximately two U.S. households for one year (SANDAG 2003).

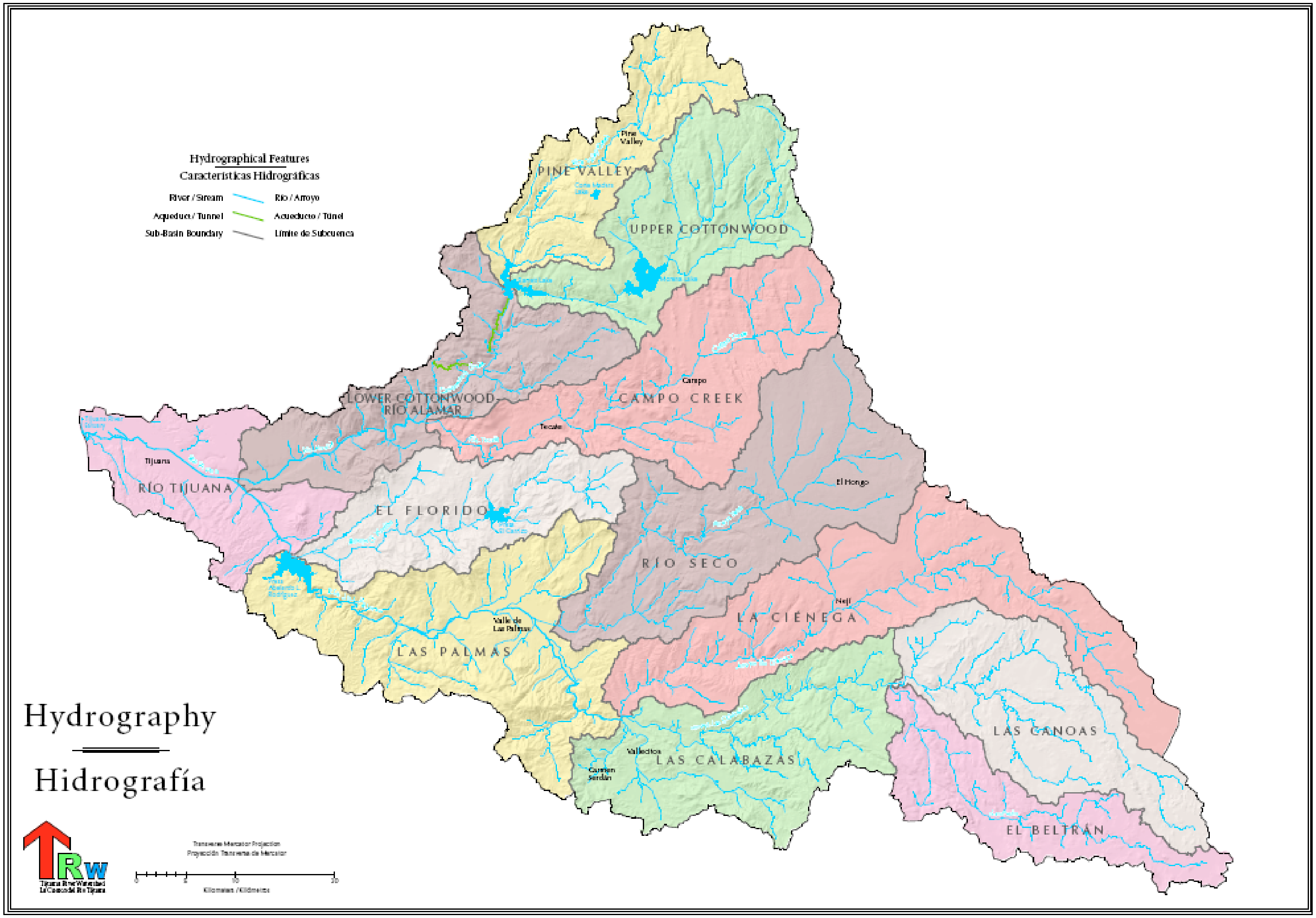


Fig. 16
Hydrography of the TRW.
Source: (SDSU and COLEF 2005).

Table 4-6 *(continued)*	Hydrologic Unit Basin Number	BENEFICIAL USE: Municipal and Domestic Supply	Agricultural Supply	Industrial Service Supply	Industrial Process Supply	Ground Water Recharge	Freshwater Replenishment	Navigation	Contact Water Recreation	Non-contact Water Recreation	Commercial and Sport Fishing	Warm Freshwater Habitat	Cold Freshwater Habitat	Estuarine Habitat	Marine Habitat	Wildlife Habitat	Preservation of Biological Habitats of Special Significance	Rare, Threatened, or Endangered Species	Migration of Aquatic Organisms	Shellfish Harvesting
Pine Valley Creek	911.30	•	•	•	•		•		•	•		•	•			•				
Inland Surface Waters [1,2]																				
Oak Valley	911.30	•	•	•	•		•		•	•		•	•			•				
Nelson Canyon	911.30	•	•	•	•		•		•	•		•	•			•				
Secret Canyon	911.30	•	•	•	•		•		•	•		•	•			•				
Horsethief Canyon	911.30	•	•	•	•		•		•	•		•	•			•				
Espinosa Creek	911.30	•	•	•	•		•		•	•		•	•			•				
Wilson Creek	911.30	•	•	•	•		•		•	•		•	•			•				
Pats Canyon	911.30	•	•	•	•		•		•	•		•	•			•				
Cottonwood Creek	911.23	+							•	•		•				•				
Dry Valley	911.23	+							•	•		•				•				
BobOwens Canyon	911.23	+							•	•		•				•				
McAlmond Canyon	911.24	+							•	•		•				•				
McAlmond Canyon	911.23	+							•	•		•				•				
Rattlesnake Canyon	911.23	+							•	•		•				•				
Potrero Creek	911.25	+							•	•		•				•				
Little Potrero Creek	911.25	+							•	•		•				•				
Potrero Creek	911.23	+							•	•		•				•				
Grapevine Creek	911.23	+							•	•		•				•				
Bee Canyon	911.22	+							•	•		•				•				
Bee Creek	911.23	+							•	•		•				•				
Mine Canyon	911.21	+							•	•		•				•				
unnamed intermittent streams	911.81	+							•	•		•				•				
unnamed intermittent streams	911.82	+							•	•		•				•				
Campo Creek	911.84	+							•	•		•				•				
Diabold Canyon	911.84	+							•	•		•				•				
Campo Creek	911.83	+							•	•		•				•				
Miller Creek	911.83	+							•	•		•				•				
Campo Creek	911.82	+							•	•		•				•				
Smith Canyon	911.82	+							•	•		•				•				
unnamed intermittent streams	911.85	+							•	•		•				•				
Coastal Waters																				
Tijuana River Estuary	911.11								•	•	•			•	•	•	•	•	•	•
Reservoirs and Lakes																				
Lake Barrett	911.30	•	•	•	•		•		•	•		•	•			•		•		
Morena Reservoir	911.50	•	•	•	•		•		• [3]	•		•	•			•		•		
Ground Water																				
TIJUANA HYDROLOGIC UNIT	911.00																			
Tijuana Valley	911.10																			
San Ysidro [4]	911.11	•	•	•																
Water Tanks	911.12	o	o	o																
Potrero	911.20	•	•	•																
Barrett Lake	911.30	•	•																	
Monument	911.40	•	•																	
Morena	911.50	•	•																	
Cottonwood	911.60	•	•																	
Cameron	911.70	•	•																	
Campo	911.80	•	•	•																

• Existing Beneficial Use
o Potential Beneficial Use
+ Exempted from the municipal uses designation by the Regional Water Quality Control Board

3 Fishing from shore or boat permitted, but other water contact recreational (REC-1) uses are prohibited.
4 These beneficial uses do not apply west of Hollister Street and this area is excepted from the sources of drinking water policy.

Table 4
Beneficial uses for the U.S. portion of the TRW.
Source: (City of Imperial Beach, City of San Diego and County of San Diego 2002).

Water supply and demand

In Tijuana in 1997, residential uses accounted for 74% of the water demand, industrial uses for 10.9%, and commercial uses for 11.1%, while public services accounted for 4% (Fig. 17) (Rangel Pérez, et al. 1998). Leaks in the delivery system accounted for around 25% of the total water use every year between 1996 and 2001, and 20% in 2004 (Cuevas 2004). The types of leaks are reported in Table 5.

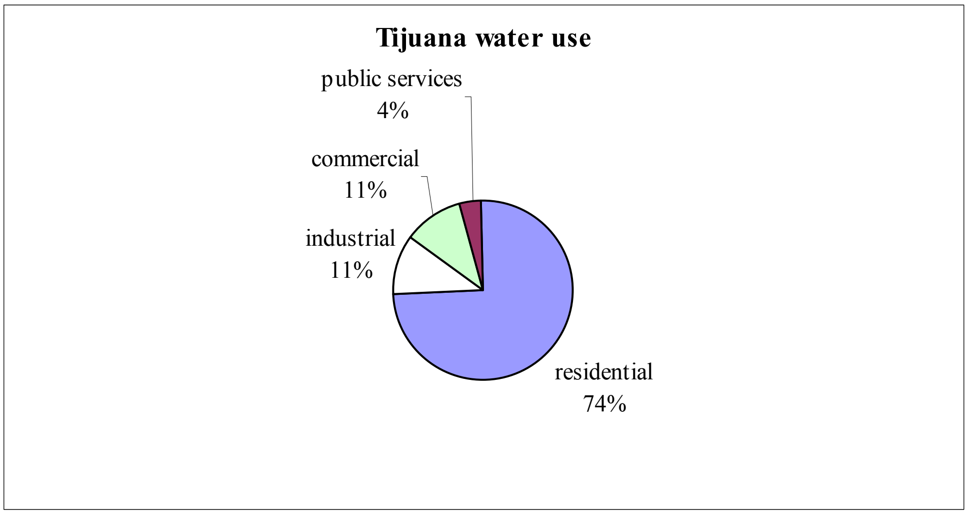


Fig. 17
Tijuana water use.
Source: (Rangel Pérez et al. 1998).

Type of Loss	Estimated Quantity (m^3/month)	Percentage
Physical Loss		
Visible Leaks	6,480.00	2.23
Invisible Leaks	3,836.00	1.32
Commercial Loss		
Clandestine	826.32	0.28
Fixed Rates	139.2	0.05
Averages	1,063.37	0.37

Table 5
Leaks in the Tijuana water delivery system.
Source: (CESPT 2002).

In Tecate in 1997, water demand included residential (61.6%), the Tecate Brewery (20.4%), industries (6%), commerce (5.4%), and public services (5.4%) (Fig. 18). Less than 1% of the water was lost through leaks in the distribution system by 2004 (Vázquez 2004).

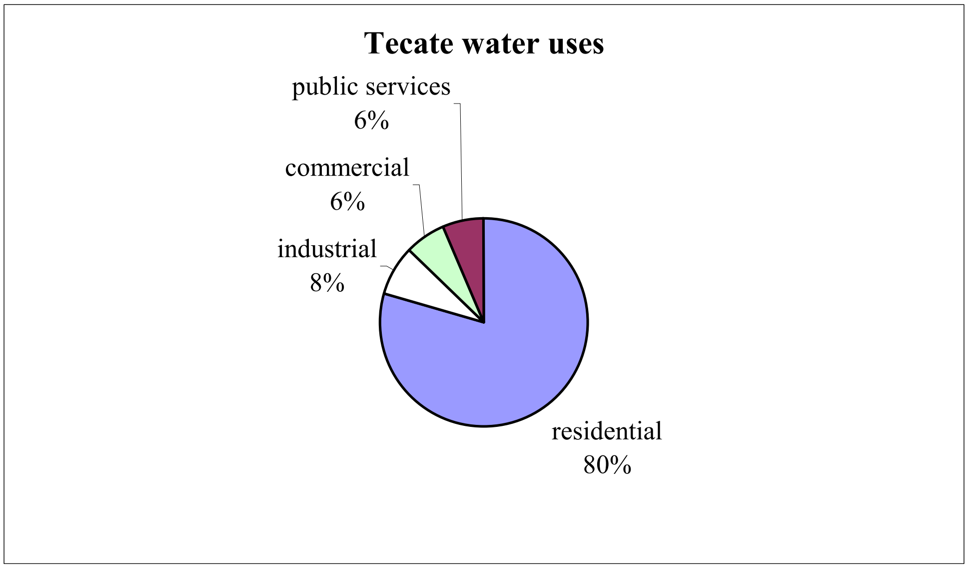


Fig. 18
Tecate water use.
Source: (Rangel Pérez, et al. 1998).

In San Diego County in 2003, the residential sector consumed 55% of the total demand, industrial and commercial 21%, agricultural 16%, and other 8% (Fig. 19) (San Diego County Water Authority 2003). Leaks in the water system averaged 5% from September 2003 to 2004 (Villarino 2004).

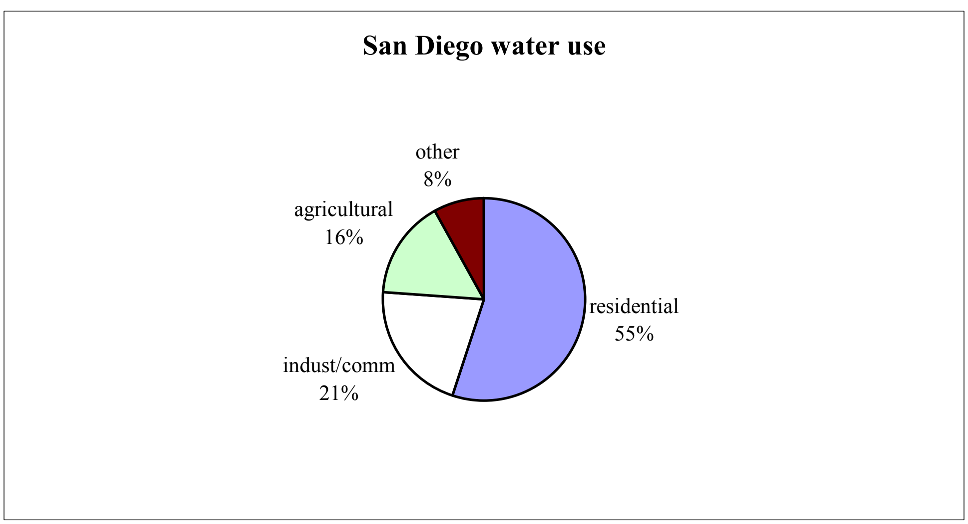


Fig. 19
San Diego water use.
Source: (San Diego County Water Authority 2003).

Two reservoirs in the U.S. portion of the TRW capture runoff—the Morena Reservoir (storage capacity 62.9 million m^3 or 50,993 acre-ft) and Barrett Lake (storage capacity 46.8

million m^3 or 37,941 acre-ft). The water from Barrett Lake is transferred via a flume to Otay Lakes in the Otay watershed for use and water storage in San Diego. Basin-to-basin transfers such as this change the water balance and the naturally functioning hydrological systems of the TRW. In Mexico, the El Carrizo Reservoir stores both surface water runoff and water from the Colorado River Aqueduct (storage capacity of 40 million m^3 or 32,428 acre-ft). The Abelardo L. Rodríguez reservoir is the primary source of local surface water supply for Tijuana (storage capacity of approximately 137 million m^3 or 111,067 acre-ft).

Ninety-five percent of the water supplied by CESPT in 2001 came from the Colorado River, while 4% was obtained from the Río Tijuana-Alamar, Rosarito, and La Misión aquifers, while the remaining 1% came from surface runoff captured in the Rodríguez Dam (CESPT 2002). Tecate currently obtains 80% of its water from the Colorado River and 20% from public wells (Ramírez 2004).

Demand for water in the San Diego region reached 846,821,064 m^3 (686,529 acre-ft) in 2002. Water imported from the Colorado River and the California Water Project meets about 90% of the San Diego region's water demands, depending on precipitation in the region. Barrett Lake and the Morena Reservoir capture and store local surface water, which is exported out of the TRW to contribute to the supply for the City of San Diego (San Diego County Water Authority 2000; CESPT 2002).

In Tijuana in 1995, there were 100 public use wells and 310 domestic wells, extracted a total of 18 million m^3 (14,592 acre-ft). In 2001, municipal wells provided 4.5% of the water supply for the Municipality of Tijuana bringing in 3.9 million m^3 (CESPT 2002). In Tecate there were 58 public wells and 12 domestic wells, together drawing 6 million m^3 (4,864 acre-ft) of water in 1995 (CESPT 2002). In 2003, private wells pumped around 58,000 m^3 (47 acre-ft), and the municipal wells pumped 2,027,940 m^3, (1,664 acre-ft) although this rate is half the production of 1993. In Valle de las Palmas, 48 public wells and 47 domestic wells, along with 4 water springs, provided 6.5 million m^3 (5,270 acre-ft) in 1995 (CNA 1995). In the eastern San Diego portion of the TRW, private wells are an important source of water. Data are unavailable for volume of water extracted because private well owners are responsible for their own extraction limits and water quality, with some testing done by the San Diego County Department of Health (Rangel Pérez, et al. 1998).

Precipitation

There are 31 rain gauge stations in, or in close proximity, to the watershed. Precipitation in the region is low and varies throughout the TRW depending on elevation and aspect (Fig. 8). Annual mean values range from just over 200 mm (8 in.) to nearly 1,100 mm (43 in.). As a result, streams are ephemeral and intermittent (seasonal). CNA recorded droughts during 1948–1959, 1960–1974, 1980–1982, and 1984–1992. In each drought event, water supply demand exceeded storage capacity of Tijuana's main water reservoir, Presa Rodríguez (CNA 1995).

Flooding and landslides

The combination of hilly topography and unplanned squatter settlements on steep slopes in Tijuana and Tecate and occasional heavy storm events have resulted in erosion, flooding, and landslides. Fig. 20 shows potential hazards for the San Diego and Tijuana border area. Intense precipitation resulted in severe floods in excess of 283 m^3/s (10,000 ft^3/s) in 1980, 1983, and 1993. These floods had devastating effects on natural habitat and human-built structures in the Tijuana River Valley (Wright, et al. 2000). The events also coincided with the overflow of water stored behind Rodríguez Dam. The 1993 flood was so powerful (283 m^3/s or 32,000 ft^3/s) that it re-routed the Tijuana River channel, moving it several hundred feet to the north. It was subsequently restored to its former channel (SDSU and COLEF 2005). Side canyons of the Tijuana River Valley, such as Goat Canyon (Cañón de Los Laureles) and Smuggler's Gulch (Cañón Matadero) are especially subject to flash flooding during heavy rainfall events. It is anticipated that flooding will continue to occur in the TRW due to increasing urbanization and impermeable surfaces, loss of vegetation on the hillsides, accumulation of sediment and other debris in drainage channels, and an inadequate storm drainage system (Wright, et al. 2000).

Because of the flood threat to the City of Tijuana, and to increased land area for development, Mexico completed a large concrete flood channel for the Tijuana River through the center of the city in 1979. In order to convey floodwaters that cross the border in this channel to the ocean, a spreading basin, or "dissipater channel" was built on the U.S. side of the border in the early 1980s. This dissipater channel terminates at Dairy Mart Road. From there, the natural floodplain is used to convey runoff to the Pacific Ocean. Although the United States had agreed with Mexico to extend the concrete channel from the border to the Pacific Ocean, environmentalists and community activists put a stop to the plans. The outcome was the creation of the Tijuana River National Estuarine Research Reserve (TRNERR) and a decision to protect much of the U.S. portion of the river valley[4]. However, there are homes in the floodplain that remain in danger of inundation in the event of a large flood (SDSU and COLEF 2005). The Municipality of Tijuana has made concerted efforts to clean storm drains and provide movement of floodwaters through urban Tijuana (Saxod 2004).

To combat flooding and disasters, a binational flood warning pilot project was initiated in 2000.[5] A binational technical advisory committee designed and implemented a warning system for regions of high risk in the lower portions of the watershed, including the Río Alamar corridor and lower Cottonwood Creek, Campo Creek, and Tecate Creek subbasins. The system provides real-time rain and river-level information and Geographic Information System (GIS) data to emergency officials on both sides of the United States-Mexico border to enable effective decision making during flood events in the lower TRW.

Seismic activities can result in landslides and liquefaction,[6] which can lead to greater earthquake damage. Earthquakes are especially devastating on steep or unstable slopes where *colonias* are often built. Emergency preparedness plans could help save lives in the event of an earthquake or other seismic event. Fig. 20 depicts slope, fault, and flood hazards identified in the Tijuana and San Diego border area in 2000.

[4] Land in the area is a matrix of federal, state, county, and city protected areas.

[5] A collaboration of Dirección Estatal de Protección Civil, County of San Diego, the National Oceanic and Atmospheric Administration, and Pacific REMS

[6] Earthquakes dramatically decrease the stability of saturated cohesionless soil. The soil becomes a viscous fluid, creating problems with any structure from bridges to buildings and to buried pipes and tanks (see http://cee.uiuc.edu/sstl/education/liquefaction/).

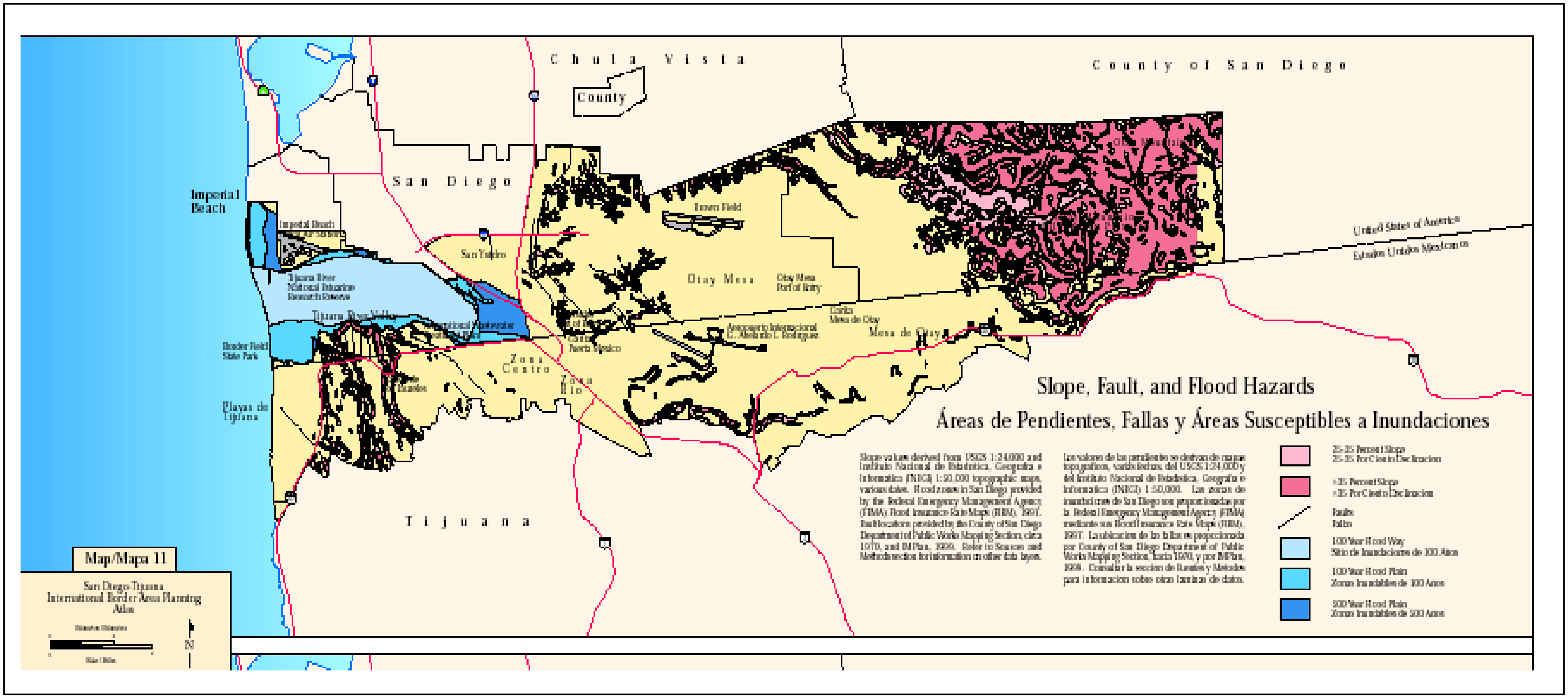


Fig. 20
Slope, fault, and flood hazards in the Tijuana and San Diego border area, 2000.
Source: (IRSC 2000).

Stream flow

Stream flow is low in the TRW and does not provide a significant source of water for beneficial uses, or human uses, in watershed. However, stream flow is important to monitor because it helps us understand the hydrologic and ecological functioning of the watershed. U.S. surface water gauging stations are located at Morena Dam, Cottonwood Creek, Tijuana River, and Campo Creek (USGS). A gauge on the Tijuana River at the Hollister Bridge is operated by the International Boundary and Water Commission (IBWC). In Mexico, there are four gauge stations operated by the CNA and the Comisión Internacional de Límites y Aguas (CILA), the Mexican counterpart of IBWC. They are located on the Río Alamar, and the Arroyo de las Calabazas, and at the Presa Abelardo Rodríguez and Presa El Carrizo Reservoirs (Gersberg and Wakida Kusunoki 1998).

Groundwater quantity

In addition to the reservoirs, the watershed contains important groundwater storage capacity. In Southern California-Baja California three primary geological water-bearing formations are found: sandy alluvium, weathered tonalites, and fractured bedrock. These formations are important because they have the ability to absorb and store water (Connolly 1997). The most significant groundwater resources of the TRW exist in the sandy alluvium in the river and creek beds of the Tijuana River and its tributaries. The alluvium is composed of mostly medium-grained, fairly well sorted, loosely packed sand, which can transmit water readily to wells (California Department of Water Resources 1965). Surface river water and groundwater interact, exchanging water and pollutants.

In the Mexican part of the TRW there are three major geohydrologic zones—the Tijuana Valley, the Tecate Valley, and Valle de Las Palmas. All three are considered by CNA to be in balance, meaning that the extraction rates are equal to the recharge rates (Gersberg and Wakida Kusunoki 1998). Table 6 describes beneficial uses and threats to the Tijuana River and the Tecate groundwater basins.

Aquifer	Location	Allocation	Utilization	Problems
Tijuana River Basin (Pacific Basin Subarea)	Spans the border at Tijuana–San Diego, draining 1,750 square miles total.	No bilateral agreement. No tacit cooperation, coordinate management, or conjuctive management practice. No information sharing.		Water quality due to sewage contamination has been cited as the principal problem.
Tecate (Pacific Basin Subarea)	Basin straddles border 40 miles east of the Pacific coast.	No bilateral agreement. No tacit, coordinate, or conjunctive management in place. No information sharing.	Well water used for municipal and industrial purposes in Tecate, Baja Calif. Norte.	Unknown.

Table 6
Beneficial uses and threats for the Mexican aquifers systems.
Source: (Mumme 2001).

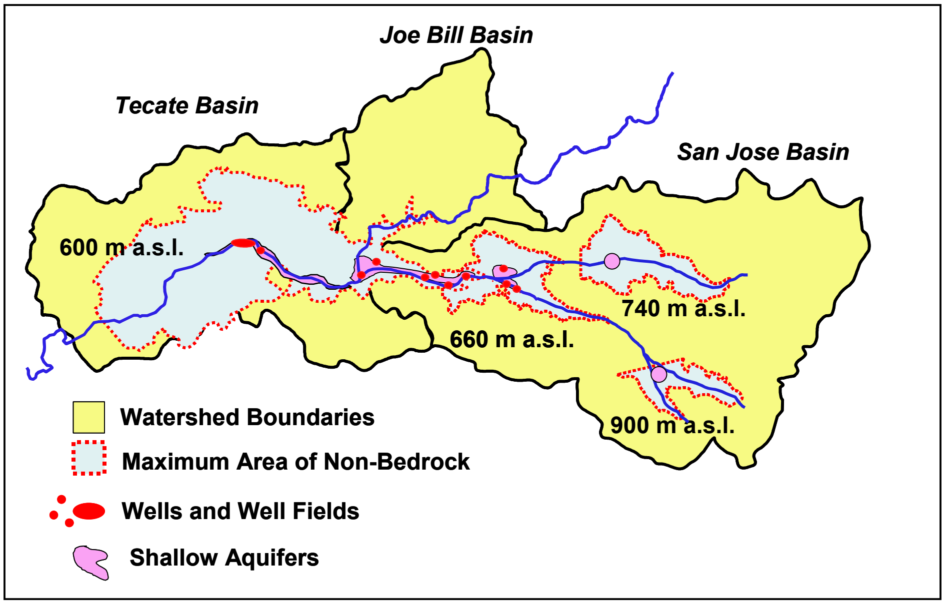
The economic and cultural advantages of properly managing the aquifers in the TRW are exemplified by the needs of the Tecate Brewery, which requires high water quality for its beer production. Since the early 1900s, the brewery has been a principal employer in the municipality, and is an important historical and cultural institution. Access to high quality groundwater is important for this key economic activity in Tecate.

Raising groundwater levels and groundwater quality is also important to supply the municipality's growing water demand, to support planned revegetation projects for the Tecate River Park, and to restore surface flow in the Tecate River. Raising the groundwater levels of the aquifer offers the municipality a potential reservoir for times of drought or interruption of the aqueduct services, and it would be protected from evaporation loss and allow a natural filtration process.

In 2004, studies were initiated to characterize the Tecate aquifer and estimate its recharge potential.[7] Fig. 21 shows the estimated extent of the main aquifer, which supplies Tecate's wells. The study suggested that the aquifer is currently being overexploited, and cannot support additional shallow aquifer wells. A recommended strategy for raising water tables is to pump recycled wastewater into the river near the Nopalera treatment plant. A wellhead protection

7 Initiated by IRSC-SDSU in collaboration with CESPTE, Fundación La Puerta, A.C., Centro de Estudios Urbanos (CUESS), the Municipality of Tecate, University of Utah, and Cuahtémoc, A.C.

program is also recommended because of the location of wells in the urban environment and past water quality tests which showed high levels of coliforms.



m.a.s.l.= meters above sea level.

Fig. 21
Estimated extent of Tecate aquifer.[8]
Source: Craig Forster, University of Utah.

In the United States, the groundwater basin beneath the lower Tijuana River Valley is part of the San Diego Formation, a large and complex coastal alluvial aquifer that extends from the Tijuana River Valley northward to the San Diego River (Fig. 22) (San Diego County Water Authority 2000). Hydrothermal activity contributes locally to groundwater in the San Diego Formation below the Nestor terrace (U.S. Department of Energy 2003). Although groundwater in this aquifer is saline, the San Diego County Water Authority believes the San Diego formation shows promise for groundwater recharge and recovery.

[8] (Forster 2005)

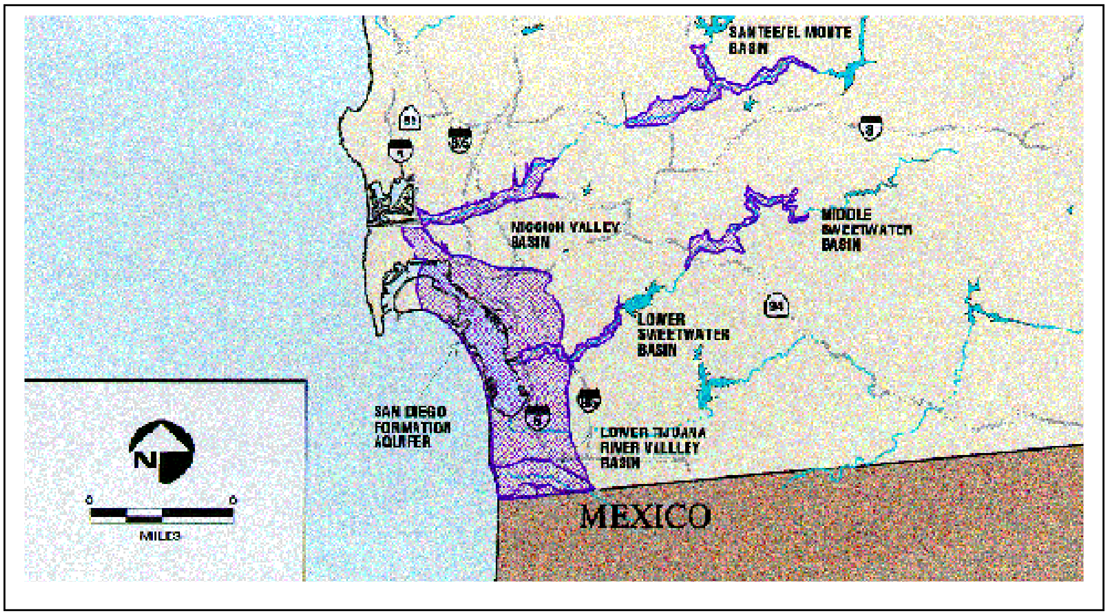


Fig. 22
San Diego Formation Aquifer.
Source: (San Diego County Water Authority 1997).

The aquifer under the alluvial fill of the Tijuana River in the United States is unconfined and can potentially store up to 80,176,320 m^3 (65,000 acre-ft) of water. The aquifer rests atop a bedrock surface and, on the average, consists of 15 to 27 m (50 to 90 ft) of sand and silt overlying 3 to 11 m (10 to 35 ft) of interbedded layers of gravel and sand, which are tapped by production wells (Municipal Wastewater District, 1996 as cited by Camp Dresser and McKee 2003; San Diego County Water Authority 1997).

A bedrock aquifer lies beneath the alluvial aquifer in the hills bounding the Tijuana River Valley. The formation is made of an upper conglomerate unit approximately 250 ft (76 m) thick and a sandy facies approximately 1,200 ft (366 m) thick (Kennedy 2001 as cited by U.S. Department of Energy 2003). Reported hydraulic conductivities of bedrock intervals range from 0.002cm/s (6 ft/day) to less than 0.0000185 cm/s (0.05 ft/day)(Dudek 1997 as cited by Camp Dresser and McKee 2003). Groundwater flow models for the Tijuana River aquifer show that 15, 657 ft^3 /day of water leaves the system to the Pacific Ocean underground, 1,392 m^3/day (49,144 ft^3/day) leaves to the ocean from the Tijuana River, and 191,878 ft^3/day leaves through evapotranspiration. Recharge of the system occurs from the Alamar and Tijuana Rivers 6,198 m^3/day (218,913 ft^3/day) and less so from precipitation 1,065 m^3/day (37,626 ft^3/day) (U.S. Department of Energy 2003).

Colorado River water quantity

The Colorado River is currently the most important water source for users in the TRW. The main water supply for the municipalities of Tijuana and Tecate is provided by the Colorado River aqueduct that was constructed in 1975 with a capacity of 4,000 l/s (1,057 gal/s). Tijuana has two filtration plants and provides potable water either through a piped supply or through water trucks (*pipas*). Without water reuse or additional imported water, the Tijuana River Basin cannot support additional urban growth with an adequate water supply (IRSC 1997).

The division of Colorado River water between the United States and Mexico is determined by the 1944 water treaty, which established a volume of 1.9 billion liters/yr (or 1,540 acre-ft/yr) as Mexico's allotment. This volume is destined mainly for agricultural uses and only 8% is used for municipal purposes in the cities of Tecate, Tijuana, and Playas de Rosarito (CESPT 2002). The Colorado River Lower Basin states (California, Arizona, and Nevada) have an annual apportionment of 9.3 million m^3 (7.5 million acre-ft), of which California's share is 5.4 million m^3 (4.4 million acre-ft).

The current capacity of the Tijuana-Colorado River aqueduct is 3,900 l/s (1,030.3 gal/s), of which 3,300 l/s (879.7 gal/s) are treated for drinking water use by CESPT at the El Florido plant, and some is treated at the Abelardo L. Rodríguez Plant. The remaining 570 l/s (150.6 gal/s) are either used by the Municipality of Tecate, which has a capacity to receive 350 m^3/s (12,360 ft^3/s) at its two treatment plants (Castro Ruíz 1998). Historically, wells supplied most of the water for Tecate, however, this trend has reversed and now the aqueduct supplies 80% of the water for Tecate (Ramirez March 2004).

Wastewater quantity and infrastructure

Tijuana currently has one wastewater plant providing secondary treatment (biological treatment) at the San Antonio de los Buenos facility with a capacity of 1,100 l/s (291 gal/s). The plant is located 10 km (6 mi) south of the border, outside the watershed boundary, at the coast near Punta Bandera. The San Antonio de los Buenos Plant discharges into the ocean at Punta Bandera through an arroyo. Some water is reclaimed and sold to the nearby Real del Mar golf course. Ecoparque[9] in Tijuana is a pilot reclamation project that treats wastewater to secondary standards for irrigation uses. Located on a steep slope above the Tijuana River, water from the plant is used for lagoons and irrigation projects. Ecoparque also serves as a field laboratory for

[9] A program of COLEF and a collaboration between private, public, and academic sectors

university students and as a tool for environmental outreach to the communities of Tijuana. There are around 90 other private wastewater treatment plants in the municipality of Tijuana, some which are industrial pretreatment operations. Some discharge into creeks and arroyos, and only three plants are monitored by CNA.

CESPT plans to renovate and expand the San Antonio de Los Buenos Plant, from 750 l/s (198 gal/s) to 1,500 l/s (396 gal/s) by 2005. Construction of the Monte Los Olivos Treatment Plant with a capacity of 460 l/s (602 gal/s) is expected begin in 2005. Construction of the La Morita and Tecolote-La Gloria Treatment Plants, with a combined capacity of 497 gal/s (380 l/s) is also included in the Tijuana-Playas de Rosarito Master Plan. CESPT will also be involved in the construction of the secondary treatment module at International Wastewater Treatment Plant (IWTP).

Tecate has one wastewater treatment plant with a capacity of 300 l/s (79 gal/s) that discharges secondary treated water into the Tecate River. The Border Environmental Cooperation Committee (BECC) approved the Improvement and Expansion of the Water and Wastewater Systems, a three-phase project to expand and improve the potable water and sewage collection system, as well as treatment capability (BECC 2000).[10] With funding from NADBANK, plans are to upgrade the plant to the point where the water can be resold for irrigation and other uses by 2006 (Vázquez August 2004).

In July 1990, the United States and Mexico agreed to build the IWTP on the U.S. side of the border to treat sewage flows that exceeded the capacity of Tijuana's sewage collection and treatment system and caused problems in U.S. waters. The IWTP began operation in 1997 and was initially approved for a capacity of 94,635 m^3/day (25 million gal/day [mgd]), with an ability to treat to 189,270 m^3/day (50 mgd), if needed. Effluent from this plant discharges into the Pacific Ocean through an outfall pipe at a depth of about 29 m (95 ft) below sea level 5 km (3 mi) offshore (see

Fig. 23) (Gersberg and Wakida Kusunoki 1998). The outfall was tunneled beneath the Tijuana River Valley in order to avoid damaging important estuarine habitats. Currently, the plant only treats sewage to the level of advanced primary-treated water (removal of solids), and is in violation of the National Pollutant Discharge permit granted by the California Regional Water Quality Control Board (CARWQB). As a result, the CARWQB has filed a lawsuit against the IWTP (owned by the federal government) for non-compliance of the permit. A Supplemental

[10] With funding from CNA and NADBANK

Environmental Impact Statement explored how best to provide secondary treatment (removal of organic materials and nutrients) at the plant itself, in Mexico, or at the Point Loma Wastewater Treatment Plant in San Diego (U.S.E.P.A. and IBWC 1999). If the cause of the toxicity of the effluent from the IWTP is determined to be ammonia or detergents (surfactants), secondary treatment will not be enough to remove the toxicity, and tertiary treatment at either the IWTP or the Tijuana plant and/or pretreatment/prevention programs may be needed.

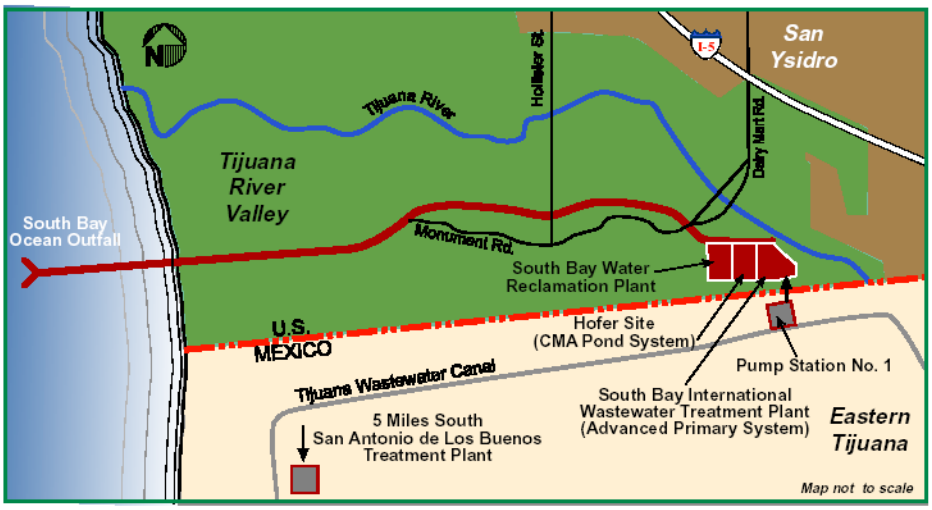


Fig. 23
South Bay and International Wastewater treatment plants.
Source: (U.S. EPA and IBWC 1999).

The South Bay Water Reclamation Plant (SBWRP) is located next to the IWTP (Fig. 25). Opened in 2002, the plant serves as backup for the South Metro Sewer Interceptor System and provides local wastewater treatment services and reclaimed water to the South Bay region of San Diego. It has a wastewater treatment capacity of 56,781,177 l/day (15 mgd) and provides both secondary treatment (for ocean discharge) and tertiary treatment (for reuse) using coal filters and ultraviolet light in order to meet State Title 22 full body contact requirements. This tertiary treated water is marketed wholesale to industrial and public service users and could also be marketed in Tijuana. Currently the plant produces 18,927 m^3/day (5 mgd) a day of reclaimed water, with a total capacity of 15 mgd (56,781 m^3/day) (San Diego Metropolitan Wastewater Department 2004). A contract with the Otay Water District will sell some of this reclaimed water for irrigation purposes starting in January 2007 or sooner, and by 2005 they will be reusing the reclaimed water to clean the IWTP (Villarino 2004). Another option for this reclaimed water is reinjection into the Tijuana River Valley aquifer.

Water quantity trends

Surface water

A stream gauge on the Tecate River measured outflow from the Tecate Wastewater treatment plant from 2001 to 2002[11] (Fig. 24). Historical data are available from four stream gauges in the United States through a U.S. Geological Survey (USGS) online database[48] (Fig. 25). In general, the TRW streams are intermittent and flow about every ten years during heavy rains, such as those during El Niño events.

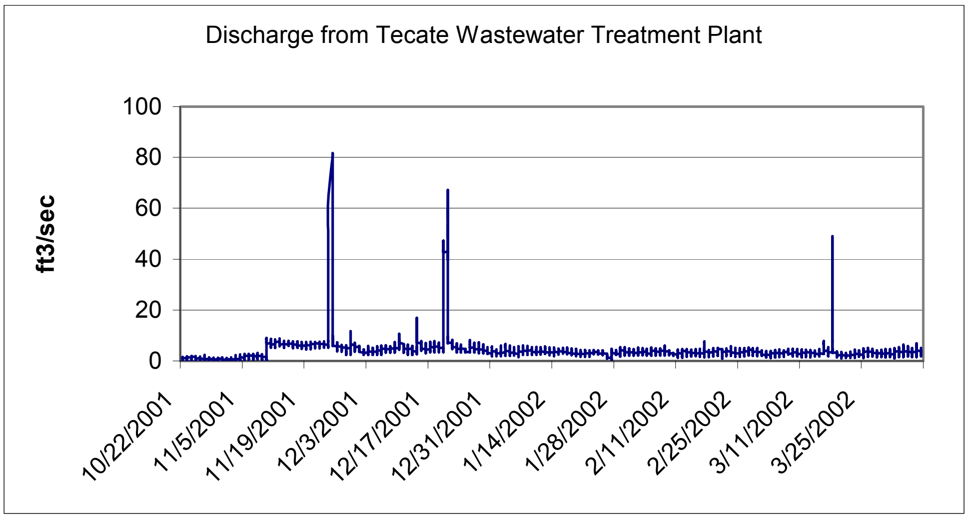
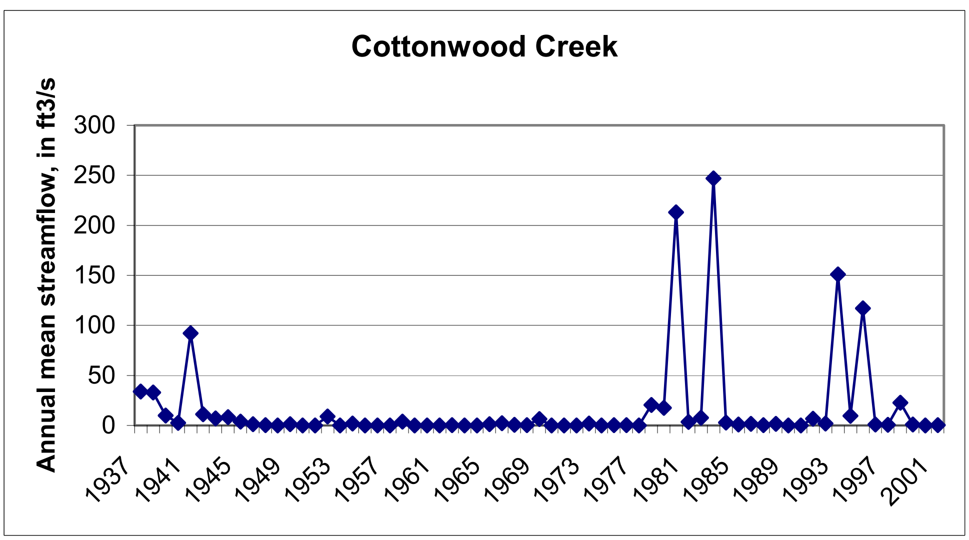
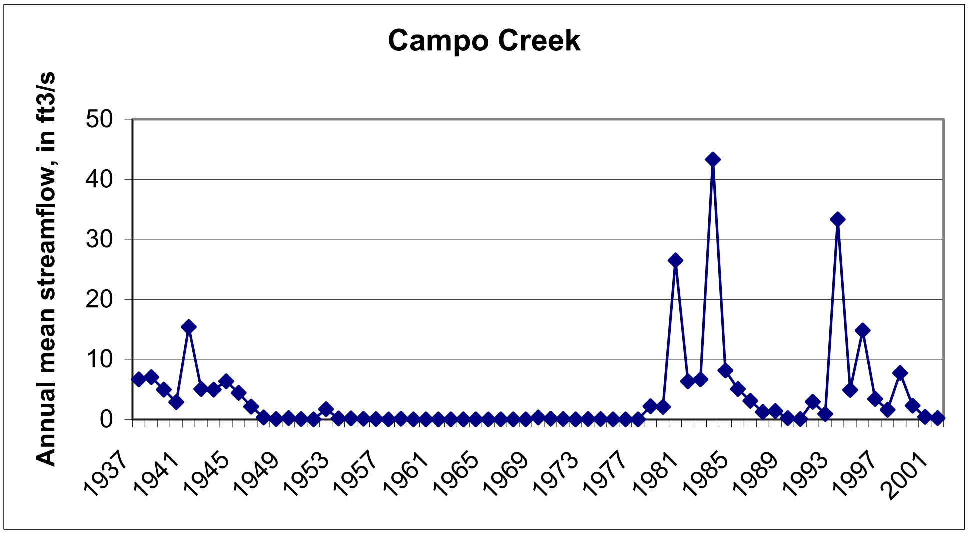


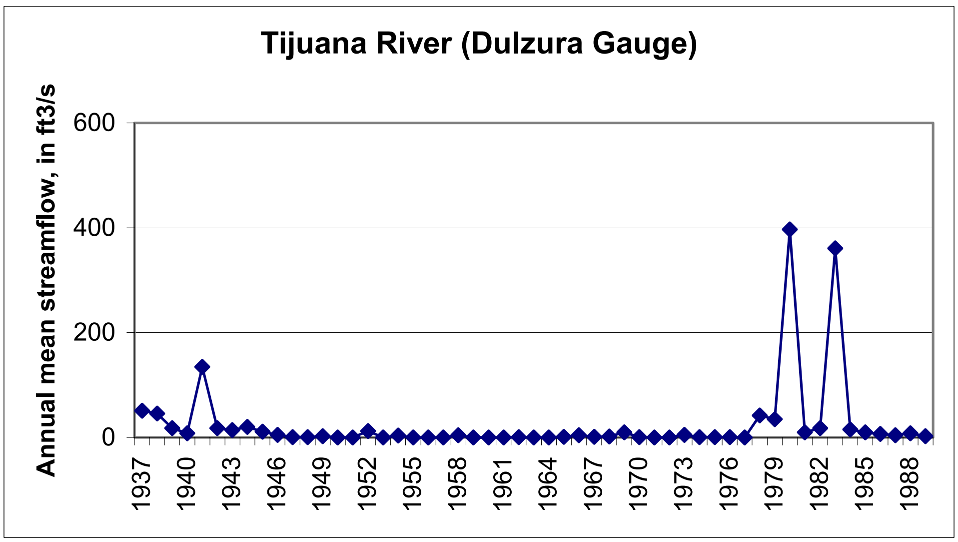
Fig. 24
Stream gauge at Tecate River 2001 to 2002.[12]

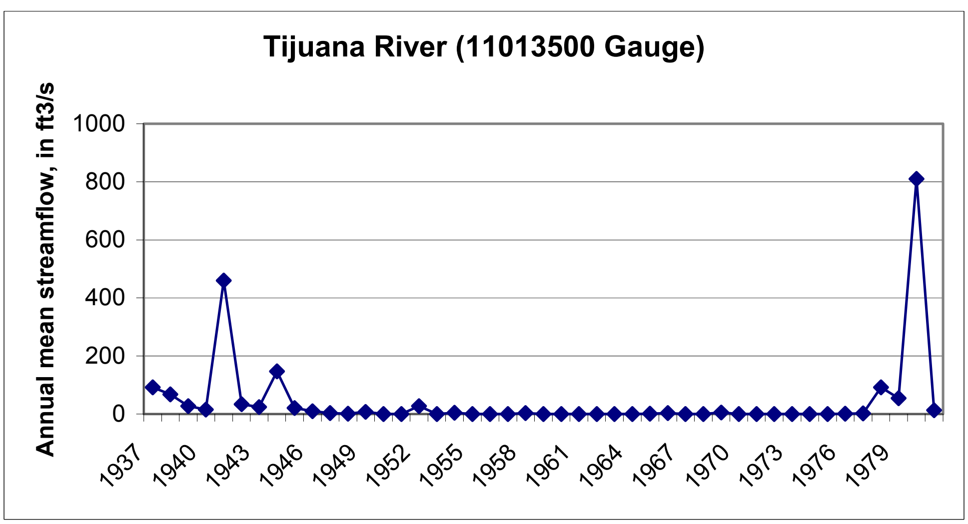


[11] A project headed by R. Gersberg, SDSU.

[12] A project headed by R. Gersberg, SDSU.


Campo Creek
Annual mean streamflow, in ft3/s
50
40
30
20
10
0
1937
1941
1945
1949
1953
1957
1961
1965
1969
1973
1977
1981
1985
1989
1993
1997
2001


Tijuana River (Dulzura Gauge)
Annual mean streamflow, in ft3/s
600
400
200
0
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979
1982
1985
1988


Tijuana River (11013500 Gauge)
Annual mean streamflow, in ft3/s
1000
800
600
400
200
0
1937
1940
1943
1946
1949
1952
1955
1958
1961
1964
1967
1970
1973
1976
1979

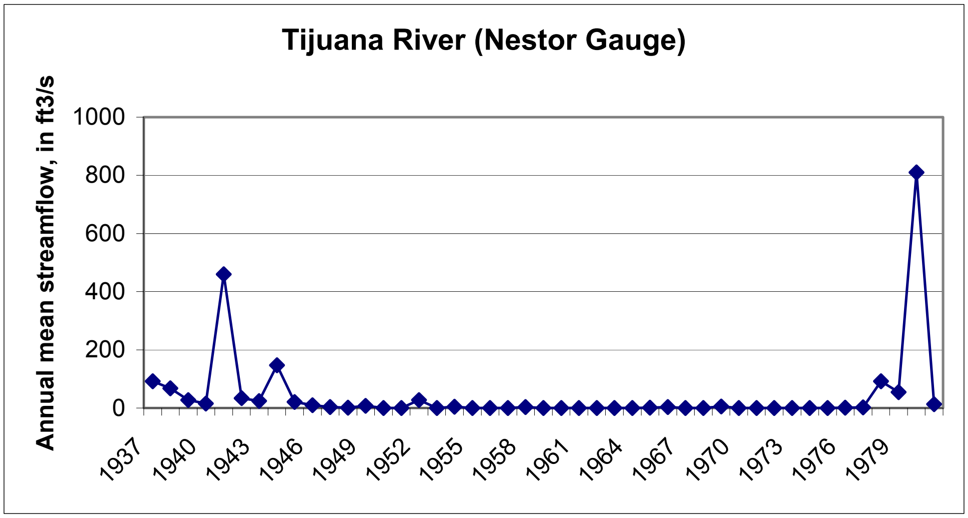


Fig. 25
Historical trends for surface water volumes of creeks in the U.S. portion.
Source: (USGS 2004).

Groundwater

Historically, groundwater consumption in the TRW was principally for potable water and for agricultural uses, although the brewery in Tecate has used large amounts of groundwater for beer production. High levels of pumping in the U.S. portion of the Tijuana River Valley during the 1950s resulted in a decrease in groundwater levels by 7 to 9 m (23 to 30 ft). By the 1960s, groundwater levels in the Tijuana River Valley had dropped below sea level, allowing highly saline groundwater and seawater to flow into the aquifer (Recon, 1994 as cited in Camp Dresser and McKee 2003). Since 1952, groundwater usage has dropped due to several factors, such as the increase in importation of irrigation water from other basins, degraded groundwater quality, and declining agricultural activities (MWWD 1996 as cited in Camp Dresser and McKee 2003). As a result, by 1998 groundwater levels had recovered to within 0 to 15 feet of the ground surface (CH2M HILL 1998 as cited in Camp Dresser and McKee 2003).

Future sources

San Diego County Water Authority projects that total water demand in the county will increase to approximately 1 million m^3/yr (872,400 acre-ft/yr) by 2030, which represents a 26% increase over the estimated use in 2003. This water is earmarked to accommodate a projected population increase of 31% over the same period (SANDAG 2003). Transfer of water from the Imperial Valley was arranged in 2003 after complex and controversial negotiations, and this transfer will bring an additional 246.7 m^3/yr (200,000 acre-ft/yr) of water via California's

Colorado River Aqueduct. In addition to the purchase of the Imperial Valley water, a canal-lining project for the All-American and Coachella Canals will free up an additional 94,978,653 m^3/yr (77,000 acre-ft/yr) for San Diego County (San Diego County Water Authority 2003). Lining the All-American Canal will significantly reduce recharge of the adjacent aquifer in Mexicali, Mexico, and will likely have a significant impact on Mexicali's agricultural production. The continued availability of imported water may delay the development of local water supply alternatives in the TRW, such as artificial aquifer recharge, water reclamation projects, storm water recycling, and rain harvesting projects.

CESPTE projects a 2010 water demand of 7.8 million m^3/yr (6,324 acre-ft/yr) of water (Castro Ruíz 1998). For Tijuana and Playas de Rosarito combined, CESPT estimates the water demand will increase from 106 million m^3/yr (85,936 acre-ft/yr) in 2001 to 216 million m^3/yr (175,114 acre-ft/yr) in 2023, which represents an increase of 106% over the current demand. For the year 2040, the projected demand is 316 million m^3/yr (256,185 acre-ft/yr) (CESPT 2002).

It is expected that Colorado River water will continue to be an important water source for Mexico in the future. The Mexican State Commission for Water Services (COSAE) proposes to upgrade the aqueduct to conduct additional water in the amount of 1,300 l/s (343.4 gal/s) (CESPT 2002). This is an expensive option with a relatively long implementation period, and obtaining additional water rights, or developing a purchase agreement with the United States would likely be necessary (CESPT 2002). There is also a plan to build a second aqueduct to the coastal communities of Baja California called Acueducto Río Colorado II. The aqueduct would be built from 2008—2011 and would have a capacity of 8,000 l/s (2,113 gal/s) and would require an estimated $3.25 billion in investment (Gobierno del Estado de Baja California, et al. 2004a)

Groundwater in the Tijuana River Valley, although currently of low quality, is a potential source of water for the San Diego County Water Authority. The goal of the City of San Diego Water Department is to eventually extract 3 million m^3/yr (2,500 acre-ft/yr) of groundwater from the San Diego Formation in the lower Tijuana River Valley, through natural and artificial recharge projects (San Diego County Water Authority 1997). Groundwater flow models[13] for the Tijuana River aquifer predict that between 7,570—9,463 m^3/day (2.0—2.5 million gallons/day) could be artificially injected through three wells on the U.S. side without reaching the surface (U.S. Department of Energy 2003).

[13] (U.S. Department of Energy 2003)

Desalinization of seawater is an alternative being explored in both Tijuana and San Diego. The main concern is that desalinization plants are very expensive to build and expensive to operate because of the energy required. In San Diego, the County Water Authority (CWA) has adopted the Seawater Desalination Action Plan with the goal of developing at least 25,000 acre-ft of supply by 2020, provided it is determined to be cost-effective and feasible. The CWA is interested in locations near the South Bay Power Plant in Chula Vista, and is and conducting a study of other potential locations where seawater desalination facilities could be developed on a regional scale. Although the potential sites are not located in the TRW, the availability of desalinized water will likely have impacts on the supply and cost of water available to TRW residents, including the emergency supply water provided to Tijuana by San Diego through International Boundary and Water Commission (IBWC-CILA) (see "International legislation" section) (SANDAG 2002).

Water quantity data

Sources of data on water quantity in the TRW are available in Appendix 7. The data includes reports, electronic files, maps, and other information in English and Spanish from both the United States and Mexico.

Water quantity data gaps

After reviewing the available data, the Research Team and others identified the following data needs for the TRW:

- More surface water gauging stations at all the tributaries in the TRW
- All stream gauge data in a centralized database (see, for example, the Flood Warning project)[14]
- Data on the extent of groundwater aquifers, quality, quantity, and flow (including transboundary aquifers)
- Research on the potential for recharge of the aquifers through natural or artificial means
- Data on runoff from precipitation and sediment loading in the rivers
- Stream flow rates for the Alamar and Tijuana Rivers on the Mexican side[15]

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[14] A collaboration of Dirección Estatal de Protección Civil, County of San Diego, the National Oceanic and Atmospheric Administration, and Pacific REMS

[15] Suggested by (U.S. Department of Energy 2003)

- Measured evapotranspiration zones and rates

The following applied research projects relating to groundwater quantity are recommended by the Vision project:[16]

- Conduct regular periodic groundwater level monitoring along the Tijuana and Alamar Rivers.
- Install an observation well near a supply well in Tijuana and conduct pumping tests to determine hydraulic conductivity of the alluvial aquifer to better determine the flow, extraction potential, and recharge rates of water.
- Test hydraulic conductivity in the San Diego Formation alluvial aquifer.

Water quantity recommendations

The Vision project recommends that water agencies focus on conjunctive water use, or the coordinated management of surface, reclaimed, and groundwater supplies. Since groundwater does not evaporate, groundwater storage, as opposed to open-air reservoirs, should be considered. Many areas in the watershed could store water underground, replenishing their wells. The Las Auras emergency storage tank in Tecate, for example, is open air, and subject to evaporation losses, high pumping costs, and seepage. Recharging the Tecate aquifer and storing water underground is an alternative worth investigating.

Reuse of water for landscaping should increase, and public education in both the United States and Mexico is needed to dispel myths that reused water is unsafe for human consumption. Stakeholder groups for groundwater are needed to make collaborative decisions on sustainable groundwater use.

TRW stakeholders at community forums, the BWAC, and the Vision Research Team jointly characterized the current situation and future desired scenarios for water quantity in the TRW. Table 7 summarizes these conclusions.

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[16] Suggested by (U.S. Department of Energy 2003)

WATER QUANTITY			
Challenges	**Opportunities**	**Goals**	**Objectives**
Growing population and industrial needs for water have outstripped local groundwater and surface water supplies Due to over-extraction, water tables are much lower than historical levels and allow saltwater intrusion, which contaminates drinking supplies Sand extraction reduces groundwater storage capacity of stream valley aquifers Increased impermeability of surfaces contributes to flash flooding, which results in loss of life and property A culture of water waste exists in the region Increased impermeability of surfaces results in a more rapid flow of water to the ocean and decreased groundwater recharge	Rechargeable aquifers Groundwater storage capacity Existing surface water flow Existing restoration and reclamation efforts: Ecoparque, Campo Indian Reservation stream restoration, Oneata Slough, Model Marsh, TETRP at Estuary Government interest in water reuse Existing reservoirs Riparian vegetation restoration	Decrease dependence on imported water Improve hydrology of watershed Improve local water production Decrease flood risk	Map and characterize aquifers Control erosion and manage sedimentation (e.g., bank regrading and revegetation, channel grade control structures, riprap) Increase permeability of developed land by redirecting runoff into bioswales, and removing unneeded hardscape Preserve open space to improve percolation into the aquifer and to decrease rapid runoff Test the feasibility of recharging the groundwater basin with surface flows Develop detailed water budget and hydrologic model Manage groundwater to prevent future overdraft Develop water source protection measures Utilize neighborhood-based and subwatershed flood detention solutions (i.e., increase groundwater percolation and slowing of surface runoff) Restore floodplain using management practices, such as reforestation, bioengineering, and/or other non-structural approaches Implement stormwater retention and rainwater harvesting techniques Create demonstration projects (i.e., septic tanks, constructed wetlands, industrial pretreatment systems) Promote comprehensive conservation programs to reduce water consumption Expand flood warning systems

Table 7
Water quantity challenges, opportunities, goals, and objectives

The 155 TRW stakeholders at the September and October 2003 meetings offered the following solutions to meet the stated water quantity goals (Table 8):

Votes	Actions	Locations
9%	Increase water reuse, new and appropriate technologies, investments	Valle de las Palmas, Arroyo Alamar, Tijuana River
7%	Analyze, monitor, and identify all water sources	Watershed-wide
6%	Identify critical points, such as deforested areas, over-exploited sand mining areas, and stream courses that are at risk	Watershed-wide
6%	Evaluate the aquifers for water quality and quantity conditions	Alamar River, Tijuana River, and watershed-wide
6%	Subdivide the TRW in "subbasins" for purposes of planning and local "task forces"	Watershed-wide
5%	Delimit streams (right of ways) to protect them	Watershed-wide
5%	Diversify water sources (alternatives)	Dams upstream of Rodríguez Dam
5%	Legally protect areas for aquifer recharge	Watershed-wide
4%	Create a natural park to protect surface and groundwater and address social problems as well	Alamar River, Tecate Creek, Cottonwood Creek, Las Palmas (future Tijuana bedroom community), upper watershed creeks, small villages, *ejidos*
4%	Create a culture of water conservation	Mexico and United States

Table 8
Priority water quantity actions from stakeholder meetings.
The voting percentages reflect ~50 persons per meeting casting 5 votes each.

Water quality

Surface water quality

The U.S. portion of the lower TRW is classified as a Category I (impaired) watershed by the CASWRCB due to point- and non-point pollution that flows into U.S. waters from U.S. and Mexican lands (City of Imperial Beach, City of San Diego and County of San Diego 2002). The most serious non-point pollution sources are nutrients and chemicals from agriculture/ranching and runoff from impermeable urban surfaces from both sides of the border. Point-source pollution comes from industries, septic tanks, and sewage treatment plants.

To address point-source pollution concerns, the Baja California Industrial Wastewater Monitoring and Pretreatment Program[17] (1998—2004) was organized. The goal was to obtain baseline information regarding the quality of the wastewater in the collector systems of Tijuana, Tecate, Mexicali, and Ensenada, and the quality of the discharge into open waters after treatment. Preliminary results of the program show that Mexican industrial point-source contaminants are sporadically detected, but have shown improvement in recent years. Due to dilution with other wastewater, almost all the industrial and commercial wastewater entering the treatment plants in Tijuana and Tecate meets the Mexican Standards, NOM-002.

Despite improvements in point-source pollution discharges by industries and the Comisión Estatal de Servicios Públicos (CESPT and CESPTE) wastewater treatment plants in Mexico, the Tijuana River still conveys contaminated waters into the United States. Likely non-point pollution sources include the commercial and residential sectors in Mexico, agricultural sectors in the United States, and clandestine dumping of hazardous materials. Table 9 outlines contaminants of concern identified by the County of San Diego Watershed Urban Management Program. The Tijuana River water was sampled at the Hollister Street Bridge in Imperial Beach in 2001—2002.

[17] Funded by CASWRCB, CalEPA, CEA. See http://www.ibwc.state.gov/EMD/Mexicali/mexicali.pdf

ANALYTE	UNITS	2003—04		
		11/12/2003	1/25/2004	2/3/2004
General / Physical / Organic				
Electrical Conductivity	umhos/cm	1174	1471	25000
Oil and Grease	mg/L	9.1	2.38	6.44
pH	pH Units	7.43	7.76	7.96
Bacteriological				
Enterococci	MPN/100 ml	500,000	5,000,000	2,400,000
Fecal Coliform	MPN/100 ml	1,700,000	800,000	800,000
Total Coliform	MPN/100 ml	3,000,000	2,800,000	1,300,000
Wet Chemistry				
Ammonia as N	mg/L	1.9	8.05	6.4
Un-ionized Ammonia as N	µg/L	16.7	127	124
BOD	mg/L	70.9	72.5	98.6
Chemical Oxygen Demand	mg/L	319	217	903
Dissolved Organic Carbon	mg/L	45.8	29.3	14.4
Dissolved Phosphorus	mg/L	1.56	3.41	1.99
Nitrate as N	mg/L	8.75	1.72	1.5
Nitrite as N	mg/L	0.42	0.59	0.34
Surfactants (MBAS)	mg/L	<0.5	1.7	<0.5
Total Dissolved Solids	mg/L	650	476	491
Total Kjeldahl Nitrogen	mg/L	16.4	19.8	19.5
Total Organic Carbon	mg/L	41.8	69.1	72.9
Total Phosphorus	mg/L	1.8	3.41	2.97
Total Suspended Solids	mg/L	590	120	128
Turbidity	NTU	383	90.6	3270
Pesticides				
Chlorpyrifos	µg/L	<0.01	0.085	<0.01
Diazinon	µg/L	0.584	0.276	0.907
Malathion	µg/L	1.46	0.788	0.284
Hardness				
Total Hardness	mg $CaCO_3$/L	328	308	417
Total Metals				
Antimony	mg/L	<0.005	<0.006	<0.005
Arsenic	mg/L	0.011	0.009	0.055
Cadmium	mg/L	0.001	<0.001	0.005
Chromium	mg/L	0.026	<0.005	0.189
Copper	mg/L	0.058	0.02	0.197
Lead	mg/L	0.048	0.007	0.278
Nickel	mg/L	0.029	0.013	0.101
Selenium	mg/L	<0.005	<0.005	0.005
Zinc	mg/L	0.288	0.056	1.53
Dissolved Metals				
Antimony	mg/L	<0.005	<0.006	<0.005
Arsenic	mg/L	0.003	0.006	0.006
Cadmium	mg/L	<0.001	<0.001	<0.001
Chromium	mg/L	<0.005	<0.005	<0.005
Copper	mg/L	0.005	0.01	0.005
Lead	mg/L	<0.002	<0.002	<0.002
Nickel	mg/L	0.003	0.011	0.007
Selenium	mg/L	<0.005	<0.005	<0.005
Zinc	mg/L	<0.02	<0.02	<0.02

ANALYTE	UNITS	2003—04		
		11/12/2003	1/25/2004	2/3/2004
Toxicity				
Ceriodaphnia 96-hr	LC_{50} (%)	14.36	18.95	17.68
Ceriodaphnia 7-day survival	NOEC (%)	6.25	12.5	6.25
Ceriodaphnia 7-day reproduction	NOEC (%)	6.25	12.5	12.5
Hyalella 96-hr	NOEC (%)	50	100	50
Selenastrum 96-hr	NOEC (%)	100	100	100

Table 9
Constituents of concern in the Tijuana River 2003—2004.
Highlighted cells indicate values that exceed recommended standards.
Source: (San Diego County Water Authority 2000) updated 2004.

In addition to the chemical analyses, the U.S. EPA reported the following impairments (including trash) to the surface waters of the U.S. portion of the lower TRW in 1998
(
Table 10).

Impairment name	Impairments reported
High coliform count (bacteria)	3
Eutrophic (depleted oxygen do to algae growth)	2
Pesticides (poisons)	2
Trash	2
Lead (heavy metals)	1
Synthetic organics – priority (specialty chemicals)	1
Trace elements (inorganic chemicals)	1
Thallium (heavy metal)	1
Solids (sediments and trash)	1
Nickel (heavy metal)	1
Organic enrichment/low dissolved oxygen	1
Total impairments reported	16

Table 10
Impairments to the U.S. portion of the lower TRW.
Source (USEPA 2000).

Wet weather monitoring of three storm events during 2002 and 2003 was recently conducted (San Diego County 2004). Results for the Tijuana River site show that diazinon, chlorpyrifos, and total and dissolved phosphorus persistently exceeded water quality objectives and benchmarks from the San Diego Basin Plan for all storms. Metals and ammonia concentrations also exceeded the plan's water quality objectives and/or benchmarks. Although testing with *Ceriodaphnia dubia*, a water flea known to be sensitive to metals and pesticides and other contaminants, showed toxic levels, no clear linkage has been identified to determine the constituents of concern responsible for the toxicity. The County of San Diego recommends continuing monitoring in the TRW, and performing a bioassessment and a toxicity identification evaluation using *C. dubia* to identify constituents of concern.

Dry weather monitoring was conducted by the County of San Diego at Cottonwood Creek and Pine Valley Creek in 2003. The sites had slow flowing water at all three sampling rounds. No site exceeded the County standard, except for the bacteria indicators that exceeded the voluntary County standards. However, follow-up investigations did not identify the likely source of the bacteria and additional source identification was scheduled for 2004.[18]

Bioassessment was performed at two sites in 2003 in the U.S. portion of the TRW, Campo Creek and Dairy Mart Road. The total number of macroinvertibrate taxa found at the sites was 12 compared to the highest site in San Diego with 32 taxa. In general, higher numbers of taxa indicate healthier streams. Richness of biodiversity was 8.3 taxa at Tijuana River-Dairy Mart Road compared to 21.0 at De Luz Creek, a reference creek in Morro Hill, San Diego. Campo Creek is reported to contain organisms highly intolerant to disturbances. Results indicate that both of these sites had very slow currents with substrates dominated by fine particulate organic matter (San Diego County 2004). The low taxa counts in the TRW likely relate to the characteristics of the stream substrate and toxicity levels of the water.

Summary of water quality testing projects for the TRW [19]

A number of water quality studies have been performed in the TRW in recent years. Although the following studies were not all long-term sampling and monitoring efforts, the results provide a useful characterization of water quality in the TRW:

a) Gersberg, Brown, Placchi, Bodensteiner, and Zambrano (1998) conducted a sampling program to assess the quality of storm waters associated with a variety of land uses in the TRW. Results showed that the heavy metals (chromium, copper, and zinc) were highest at the industrial land use site, and lead levels were highest at the urban site. Generally, metal concentrations in samples collected during the first 2 to 4 hours of runoff (early-storm) were higher than those in samples collected 24–36 hours into the rain event. A notable exception

[18] Data provided by Jeffery Pasek, San Diego County Water Department

[19] Excerpt from (Gersberg and Wakida Kusunoki 1998)

to this pattern was observed for the site on Tecate Creek, where levels of cadmium, chromium, copper, and nickel were higher in the "late-storm" sample. This is probably due to the point-source discharge of wastewater effluent from the Tecate Municipal Treatment Plant just one mile upstream. At the industrial site, concentrations of copper, lead, and zinc in samples of early-storm runoff fell in the 80th percentile range of a U.S. industrial runoff dataset (Line, et al. 1997) but were generally lower than 90th percentile values for wet weather runoff in an urban watershed of Los Angeles County. These data suggest that non-point source pollution arising from a variety of land uses in the TRW will continue to enter the Tijuana River Estuary and nearshore ocean during wet weather, arguing for basin-wide wastewater and storm water management in this urban watershed.

b) Water quality data for Tecate Creek were obtained in the early 1990s (Lozano 1995). Levels of fecal indicator bacteria at the Tecate Creek site were as high as those found in raw sewage, with densities of 10^{7}—10^{8} MPN/100 ml for total coliforms (TC) and fecal coliforms (FC) and 10^{6}—10^{7} MPN/100 ml for enterococci.

c) Data on sediment contamination of the Estuary were reported for metals (Meyer and Gersberg 1997). Only at a site near a City of Imperial Beach storm drain were any of the metal concentrations above the effects range-median values of 50 mg kg^{-1} Ni , 270 mg kg^{-1} Zn, and 9 mg kg^{-1} Cd, which are the concentrations approximately midway in the range of reported values associated with biological effects (NOAA 1991 as cited by Meyer and Gersberg 1997). Even at the most contaminated site in the Estuary, the SEM:AVS (simultaneously extractable metal: acid volatile sulfide) ratio was several orders of magnitude lower than the potential toxicity threshold of 1.0. Therefore, despite significant metal loading to the Tijuana River and the Estuary in recent years, the sediment SEM:AVS ratios indicate that the sulfides in the sediments should be more than sufficient to bind to the metals and prevent toxicity.

d) The Bay Protection and Toxic Cleanup Program (BPTCP) (CASWRCB 1996) collected data on the sediment chemistry and toxicity of sediments in the Tijuana River Estuary at six sites. The chemical analyses for the chemicals of concern (including copper, mercury, zinc, total chlordane, total PCBs, and total Polycyclic Aromatic Hydrocarbons [PAHs]) showed that only the low molecular weight PAHs exceeded the probable effects level in the Tijuana Estuary (at a single site in the northern arm). However, sediments at a number of stations in both the southern and northern arms of the Tijuana Estuary showed toxicity (significant difference in survival at less than 80% of lab controls) using amphipod and sea urchin development pore water toxicity tests. Since sediment grain size (for bulk sediment toxicity tests) and ammonia and/or sulfide may cause toxicity in addition to anthropogenic chemicals, the BPTCP Report did not determine which particular chemical(s) caused the observed toxicity.

e) The CASWRCB also oversaw the State Mussel Watch (SMW) Program (1996) and Toxic Substances Monitoring (TSM) Program (1992). These programs involved the collection and analysis of mussels and fish for a variety of contaminants. Unfortunately, the SMW Program stopped sampling mussels in the Tijuana River in 1986, and the TSM Program ended sampling of fish in the Tijuana Estuary in 1992. The last study showed that for several contaminants (selenium and copper), there was indication of elevated levels in mullet from the Estuary. Gersberg, Trindade, and Norby (1989) found that among the toxic metals tested in fish from the Tijuana Estuary, only lead exceeded an international standard for edible tissue (2 mg/kg). However when a human health risk assessment was conducted, and considering that the Tijuana Estuary is not a significant commercial or sport fishery, it was concluded that lead contamination does not pose a major threat to human health (Gersberg, Trindade and Nordby 1989).

f) The San Diego County Department of Environmental Health collects data on coliform levels at the Tijuana River mouth as well as the Imperial Beach Pier. Data indicate that the coliform standards for recreational use (1,000 CFU/100 ml for total coliforms and 200 CFU/100 ml for fecal coliforms) are generally attained at these sites during the summer, except during rain events or spills or breaks in sewage pipes further up the watershed (Wakida and Riveles 1997). Gersberg, Dodge, Parsons, and Zedler (1994) studied the microbial quality of the Tijuana Estuary under a range of tidal conditions during both wet and dry weather. This study found that during wet weather, the whole Estuary was contaminated, but that the mean levels of both total and fecal coliforms during dry weather were similar to indicator levels in dry weather flows throughout Southern California (Gersberg, et al. 1994).

g) The San Diego Water Department conducts routine (almost monthly), ongoing water quality monitoring at Barrett and Morena Reservoirs and several creeks tributary to these reservoirs. The San Diego Water Department's monitoring of the reservoirs began in earnest in 1989, while there is some monitoring data from the reservoirs extending back to the 1940s. Monitoring of the tributary streams began in 1999.

h) The Autonomous University of Baja California's Department of Chemistry has conducted several studies of the Tecate River water quality, including parameters such as heavy metals, hardness, biological oxygen demand (BOD), chemical oxygen demand (COD), greases, and so forth (Lozano 1995). In 1987, the Department tested La Gloria, a neighborhood in Tijuana, for lead in the soils, plants, and people.[20] Between 1992 and 1993, the department tested discharge points not connected to the sewer system in the Industrial Zone of Otay-Mesa in Tijuana for iron, chromium, copper, manganese, lead, and zinc.[21]

i) The Baja California Industrial Wastewater Monitoring and Pretreatment Program[22] sampled all four Baja California treatment plants and key industrial plants from 1998—2004. In addition, the project involved the training of personnel from the CESPs in wastewater sampling techniques and the transfer and calibration of equipment. A liaison with Mexican Agencies Team compiled wastewater testing data and made suggestions for policy changes in Mexico. An Industrial Advisory Team, consisting of industrial wastewater plant operators and pretreatment experts, made suggestions about how to economically sustain a pretreatment program while maintaining an attractive business climate for industries.

The above studies provide snapshots for water quality at various locations in the TRW. Data gaps and recommended future studies are provided at the end of this section.

Groundwater quality

Currently, the quality of groundwater in the U.S. portion of the Tijuana River Valley is characterized by high levels of total dissolved solids and sodium chloride. It has been rated inferior for domestic use due to high sulfate and fluoride concentrations. In addition, it was rated inferior for irrigation purposes because of high electrical conductivity, high chloride levels, and a high percentage of sodium. Several factors have been suggested to explain the poor quality of groundwater, including seawater intrusion, leakage from the San Diego Formation, sewage from the community of San Ysidro, irrigation return to groundwater, and groundwater movement from the international boundary (Recon 1994 as cited by Camp Dresser and McKee 2003).

In Mexico in 1980, total dissolved solids levels of the wells ranged from 500 to 3,000 mg/L in the Tijuana River Valley, 200 to 2,500 mg/L in the Tecate Creek Valley and 1,000 to 4,000 mg/L in Valle de Las Palmas (INEGI 1995 as cited by Gersberg and Wakida Kusunoki 1998). Geochemical analysis of the groundwater in the Tijuana River alluvial aquifer showed poor quality with high dissolved solids averaging 2,413 mg/L. Salt within the sediments of the

[20] See Benigno Perez Ruesga, UABC Chemistry Department

[21] See Ruben Guillermo Sepúlveda Marques, UABC Chemistry Department

[22] Funded by CASWRCB and Cal EPA

alluvium and bedrock, along with seawater intrusion from lowered water tables, contributes to the saline character of the groundwater (U.S. Department of Energy 2003).

In 1996 a preliminary study was conducted of the water quality of five Indian communities in Baja California, some of which occur in the TRW.[23] Applying U.S. water standards (total coliform = 0; nitrate = 10 mg/L; and dissolved solids = 500 mg/L), the researchers found that all five communities had high levels of contamination in their drinking water, which principally come from wells. The researchers suggested that the total coliform and fecal coliform counts indicated contamination from human waste or animal feces, since cows, goats, and horses graze upstream from these community water sources. The high nitrate levels might be attributed to the effects of fertilizer runoffs (Kilpatrick 1998; Medina 2002).

Colorado River and State Project water quality

Water from the Colorado River is considered good quality water, although slightly saline. In Mexico this water must be treated with chlorine or other disinfectant prior to distribution to users (CESPT 2002). Bottling plants in the Mexican portion of the TRW buy municipal water and treat it with reverse osmosis. In the United States, Colorado River and State Project water is given full conventional treatment including flocculation, sedimentation, filtration, and disinfection prior to distribution to through municipal water systems.

Wastewater quality

In April 1990, the IBWC initiated a water-sampling program to evaluate the wastewater flows from Mexico that would be treated by the IWTP. Based on the measured concentration of pollutants and an estimated flow rate of 37,854,118 l/day (10 mgd), the study showed that 401 kg (884 lbs) of lead, 146 kg (322 lbs) of cyanide, 548 kg (1,208 lbs) of chromium, 1,606 kg (3,541 lbs) of copper, and 1,350 kg (2,976 lbs) of zinc were being introduced annually into the Tijuana River from these wastewater flows (Recon 1994 as cited by Gersberg and Wakida Kusunoki 1998). Despite infrastructure improvements in Mexico and the opening of the IWTP in 1997, during rain events, serious contamination of the Estuary and near shore marine waters continues to occur. Prior to the completion of the IWTP, discharges from the Tijuana River contained the highest concentrations of suspended solids among the eight largest creeks and rivers in Southern California (SCCWRP 1992 as cited by Gersberg and Wakida Kusunoki 1998).

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[23] A collaboration of the Campo Environmental Protection Agency, the Southwest Consortium for Environmental Research and Policy, CUNA, SDSU, and others

Water quality data

Sources of data on water quality in the TRW are available in Appendix 8. The data includes reports, electronic files, maps, and other information in English and Spanish from both the United States and Mexico.

Water quality data gaps

After reviewing the available data, the Research Team and others identified the following data needs for the TRW:

- GIS data of residential areas with no piped potable water and/or sewage connection
- More data on groundwater quality in the Mexican portion of the watershed
- Temporal data on how pollutant loads vary in baseline and wet weather conditions[24]

Water quality recommendations

Improvements in the sewage infrastructure of Mexico are needed in order to keep pace with the growing urban population and to assure better water quality in the TRW. Government agencies in Mexico must enforce hazardous waste disposal laws. Government should require and support industrial pretreatment of wastewater before it is discharged into the municipal sewer system.

Suggested applied research projects relating to water quality are:[25]

- A monitoring program to determine toxic accumulation in sediments and biota of the Estuary
- A mathematical model of the rate of transport of surface water pollution over the TRW
- Research on the impact of contaminated sites on surface and groundwater quality
- A binational surface and groundwater quality testing program with common methods and quality control for Mexico and the United States
- Automatic sampling of pollutant loading and sediment loading in the Tijuana River

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[24] From (Gersberg and Wakida Kusunoki 1998)

[25] From (Gersberg and Wakida Kusunoki 1998).

TRW stakeholders at community forums, the Binational Watershed Advisory Council, and the Vision Research Team jointly characterized the current situation and future desired scenarios for water quality in the TRW. This information is available in Table 11.

WATER QUALITY			
Challenges	**Opportunities**	**Goals**	**Objectives**
Toxic materials are entering streams and groundwater, causing human health problems and ecosystem impacts Urbanization (paving) decreases filtering of contaminants by vegetation and soil Channelization of Tijuana River and other streams decreases filtering of contaminants by vegetation and soil Channelization of Tijuana River and other streams increases quantity and speed with which contaminants are transported downstream to the ocean Industrial discharge in the watershed is partially uncontrolled, leading to degradation of water Deforestation in riparian and recharge zones reduces filtration of pollutants by vegetation Runoff from urban, industrial, and agricultural activities contributes to water contamination Erosion of bare slopes and agricultural and construction activities are leading to increased sedimentation, which affects stream valleys and the Tijuana River Estuary functioning Inadequate sewage treatment capacity and spatial coverage gives rise to renegade sewage flows that contaminate surface and groundwater Urban and agricultural development increases water temperatures, which affects aquatic biota	University water quality research projects Existing water quality monitoring programs Existing riparian areas Binational agreement on industrial pretreatment Potable Water and Wastewater Master Plan for Tijuana and Playas de Rosarito IWTP Plans for Tecate wastewater infrastructure improvements Rehabilitation studies on the Tecate River by Cal Poly Pamona Alamar River study by SDSU and ASU CalEPA-CEA Industrial Pretreatment Program Ocean plume imagery by Ocean Imaging Remote sensing work by UABC Ocean water quality visualization techniques by SDSU Water quality modeling by SDSU	Enhance low-cost, local clean water supply Decrease point-source contamination from industry Decrease non-point runoff from urban and agricultural areas Decrease health risks from contact with contaminated waters, fish, and shellfish Improve water quality in the TRW Estuary and near shore marine environment	Modify the concrete channels and other flood control structures Plant native riparian species to filter and slow pollutants Create river parks Create meanders and braiding in floodplain Restore floodplains using existing open spaces and green areas Build weirs and berms to slow transport of pollutants downstream Build erosion-control structures on steep slopes Create holding ponds to filter pollutants and recharge groundwater Enforce the mitigation of hazardous material disposal and industrial discharge Design urban green areas for percolation and filtration purposes Reforest the upper basin to slow runoff and reduce erosion Provide adequate sewage systems for all communities Restrict hillside development to reduce erosion Continue university water quality research projects Expand and coordinate water quality monitoring in streams and test for toxics in the tissues of benthic invertebrates Remove hardscape where possible to allow filtration of storm water Continue to monitor nutrients and biota in Estuary Revegetate steep slopes Implement binational watershed health indicators program Develop integrated water quality water quantity model

Table 11
Water quality challenges, opportunities, goals, and objectives

At community meetings in the fall of 2003, the stakeholders voted on priority actions for meeting the goals for water quality listed in Table 12.

Votes	Actions	Locations
7%	Collect groundwater quality data, including bacteria and nitrates	Watershed-wide
6%	Analyze and discuss the new sewage treatment plants project	Tijuana
6%	Educate people so they are aware of their actions (for water conservation and pollution prevention)	Watershed-wide
3%	Look for ways for the government to obtain funding for total sewage coverage	Tijuana and Tecate
3%	Apply pretreatment to 100% of the wastewater	Critical points of discharge
3%	Implement activities, such as taking out channels and cleaning streambeds	Watershed-wide
2%	Educate children on ecosystems with the goal of educating the parents	Schools
2%	Restore vegetation (native species) to slow erosion	Construction sites on slopes and canyons
2%	Increase the infrastructure in the treatment plants so they are more efficient	Urban zones in B.C.
2%	Put in pretreatment processing plants	New developing areas

Table 12
Priority water quality actions from stakeholder meetings.
The voting percentages are based on ~ 50 persons per meeting casting 5 votes each.

Ecosystems and natural resources

Biodiversity

Biodiversity, or the abundance of many different kinds of species, is important to a healthy ecosystem. With sheer numbers, biodiverse areas have a higher chance of providing ecosystems with fit species that can fill ecological roles (e.g., pollinators, predators, carrion eaters, herbivores, decomposers), and with numbers are better able to withstand competition and disasters. High biodiversity can be compared with having a diverse investment portfolio (Naeem, et al. 2000). Healthy ecological systems such as watersheds provide important services to humans, including water cycling and purification, nutrient cycling, air purification, and soil generation.

The TRW is located in the California-Baja California Floristic Province

Fig. 26), which was identified by Conservation International as one of the world's 25 biological hot spots. Biological hot spots are regions with high numbers of endemic species living in 30% percent or less of their original vegetation habitat.

Fig. 26
The California floristic province.
Source: (Conservation International 2004).

According to the U.S. EPA, the most critical issue for the U.S. portion of the TRW is the loss of species (EPA 2004), including endangered and threatened species, such as the bighorn sheep (*Ovis canadensis cremnobates)*, Stephens' kangaroo rat (*Dipodomys stephensi),* the Arroyo toad (*Bufo microscaphus californicus),* and several avian species. Many of these species are migratory and use habitat on both sides of the border. The TRW and is also an important region for valuable vegetation communities, such as coastal sage scrub and chaparral (Delgadillo 2000), which are diminishing due to human impacts.

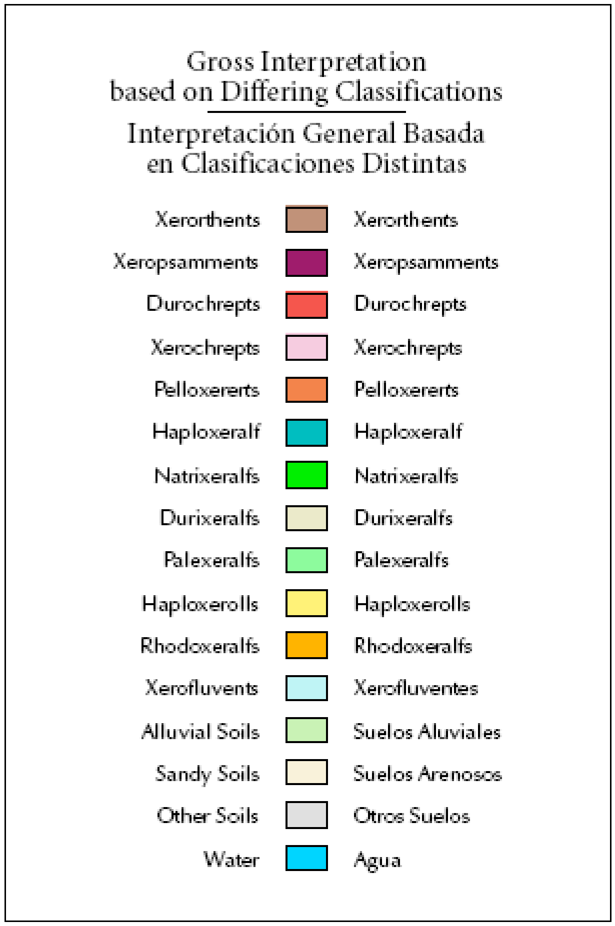
Fragmentation

Loss of biodiversity in the TRW has been attributed to fragmentation, or the creation of habitat islands and separation of habitats. Habitat fragmentation prohibits gene flows of individual species because they cannot physically reproduce with neighboring populations, resulting in population sinks that can lead to a decreased resistance to disease and disasters, or even extinction (MacArthur 1967; Diamond 1975; Westman 1985; Ney-Nifle and Marc 1999). Extinction of bird populations has been documented in island-like fragments of vegetation in San Diego County (Bolger, Allison A. C. and Soule 1991). North-south and east-west habitat connectivity is important in order to support the variety of plants and wildlife that are found in the TRW (CBI, Pronatura, and TNC 2004).

Soils

Soil development within the Tijuana River Basin is controlled by three dominant factors: a) the semiarid (xeric) climate, b) sparse vegetation dominated by brush and short grasses, and c) geomorphic environments with little vegetation cover or sub-soils made up of shrink-swell clays.

On the U.S. side of the TRW, a detailed soil survey provides very specific descriptions and taxonomy of the soil cover based upon the Natural Resource Conservation District's Seventh Approximation. The Mexican side of the watershed appears to have comparable soils, but existing surveys are scant and based on different taxonomic criteria (U.N. Food and Agricultural Organization [FAO]) that are difficult to correlate with the American system (Fig. 27) (Greenwood 2005). However, the United States is moving toward using a State Soil Geographic Database (STATSGO) that is more compatible with FAO.


Gross Interpretation
based on Differing Classifications
Interpretación General Basada
en Clasificaciones Distintas
Xerorthents
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Suelos Arenosos
Other Soils
Otros Suelos
Water
Agua

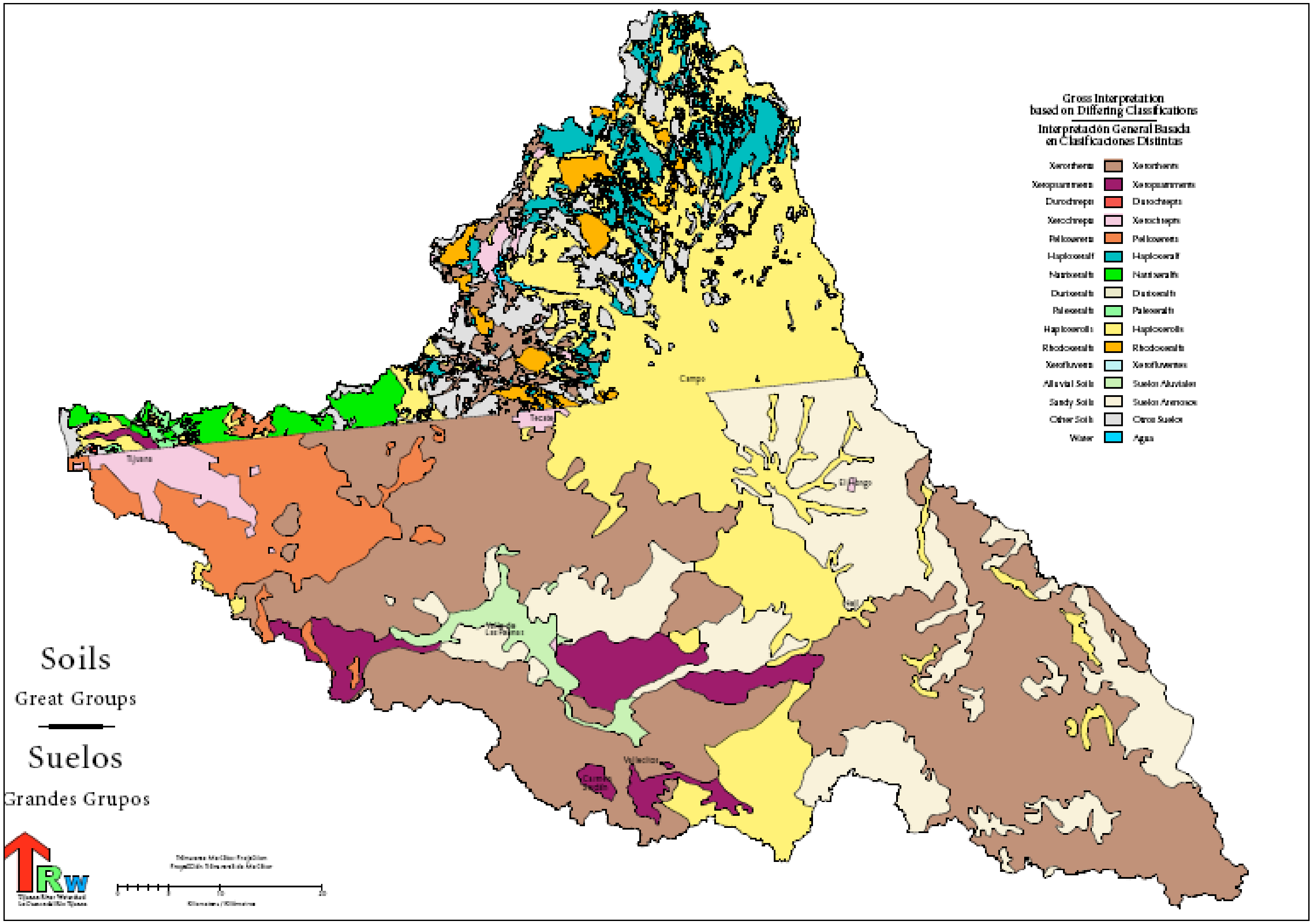

Fig. 27
Soils in the TRW.
Source: (SDSU and COLEF 2005).

The map of the U.S. side of the lower basin and foothills shows a dominance of Entisols (soils with little or no morphological development) and Inceptisols (soils with weakly developed subsurface horizons). Active floodplains and eroding slopes prevent the climate and vegetation from creating mature profiles. Further inland and at slightly higher elevations with more stable vegetative cover, zonal soils (mature horizon development) are dominated by Alfisols (moderately leached soils with a subsurface zone of clay accumulation and >35% base saturation) and Mollisols (grassland soils with high base status). Vertisols (clayey soils with high shrink-swell capacity) are found scattered throughout the basin depending on the occurrence of high shrink-swell clays in the parent materials (University of Idaho 2004; Greenwood 2005).

Flora

The flora of the Californias are known internationally for their diversity and endemism (Oberbauer 1999). Vegetation species recorded during a 1994 biological survey in the U.S. portion of the Tecate River[26] found the highest quality riparian habitat remaining in Southern California. Three hundred plant species were observed as well as a few non-native species. Vernal pools are seasonal wetlands containing species, such as Orcutt's brodiaea (*Brodiaea orcuttii*), San Diego button celery (*Eryngium aristulatum ssp. Parishii*), California ocutt grass (*Orcuttia californica*), and spreading navarretia (*Navarretia fossalis*) (USFWS 1996 November).

Examples of U.S.-listed endangered flora in the TRW are Otay tarplant (*Hemizonia conjugens)*, San Diego thornmint (*Acanthomintha ilicifolia lamiaceae)*, Mexican flannelbush (*Fremontodendron mexicanum)*, Otay Mesa mint (*Pogogyne nudiuscula)*, Tecate cypress (*Cupressus forbesii,)* and the Tecate tarplant (*Hemizonia floribunda*) (Delgadillo 2000). Distribution of 1994 vegetation is shown in Fig. 28.

[26] Performed by the U.S. EPA

Communities

Comunidades

Oak Woodland	Arbolado de Encinos
Black Oak Woodland	Arbolado de Encinos Negros
Jeffrey Pine Forest	Bosque de Pinos Jeffrey
Pinyon-Juniper Forest	Bosque de Enebros o Juníperos
Southern Interior Cypress Forest	Bosque Interior de Cipreses del Sur
Mixed Oak and Conifer Woodland	Arbolado de Encinos y Coníferos Mixtos
Sierran Mixed Coniferous Forest	Bosque de Coníferos Mixtos de la Sierra
Chaparral	Chaparral
Coastal Sage Scrub / Chaparral	Matorrales Costeros de Salvia / Chaparral
Coastal Sage Scrub	Matorrales Costeros de Salvia
Great Basin Sagebrush	Artemisa de la Gran Cuenca
Alkali Seep or Meadow	Filtración de Álcali o Prado
Grassland	Pradera
Developed	Urbanizado
Disturbed Habitat	Hábitat Perturbado
Bare Rock	Roca
Southern Foredunes	Dunas del Sur
Natural Floodchannel / Streambed	Canal Aluvial Natural / Cauce del Río
Freshwater Marsh	Pantanos de Agua Dulce
Southern Coastal Saltmarsh	Marisma Costera del Sur
Riparian Woodland	Arbolado Ripario
Open Water	Cuerpos de Agua

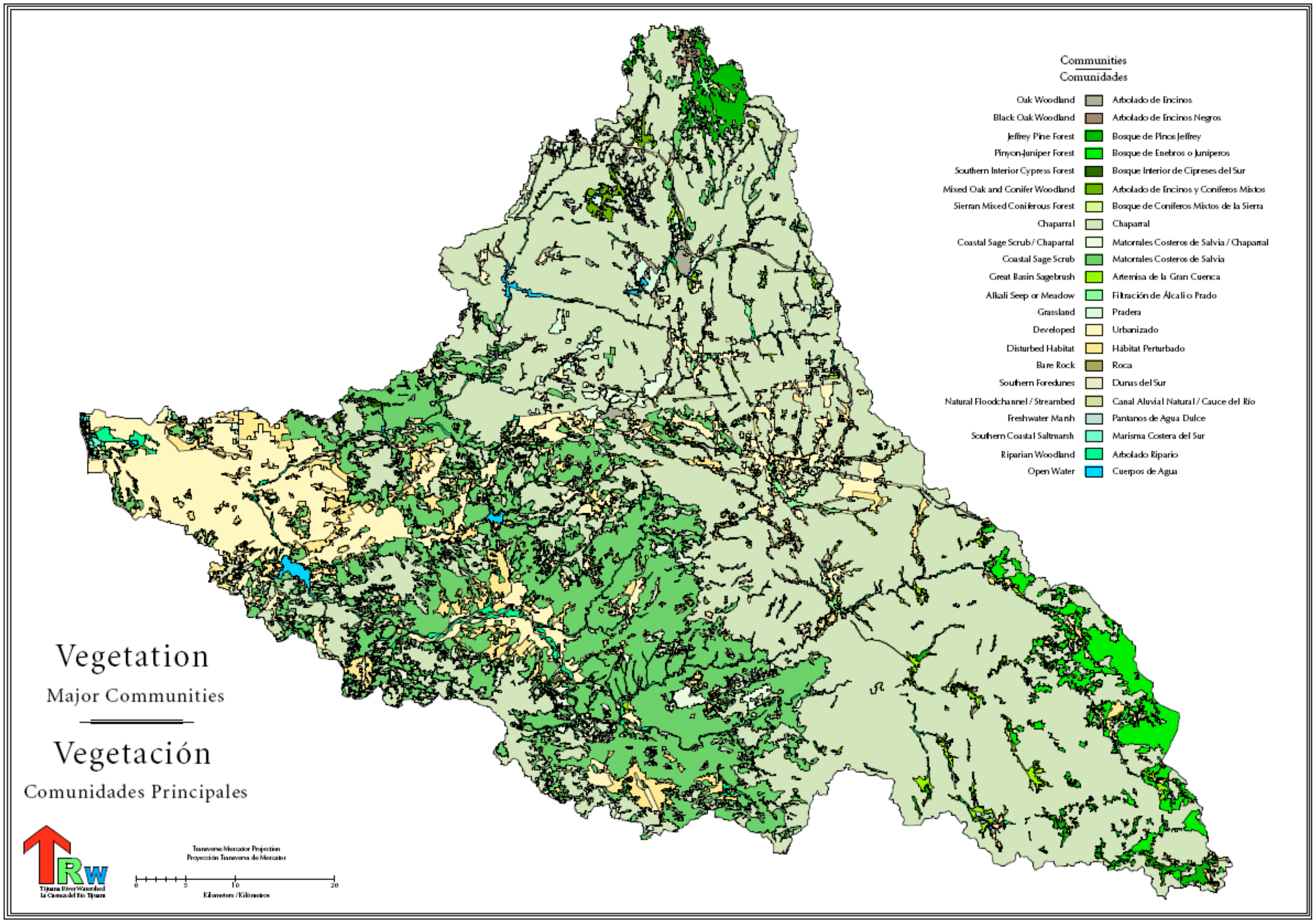

Fig. 28
Vegetation in the TRW.
Source: (SDSU and COLEF 2005).

Descriptions of major vegetation classes [27]

Owing to its geological, topographical, and climatological diversity, the watershed supports a wide variety of native plant communities. Vegetation types range in elevation from sea level (e.g., coastal saltmarsh and southern foredunes) to Sierran mixed coniferous forest, found in the highest northern portion of the watershed where precipitation is greatest. The following vegetation classes are found in the TRW (O'Leary 2005).

Wetland types

Southern coastal marsh is located at the mouth of the Tijuana River. The Tijuana River Estuary is one of the few salt marshes remaining in Southern California and northern Baja California (O'Leary 2005). Sea-rocket (*Cakile maritima*), pickleweed (*Salicornia virginica*), and Parish's glasswort (*S. subterminalis*), along with alkali heath (*Frankenia salina*), saltgrass (*Distichlis spicata*), alkali heath, (*Jaumea carnosa*), western marsh-rosemary (*Limonium californicum*), wooly sea-blite (*Suaeda taxifolia*), Parish's glasswort (*Salicornia subterminalis*), red sand verbena (*Abronia maritima*), pink sand verbena (*Abronia umbellata*), and beach evening primrose (*Camissonia cheiranthifolia* ssp. *suffrutescens*) are important plant species of the salt marsh (Merkel and Associates 2004).

Shrubland types

Coastal sage scrub and chaparral are two shrubland types that cover approximately 74% of the entire watershed. Coastal sage scrub[28] is found almost entirely on drier, lower-elevation slopes that occur in the western half of the watershed. Coastal sage scrub and chaparral formerly covered most of the land in and around Tijuana, which is now developed. They are low-lying scrubs of varying shrub densities with soft-woody, drought-resistant, deciduous species. Characteristic species are California sagebrush (*Artemisia californica*), broom baccharis (*Baccharis sarothroides*), California encelia (*Encelia californica*), interior flattop buckwheat (*Eriogonum fasciculatum* var. *foliolosum*), coastal deerweed (*Lotus scoparius* var. *scoparius*), laurel sumac (*Malosma laurina*), San Diego monkeyflower (*Mimulus aurantiacus*), lemonadeberry (*Rhus integrifolia*), spiny redberry (*Rhamnus crocea*), black sage (*Salvia mellifera*), and white sage (*Salvia apiana*). Succulents are common in western, coastal portions of the watershed and include velvet cactus *(Bergerocactus emoryi)*, Shaw's agave (*Agave*

[27] Derived from (O'Leary 2005) and (Merkel and Associates 2004)

[28] Coastal sage scrub provides critical habitat to a large number of rare, threatened, and endangered species, most notably the California gnatcatcher.

shawii), and coastal beavertail (*Opuntia basilaris)*. Evergreen hard-leaved shrubs, such as laurel sumac *(Malosma laurina)*, lemonadeberry (*Rhus integrifolia*), and sugar bush *(Rhus ovata)*, are often distributed in patches throughout the TRW. Coastal sage scrub in the border region, especially from Otay Mountain westward, serves as a vital dispersion link for the California gnatcatcher and other species between the United States and Mexico.

Chaparral covers about 56% of the watershed and largely occurs above coastal sage scrub in the eastern half of the watershed. Taller and denser than sage scrub, chaparral is dominated by deep-rooted evergreen shrubs that possess relatively tough, leathery leaves. Several chaparral types occur in the watershed, depending generally on elevation, slope, and aspect. Chamise chaparral is the most common chaparral type in the more western portion of chaparral's overall distribution in the watershed. It is dominated by chamise *(Adenostoma fasciculatum)* and occurs largely on flat or south-facing slopes in the lower, drier portion of chaparral's overall distribution. Mixed chaparral occurs most commonly on relatively mesic (flat-topped), north-facing slopes and is a mixture of medium to tall shrub species. Red shank *(Adenostoma sparsifolium)* chaparral commonly forms large unbroken stands in the eastern, upper-elevation portions of chaparral's distribution in the watershed (O'Leary 2005). Characteristic chaparral species are big-berry manzanita (*Arctostaphylos glauca*), Ramona ceanothus (*Ceanothus tomentosus*), San Diego mountain-mahogany (*Cercocarpus minutiflorus*), chamise (*Adenostoma fasciculatum*), holly-leaf redberry (*Rhamnus ilicifolia*), sugar bush (*Rhus ovata*), and fuchsia-flowered gooseberry (*Ribes speciosum*) (Merkel and Associates 2004).

Upland woodland and forest

Oak Woodland, Pinyon-Juniper Woodland, and Jeffrey Pine Forest account for but a small fraction of the watershed, they serve as valuable habitat for a variety of wildlife types**.** Culturally important species that are protected in Mexico include the Tecate cypress (*Cupressus forbesii*). Oak woodland is dominated by the coastal live oak *(Quercus agrifolia)* and occurs most commonly in lower-elevation portions of the watershed on mesic, north-facing slopes and valley bottoms. Canyon live oak *(Quercus chrysolepis)* is a more common dominant species at higher elevations in the eastern portion of the watershed. Pinyon-Juniper woodland is dominated by the one-leaf pinyon *(Pinus monophylla),* the four-leaf pinyon *(Pinus quadrifolia),* and the California juniper *(Juniperus californica)*, and occurs at higher elevations in the watershed's southeastern extreme section. Jeffrey pine forest is dominated by the Jeffrey pine *(Pinus jeffreyi)*.

Riparian vegetation types

The watershed also contains several riparian vegetation types that serve as valuable habitat to a rich diversity of avian species, reptiles, mammals, freshwater fish, and amphibians. Most riparian vegetation near Tijuana has been removed or seriously disturbed as a result of spreading urbanization. However, notable examples still exist along the Tijuana River's various tributaries, such as Cottonwood Creek. Riparian woodland is usually dominated by low-density stands of western sycamore (*Platanus racemosa*), although other trees, such as coastal live oak *(Quercus agrifolia)* and cottonwood (*Populus fremontii*), may also be intermixed. Associated subordinate species may include western poison oak (*Toxicodendron diversilobum*), fuchsia-flowered gooseberry (*Ribes speciosum*), and blue elderberry (*Sambucus mexicana*). Oak riparian forest is less common but can be found in the upper reaches of tributary streams in the watershed. Oak riparian forest is characterized by dense stands of coastal live oak that occupy a stream channel's outer perimeter and winter-deciduous species of willow and cottonwood situated closer to the stream channel. Riparian forest is the least common riparian type in the watershed and is dominated by Gooding's black willow (*Salix gooddingii*), arroyo willow *(Salix lasiolepis)*, Fremont cottonwood (*Populus fremontii*), white alder (*Alnus rhombifolia*), and coast live oak. Characteristic understory plants are mugwort (*Artemisia douglasiana*), mule fat (*Baccharis salicifolia*), and hoary nettle (*Urtica dioica spp. holosericea*). Riparian Scrub is the most prevalent type of riparian vegetation in the watershed and includes communities, such as willows *(Salix spp.)* and mulefat. Riparian scrub vegetation is especially common along the Río de las Palmas, where a substantial amount of it is disturbed and has been invaded by non-native shrubs, such as giant reed (*Arundo donax*), four-petal European tamarisk (*Tamarix parviflora*), pampas grass (*Cortaderia selloana*), and castor bean (*Ricinus communis*).

Plant species listed at the international or national level in the Mexican portion of the TRW are coastal prickly pear (*Opuntia littoralis*), coastal cholla (*Opuntia prolifera*), barrel cactus (*Ferocactus viridescens*), scrub-oak (*Quercus dumosa*), Baja rose (*Rosa minutifolia*), Tecate cypress (*Cupresus forbesii*), Southern California locoweed (*Astragalus trichopodus*), scrub oak (*Quercus cedrosensis*), Weed's mariposa lily (*Calchortus weekii*), Otay mountain ceanothus (*Ceanothus otayensis*), brasil (*Ceanthus tomentosus*), and barberija (*Chamebatia australis*) (Pronatura 2003). In 2004 the municipality of Tecate passed a municipal ordinance that listed *encinos* (oaks) and the Tecate cypress (*Cupressus forbesii)* as protected species under Article 176 of the Reglamento Municipal de Ecología del Ayuntamiento de Tecate. Fig. 29

shows vegetation patches from 1994 that are considered by experts[29] to be high conservation priority in 2004 (i.e., coastal sage scrub, oaks). These were unioned with land use categories from 1994 that were considered by experts to be high risk to vegetation (i.e., industrial, urban). These patches deserve further investigation and possible protection.

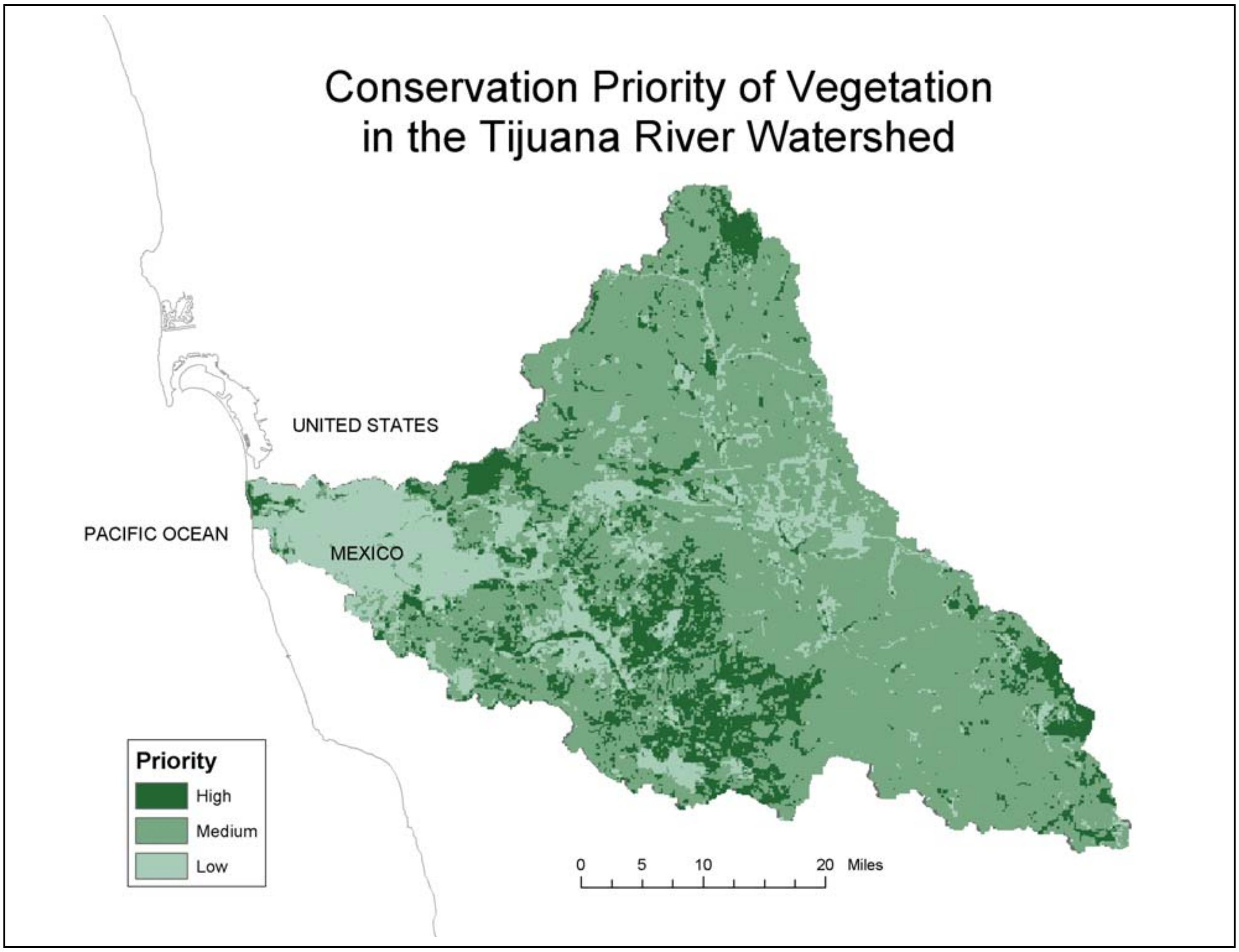

Fig. 29
Vegetation patches of high conservation priority (1994).
Source: Merrilee Willoughby, SDSU unpubl.

The environmental and economic value of trees to the urban areas of the San Diego portion of the watershed was calculated (see

[29] Expert opinions: Tom Oberbauer, County of San Diego MSCP Division and John O'Leary, Profesor, Geography Department, SDSU.

Table 13). In the Tijuana River Valley, San Ysidro, and Otay Mesa green areas contributed 20,000 acres of vegetation, which was estimated to bring $18,528,500 worth of storm water control to the cities. This area was estimated to remove 264,679 pounds of air pollution through filtration and conversion of carbon dioxide to oxygen through the photosynthesis process (American Forests and USFS 2003).

Environmental Benefits of Trees by City of San Diego Community Planning Area

Community	Acres	% Trees	% Shrub	% Impervious	% Grass	Air Pollution Removed Annually (pounds)	Air Pollution Value (Annually)	Retention Volume Required to Mitigate Loss of Trees cu. ft. (2-yr, 24-hr storm)	Stormwater Control Value (One-time Value)	Carbon stored (Total Tons)	Carbon Sequestered (Tons Annually)
Otay Mesa	9,308	5	5	44	21	68,580	173,577	3,660,543	$7,321,086	18,896	147
Otay Mesa-Nestor	5,314	8	2	42	29	70,214	177,712	2,258,032	$4,516,064	19,346	151
Tijuana River Valley	3,573	15	9	18	31	81,044	205,125	1,157,096	$2,314,192	22,330	174
Southeastern	2,928	9	0	65	24	41,115	104,063	1,333,535	$2,667,070	11,329	88
San Ysidro	1,875	8	0	60	25	23,726	60,052	855,044	$1,710,088	6,537	51

Table 13
Environmental Benefits of Trees in San Diego.
Source: (American Forests and U.S.F.S. 2003).

Natural fire regimes have been altered in the TRW by deforestation for grazing, urbanization, and fire management practices. Natural fires are critical for some plant communities to regenerate. Changes in the fire regime have led to increased erosion rates when fires burn too frequently at the urban edge (Ojeda Revah 2000).

Fauna

Flora and fauna are related because vegetation provides habitat for wildlife, and wildlife help propagate seeds and pollen for plants. Habitats for animals in the TRW range from Peninsular Range elements in the upper basin, to widespread coastal sage scrub and chaparral elements in the lower elevations, to marsh and wetland species in the Tijuana Estuary. There are also some sensitive upland elements on the fragmented mesa sides and tops, and species unique to the sand dunes. There are many vernal pools, and the eastern upper slopes of the Laguna

Mountains and Sierra Juárez contain riparian and coniferous habitat (Case and Fisher 1998). Riparian corridors at all elevations house migratory and resident species of fish, reptiles, birds, and mammals.

The following list is not exhaustive but provides examples of species likely found in the TRW that are either endangered or threatened at the California or U.S. federal level under the Endangered Species Act (ESA) (MSCP 1996; CEC 2000) or protected at the federal level in Mexico under NOM-059 (SEMARNAT 2002; Pronatura 2003). Some species are considered threatened or endangered in Mexico but not the United States, and vice versa:

- Species listed only in the United States include the southwestern willow flycatcher (*Empidonax traillii extimus*), southwestern pond turtle (*Clemmys marmorata pallida*), California red-legged frog (*Rana aurora draytoni*), San Diego fairy shrimp (*Branchinecta sandiegoensis*), and Quino checkerspot butterfly (*Euphydryas editha quino*)
- Species listed only in Mexico include the Pacific great blue heron (*Ardea herodias santilucae*), Mexican long-tongued bat (*Choeronycteris mexicana*), and spiny pocket mouse (*Perognathus amplus rotundus*)
- Species listed on both sides of the border include Belding's Savannah sparrow (*Passerculus sandwichensis rostratus*), burrowing owl (*Speotyto cunicularia*), Least bell's vireo (*Vireo bellii pusillus*), Mexican longnosed bat (*Leptonycteris nivalis*), bighorn sheep (*Ovis canadensis californiana*), California condor (*Gymnogyps californianus*), California coastal gnatcatcher (*Polioptila californica* californica), golden eagle (*Aquila chrysaetos*), and orange-throated whiptail (*Cnemidophorus hyperythrus beldingi*)

A major challenge in binational watersheds is the management of migratory species, or species with large ranges within a binational watershed. For example, the border fence and unchecked habitat destruction along the border on the U.S. side, including the development of new roads for border patrol vehicles, increased traffic on existing roads, and the clearing of vegetation for new fences, threaten habitat and migratory routes in the TRW. Portions of the westernmost 14 miles of the U.S.-Mexican border include secondary and tertiary fencing, roads, and other improvements deemed necessary by the U.S. federal government for border security. This is in addition to the primary fencing already in existence for the entire 14 miles. The government has made plans to meet the additional congressional fencing mandate. There is great concern that the proposed additional fencing will result in significant sedimentation impacts on the Tijuana Estuary since substantial cut and fill would be required for the fencing and supporting roads. How to meet the operational requirements of the U.S. Border Patrol while protecting the irreplaceable resources of the Estuary is a difficult issue that must be resolved in the near future (SDSU and COLEF 2005).

The Las Californias Binational Conservation Initiative[30] is developing a binational conservation strategy for the border region that includes the TRW. The project involved surveys of fauna in the border region. Species with international protection under United States (Endangered Species Act) and Mexico (NOM-059), as well as the international classifications of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the World Heritage Centre (IUCN) are found in Table 14. Of these species identified as sensitive, 24 species of plants and 22 animals, were sighted in areas on the Mexican side of the TRW (Pronatura 2003).

Habitat	Ecological and socio cultural importance	Sensisitive species	Threats and impacts
oarian forest	Biological corridor, refuge for great diversity of fauna, flow and recharge of water regulator. Sites with archeological vestiges	California Gnatcatcher, Bell's Vireo, Rufus-sided Towhee, Whiptails lizard	Deforestation, water contamination, presence of exotic species
k Woodlands	Biological corridor, refuge for great diversity of fauna; aquifer recharge areas indicator, sites with archeological vestiges.	Coast live oak, Scrub-Oak ,Thick-Leaf, Cooper's Hawk, Northern Harrier, Red-Tailed Hawk, White-tailed Kite, Whiptails	Deforestation, agriculture, cattle and residential land uses, off-road races
osed cone-nifer forest	Tecate Cypress forest are relicts and growth at limited areas in gabbro.	Southern mountain misery, Tecate cypress, Barrel Cactus, Martin's Prickly Pear, Cholla, Bell's Vireo, California Gnatcatcher, Bank Sallow	Deforestation, agriculture and cattle land uses
iter reservoirs	Important deposits for the supply of water in region. Habitat of a great amount of migratory and resident birds.	Attenuate live-forever, Live-forever, Mallard (duck), Elegant Tern, Chipping Sparrow, Whiptails, Cooper's Hawk, Golden Eagle, Great Egret, Great Blue Heron, Elegant Tern	Reservoirs are to 30% for lack of rains, private properties exist around, impacts for residual waters and garbage.
rnal Pools	Conspicuous characteristics of this habitat allow endemic and rare species to live in it.	Pogogyne nudiuscula, Navarrieta fossalis, Mimulus latidens, Myosurus minimus, Psilocarpus tenellus	Areas in risk of disappearing due to its conversion to agriculture, cattle and residential land uses.

Table 14
Species identified as protected under multiple governments and a description of their habitats.
Source: (Pronatura 2003).

Based on the portfolios and other studies, the Las Californias Binational Conservation Initiative plan proposes the following regional goals (CBI, Pronatura, and TNC 2004):

[30] A collaboration of the International Community Foundation (ICF), Conservation Biology Institute, Pronatura, A.C., and The Nature Conservancy (TNC).

- Encompass biogeographically important and unique natural resources, distributed from the coast, across the mountains, to the desert.
- Identify threats to maintaining an interconnected conservation network and sustaining ecosystem processes.
- Identify large, intact wildlands that represent the region's biodiversity.
- Link protected areas to facilitate wildlife movement and protect existing conservation investments.
- Promote collaboration in implementing land-protection strategies that result in secure and sustainable conservation.
- Lay the foundation for a binational park system that connects the Parque Constitución de 1857 in Mexico to wilderness areas, forests, and parklands in the United States.
- Heighten the visibility of this little-studied, multicultural area and the global importance of implementing a strategy that conserves the integrity and functionality of its ecosystems while enriching the health, economy, and standard of living of its residents.

Pronatura developed several maps of recommended areas for preservation of open space, native vegetation, and green areas, along with habitat protection and enhancement.

Fig. 30 is a study within the TRW. Fig. 31 shows a regional view of connectedness with U.S. protected areas.

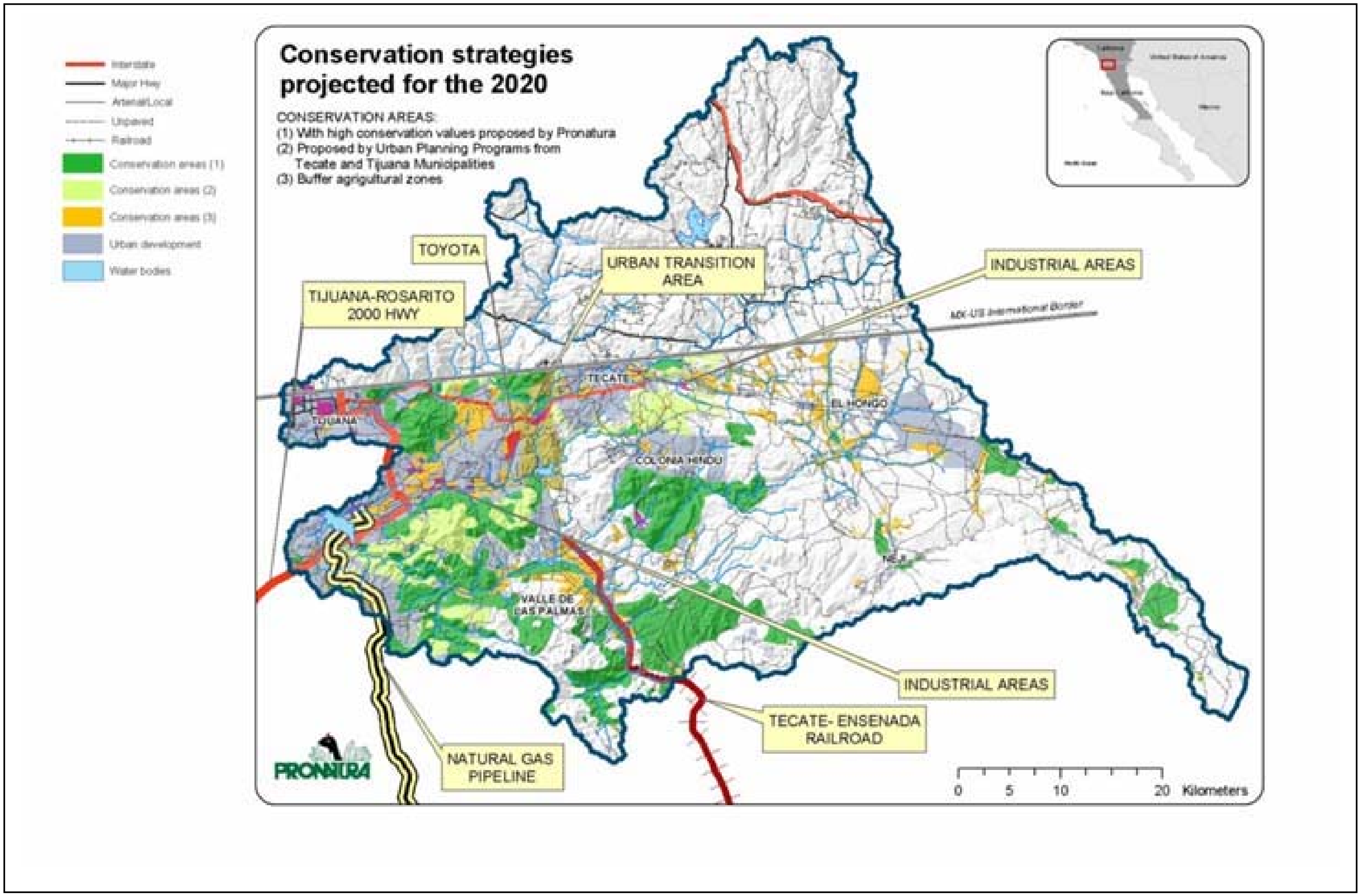

Fig. 30
Proposed conservation areas for Mexican portion of TRW for 2020.
Source: (Pronatura 2003).

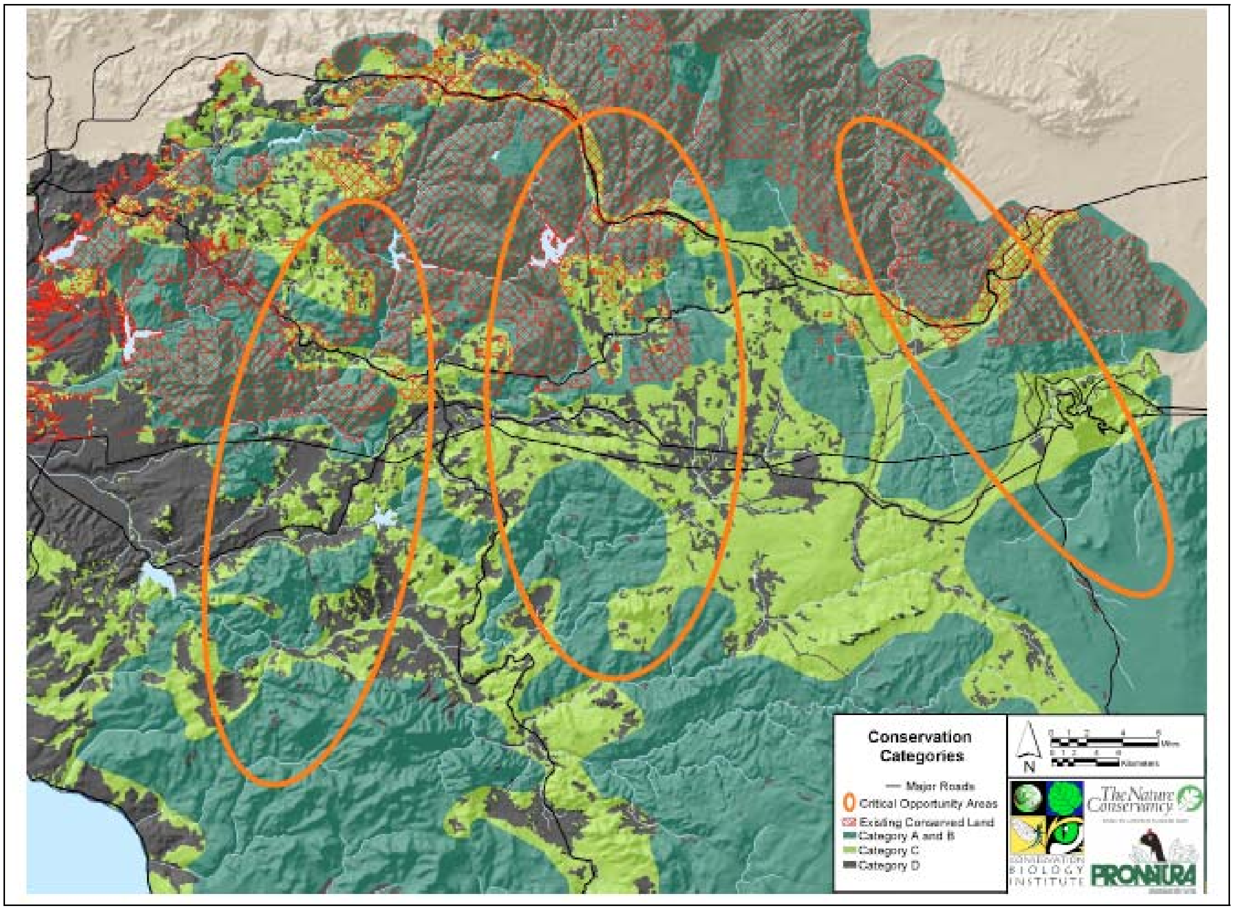

Fig. 31
Recommended Mexican conservation areas and their connection with U.S. conservation areas.
Source: (Pronatura 2004).

A detailed study of the area between Tijuana and Tecate, which lies in the San Dieguense Fauna district in both the United States and Mexico, is a natural corridor for animals passing from the San Dieguense district to the San Pedro Mártir district, and from the United States to Mexico. Some rock mining occurs, but the land is mostly undeveloped and covered with chaparral and coastal sage shrub. The Alamar River traverses this corridor, providing shelter for animals. Some threats to the corridor are the existing border fence and Highway 2 in Mexico, both of which block safe movement of animals. There are currently only about nine available tunnels and bridges along Highway 2 where animals can cross. More crossings are needed (Pronatura 2004). Illegal smugglers and border crossing also can harm vegetation and frighten animals. Future threats to the corridor are private development plans east of the study area, the extension and fortification of the border fence, and U.S. Border Patrol off-road activities. In addition to protection of fauna, this corridor is important to protect encroachment of Tijuana urban neighborhoods into Tecate's relatively rural neighborhoods.

On a larger scale, the TRW is also an important stop for migratory birds on the Pacific Coast Flyway, a migratory route from Alaska to South America, with several hundred species having been recorded at the Tijuana Estuary alone (Fig. 32).

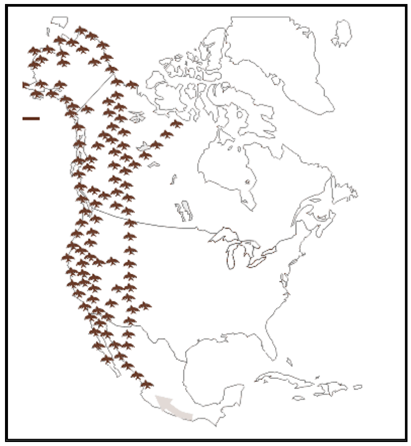

Fig. 32
Pacific Coast Flyway.
Source: Texas Parks and Wildlife.[31]

Some species are sensitive to changes in the environment and manifest changes in population or behavior as a result. These "indicator species" are watched closely because they serve as representatives for the overall health of the ecosystems they inhabit. Some Bureau of Land Management indicator species found in the TRW are the southwestern pond turtle (*Clemmys marmorata pallida*), orange-throated whiptail (*Cnemidophorus hyperythrus beldingi*), unarmored three-spined stickleback (*Gasterosteus aculeatus wiliamsoni*), and Mexican flannel bush (*Fremontodendron mexicanum)* (Cagle and Esepejel 1998).

The following sections summarize several efforts to study and conserve the ecosystem resources of the TRW.

The Multiple Species Conservation Program (MSCP)

The Multiple Species Conservation Program (MSCP) is an effort to balance habitat protection and economic development in San Diego County. Part of the Multiple Species MSCP lands fall within the U.S. portion of the watershed. The conservation goal for the 200 km^2 of MSCP lands, 50% of which is coastal sage scrub, is connectivity of the landscape and habitats (MSCP 1996). The conservation measures specified in the MSCP subregional plan and subarea

[31] http://www.tpwd.state.tx.us/nature/birding/migrant/section2/images/pacificmap.gif

plans provide for “coverage” of 85 species of plants and animals under state and federal endangered species laws. The MSCP also includes a preserve management program and a subregional biological monitoring program to gauge the progress of the program toward meeting its biological objectives (California Department of Fish and Game 2004). Mitigation for species take (kill) or habitat destruction outside the MSCP can be met by purchasing land inside the 2,330 km^2 (900mi^2) planning area (see
Fig. 33).

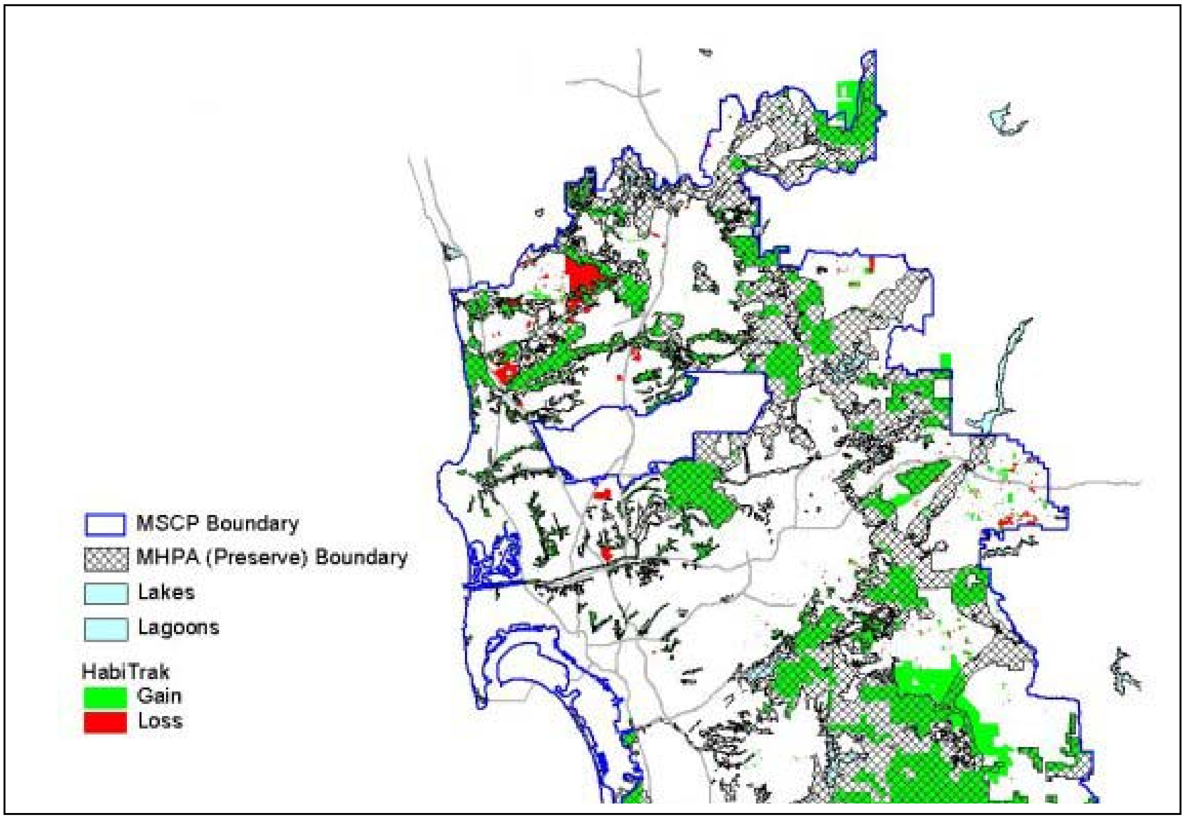

Fig. 33
San Diego Multiple Species Conservation Program.
Source: (California Department of Fish and Game 2004).

The MSCP stops at the border. Many of the endangered and endemic species in the region are migratory or their breeding, foraging, or wintering ranges extend across the border (MSCP 1996; CEC 2000). Thus, connecting areas of the MSCP to similarly protected areas across the border would greatly enhance species and habitat protection in the transborder region.

Cuchumá easement

Cerro Cuchumá, or Tecate Peak, is a sacred mountain for the Kumiai as well as being biologically rich, containing endangered flora and fauna. In 2003, Pronatura helped negotiate an ecological easement of Rancho La Puerta, A.C., Mexican lands that are contiguous with BLM lands on the U.S. side of the border. In effect, this created a transborder ecological easement. Pronatura acts as a third party for the easement contract, and monitors and protects the terms of the easement, which include no development or activities harmful to the environment (Ochoa 2004; Vargas Téllez 2004). The easement is in perpetuity, so even if the lands are sold, they remain protected.

The Tijuana Estuary

The Estuary is one of Southern California's most pristine coastal wetlands and has high potential for restoration. Its designation as a National Estuarine Research Reserve by the NOAA in 1991 has allowed for increased protection and study of its resources (Desmond 1998). The Tijuana Estuary is dominated by coastal saltmarsh, an increasingly rare and threatened habitat in Southern California. It is one of the few estuaries in San Diego County whose tidal inlet has not been obstructed by a highway or railroad; it has maintained its connection to the sea almost continuously over the past century. The Tijuana Estuary and near shore marine habitats host at least 29 species of fish, and 398 species of birds, including 24 sensitive species, such as the California Least tern, the clapper rail, and Least bell's vireo. The Estuary supports juveniles and several commercial/recreational fishes, including the California halibut (Nordby and Zedler 1991 as cited by Desmond 1998), although shellfish are unfit for human consumption due to high contamination levels.

Although sewage flows into the Estuary decreased with the installation of the sewage diversion system in 1991 (Zedler and Nyden 1993 as cited by Desmond 1998) and the IWTP in 1997, sewage-contaminated waters still enter the Estuary during storm events, when there are breaks in the collection system or whenever flow exceeds the system's capacity. Development in both Tijuana and San Diego and vehicular disturbances in the surrounding watershed have led to greater amounts of freshwater runoff and sediment deposition in the Estuary. Due to sedimentation, the tidal prism was closed to saltwater inputs during 1984, causing ecological damage. Increased freshwater input through urban storm runoff can also promote the spread of exotic plant species by decreasing soil salinity and increasing soil saturation (Kuhn and Zedler 1997; Callaway and Zedler n.d. as cited by Desmond 1998). Given the right conditions, these exotic plants can out-compete native species and negatively affect habitat functioning in the Estuary. Other estuarine problems include heavy human traffic through the Estuary, damages caused by off-road vehicles, heavy noise from helicopters at nearby Ream Field (U.S. Navy), and feral animals that hunt native species.

To combat some of these issues, the Tijuana Estuary Tidal Restoration Program began in 1992 with the goals of restoring the natural tidal prism (saltwater access), restoring intertidal habitats, improving water quality, and restoring the barrier beach dunes. This requires the removal of fill material and accumulated sediment already in the Estuary, the construction of canyon-mouth sediment basins that will be routinely excavated, and implementation of erosion-control projects throughout the watershed. Two completed restoration projects, the Oneonta Tidal Linkage (1997) and the Model Marsh (2000), have restored critical saltmarsh habitat and attracted endangered species. Sediment management basins in Goat Canyon (2004) plan to control the large sediment load delivered through the Los Laureles Canyon upstream in Mexico. Future studies will support a second and larger phase of the restoration program that will aim to disperse flood energy and silt. The plan may also include pumping sandy material to the beach, and combining saltmarsh restoration with beach replenishment (SDSU and COLEF 2005).

Future projects will focus on upstream impacts on the Estuary. This holistic approach recognizes the connection between downstream problems, such as tidal blockage, trash, and pollution with upstream solutions. One phase is a series of pilot projects to demonstrate successful erosion-control techniques. Another educational phase will produce bilingual materials, including a brief video and CD-ROM of the history, social concerns, objectives, impacts on land and coastal ecosystems of Los Laureles Canyon and the TRNERR. Official documents, sustainable guidelines, maps, and GIS databases will also be included.

Cleveland National Forest

This nationally protected forest includes three principal mountain ranges: the Santa Ana, Palomar, and Laguna (Cuyamaca) Mountains. The latter falls within the TRW. The Cleveland National Forest offers open space and recreational opportunities. Elevations range from 140 m (460 ft) to 1,911 m (6,271 ft) on Monument Peak. More than 75% of the vegetation is chaparral, predominantly coastal sage, chemise, manzanita, and ceonothus. A few riparian areas exist, but they make up only about 1% of the forest. There are large oaks in meadows and along streams, and Jeffrey and Coulter Pine forest at higher elevations. Some wet meadows are found between the high-elevation pines (Wildernet 2004).

The U.S. Department of Agriculture (USDA) and the U.S. Forest Service (USFS) have updated their Southern California Land Management Plan, and hope to expand the Pine Creek Wilderness Area of 54 km^2 (13,400 acres) with and additional 1.7 km^2 (409 acres). They use a holistic approach to land management and are proposing actions that could affect the TRW in positive ways. Their goal is to move toward elimination of existing roads and power lines within the wilderness areas, and minimize trespassing by motorized vehicles, while improving trail networks. Their plans include (1) developing common management goals for open-space protection and land acquisition plans for Lake Morena and Barrett Lake in cooperation with City of San Diego water authorities; (2) working with San Diego water authorities to achieve water discharge from Lake Morena that mimics natural conditions and supports unique wildlife and plant values; (3) through the Border Fire Prevention Program, minimizing wildland fires related to immigration routes, and maintaining existing fuel breaks and increasing community protection and safety efforts; and (4) controlling and reducing resource damage caused by undocumented immigration through the area (USDA and USFS 2004). This human foot traffic produces significant quantities of trash, informal trails that are prone to erosion and can cause habitat destruction/fragmentation, and campfires that sometimes cause wildfires.

Ecosystems and natural resources trends

Few data have been collected on TRW ecosystem functions, such as soil, water, and nutrient cycling. Therefore, historical ecological analysis is limited to vegetation. Vegetative processes are tied directly to processes in fauna, soils, water, and nutrients, and thus, are important to study. Historic maps and accounts have pieced together a picture of vegetation changes since 1766. Vegetation communities in Baja California were altered by agricultural clearing by grazing of livestock and the introduction of herbaceous exotics. Exotic species, such as Mediterranean grass (*Schismus barbatus*), foxtail chess *(Bromus rubens*), and Saharan mustard *(Brassica tournefortii*), can increase fire fuel and burning rates (Minnich and Vizcaino 1998). Timber needs result in heavily exploited coast live oak *(Querus agrifolia)* forests, but chaparral and forest densities seem to have maintained a stable composition since European settlement.

In recent decades almost all the native vegetation in the TRW has suffered degradation, fragmentation, and perforation. Between 1970 and 1994, coastal sage scrub lost the greatest area (33 mi^2 or 86 km^2), followed by chaparral (26 mi^2 or 68 km^2) and Juniperus (12 mi^2 or 32 km^2). Nevertheless, within its own distribution area the most damaged community was Juniperus, which lost 19%, followed by mountain meadows, which lost 12%, and mixed conifer forest and coastal sage scrub, which lost 10% and 8% of their original area, respectively. Analysis of rates of change in area over time shows that the most threatened habitats are coastal sage scrub with losses of 4 km^2/yr (1.5 mi^2/yr), chaparral loses at 3 km^2/ yr (1.2 mi^2/yr), Juniperus at 1.5 km^2/yr (0.6 mi^2/yr), and mountain meadows at 1 km^2/ yr (0.4 mi^2/yr). Juniperus loss was due mainly to its use as fuel, whereas chaparral and coastal sage scrub has given way to urban development, agriculture, and grasslands (Ojeda 2001). Fig. 34 shows habitat fragmentation in the TRW over a 40-year period.

Riparian areas in the TRW have also suffered significant damage particularly in recent decades. Urbanization and channelization of stream courses have destroyed riparian areas in Tecate and Tijuana. Extraction of water from aquifers underlying riparian areas has lowered water tables and drastically reduced surface waters necessary for many riparian species. Sand extraction throughout the TRW has permanently altered the hydrological characteristics of many arroyos and has destroyed habitats of endangered species of fish, amphibians, and birds. Livestock grazing has stripped many riparian areas of critical plant species, such as willows, and compacted and trampled stream banks, setting the stage for severe erosion during winter storms.

It is assumed that animal populations have been diminishing in the TRW due to the same forces that take vegetation; namely urban encroachment, pollution, cattle ranching, and fragmentation of habitats with roads and off-road vehicular traffic.

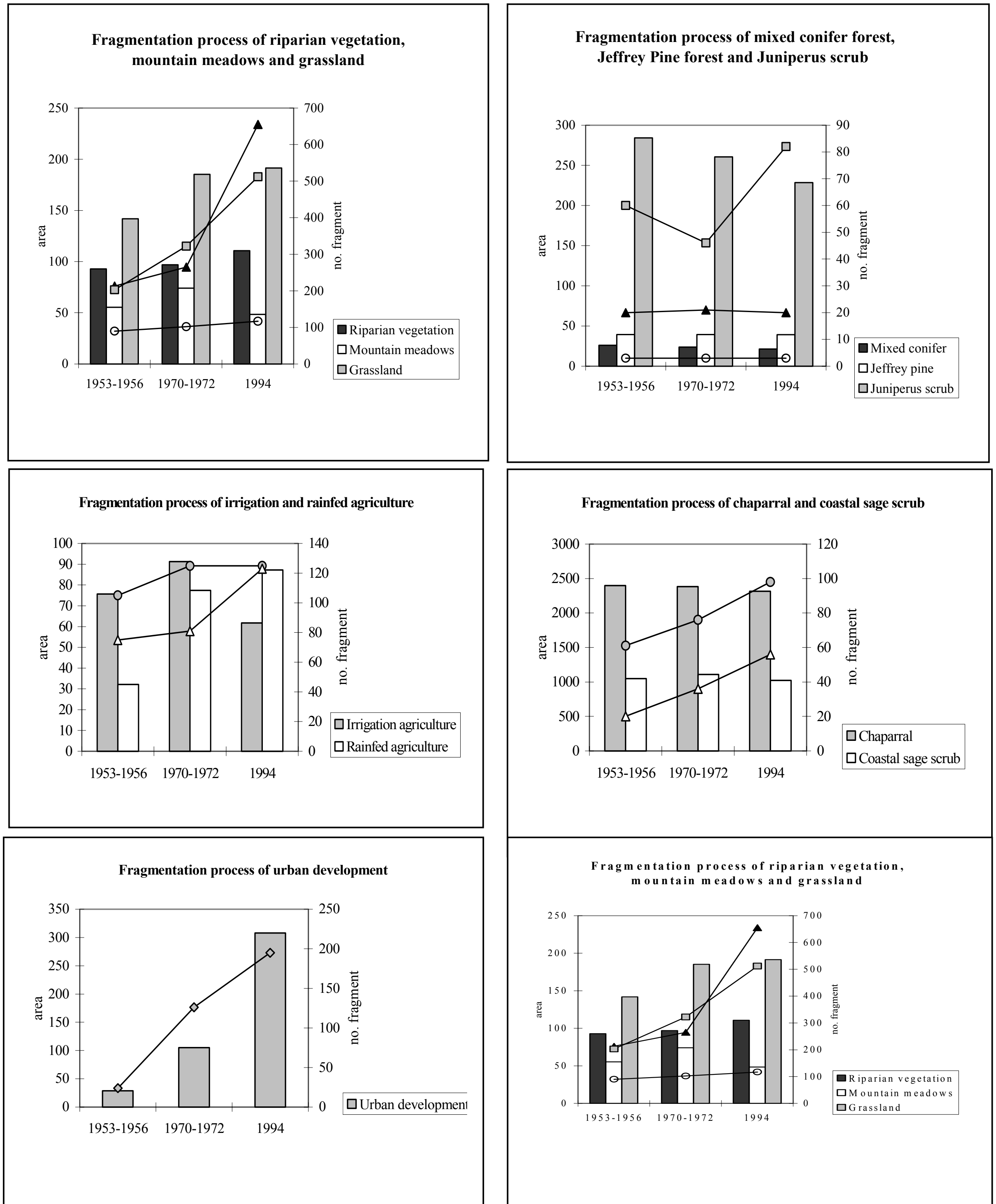

Fig. 34
Habitat fragmentation in the TRW 1953 to 1994.
Lines represent number of fragments and the bars represent area.
Source: (Ojeda 2002).

Ecosystems and natural resources data

Sources of data on ecosystems and natural resources in the TRW are available in Appendix 9. The data includes reports, electronic files, maps, and other information in English and Spanish from the United States and Mexico.

Ecosystems and natural resources data gaps

After reviewing the available data, the Research Team and others identified the following data needs for the TRW:

- Pre-European data to evaluate the effect of livestock grazing on coastal sage scrub
- A localized list of sensitive flora and fauna that is useful for authorities in San Diego, Tijuana, and Tecate
- Maps of the distribution of fauna in general throughout the entire system, especially rare or endangered riparian species, such as the California red-legged frog, Arroyo toad, Southern steelhead, Western willow flycatcher, and Least bell's vireo
- The identification of binational movement corridors for large mammals, especially mountain lions and mule deer
- Current information on the Tijuana Estuary's bird populations
- Improved methods for dune restoration to prevent sand deposition into the Estuary

Ecosystems and natural resources recommendations

The Research Team, BWAC, and stakeholders produced suggestions for applied research and applied conservation projects in the TRW that would benefit ecosystems and natural resources. Suggested applied research projects include:

- Mapping analysis of basin-wide rates of vegetation change, including succession (turn over) and recruitment (new members of populations)[32]
- Binational multi-species habitat modeling of critical areas to be conserved
- Research on invertebrates, including insects and decomposing microorganisms
- Research on the impacts of Border Patrol activities, such as the building of a border triple fence with lighting, and on the movement patterns of medium and large carnivores across the border[33]

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[32] (Minnich and Vizcaino 1998)

- Research on the impacts of human traffic through fragile riparian corridors on both sides of the border
- The impacts of water quality on in-stream native invertebrates and vertebrates (bioassessment)
- Research on methods of sediment control, especially near Goat Canyon (Cañon de los Laureles) and Smuggler's Gulch (Cañon de Matadero)
- More detailed information on wetland restoration methods[34]
- More research on contaminants in the Estuary
- Update the state and federal endangered species lists on both sides of the border.
- Investigate land tenure on the Mexican side of the border (CBI, Pronatura, and TNC 2004).

Policy initiative suggestions include (CBI, Pronatura, and TNC 2004):

- Explore possible *unidades de manejo y aprovechamiento de la vida silvestre* (UMAs) (areas of management and use of wildlife) in Mexico to protect bighorn sheep populations from overhunting.
- Develop a binational wildlife corridor from the Laguna Mountains in the Untied States to the Sierra Juárez Mountains in Mexico through the TRW (a concept known as Parque to Park).
- Explore the potential for mitigation impacts of California development projects with conservation projects in Baja California.
- Develop and enforce mitigation laws in Baja California.
- Create a privately-funded and managed Las Californias Ventures Fund to implement the Las Californias Initiative plan.
- Encourage BLM to swap privately held land that is high in biodiversity or cultural resources with low conservation BLM lands.
- Create a Las Californias program within the California Resources Agency and include Baja California representatives on the California Biodiversity Council.
- Work with the Natural Resources Conservation Service (NRCS) and non-governmental orgnizations (NGOs) to secure easements and funds for farmers and ranchers who practice conservation measures on their lands.

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33 (Case and Fisher 1998)

34 (Desmond 1998)

- Work with Mexican federal, state, or municipal government agencies to decree parks or natural protected areas (*áreas naturales protegidas*).

Suggested infrastructure projects include the construction of underpasses under the border fence, highways, and major roads. Fig. 35 shows suggested wildlife corridors and underpass locations from around Tecate. Implementation of the recommendations in the Las Californias Binational Conservation Initiative (CBI et al. 2004) should be supported. Binational parks and greenbelts along riparian and other migratory corridors should be initiated.

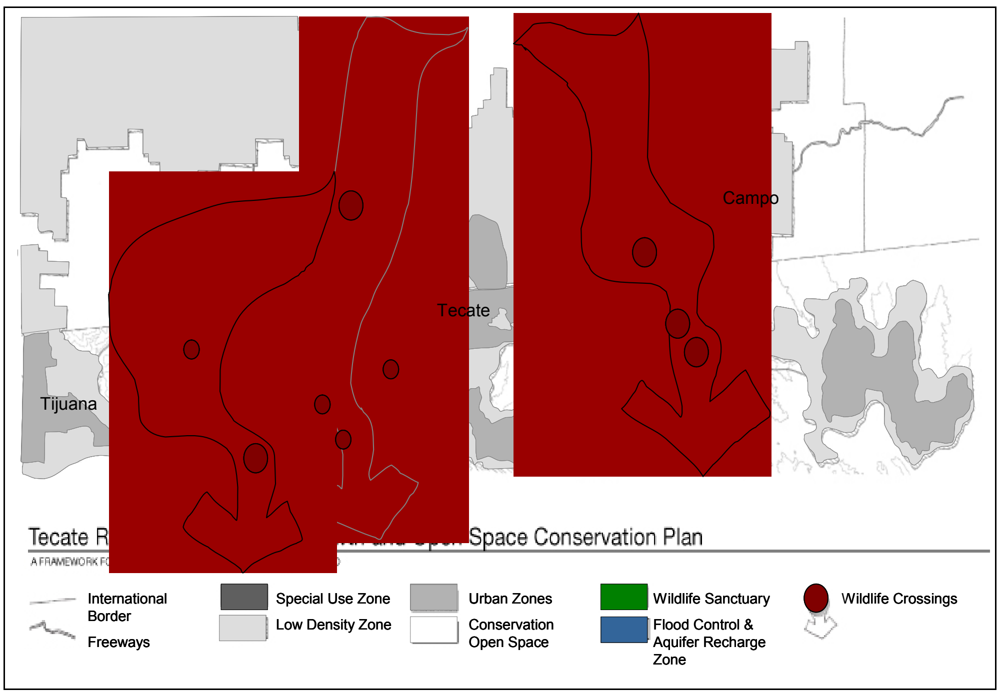

Fig. 35
Wildlife corridors and needed underpass locations around Tecate.
Source: (California State Poly Technic University 2003).

TRW stakeholders at community forums, the BWAC, and the Visions Project Research Team jointly characterized the current situation and future desired scenarios for ecosystems and natural resources in the TRW. Table 15 summarizes this work.

ECOSYSTEMS AND NATURAL RESOURCES			
Challenges	**Opportunities**	**Objectives**	**Goals**
Land development is increasing the number of endangered and threatened species through loss of habitats, direct kill, and by disconnecting breeding populations Land development is increasing habitat fragmentation and the inability for animals to reach the resources they need in all life stages Loss of riparian corridors is reducing important animal, fish, and plant habitats and the ability to move between habitats The spread of exotic species (i.e., *Arundo donax* and Tamarix sp.) is contributing to the loss of native species Loss of forests, wetlands, meadows, and other habitats is decreasing the overall functioning of carbon, nitrogen, and hydrologic cycles, and soil regeneration process Wetland and habitat loss affects on migrating birds stopping over on the Pacific Flyway Lack of protected areas that extend across border	Existing riparian corridors High percentage of undeveloped land Existing public lands: Cleveland National Forest, Bureau of Land Management, Lake Morena County Park, TRNERR, MSCP, Biological easement in Tecate Internationally recognized as a hot spot of biodiversity Current and past initiatives to create binational reserves	Balance economic needs and environmental preservation Improve ecosystem functioning and increase associated natural capital Fire management strategy that balances ecological functioning with public safety	Create legal protection for biological core areas, such as patches of forests, sage scrub, chaparral, riparian, and other vegetation Create a legally protected binational preserve network between existing open spaces, protected areas, and core areas with easements, agricultural preserves, land trusts, research reserves, river parks, and wildlife preserves Continue existing university research on ecosystem functions Begin a program to monitor animal movement and habitat use Restore surface water flow in streams and rivers to improve aquatic habitat Restore wetlands, such as vernal pools, salt marshes, and estuaries Enforce endangered species laws and habitat protection laws Create urban green areas for birds and other wildlife Maintain water and sediment quality that will sustain populations of fish and other wildlife Eradicate and control movement of non-native species and introduce native species

Table 15
Ecosystems and natural resources challenges, opportunities, goals, and objectives.

At meetings in the fall of 2003, the stakeholders voted on the following priority actions for meeting the goals for ecosystems and natural resources. These are presented in Table 16.

Votes	**Action**	**Location**
4%	Educate children on ecosystems with the goal of education of the parents	Schools
3%	Perform a survey of sediment sources and prioritize them	Watershed-wide
3%	Implement a neighborhood watch program (community environmental inspectors)	Watershed-wide
2%	Promote reforestation through adoption programs with native species	Watershed-wide
2%	Reforest urban areas that are not appropriate for development (*áreas accidentadas*)	Urban zones
2%	Develop of public outreach campaigns and funding	Watershed-wide
2%	Protect pristine areas legally or with land acquisition techniques	Riparian zones, mountainous zones, Río Alamar, Valle de las Palmas, Urban/Rural Transition zones
2%	Develop marine indicators to monitor watershed health and ecosystems	Around the Estuary
2%	Observe land use norms and management plans at all levels of government	Watershed-wide
2%	Remove exotic species	Riparian areas
2%	Establish more stringent policies for environmental impact assessment and monitoring	Watershed-wide
2%	Encourage cross-border cooperation on power plants, land fills, land use	Entire border

Table 16
Priority ecosystems and natural resources actions from stakeholder meetings.
The voting percentages are based on ~ 50 persons per meeting casting 5 votes each.

Solid and hazardous waste

Trash accumulates in rivers and creeks in the TRW, harming wildlife and polluting surface and groundwater. Landfills are inadequate in the Mexican portion of the TRW, and recycling is not a consistent practice on either side of the border. In surveys conducted in Tijuana and Tecate in 2002, many watershed residents identified trash as an important environmental problem (SDSU, UABC, and COLEF in prep). Hazardous wastes, including industrial waste, commercial waste, and biological waste, are illegally dumped due to lack of enforcement, cross-border transportation costs and complexities, and lack of proper disposal and confinement facilities in Mexico. Trash is sometimes burned, causing air pollution and health risks.

Trash

The Municipality of Tijuana received 1,638 tons of trash a day from both government agencies and private parties in 2000. This number does not include the large amount of waste left in the streets and empty lots (Moreno and Muñoz 2003). Urban growth onto hilly terrain is one of the main reasons for trash accumulation in Tijuana. The waste collection trucks cannot serve the *colonias* in inaccessible places. In response to this problem, the Municipality of Tijuana has purchased smaller trucks and distributed large bins around the city. Culturally, because Tijuana houses many migrants and recent arrivals from other areas of Latin America, a sense of ownership and pride in the community is lacking, and clandestine dumps are a problem. Also, the United States contributes to the trash problem in Mexico by donating “used” items such as tires, appliances, and clothes, etc., that have to be disposed of in Mexico at the end of their short lifespans.

The Municipality of Tecate generated 82.4 metric tons of residential waste per day; an average of 1.06 kg (2.34 lbs) per person each day in 2000. This figure is somewhat high compared to Mexico City and other Latin American cities. Tecate also generates 40 metric tons of commercial and industrial waste a day (Medina 2002).

U.S. citizens generate more than twice as much trash as Mexican citizens. On average, the U.S. resident generates 1.97 kg/day (4.34 lb/day), while the average is 0.85 kg/day (1.87 lb/day) in Mexico. Fig. 36 compares the San Diego to other parts of California in terms of waste disposal. Although it is not possible to disaggregate the waste figures for the TRW from the other parts of the City of San Diego, as a city, San Diego disposed of a large amount of trash in

2000 compared to other cities in the California—1,723,501 tons, or 4,722 tons/day. Unincorporated San Diego, which constitutes around 90% of the U.S. portion of the watershed, disposed of less waste than other jurisdictions in the state in 2000—461,371 tons or an average of 1,264 tons/day (Fig. 36) (State of California 2005). The comparisons with other cities with similar populations, such as San Francisco and San Jose point to a need to promote a culture of waste reduction, reuse, and recycling in the City of San Diego, part of which lies in the TRW. It is also interesting to note that more than half the waste was non-residential in both San Diego County and the City of San Diego, indicating a problem with commercial and industrial waste management.

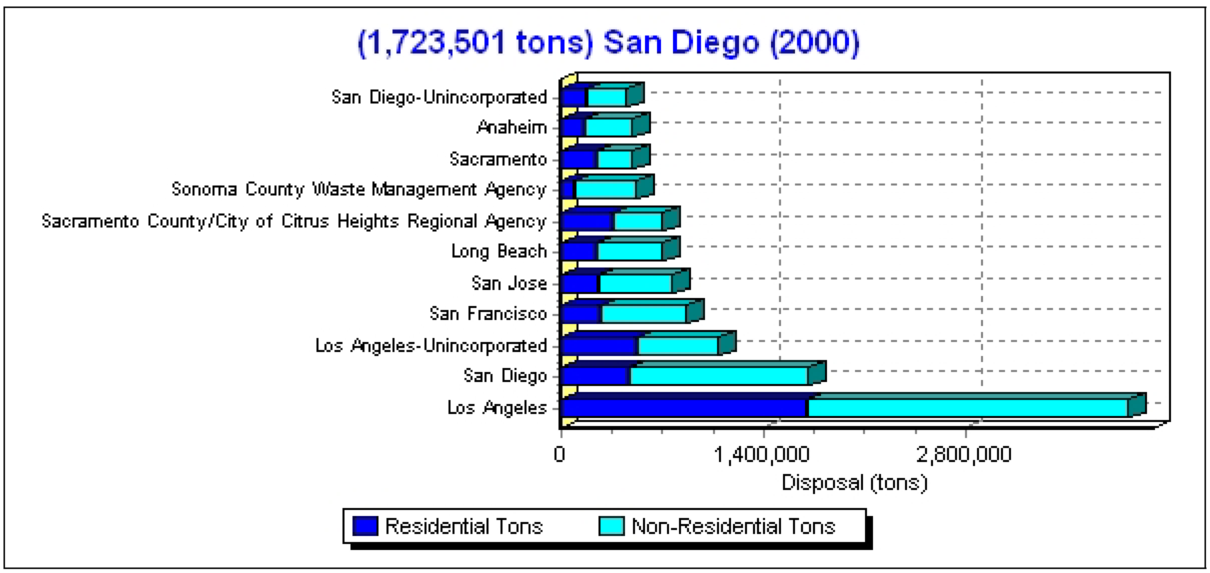

Fig. 36
Comparison of waste generation among California areas.
Source: (State of California 2001).

Recycling

As of 2003, seventeen recycling depots in Tijuana formed the Asociación de Recicladores de Desechos Industriales de Tijuana. Another fourteen centers operate independently. The recyclables are classified and processed to be reused or transformed into other products, such as steel, bronze, copper, iron, laminate, paper, plastic, and glass, all with marketable commercial value (Moreno and Muñoz 2003). Scavengers, or *pepenadores* (informal collectors of recyclables), recycle about 20% of Tijuana's reusable items, metals, plastics, and cardboard from the landfills. Tijuana has the highest number of junked cars, stored in *yonkes*, or car recycling yards, per capita in Mexico. Tires abound in the watershed, originating from these yonkes and from used tire sales from the United States. In 1996 approximately 184,000 tires were imported into Tijuana; 113,000 tires were imported in 1997. Tires are used for fuel, to build houses, for planters, soles of shoes, and for retaining walls. After use, tires are often dumped into the rivers and canyons, causing flooding and environmental problems (Dirección de Ecología del Estado de Baja California as cited in Moreno and Muñoz 2003). The new Tijuana landfill opened in 2004 and has, among other recycling operations, a tire shredder that processed around 30,000 tires in August 2004 (Saxod 2004). Shredding tires helps them biodegrade, takes up less landfill space, discourages burning, and prevents water from accumulating in the insides, attracting mosquitoes and other insects.

Border WasteWise[35] was a pilot project established in 1995 to help companies in Tijuana reduce waste and improve economic competitiveness; a total of twenty-seven businesses participated. The City of San Diego's Department of Environmental Services Division of Environmental Programs is responsible for the City of San Diego's recycling programs. San Diego County (including parts of the TRW) offers recycling throughout the South San Diego's Recycling Market Development Zone. Tecate's government does not currently support recycling. However, Tecate's *pepenadores* recycle materials, such as cardboard, aluminum, and iron/steel scrap (Medina 2002). Scrap collected in Tecate and Tijuana is often sold in San Diego and constitutes a binational market.

Landfills

In Baja California, state law establishes that the Dirección General de Ecología del Estado (DGE) is responsible for evaluating the environmental impacts of landfills. The Departamentos de Limpia in the Municipalities of Tijuana and Tecate manage municipal waste.

The City of Tijuana has two waste transfer centers to streamline the daily movement of trash to the landfill. One is located in Colonia Libertad near the border and is 7,179 m^2 (1.8 acres) in area and in 1998 took in 15% of the waste generated in the municipality, mostly from Mesa de Otay (70%) and Zona Centro (30%). The second is in Fraccionamento Mariano Matamoros in the eastern part of the city which accepted 4% of the trash generated in the Municipality, mainly from La Presa. This transfer center is 10,000 m^2 (2.5 acres) in size and has

[35] A collaboration of Institute for Regional Studies of the Californias, San Diego State University; Environmental Services Department, City of San Diego; Dirección de Obras y Servicios Públicos, Ayuntamiento de Tijuana; California Environmental Protection Agency, Integrated Waste Management Board; U.S. Environmental Protection Agency, Region IX, Science Applications International Corporation (SAIC); Facultad Internacional de Economía,Universidad Autónoma de Baja California

the capacity to handle 150 tons/day with a total storage capacity of 225 tons (Moreno and Muñoz 2003).

Until February 2003 there was only one landfill in Tijuana at Colonia Lomas del Jibarito, in the Delegación San Antonio de los Buenos. In 1998 it received more than 100 loads per day from city trucks and an unknown number of visits from private trucks. It is estimated that the landfill reached its capacity in 1997. It was an open-air landfill and has experienced fires, resulting in an investigation by environmental officials in 1990 (Moreno and Muñoz 2003). The Municipality of Tijuana opened a state-of-the-art landfill in 2004 with a total area of 1,000,005 m^2 (247 acres). Its expected capacity over the next 19 years will be 27,882,766 m^3 (36,469,281 yd^3) (DGE 2003).

Tecate's landfill has also exceeded its lifespan and has caught on fire in the past. Local authorities have proposed a new landfill that would occupy 0.47 km^2 (0.18 mi^2) south of town with a lifespan of 50 years and a section for industrial waste (Medina 2002). Although funding was approved by NADBANK, public debate about the location of the landfill and property title issues have delayed construction.

The Otay Landfill lies north of the watershed boundary, is regulated in terms of water quality by waste discharge requirements issued by the California Regional Water Quality Control Board. Currently, the facility provides biosolids disposal services for the City of San Diego and other municipalities in the San Diego metropolitan area. The remaining capacity in 2003 was 31,336,166 tons (San Diego County 2004).

Hazardous waste

The storage, transportation, treatment, recycling, and disposal of hazardous waste is regulated by the Mexican federal Secretariat of Environment and Natural Resources (SEMARNAT) and the National Environmental Institute (INE). In the United States, hazardous waste is regulated by the EPA's Region 9 Waste Management Division.

Mexican agencies define hazardous waste as corrosive, reactive, explosive, toxic, flammable, or infectious materials (CRETIB). Hospitals, clinics, and laboratories generate infectious waste and households generate hazardous waste, such as batteries and cleaning products. Mexico and the United States have separate tracking systems for monitoring hazardous wastes. Data on sources and quantities are unreliable and scarce. In Mexico, the *maquiladora* industry is likely the largest generator of industrial hazardous waste (Medina 2002).

The 1994 North American Free Trade Agreement (NAFTA) emphasizes opening borders and increasing transborder economic integration. Under the terms of NAFTA and Mexican environmental law, international *maquilas* and industries, to return their hazardous materials to the country of origin for proper disposal. The border crossing at Otay Mesa is the only assigned port of entry for the import and export of hazardous waste in the TRW.

Waste trends

Fig. 37 shows an average 8% annual increase in trash for Tijuana (Moreno and Muñoz 2003).

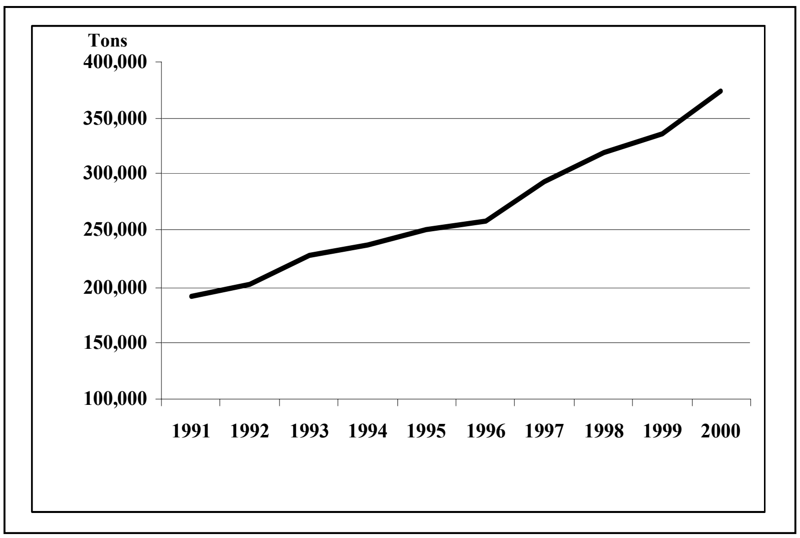

Fig. 37
Ten-year trend for Tijuana trash generation.
Source: Subdirección de Servicios, XVI Ayuntamiento de Tijuana.

Haztracks was a centralized database created by the U.S. EPA and its Mexican counterpart that was used after the passage of NAFTA to document and monitor hazardous waste crossing the border. However EPA shut down Haztracks in 2003, because it was inadequate, and currently no official database exists. Officials have no idea how much waste is being transported across the border, although reports filed from Mexico in 1997 showed 11,052 tons being shipped, a 17% increase over 1996 (Cantlupe 2003).

Waste data

Sources of data on waste in the TRW are available in Appendix 10. The data includes reports, electronic files, maps, and other information in English and Spanish from both the United States and Mexico.

Waste data gap

After reviewing the available data, the Research Team and others identified the following data needs for the TRW:

- Quantified amount and type of waste crossing the border
- Information on tons of recycled materials collected per year in the TRW

Waste recommendations

Suggested research includes:

- Perform periodic characterizations of the source of the waste.
- Perform scientific studies to support public policy making.
- Study the role of landfill recyclers, or *pepenadores.*
- Study the successful experiences with recycling in other cities in Mexico and abroad.
- Research on classification of recyclables is needed.

The following recommendations were made by the civic group Tijuana Trabaja in 2003 (Moreno and Muñoz 2003). Although they focus on Tijuana, the suggestions apply broadly throughout the TRW.

- Implement a strategy for organizing data and diffusing information on transboundary waste.
- Privatize Mexican waste collection through a contract that contains precise clauses and follow-up by the municipal authority.
- Perform an immediate inventory of Tijuana waste collection and storage equipment, and replace in stages.
- Inspect and maintain equipment.
- Redesign routes for trash collection in Tijuana.
- Supply the transfer station with urgently needed heavy equipment, efficient operational control, expanded manpower, offices, and services for operators.
- Develop and diffuse programs to improve the efficiency of Mexican collection system efficiency, such as posted schedules, hours, routes, general information, and ways to help evaluation activities.
- Strengthen supervision and enforcement of law and punish lawbreakers.
- Create an information center and follow-up on complaints and reports of violations.

- Develop a Tijuana master plan for the management of solid waste that includes a feasibility. study and economic analysis for priority projects and promotes the well being of the citizens and environmental protection.
- Transform the current Departamento de Limpia and start an integrated recycling program with the private, education, and government sector involvement.
- Create an information system about the specific benefits of the recycling processes like guides, collection programs, and all types of materials in the city parks and recreational centers. Citizen training and presentations are needed.
- Implement a pilot recycling program in the schools that could become a model for city-wide application in Tijuana.
- Create a management plan for car junk yards *(yonkes)* and tires.
- Promote family and institutional practices of composting.
- Explore government-sponsored composting options for organic matter.
- Explore incineration options for volume reduction and energy generation.
- Eliminate the fee at the Mexican landfills with the goal of reducing illegal dumping and burning.

TRW stakeholders at community forums, the BWAC, and the Vision Project Research Team jointly characterized the current situation and future desired scenarios for waste in the TRW. This information is presented in Table 17.

SOLID AND HAZARDOUS WASTE			
Challenges	**Opportunities**	**Goals**	**Objectives**
Control of hazardous materials transport and disposal within each country and across the border Population growth is generating increased waste Industry is producing unmitigated waste Waste is being carried by streams and deposited downstream Non-point source pollution from small and medium businesses	Recycling center at the border Existing cross-border education and outreach programs Previous university research Visibility of the challenge Value of recycled materials Cross-border synergies for recycling	Decrease amount of solid waste generated Decrease amount of solid waste entering waterways Decrease production and transport of hazardous waste Increase recycling	Educate citizens and businesses on proper waste disposal Enforce industrial waste laws Implement laws to mitigate flow of waste into waterways, including industrial pretreatment programs Create more recycling centers and foster a recycling culture Remove existing waste, and develop strategy for continual monitoring and cleanups Create economic incentives to curb the illegal disposal of hazardous waste Implementation of pollution prevention programs by industry

Table 17
Waste challenges, opportunities, goals, and objectives.

At meetings in the fall of 2003, the stakeholders voted on the following Priority actions for meeting the established goals for waste (Table 18):

Votes	**Action**	**Location**
10%	Integrate the management of trash (education, incentives, bins, recycling, penalties, citizen participation)	TRW Region
7%	Provide waste education and training for teachers, students, parents, *promotoras*	Watershed-wide
7%	Promote a culture of municipal solid waste generation and management	Schools, universities, work centers
6%	Improve infrastructure for transport, treatment, storage, and disposal	Watershed-wide
5%	Implement and give value to environmental legislation in all branches of government	Watershed-wide
5%	Convince the Campo Band of Kumeyaay Indians to abandon the proposed 400-acre landfill	Campo Reservation near Jardines de Rincón
4%	Perform an environmental risk assessment for dump sites	Tijuana Tecate, Campo Indian Reservation
4%	Encourage the use of school-based environmental curricula on reduction, recycling, reuse, and safe hazardous waste disposal	Mt. Empire, San Diego, Tijuana, and Tecate schools

Table 18
Priority waste actions from stakeholder meetings.
The voting percentages are based on ~ 50 persons per meeting casting 5 votes each.

Air quality

Pollutants in the atmosphere impact the health of humans, flora, and fauna in the TRW through direct inhalation of pollutants, deposition onto plants and soils, and absorption into water bodies. The major source of pollutants to the atmosphere in the TRW originates from human activities that take place within the metropolitan region of San Diego-Tijuana-Tecate, although some atmospheric pollutants may be transported from outside the basin through prevailing wind patterns (Sweedler 1998).

Mexico and the United States have each established standards for the most important air pollutants which include:

- Carbon monoxide (CO)
- Ozone (O_3)
- Nitrogen dioxide (NO_2)
- Sulfur dioxide (SO_2)
- Particulate matter 2.5 micrometers or less in diameter (PM 2.5) *United States only*
- Particulate matter 10 micrometers or less in diameter (PM 10)
- Total suspended particulate matter (TSP) *Mexico only*
- Lead (Pb)

The standards established by Mexico are fairly close to the U.S. air quality standards. There are also separate State of California standards for some criteria pollutants that are stricter than both the U.S. and Mexican standards.

Only in the late 1990s were monitoring stations established in the Tijuana region to provide information about ambient air quality (Sweedler 1998). These new stations complement existing stations in San Diego to provide information about air quality in the binational region and the TRW. Fig. 38 displays the location of air quality monitoring stations available in 2004.

Fig. 38
EPA-CICA air quality monitoring stations.
Source: U.S.EPA.[36]

The Centro de Información sobre Contaminación de Aire **(**CICA) is an air pollution information program sponsored by U.S.EPA's Center for Clean Air Center to provide technological assistance to border areas. CICA data show that as of October 2004, Tijuana's air exceeded the EPA standards for 8-hour ozone and the annual mean particulate matter. San Diego also exceeded the annual mean particulate matter, known as PM 10s (Data in boldface exceed U.S. standards
Table 19) (EPA 2004).

[36] http://www.epa.gov/ttn/catc/cica/sd_map_e.html.

	Carbon monoxide		Nitrogen dioxide	Ozone		Sulfur dioxide		Particulate 2.5		Particulate 10		Lead
	2nd Max 1-hr	2nd Max 8-hr	Annual Mean	2nd Max 1-hr	4th Max 8-hr	2nd Max 24-hr	Annual Mean	98th Percentile	Annual Mean	2nd Max 24-hr	Annual Mean	Quarterly Mean
Tijuana-Tecate	13.8	7.2	0.025	0.109	**0.092**	0.004	0.002			143	**64**	0.08
San Diego Co.	6.1	3.8	0.022	0.104	0.082	0.015	0.004	42	14.9	104	**53**	

Data in boldface exceed U.S. standards

Table 19
Air quality data for the Tijuana, Tecate, San Diego County region, 2004.
Source: EPA-CICA.[37]

Description of data in Data in boldface exceed U.S. standards
Table 19:
Carbon monoxide: 35 ppm (1-hour average), 9 ppm (8-hour average)
Nitrogen dioxide: 0.053 ppm (annual mean)
Ozone: 0.12 ppm (1-hour average), 0.08 ppm (8-hour average)
Sulfur dioxide: 0.14 ppm (24-hour average), 0.030 ppm (annual mean)
Particulate 2.5 (diameter < 2.5 micrometers): 65 $\mu g/m^3$ (24-hour average), 15.0 $\mu g/m^3$ (annual mean)
Particulate 10 (diameter < 10 micrometers): 150 $\mu g/m^3$ (24-hour average), 50 $\mu g/m^3$ (annual mean)
Lead: 1.5 $\mu g/m^3$ (quarterly mean)

[37] See http://www.epa.gov/ttn/catc/cica/monvals_e.html?ba~sd~San%20Diego/Tijuana

Sources of air pollution in 1998 in Tijuana are given in Table 20 (Sweedler 2005).

	PM 10		NOX		VOC	
	Tons/yr	**%**	**Tons/yr**	**%**	**Tons/yr**	**%**
Industrial sector						
Energy generation	1,043	3.6	3,104	10.8	122	0.2
Other industry	2,256	7.6	397	1.4	8,207	10.6
Total industrial sector	3,299	11.2	3,501	12.2	8,329 10.7	
Area sources						
Paved roads	4,324	14.7	NA	NA	NA	NA
Unpaved roads	17,860	60.9	NA	NA	NA	NA
Other area sources	1,379	4.7	1,649	5.7	31,304	40.3
Total area sources	23,563	80.3	1,649	5.7	31,304	40.3
Transportation sector	1,214	4.1	23,501	81.6	36,908	47.5
Wind erosion and vegetation	1,273	4.3	145	0.5	1,195	1.5
TOTAL	29,349	100	28,796	100	77,736	

NA: Does not apply.

Table 20
Main sources of PM 10, NO_X and VOC emissions in Tijuana-Rosarito, 1998.
Source: (SEMARNAT 2000 as cited in Sweedler 2005).

Unpaved roads are the main source of particulate matter pollution in the Tijuana region, while the transportation sector is primarily responsible for emissions of NOx and VOCs, the main precursors to ozone formation. The energy sector also contributes about 10% of the NOx load in the basin, while industry contributes a similar percentage of VOCs (Sweedler 2005).

Of relevance to the TRW's air basin is the San Diego County air basin, which covers a total of 4,260 mi2 (11,033 km2). It includes about 8% of the state's population and produces about the same percentage of the state's pollutant emissions. Although in close proximity to Los Angeles and Tijuana, studies show that emissions from the San Diego air basin alone are sufficient to cause violations of the ozone standards. In the San Diego air basin there were 2 days in 2003 above the national standard and 24 days above the state standard for PM 10 (California Air Resources Board 2003). For particulate matter, San Diego meets federal, but not California, standards (Sweedler 2005). The test for "8-Hour Carbon Monoxide Averages" only exceeded the national and state standards 1 day in 2003. The "4 Daily Maximum Hourly Nitrogen Dioxide Measurements" did not exceed the state standard in 2003 (no national standard was reported). Other contaminant data were not available at the air basin scale for that year (California Air Resources Board 2003).

Air quality trends

Ozone levels in San Diego have decreased during the past 23 years. An Air Quality Index of 100 roughly corresponds to the national ambient air quality standard. When an area exceeds the standard, the air is unhealthy. Fig. 39 shows that the number of days above the index dropped from 1980 to 2001 (U.S. EPA 2004).

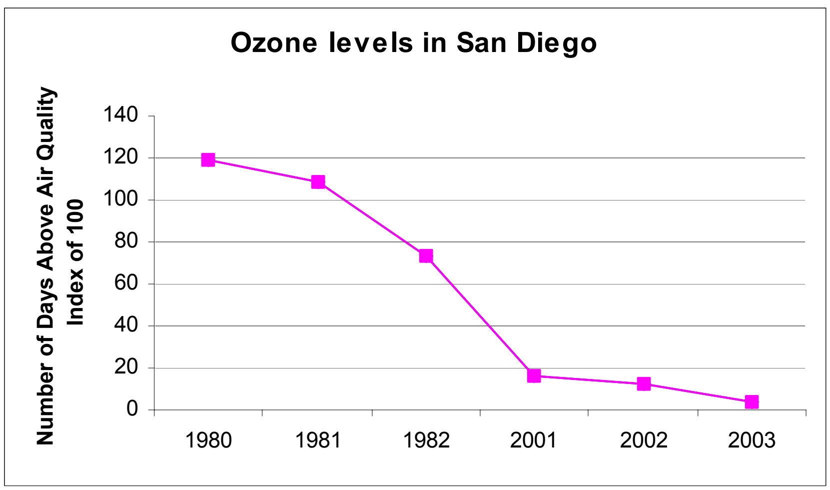

Fig. 39
Number days above the national Air Quality Index for San Diego from 1980 to 2003.
Source: (U.S. EPA 2004).

Tijuana does not yet meet Mexican ozone standards. However, the number of days during the year that are in violation are very few—only 3 days in 1997 and 1 in 1998. For PM 10, Tijuana exceeded the Mexican norms 5.5% of the time in 1998 (SEMARNAT 2000 as cited in Sweedler 2005).

The Chula Vista air monitoring station and the Otay Mesa-Paseo International station showed that fewer days exceeded the national and state standards for 1-hour ozone averages over the years. Fig. 40 and Fig. 41 provide historical data for air quality trends near Chula Vista and Otay Mesa.

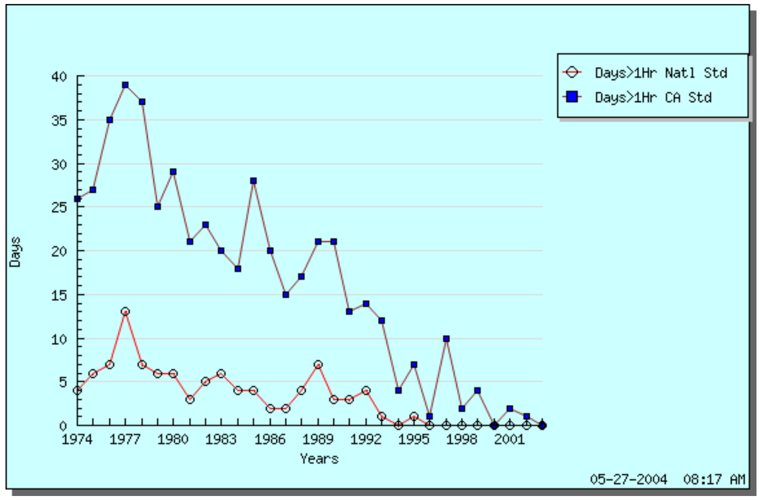

Fig. 40
Trends for the Chula Vista air quality station.
Source (California Air Resources Board 2003):.

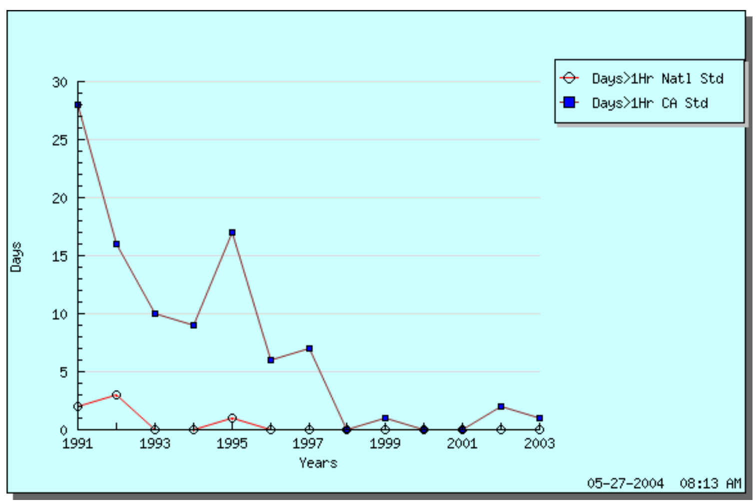

Fig. 41
Trends for the Otay Mesa-Paseo International air quality station.
Source: (California Air Resources Board 2003).

A review of air quality in Tijuana for 1996 was performed at SDSU.[38] In the Tijuana region, the highest monthly maximum 8-hour concentrations of carbon monoxide for 1996 values were observed at the La Mesa monitoring station, where there is a heavy concentration of

38 See (Sweedler 1998).

commercial and urban traffic. Emissions from cars and trucks constitute a major source of carbon monoxide. Even though the carbon monoxide levels were high, they were within the Mexican federal standards. The highest 1-hour maximum concentrations for nitrogen dioxide occurred at the heavily congested La Mesa monitoring site. NO_2 is a precursor to ozone formation and also results from combustion of petroleum-based fuel in cars and trucks. PM 10 were fairly high, although less than what is observed in the eastern portion of the TRW. The nature of air over the TRW has not been characterized but it is clear that air movements transport pollutants. up and down river valley

Air quality data

Sources of data on air quality in the TRW are available in Appendix 11. The data includes reports, electronic files, maps, and other information in English and Spanish from both the United States and Mexico.

Air quality data gaps

After reviewing the available data, the Research Team and others identified the following data needs for the TRW:

- More air quality monitoring data for Mexico and at border crossings

Air quality recommendations

A very important element in reducing air pollution in the region is the development of an adequate emissions inventory. Knowledge of the source and quantity of pollutants emitted into the atmosphere is a precursor for developing a program updated to reduce air pollution in the region. Suggested research topics include studies concerning the links between air pollutants and water quality in the TRW (Sweedler 1998).

TRW stakeholders at community forums, the Binational Watershed Advisory Committee, and the Vision Project Research Team jointly characterized the current situation and future desired scenarios for air quality in the TRW. Table 21 provides these results.

AIR QUALITY			
Challenges	**Opportunities**	**Goals**	**Objectives**
Industrialization and urbanization have increased air pollution, which causes environmental and health effects Motor vehicles are a major source of pollution Open burning is a source of pollution Nitrogen deposition from air pollution effects native and invasive plant species Global warming and climate change exacerbate problems Air quality effects of power plants Regional climatic conditions Unpaved roads are major contributors of solid particles in the air	Existing South Bay, Tijuana, and Tecate air quality monitoring stations	Improve quality of air	Promote solar and renewable energy Improve public transportation Enforce emissions standards for industry and vehicles Monitor air quality in Mexico and provide public access to data Educate citizens about open burning Research future effects of global warming on the region Decrease health risks from air pollution Decrease environmental impacts from air pollution Conduct transborder air quality modeling and analysis Reduce point-source pollution Reduce mobile sources of air pollution Develop transborder air basin (Binational Air Quality Alliance [BAQA]) Develop emissions-trading mechanisms Coordinate energy planning (Border Energy Forum) Pave roads Obtain formal recognition of the transborder air basin

Table 21
Air quality challenges, opportunities, goals, and objectives

At meetings in the fall of 2003, the TRW stakeholders voted on the following priority actions for meeting the goals for air quality (Table 22):

Votes	**Action**	**Location**
7%	Create green areas: *áreas naturales protegidas*, parks, and gardens	Watershed-wide
4%	Decrease waiting time for border crossing	Ports of entry
3%	Develop congruent and collateral public policies on air quality standards	Border-wide
3%	Revegetate to reduce dust	Watershed-wide
3%	Regulate power plant emissions at local, regional, and national levels	Northern Baja
3%	Monitor and inspect air emissions from fish farms, dairy farms, and cattle ranches	Mexico
3%	Create economic incentive for users to get *verificentros* smog checks	Mexico
2%	Enforce air quality laws fairly and systematically	Watershed-wide
2%	Develop better monitoring and inspection for industrial and commercial emissions by competent authorities	Mexico
2%	Study air quality by air basin	Watershed-wide

Table 22
Priority air quality actions from stakeholder meetings.
The voting percentages are based on ~ 50 persons per meeting casting 5 votes each.

Socioeconomic issues

Economy

Disaggregating social and economic data to coincide with the physical boundaries of the TRW is, in most cases, not possible. At the same time, harmonization of data across the international boundary is not always possible or is too difficult or costly to be undertaken. Consequently, much of the discussion of socioeconomic issues will focus on the larger region of San Diego County, the Municipality of Tijuana, and the Municipality of Tecate.

Since World War II, the economy of Southern California, despite periods of recession, has been very dynamic, demonstrating impressive growth over the long term. Military expenditures and tourism have remained central to San Diego's economy, and the region has transitioned from the loss of aerospace jobs in the early 1990s to biotechnology, software, and electronics quite successfully. Typically, unemployment in San Diego has remained lower than the rest of the state or nation (Rey and Clement 1998).

The economic contrasts between San Diego and Tijuana-Tecate are striking. Depending on the peso-dollar exchange rate, the regional product of San Diego is typically more than fifteen times that of Tijuana and minimum wages are about ten times in the United States. Other economic measures reveal similar asymmetries, including municipal budget expenditures per capita. The regional asymmetries are characteristic of those between highly developed industrial nations and developing countries (SANDAG 1998 as cited in (Rey and Clement 1998; Rey, et al. 1998) (Fig. 42).

At the same time, Tijuana is better off economically relative to the rest of Mexico, while some aspects of San Diego's economy, like affordable housing, lag behind the rest of the United States. In areas such as per capita income, the entire U.S.-Mexican border, including San Diego, have fallen behind the natural average. In both San Diego and Tijuana, income distribution has become more unequal, with larger percentages of workers and the population at or near the poverty level. This suggests that the benefits of economic expansion before and after NAFTA have accrued mainly to groups at the top of the income scale. Inequality is growing within the region (Rey and Clement 1998) (see Fig. 42).

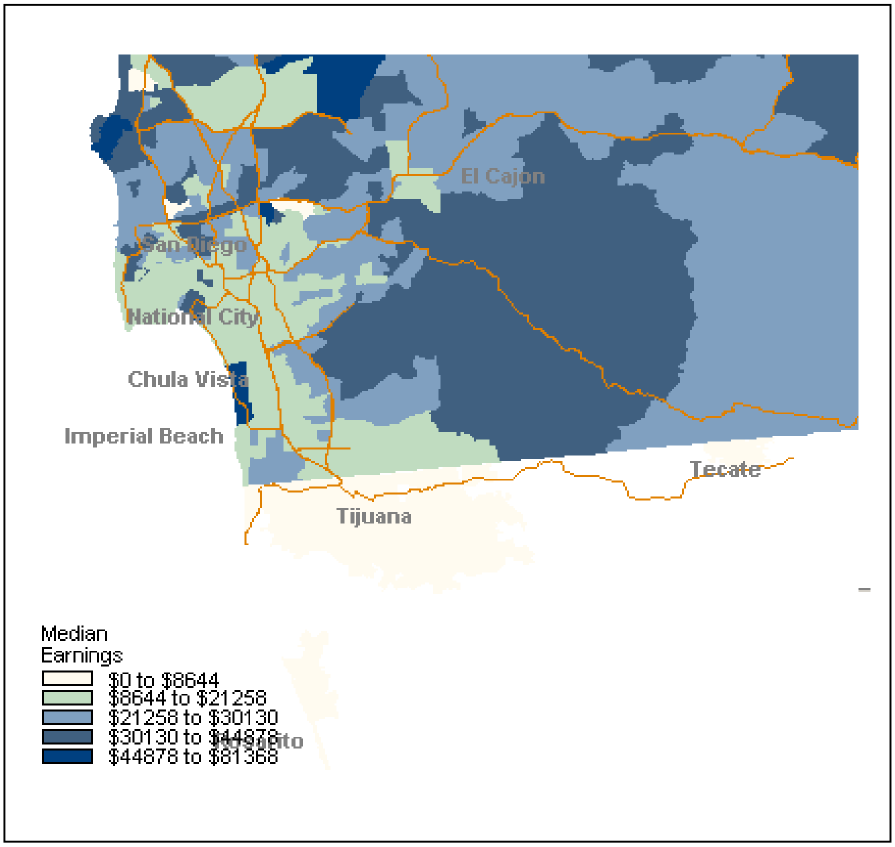

Fig. 42
Median income distribution.
Source: (SANDAG Interactive Atlas, 2000).

The manufacturing sector in Tijuana and Tecate (mostly foreign-owned *maquiladora* assembly plants) grew rapidly from the mid-1980s and, by 2004, approximately 150,000 persons were employed by 571 *maquilas*. Tecate's *maquilas* employed about 9,400 persons at 106 factories in 2004 (INEGI 2004). Manufacturing in San Diego is declining as its economy shifts toward service activities (Rey and Clement 1998). Some argue that the two regions' economies should be looked at as a whole "transfrontier metropolis." Several factors, principally NAFTA, globalization, transborder labor markets, and transnational land investment are producing greater integration between Tijuana-Tecate and San Diego.

International commuters

The San Ysidro port of entry at Tijuana is one of the busiest border crossings in the world and the busiest in the Western Hemisphere. It is estimated that over 40,000 commuters cross these ports on a yearly basis (SANDAG 2003). The physical infrastructure and administrative resources at existing border ports of entry are already strained. Anticipated increases in population growth and international trade will place even greater pressures on the existing infrastructure. Crossings of passengers and goods at the U.S.-Mexican international border are projected to increase by nearly 90% by 2030 (SANDAG 2004).

According to the 2000 Mexican census, 50,000 Tijuana residents worked in the United States (INEGI 2004). Many worked legally, but thousands of others cross illegally to work with border crossing cards that were issued for non-work purposes. Whether working legally or illegally in the San Diego region, these workers earn significantly higher wages than most workers employed in Tijuana and Tecate. Thus, it is very likely that the total payroll of these commuter workers exceeds the total payroll of the *maquiladora* line workers in Tijuana and Tecate (Rey, et al. 1998). In 2002, total of 42.2 million persons legally crossed the border at San Ysidro, 11.3 million crossed at Otay Mesa, and 2.7 million crossed at Tecate, totaling 56.5 million individuals.

The value of goods crossing the border in 2003 was and $20 billion and is expected to increase by $34 billion by 2030, or 200%. The current port of entry and roadway network serving the border are not adequate to handle the projected increase (SANDAG 2004). The increased scrutiny of persons entering and leaving land ports of entry mandated by the U.S. Department of Homeland Security will likely significantly increase border congestion when implemented in 2005.

Transborder tourism and retail trade

In the 1920s, the prohibition of alcohol and gambling in the United States sparked Mexican border tourism. Tourism continues to be a large generator of revenue in the border region, particularly in Tijuana, but also in Tecate. Border tourism typically includes many thousands of visits for short periods of shopping or dining and relatively low expenditures. For many years, tourism authorities in Tijuana have tried to improve tourism through encouraging overnight stays and expanding the number of venues. Tecate, in contrast, has begun to focus on the possibilities of ecotourism and cultural-historical tourism to take advantage of the rich environmental and human resources of the upper TRW. Cross-border shopping has been important in the TRW region for more than a century. Merchants in San Ysidro and south San Diego, as well as merchants in Tijuana, depend upon visitors for an important part of their sales.

Due to these factors and others, the economies of San Diego and Tijuana have been expanding; however, there have been negative consequences for the region's quality of life. More jobs have attracted many more residents and contributed to urban sprawl and traffic.

Unfortunately, more jobs and more people do not necessarily translate to higher incomes or more tax dollars for infrastructure. As a result of the population boom, there is an infrastructure deficit for all cities in the TRW that threatens to undermine the potential for long-term prosperity and a high quality of life (Rey and Clement 1998).

Housing

San Diego is usually among the top 20 least affordable housing markets in the nation due to its relatively low wages and high housing costs. There has been a housing affordability crisis in San Diego since 1978. The housing crisis is especially acute for low and very-low income households (Calavita 1998). In the City of San Diego 155,910 households paid more than 30% of their income on housing in 2000 (U.S. Census Bureau 2004). Just 11% of households in San Diego County had income levels that were sufficient to purchase a home (California Association of Realtors 2004).

A larger portion of residents in Mexican municipalities own their homes—Tijuana (68%) and Tecate (67%). Nearly 45% of the low-income sector of Tijuana lacked any formal housing options and could not get credit in 2000 (Gobierno Estatal de B.C. 2002).

Baja California already has the one of the largest communities of expatriate U.S. homeowners in Mexico (second only to the Guadalajara region). Between 5,000–20,000 U.S. citizens resided in homes along the Baja California coast in 1998. The extremely high housing costs in the San Diego region have encouraged many to acquire more affordable housing south of the border. Meanwhile, increasing numbers of Mexican immigrants are purchasing homes on the U.S. side of the border as they formalize their work and immigration status. Also, many well-to-do Mexicans purchase homes in San Diego due to public safety concerns in Tijuana (Herzog and Graizbord 1998).

Infrastructure

In 2000, nearly 88% of houses in the municipality of Tijuana had potable water supplies. Seventy-three percent of households had running water inside the houses, and 15% outside the homes, the latter most likely in the form of water truck deliveries to barrels. Almost 85% of houses were connected to the municipal sewage system—75% of those had direct connection, 8% had septic tanks, and 1% drained to soils, rivers, or lakes (INEGI 2004).

For residents of Tecate, 80% of houses had potable water supplies in 2000 (70% inside the homes and 10% outside). Sixteen percent of households had to go to a public source or had no water supply. Eighty-five percent of Tecate's homes have sewage connections (69% direct connection, 15% through septic tanks, 1% into open bodies of water) (Fig. 43) (INEGI 2004).

Due to the rapid rate of population increase in Tijuana and Tecate, providing public services to the expanding urban area is very challenging. The public utility commissions of Tijuana and Tecate (CESPT and CESPTE) have done an excellent job of meeting the demand for services despite financial limitations. However, as long as rapid population rates continue, there will always be unserved residential areas that lack municipal water supply, with resultant human health and environmental costs.

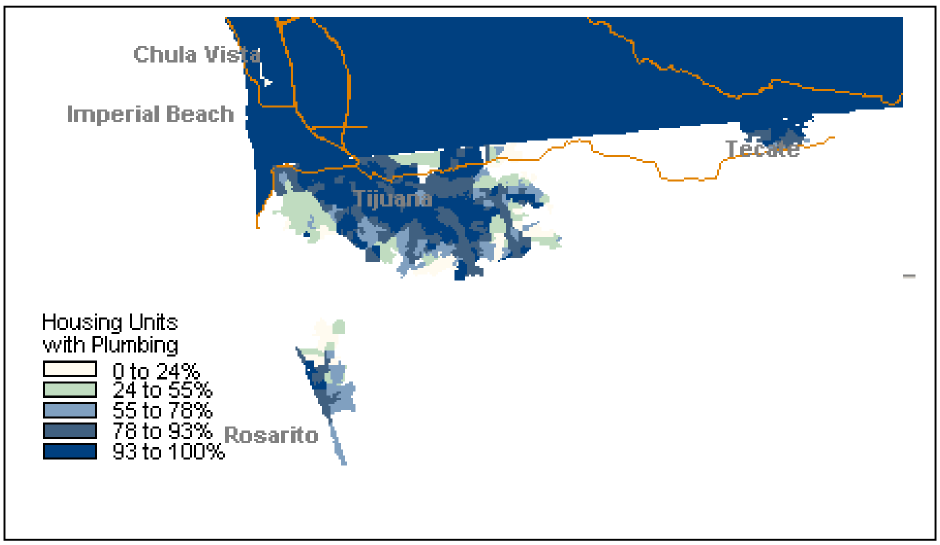

Fig. 43
Housing units with sewage connection, 2000.
Source: (SANDAG interactive atlas, 2004).

Human health

Some factors that cause health problems in the TRW are:

- The water quality of the Tijuana River and groundwater
- The inadequate disposal and treatment of sewage and wastewater
- A high concentration of industrial factories resulting in air, soil, and water pollution
- Agricultural industry with livestock, and pesticide and chemical use
- Exposure to lead
- Rapid urbanization and crowding in the more densely populated communities in the City of San Diego, Tijuana, and Tecate (Brodine and Gresham 1998)

Food- and water-borne diseases are a major health problem in this region. These include bacterial and viral diseases, from pathogens, such as brucella, salmonella, shigella, and hepatitis A. The hepatitis A rate in San Diego in 1998 was almost three times higher than the national rate. Other problems are the presence of toxins, such as pesticides and lead. Also, there is significant local marine pollution, with bacterial contamination and demonstrated levels of heavy metals and pesticides in the shallow waters off of San Diego and Tijuana, which makes shellfish and fish consumption dangerous (Brodine and Gresham 1998). Intestinal infections by parasites affected 11.1 % of the population of Tecate between the ages of 15 and 64 (Gómez and Lozano 1998).

Respiratory disease, both infectious and non-infectious, is a significant problem in the TRW. Infectious respiratory illnesses occur due to a variety of pathogens, such as tuberculosis, coccidiomycoses, and viruses. The rates of tuberculosis are higher in San Diego County than most parts of the United States, and forms of tuberculosis that are resistant to drugs are a growing threat. Air pollution (e.g., carbon monoxide, ozone, particulate matter) is directly linked to respiratory diseases, such as asthma and bronchitis, particularly in children. Air pollution is a problem in the TRW and originates from vehicle fleet emissions, impaired roads, industry, and pollution from other air basins imported by air currents. Tecate reported that in 2000, 64% of the population between 15 and 64 years of age had acute respiratory infections, and 0.9% had asthma (ISESALUD as cited in Gómez and Lozano 1998). Increases in water, soil, and air pollution have led to a growing concern that these exposures could result in birth defects. Widespread use and presence of hazardous materials, including solvents, PCBs, and pesticides, also pose a risk for cancers (Brodine and Gresham 1998).

Sexually transmitted diseases and drug use occur at high rates in the TRW region. Some diseases include chlamydia and gonorrhea (which are curable), human immunodeficiency virus (HIV), hepatitis B, and hepatitis C (not curable). There is a high level of morbidity due to HIV in San Diego County compared to other parts of the United States. Binge drinking by teens and young adults in Tijuana contributes to health problems and motor vehicle accidents. The increase in traffic with urbanization contributes to increased vehicle accidents and violence (Brodine and Gresham 1998).

Table 23 summarizes some environmental contaminants and sources that can be found in the TRW (Michel and Graizbord 2002) and the potential health problems (U.S. EPA Office of Water 2004) associated with exposure to the contaminants.

Pollutant	Major Sources	Negative Health Effects
heavy metals (chromium, lead, mercury, copper, cadmium, zinc, selenium)	automobile emissions, atmospheric deposition, industrial activities, commercial activities	hemolytic anemia, bone-marrow dysplasia, cancer (different types depending on the metal), kidney damage, skin irritation, circulatory system damage, nervous system damage
aromatic hydrocarbons (oil, grease, petroleum-based products, polycyclic aromatic hydrocarbons)	parking lots and roads, restaurants, household activities, automobile emissions, improper disposal of motor oil and solvents	nervous system disorders, immune system disorders, anemia, depression, liver and kidney damage, cancer, memory loss, nausea, fatigue
nutrients (nitrates and phosphates)	fertilizers, animal waste, detergents, atmospheric deposition, leaking sewer pipes	reduced oxygen-carrying capacity of blood, amyloid (starch) deposits in tissues, spleen hemorrhage, diuresis, bone loss
toxic organic compounds (pesticides, polychorinated biphenyls (pcb's), dioxin, heptachlor, etc)	lawn care products, agricultural use, industrial uses, household activities (paints and solvents), illegal dumping into storm water drainages	skin irritation, mucous membrane damage-gastro-intestinal tract, nose, throat, liver dysfunction, cancer, leukemia, reproductive effects, endocrine disorders
pathogenic bacteria and other microbes (salmonella, legionella, campylobacter, shigella, cryptosporidia, giardia, cholera, polio, etc.)	pet and animal waste, agricultural waste, rotting organic material, sewage overflow/leakage, market and restaurant waste	gastroenteritis, diarrhea, nausea, headaches, cramps, hemolytic-uremic syndrome (rare), and even death in immune-compromised individuals, very young and very old.

Table 23
Environmental contaminants, sources, and the potential health problems associated with exposure.
Sources: (Michel and Graizbord 2002; U.S. EPA Office of Water 2004).

Tourism and recreation

The natural and cultural features of the TRW are well suited for resource-based tourism. While tourism is generally considered a market-driven service industry, its long-term viability depends on a quality natural and cultural resource base (Williams 1992 as cited in Beck and Lamke 1998).

San Diego County attracted 14 million tourists per year in the 1990s, with a total of 26.4 million visitors in 2003. This represents a $5.3 billion tourism industry. The estimated contribution of ecotourism to total regional economic activity in 1997 was $1.24 billion annually, and in that year ecotourism employed approximately 9,340 people, twice the number employed in 1990. It is estimated that an additional 7,500 jobs were created as a result of the business transactions generated by ecotourism (Ecotourism Summit Fact Sheet 1997 as cited in Beck and Lamke 1998). An Ecotourism Action Committee in San Diego works to promote nature-based ecotourism in the region and is identifying several possibilities within the TRW (Beck and Lamke 1998).

Some statistics are available for tourism in Baja California based on surveys in August 2000 of 300 tourists in Tecate and 600 tourists in Tijuana. The participants in the surveys rated the public services of Tecate as 17% excellent, 68% good, and 16% poor. Tijuana's services received an excellent rating only from 2% of participants, 44% gave a good rating, and 52% a poor rating, with a very poor rating from 3% of the participants. Public safety was also rated as poor for Tecate (43%) and Tijuana (64%). Half the visitors reported that the purpose of their visit to Tecate was for rest and relaxation (51%), while in Tijuana, participants were visiting family and friends (51%). Tourists in Tecate rarely spent more than $300 per trip, while in Tijuana tourists spent between $200 and $500. However, it is noteworthy that foreign tourists to Tecate earn more $70,000 annually on average (INEGI 2004). It is suspected that these are visitors to Rancho La Puerta spa. Rancho La Puerta is relatively low-impact tourism that employs many local residents. It established a non-profit arm, Fundación La Puerta, that conducts outreach and funds research. Rancho La Puerta and its foundation are a model for other parts of the TRW.

Historical and cultural resources

There are many significant historical and cultural monuments and sites in the TRW, including the Campo-Tecate railroad, Parque Hidalgo in Tecate, the Railroad Museum in Campo, the Centro Cultural in Tijuana, the bullring in Tijuana, many historic buildings in Tijuana and Tecate, and numerous archeological and native peoples' cultural sites. A more complete list of resources and descriptions is provided in Appendix 5 of this document.

Besides the cultural resources of the Mexican, American, and Mexican-American communities in the TRW, the tribal peoples in the rural areas are a cultural resource that is threatened by modernization and encroachment of urban areas. Traditionally, the Kumiai[39] Indians have occupied the territory situated approximately 70 miles north and south of the U.S.-

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[39] This document uses Kumiai, although Kumeyaay is also used

Mexican border (Fig. 44). The traditional lands of the Kumeyaay include much of the TRW (Kilpatrick and Wilken 1998).

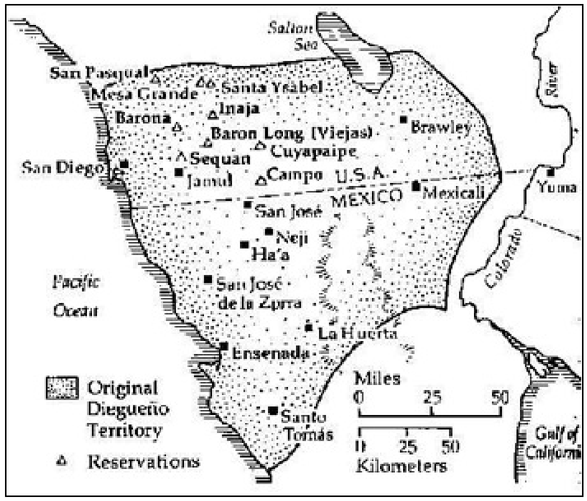

Fig. 44
Historic distribution of indigenous groups in the TRW.
Source: Roberta Ladastida and Diana Caldeira.

On the U.S. side of the border, several Kimeyaay reservations are located in southeastern San Diego County: Campo, Manzanita, La Posta, and Cuyapaipe. The Campo are wholly within the watershed and the others have portions of their lands within the TRW. The Mexican bands are the most environmentally affected of the Indian groups in this region. They include the rural Kumiai communities of Tanamá, Aguaje de la Tuna, Juntas de Nejí, Peña Blanca, and San José Tecate, whose members live without adequate infrastructure, such as running water and electricity (Kilpatrick and Wilken 1998).

As of 2004, only one Mexican Indian community, Juntas de Nejí, has title to its land, while several other traditional settlements struggle to regain or retain their land against the encroachment of *ejidos* and other powerful interests. Many of the members of these communities live only part-time in their communities, residing most of the time in Tecate, Valle de las Palmas, El Testerazo, or other neighboring towns, where they can find easier access to employment, schools, and services (Wilken-Robertson 2002).

Both U.S. and Mexican tribal entities are rural communities in the upper watershed above sources of industrial and urban water pollution. Nevertheless, water quantity and quality remains a major concern for all of the indigenous groups living in this region due to non-point source pollution from grazing and farming and other human activities. Protecting their land from overgrazing, soil erosion, and illegal dumping are just some of their concerns. Also, a challenge is access to traditional wild foods and materials in the face of expansion of human settlements, ranching and farming activities, and other economic endeavors in the watershed (Kilpatrick and Wilken 1998).

San José Tecate, Tanamá, and Aguaje de la Tuna in Baja California are small traditional Kumiai settlements that have been deeply impacted by the urban sprawl of Tecate (Wilken-Robertson 2002). The remote El Alamo (Ja'a) canyon of Juntas de Nejí is one of the few areas with a year-round flowing stream as well as important historic and prehistoric archaeological sites. Acorns are one of the most important natural resources utilized in the area of Nejí, and residents depend on other wild foods and medicinal plants as well as occasional hunting as part of a diversified survival strategy. Although a tradition of *juncus* and willow basketry once existed in the area, there are currently only a few women occasionally producing baskets (Wilken-Robertson 2002).

Socioeconomic trends

Economy

The transborder economy of the San Diego-Tijuana region has grown relatively quickly over the last decade and a half, except from 1990 to 1995 when San Diego suffered the general national recession and the impacts of defense-related cutbacks in the federal budget. Since the 1982 Mexican debt crisis, Tijuana's economy has been driven by the rapidly expanding *maquiladora* industry and has grown at annual rates of 20–30% (Rey and Clement 1998). From 1988 to 2000, approximately 7% of Tijuana's economically active population was employed in the United States, although this percentage decreased approximately 0.5% from 2000 to 2003 (INEGI 2004). Based on previous trends and future population projections adding to the workforce, *maquiladoras* are likely to continue to be an important part of the TRW economy.

Housing

Housing demand follows population trends. From 1990 to 2000 Tijuana's population rose 5.33% per year and its housing growth was 6.2% per year. For Tecate, there was an annual 4.2% growth in population and a 5.11% growth in housing for the same period. Tijuana added an average of 13,235 houses per year from 1990-2000, while Tecate added 747 houses per year during that decade (Gobierno Estatal de B.C. 2002). Discrepancies between the higher rates for housing than population is likely due to census undercounting. The San Diego section of the TRW had about 10,000 houses in 1990 and about 11,200 houses in 2000 (U.S. Census Bureau 2004).

The Municipality of Tijuana estimated that the 2007 demand for new lots with services 16,284 lots and 750 lots for Tecate. The need for more developable land was calculated at 2,300 more hectares for Tijuana, while Tecate will require 120 more hectares. Tijuana is projected to build 59 houses per hectare and Tecate 47 houses per hectare (Gobierno Estatal de B.C. 2002). San Diego experts project that between 1995 and 2020, the overall demand for housing in the region will increase 41%. The number of units in the region in 1995 was 996,400 and 405,800 new units will be needed to accommodate the projected population growth (SANDAG 1999). Developing land for housing often sacrifices open space and green areas to make way for single family houses with yards. Building inward and upward, in existing urban areas, termed "smart growth" is a recommended option for planners in the TRW.

Infrastructure

Fig. 45 shows the water and wastewater infrastructure for the border areas between San Diego and Tijuana in 1994.Building permits for San Diego's new housing developments will require appropriate infrastructure services of potable water, sewage, electricity, roads, schools, and hospitals. Mexican settlements are guaranteed water and sanitation services from the government, although residents of *colonias* often wait years for service. Infrastructure improvements in Mexico can lag years behind the demand.

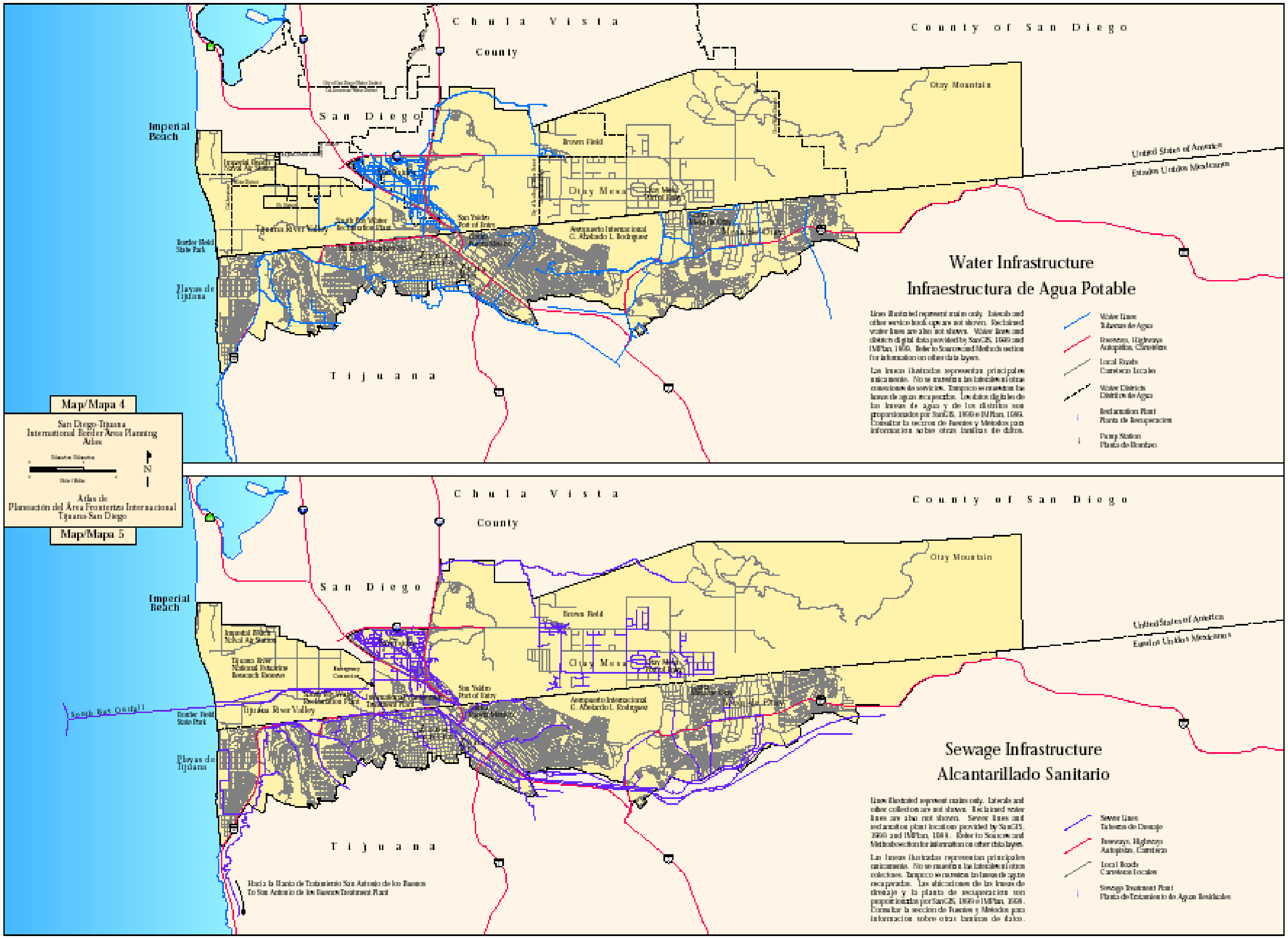

Fig. 45
Water and wastewater infrastructure for San Diego and Tijuana.
Source: (IRSC 2000).

Socioeconomic data

Sources of data on socioeconomic issues in the TRW are available in Appendix 12. The data includes reports, electronic files, maps, and other information in English and Spanish from both the United States and Mexico.

Socioeconomic data gaps

After reviewing the available data, the Research Team and others identified the following data needs for the TRW:

Economy

There are significant data gaps for understanding socioeconomic features of the TRW. Of particular concern is the lack of data that are collected in the same way on both sides of the border in order to better understand the linkages across the border. Important data gaps are indicated in the following list:

- Number of cross-border commuters
- Cross-border expenditures by consumers (in San Diego and Tijuana)
- Tourism expenditures
- Linkages of assembly plants across borders
- Binational use of services (such as medical and recreational services)
- Cross-border housing markets[40]
- Percentage of population with recreational facilities and natural settings within a 10-minute walk[41]
- Participation in organized youth programs at city centers
- Annual municipal expenditures on parks, open spaces, and streetscapes

Health

- Data on specific disease rates for comparison to national rates[42]
- The impact of disease in terms of morbidity, mortality, or quality years lost

[40] (Rey and Clement 1998)
[41] (Kjos and de la Rosa 1998)
[42] (Brodine and Gresham 1998)

- Prioritization for intervention strategies
- Number of people going to clinics for respiratory problems
- New cases of asthma[43]

Tourism

- Tourism statistics from urban areas, Indian tribes, and land-managing agencies on both sides of the border[44]

Socioeconomic recommendations

The follow studies are recommended in the area of public health:

- Microbial studies are needed to assess disease patterns and trends of water quality, emerging infections, enteric infections, and microbial-resistant organisms, such as tuberculosis and gonorrhea.[45]
- Studies to carry out systematic surveys and land-use patterning analysis to help predict where cultural heritage sites may be located and conserved.[46]
- Research existing or previous water treatment methods of border tribes may provide insights into current management techniques.
- Research indigenous historical and current perspectives on animal habitat, vegetation communities, and medicinal plants and document them.

The following issues were identified from the literature as critical to overcoming socioeconomic issues in the TRW (Kjos and de la Rosa 1998):

- Dispel ignorance about the other side of the border. Although improvement has been made in recent years, historic reasons, as well as stereotypes, continue to complicate efforts to coordinate across the border.
- Facilitate access to information, particularly in Tijuana. This is also changing as more information is now being generated. Mexico's recently approved transparency law

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43 (Brodine and Gresham 1998)

44 (Beck and Lamke 1998)

47 (Brodine and Gresham 1998)

46 (Kilpatrick and Wilken 1998)

guarantees citizens the right to governmental information has been a great help in providing public access to data.

- Standardize methods for defining, categorizing, and producing information on both sides of the border in order to facilitate collaborative efforts.

Health

- Improve surveillance, reporting, and outbreak investigations in order to better define the spectrum of food- and water-borne illness.
- Provide improved access to care, including emergency and disaster services.
- Make health services responsive to the community's diversity and local needs and reflect increased cultural competency and respect.
- Provide binational case management. Due to the mobility of the border population, binational case management is crucial, particularly for those with chronic diseases that require long-term compliance with therapy, or have a potential for continued disease transmission, such as tuberculosis. This cross-border cooperation is also critical for adequate outbreak investigation and implementation of control measures.[47]
- Train tribal members to conduct water monitoring.[48]
- Apply low-tech strategies to solve chronic environmental problems such as rock drops, or weirs, at appropriate places in rivers to recharge local water supplies.
- Fence off water sources from cattle.
- Cap wells.

Tourism

- Provide opportunities for ecotourism. Ecotourism can promote employment and provide income to local communities, while allowing the continued existence of the natural resource base.
- Monitor the impacts of tourism on wildlife and vegetation
- Provide access to sites for the disabled, public transportation to various destinations, and bilingual tourism materials.[49]
- Organize binational workshops between U.S. and Mexican bands of Kumiai.

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[47] (Brodine and Gresham 1998)

[48] (Kilpatrick and Wilken 1998)

[49] (Beck and Lamke 1998)

- Share geographic information system (GIS) capabilities.
- Tanamá could be the first stop on an ecotour including Peña Blanca and Juntas de Nejí.[50]
- Develop a relationship with the National Institute of Anthropology and History (INAH) in order to identify common goals and possibilities for collaboration.
- Develop partnerships between indigenous communities and NGOs, such as Native Cultures Institute of Baja California (CUNA), academic institutions, such as UABC and SDSU, and Mexican federal agencies, such as the Instituto Nacional Indigenista (INI).[51]
- Implement strategies designed to involve local communities in appropriate site management and ecotourism.
- Include formal tribal representation in the BECC, NADBank, the IBWC, and their counterparts in Mexico.[52]

Infrastructure

- Provide public transportation, such as subways, buses, and vanpools, walkable-ridable urban centers.
- Provide sewage and water connection to the *colonias.*
- Recharge the aquifers along the rivers using simple technologies, such as bulldozing lagoons and collecting runoff, frequently cleaning the surfaces and/or moving the lagoons a few meters from the original location.[53]
- Create emergency reservoirs in case of interruption of aqueduct service.
- Add another border crossing (East Otay Mesa and/or Jacumba-Jacumé).
- Add additional air pollution monitoring stations throughout the TRW.
- Invest in renewable energy sources, such as wind generators and solar panels.
- Designate pocket parks and greenways throughout urban centers.
- Promote the San Ysidro and Otay crossings as pilot projects for all the newest border-crossing technology.
- Collaborate with Homeland Security, the Border Patrol, and Immigration and Naturalization Services in order to maintain a flow of information and concerns, with the goal of creating safe, seamless, transparent borders similar to some in Europe.

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[50] (Valdez Flores 2002 as cited in Wilken-Robertson 2002).

[51] (Wilken-Robertson 2002)

[52] (Good Neighbor Environmental Board 2001)

[53] (Forster 2005)

TRW stakeholders at community forums, the Binational Watershed Advisory Committee, and the Vision Project Research Team jointly characterized the current situation and future desired scenarios for socioeconomic issues in the TRW; findings are presented in Table 24.

SOCIOECONOMIC ISSUES			
Challenges	**Opportunities**	**Goals**	**Objectives**
Different perspectives based on nationality and economic sector Urban sprawl encroaches on green areas and decreases access to recreational opportunities Loss of riparian zones decreases recreational opportunities Beach closures decrease recreational opportunities Deforestation decreases wildlife viewing and hiking areas Inadequate transportation systems increase traffic congestion and smog Lack of planning results in squatter settlements with a lack of infrastructure Inadequate potable water delivery and sewage treatment systems contribute to residents' health problems Historical and culturally important landscapes are threatened by commercial development Air and water pollution causes illnesses Residents and property in flood zones and steep, unstable slopes are at risk	Development of baseline binational quality of life indicators for this area Tijuana and Playas de Rosarito potable water and wastewater master plan Binational flood warning system National and binational NGOs concerned with environmental and human health	Improve binational quality of life through cultural, economic, historical, educational, and recreational enhancement of the basin Decrease environmental health risks Maintain a strong economic base for sustainable development	Monitor quality of life through indicators Relocate residents from flood zones to safe areas Create flood control structures that also provide recreational opportunities, such as river parks Improve and expand sewage system services Provide public transportation alternatives, bike paths, and improve traffic flow Create trail systems for hiking and horseback riding Create open spaces and green areas within cities and in the outskirts Create green buffers for noise and air pollution, and to decrease urban heat islands Create historical zones, restore historical buildings, and attract tourism Create wilderness preserves for education and recreation Clean beaches and monitor pollution violations upstream Create urban tree-planting programs Provide safe recreational opportunities, open space, wildlife viewing, green areas, tourism opportunities, and clean beaches and rivers Reduce erosion and landslide hazards

Table 24
Socioeconomic challenges, opportunities, goals, and objectives.

At TRW stakeholder meetings in the fall of 2003, the participants voted on the following priority actions for meeting the goals for socioeconomic issues (Table 25):

Votes	Action	Location
11%	Recognize and respect the Kumiai people	Watershed-wide
9%	Reimplement the *Bracero* (temporary guest worker) program to help control undocumented immigration and drug trafficking	United States
8%	Market existing recreational opportunities and expand infrastructure for cross-border vacations, driving loops, ecotourism, camping. Lengthen the Pacific Crest Trail to the Sierra Juárez. Promote cross-border field visits, training, planning for agencies.	Laguna Mountain, Cleveland National Forest, Laguna Hanson, Sierra Juárez
8%	Build/enhance GIS-based surveys of cultural and historic sites	Watershed-wide
6%	Increase local green space using low-tech infrastructure, local skills, and community groups. Build/restore wetlands, hiking trails, river floodplains, recreation areas, habitat linkages, and earthen flood control berms	Alamar River, Tecate Creek, Cottonwood Creek, Las Palmas (future Tijuana bedroom community), upper watershed creeks, small villages, *ejidos*
5%	Encourage greater use of Mexican roads to reduce truck traffic on California Highway 94	Mexico
5%	Create planning and regional coordination mechanisms for the watershed	Watershed-wide
4%	Use scientific studies for land use planning	Campo and backcountry
4%	Create incentives for conservation and development of natural areas and provide economic, training, assessment, and technical support	Watershed-wide
4%	Give legal and official recognition to the Kumiai people of Baja California	San José Tecate, Juntas de Nejí, Tamaná
4%	Distribute information about the natural capital benefits of the watershed and cultural responsibility	Urban zones

Table 25
Priority socioeconomic issues action from stakeholder meetings.
The voting percentages reflect ~ 50 persons per meeting casting votes 5 votes each.

Implementation time line

Table 26 lists the 14 priority actions suggested by participants in the 2003 stakeholder meetings and indicates approximately when they should be implemented. Planning for these actions should begin well ahead of the implementation year. To prioritize the actions, stakeholder suggestions from all five public meetings and all critical resource areas were combined, and the percentage vote per meeting was used to rank the top eight actions. Four actions were added from the literature. Higher ranked actions were considered more urgent and placed sooner on the time line. Logistical considerations, such as political momentum, bureaucratic delays, and funding requirements were also considered during the creation of the time line. More detailed plans for each action follow Table 26. Some simple things that residents can do to help meet the goals of the Vision project can be found in Appendix 6.

Action	Implementation should begin			
	2004	2005	2006	2007
1. Identify important conservation areas for restoration and rehabilitation based on ecosystem function and threats	x			
2. Increase knowledge of the cultural characteristics of indigenous and other peoples of the watershed	x			
3. Protect sensitive habitat as well as cultural and historical areas	x			
4. Market sustainable tourism opportunities	x			
5. Binational planning for floods	x			
6. Evaluate and protect groundwater supplies	x			
7. Develop and implement watershed education programs and products for children and adults	x			
8. Connect conservation areas across the border		x		
9. Expand water reuse			x	
10. Facilitate cross-border vehicular traffic flow and reduce impacts in adjacent communities			x	
11. Develop an integrated waste management system with recycling components			x	
12. Develop a binational water quality monitoring system			x	
13. Develop point and non-point source water pollution prevention programs				x
14. Develop mechanisms for transborder watershed management				x

Table 26
Time line of Priority 14 actions.

The following section details the status of the actions, the recommendations for implementation, the implementation time frame, and the recommended leaders for implementing each of the above actions in the TRW.

Action plan: Identify areas for conservation restoration and rehabilitation based on ecosystem function and threats

Current status of the proposed action—What has happened in the past? What is going on now?
A conservation assessment for the California-Baja California binational region, the Las Californias Binational Conservation Initiative,[54] includes much of the TRW. The conservation plan identified portions of the binational study area that support natural resources representing the biodiversity of the region and are relatively intact. This effort is serving as a refinement of a portion of TNC's South Coast Ecoregion Assessment, which is still in draft form.

Recommended future steps to implement this action

- Link the Los Pinos and San Ysidro units, using Bureau of Management (BLM) lands between McAlmond Canyon and Tecate Peak and City of San Diego Water Department land adjacent to Cottonwood Creek as building blocks.
- Link the San Ysidro unit to the La Presa and Canada de Águila. Unite with adjacent areas, such as the undeveloped land west of Tecate, and culturally important land on the flank of White Mountain to the east of Cottonwood Creek.
- Create core conservation areas with connections at BLM lands around the La Posta Microwave Station, and Hauser Mountain across Highway 94 to BLM lands at the border.
- Develop a binational wildlife corridor, "Parque to Park," from the Laguna Mountains in the Untied States to the Sierra Juárez Mountains in Mexico through the TRW.
- Provide north-south linkages from Otay Wilderness Area to Playas de Rosarito by creating conservation areas between Tijuana and Tecate and on the eastern perimeter of Tijuana.
- Provide east-west habitat linkages or stepping stones for species whose distribution ranges across coastal, trans-montane, and desert habitat by creating conservation areas in the Campo Valley across the Tecate Divide to Jacumba.
- The above strategies could be implemented with the following tools: mitigation land purchases from the Toyota plant in west Tecate, land trust purchases, conservation easement contracts, County of San Diego 2020 General Plan rezoning, BLM-private land exchanges,

[54] A collaboration of Conservation Biology Institute, Pronatura, A.C., TNC, the San Diego Foundation, Resources Legacy Fund Foundation, and the International Community Foundation

creation of USFS Wilderness Areas, Caltrans and Mexican federal rights-of-way improvements, decree *áreas naturales protegidas,* conservation of City of San Diego Water Department lands around Morena Reservoir and upstream from Cottonwood Creek.

- In addition to habitat connectivity studies, a basic biological survey is needed for the TRW and research on the ecosystem functioning of the TRW including hydrology, nutrient and soil cycling, geo-chemical processes, and so forth.
- The U.S. Homeland Security and Border programs have needs, such as open areas for improved visibility of the border that are synergistic with open space preservation. These opportunities should be explored (CBI, Pronatura, and TNC 2004).

When should implementation start? How long will it take?
Implementation should start in the fall of 2004. Implementation of land conservation actions will be incremental and ongoing, probably for many years. Many actions will be taken as opportunities arise or funding is available. Land management will be ongoing in perpetuity.

Where should this action be implemented?
Actions should be implemented within the conservation blueprint maps developed by the Las Californias Binational Conservation Initiative and refined by future field studies and changing land use patterns.

What agency, organization, or individual should be the lead in implementing this action?
TNC, Pronatura, CBI, Backcountry Land Trust, ICF, San Diego Foundation, USFS, U.S. Navy, Toyota plant, County of San Diego planners, BLM, Caltrans, CNA, SEMARNAT, City of San Diego Water Department

References:

Conservation Biology Institute. 2003. La Posta Linkage Portfolio, p. 30. Tertiary La Posta Linkage Portfolio. San Diego County, CA.

Conservation Biology Institute, Pronatura, and The Nature Conservancy
2004 Las Californias Binational Conservation Initiative: A Vision for Habitat Conservation in the Border Region of California and Baja California. Prepared for the San Diego Foundation, Resources Legacy Fund Foundation, and the International Community Foundation. San Diego, CA, Sept.

Pronatura. 2003. Las Californias Binational Conservation Initiative Localities Portfolios. Tertiary Las Californias Binational Conservation Initiative Localities Portfolios. Ensenada, B.C.

Pronatura. 2004. Iniciativa Binacional de Conservatión "Las Californias." Pronatura, Ensenada, B.C., June.

Action plan: Increase knowledge of the cultural characteristics of indigenous and other peoples of the watershed

Current status of the proposed action—What has happened in the past? What is going on now?
There has not previously been any concerted effort to organize and disseminate cultural information at the watershed level. Currently, through the project "Cultural Ecology and the Indigenous Landscape of the TRW," a database of the prehistoric and ethnohistoric indigenous cultural heritage of the Mexican side of the TRW is being created.[55] The study involves indigenous and university participants and should be finished by summer 2005. This Vision document lists some historically and culturally important monuments and places in Appendix 5.

Recommended future steps to implement this action
- A similar prehistoric and ethnohistoric indigenous cultural heritage database needs to be created for the U.S. portion of the TRW.
- Additional work is needed on historic and contemporary cultural resources within the entire watershed.
- In all cases, it is important to make the information available to the public, on a Web site, particularly educators and decision makers. The Instituto Nacional de Anthropología e Historia (INAH) could take the lead on providing the information that it already has (except information, such as rock art locations that is considered sensitive).
- A map of important cultural and historical sites is needed for restoration and protection efforts. This map may be accessed only through government offices to registered persons to protect sites from vandalism.

When should implementation start? How long will it take?
As soon as possible. General overviews of the existing literature on cultural resources should not take more than a year. Sacred and historical monuments are being vandalized and need immediate protection.

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[55] With funding from SCERP

Where should this action be implemented?
This action should take place watershed-wide.

What agency, organization, or individual should be the lead in implementing this action?
The suggested studies could be carried out in Mexico by INAH and The Instituto de Investigaciones Históricas of UABC. In the United States, the local historical societies or universities could carry out the projects.

Action plan: Protect sensitive habitat and cultural areas

Current status of the proposed action—What has happened in the past? What is going on now?
The Las Californias Binational Conservation Initiative has assessed binational conservation priorities in the South Coast Ecoregion, with specific suggestions for land that has high conservation value in the TRW (see Action Plan: Identify areas for conservation restoration and rehabilitation based on ecosystem function and threats). A binational group identified target species for binational protection at the South Coast Missing Linkages Workshop in 2002. In 2003 a conservation easement contract was signed protecting Tecate Peak-Cerro Cuchumá from development. An ongoing study is identifying important cultural and indigenous areas using mapping techniques and outreach.[56]

Recommended future steps to implement this action:
- Implement the recommendations from the Las Californias Initiative.
- Use public and private land acquisition tools to protect culturally and ecologically important spaces.
- Create river parks at the Campo, Tecate, and Alamar Rivers.
- Connect the river parks across municipalities and the international border.

When should implementation start? How long will it take?
Immediately. Five to 10 years.

Where should this action be implemented?
Initial focus should be on the zone between Tijuana and Tecate, where a large migratory corridor exists and urbanization is imminent. Rivers and other wetlands, such as those found in Campo, Tecate, and along the Alamar River should also receive priority.

[56] A SCERP-funded project headed by Michael Wilken, CUNA and Hynn Garable, SDSU (see Action Plan: Increase knowledge of the cultural characteristics in the watershed)

What agency, organization, or individual should be the lead in implementing this action?
TNC, Back Country Land Trust, Terra Peninsular, Trust for Public Land, and Fundación La Puerta, A.C. are pursuing individual parcels in their geographic interest areas. The Border 2012 Water Task Force for the TRW, or a similar binational planning entity, could coordinate the fusion of these individual efforts so they serve the purposes of watershed health and ecological integrity.

References:
Conservation Biology Institute. 2003. La Posta Linkage Portfolio: San Diego County, California, grant report, July.
Pronatura Noroeste-Mar de Cortés. 2003. Las Californias Binational Conservation Initiative, Phase I. grant report, January.
Pronatura Noroeste-Mar de Cortés. 2003. Las Californias Binational Conservation Initiative, Localities Portfolios. grant report, January.
Pronatura Noroeste-Mar de Cortés. 2004. Las Californias Binational Conservation Initiative, Phase II. grant report, July.

Action plan: Market sustainable tourism opportunities

Current status of the proposed action—What has happened in the past? What is going on now?
Tourism has not been promoted much outside of curio shopping in Tijuana, Rancho La Puerta in Tecate, and some hunting in the upper watershed. A map-based online photo tour of the watershed is being developed in order to guide interested persons through cultural and natural resources.[57]

Recommended future steps to implement this action:
Start a pilot project in Tecate, which has a tradition of cultural interchange at the border with the United States, with some existing tourist ranches offering spa services surrounded by native vegetation.

- Invite the Association of Tourist Ranches to participate in activities concerning the TRW.
- Visit and tour the tourist ranches to better market their opportunities.
- Organize a meeting in the Municipality of Tecate at one of the ranches.
- Set up a tourist route and market the tour.
- Look for other areas of the watershed to perform similar routes, such as Campo, Valle de las Palmas, the upper watershed.

When should the implementation begin? How long should it last?
Immediately. Spring and autumn are the best seasons.

Where should we implement the action?
Tecate, Campo, Tijuana, and Valle de las Palmas.

[57] Initiated by IRSC-SDSU

Which agencies, organizations, or individuals should lead this action's implementation?
For the Tecate pilot project:
Association of Tourist Ranches of Tecate, Department of Social Communication of the Municipality of Tecate, Department of Urban Development and Ecology of the Municipality of Tecate, CUNA, and INAH.

References:

Beck, L., Lamke, G. 1998. Tou*rism and Recreation. In The State of the Environment of the Tijuana River Basin, Working Draft, eds. Institute for Regional Studies of the Californias, pp. 34-35. San Diego: IRSC.*
Valdez Flores, J.R. 2001. Levantamiento de datos Zona Kumiai. Available at CUNA. August.

Action Plan: Binational planning for floods

Current status of the proposed action—What has happened in the past? What is going on now?
Agencies from both side of the border have developed a real-time flood warning system for the western portion of the watershed which includes Cottonwood Creek, Campo Creek, Tecate Creek, and the Río Alamar. Additional precipitation and stream flow gauges have been installed and locations for other stations are being considered. Equipment for receiving information from the gauges exists in the County of San Diego Department of Public Works Office. Currently, data from the gauges are transferred via file transfer protocol from the County of San Diego's flood warning base station to partnering agencies in the United States and Mexico. The County of San Diego has a Web page where data is accessible to the public.

Recommended future steps to implement this action:

- Ensure the maintanence of the flood warning system.
- Expand the program—install more stations.
- Build a Spanish Web page for the public.
- Use radio repeaters to ensure that the system will remain intact during a storm emergency.
- Install a receiving station at the Tijuana River National Estuarine Research Reserve (TRNERR).
- Create a public awareness campaign for emergencies.

When should implementation start? How long will it take?
Implementation should begin in 2005 and take approximately a year to complete.

Where should such this action be implemented?
Equipment should be installed at the emergency response agencies on both sides of the border, TRNERR, and the International Boundary and Water Commission (IBWC).

What agency, organization, or individual should be the lead in implementing this action?
The working group of the flood warning program, the Comisión Nacional del Agua, County of San Diego Department of Public Works, Dirección Estatal de Protección Civil, la Dirección Municipal

de Protección Civil de Tijuana, IBWC, the City of San Diego, and TRNERR should take the lead in working with other agencies to fully implement the system.

References:

Ponce, V. M. 2003. *Flood hydrology of the binational Cottonwood Creek-Arroyo Alamar, California and Baja California*. SDSU.

Wright, R. D., Baron, K., Conway, K., Warner, R. 2000. Flood hazard and risk assessment modeling with GIS in the transborder Tijuana River watershed, p. 15. Watershed 2000. Vancouver, BC, Canada.

Action plan: Evaluate and protect groundwater supplies

Current status of the proposed action—What has happened in the past? What is going on now?
Monitoring of well levels is performed by the City of San Diego Water Department, and by CNA. A characterization of the Tijuana River Valley aquifer was performed in 2003 (U.S. Department of Energy 2003) and a Tecate aquifer characterization study was completed in 2004.[58] A study of the Alamar-Cottonwood hydrology included groundwater interactions with surface water has been published (Ponce 2003) as well as the same type of study in the nearby Ojos Negros Valley (Ponce 2000). Research has been undertaken relating to the feasibility of replenishing groundwater with treated wastewater (Ponce 2004). Applied projects include ecohydrological plans versus concrete channelization plans for the Alamar and Tecate Rivers, and Campo Indian Reservation community projects that installed rock drops, or weirs, and revegetated Campo Creek to increase groundwater levels. Water quality testing on wells at Indian reservations and communities has been performed (Kilpatrick 1998).

Recommended future steps to implement this action:

- In addition to the aquifers that have been studied, look for areas with sand or areas in valley bottoms for potential groundwater sources.
- At these locations, perform an analysis of historical depletion from well pumping (if no wells exist, find the mean depth of the water table).
- Form stakeholder groups in the United States, and *comités técnicos de aguas subterráneas* (COTAS) for Tijuana, Valle de Las Palmas, and Tecate, and/or a binational groundwater working group.
- Decide politically on the level of equilibrium for the groundwater and regulate the levels to avoid over-exploitation. Decide on enforcement and fines.
- Reform water laws in the United States so that either the California State Water Resources. Control Board (CASWRCB) or the International Boundary and Water Commission (IBWC) monitors the rate and quality of water pumped from private U.S. lands.
- Studies should be performed to determine a more equitable rate for agricultural electricity charges in order to discourage over-pumping.

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[58] (Forster 2005)

- Study the feasibility and energy costs (monetary and to the environment) of recharging the Alamar River subsurface waters with IWTP treated waters and/or CESPT treated waters from the San Antonio de los Buenos wastewater treatment plant.
- Study the connectivity of all the aquifers to see how recharge projects on the Alamar River could recharge the Tijuana aquifer, the Tijuana wells, and the wells in the Tijuana River Valley in the United States.
- Implement recommendations to build low-tech recharge ponds in the Tecate dry riverbed or possibly the Alamar River. Recharge ponds are less costly than injection wells, are less susceptible to plugging, and damage to the ponds during floods is less costly. Fill ponds with raw water from aqueduct using existing pipelines, new pipelines, or raw water. Fill during the winter when evaporation is at a minimum and most water is available. Regularly scrape pond bottoms to stop plugging.[59]
- Implement plans for the Alamar and Tecate River Parks to facilitate recharge through green areas, and slow water velocities with more naturally meandering rivers.
- Publish groundwater levels and quality data on the Internet in a central binational database.
- Implement a wellhead protection plan in urban areas that prohibits all activity within 30 m (98 ft) of wellheads. Exclude most hazardous activities within 100 m (330 ft) or more of wellheads. Prohibit new wells in the shallow aquifers, and monitor water levels in all shallow aquifers during wet weather and floods.
- Build up stocks of stored groundwater water to prepare for drought conditions or breaks in the aqueduct.[61]

- Conserve water by implementing public outreach campaigns.
- Protect areas identified as important aquifer recharge areas from development.
- Complement the binational aquifer study (U.S. Department of Energy 2003) with additional data.
- Evaluate the environmental impacts of urban expansion on the Rodríguez Reservoir.

[59] (Forster 2005)

When should implementation start? How long will it take?
Immediately.

Where should this action be implemented?
In Tecate, recharge ponds might be placed in El Descanso below El Nopalera. The Alamar River study should explore exact locations for recharge potential.
In Valle de las Palmas new sources of water may be explored at Pino Suárez, El Escondido, Valle las Palmas, and La Tuna where alluvium is found (Ponce pers. comm. 2004).

References:
Forster, C. "Characterization of the Tecate aquifer" Report to IRSC-SDSU. In prep.

Kilpatrick, A. 1998. An environmental assessment study of indian tribes living in the U.S.-Mexican border region (planning phase). *Final Report SCERP Project Number: IT98-1*.

Ponce, V. M. 2003. *Flood hydrology of the binational Cottonwood Creek-Arroyo Alamar, California and Baja California*. SDSU.

Ponce, V. M. 2000. *Sustainable management of water in the Ojos Negros Valley, Baja California*. San Diego State University, Universidad Autónoma de Baja California, Instituto Nacional de Investigaciones Agrícolas, Forestales y Pecuarias.

U.S. Department of Energy. 2003. *Groundwater flow model for the Tijuana River Basin*. Southwest Border Project. Grand Junction, Colorado: Dept. of Energy. GJO-2003-408-TAC.

Action plan: Develop and implement watershed education programs and products for children and adults

Current status of the proposed action—what has happened in the past? What is going on now?
For the last ten to twelve years, mainly citizens groups have been in charge of developing and implementing an environmental education agenda in the TRW. This includes collaboration of Mexican and U.S. organizations (see Appendix 3 for specific groups). Today there are several environmental education initiatives in the watershed, some of which target the general public, some target teachers, others target students of different educational levels, and some involve environmental organizations. In the case of Tijuana, there is a recent initiative aimed at incorporating environmental education themes into the curriculum for middle schools and junior high schools. At present, there are several electronic educational tools about the watershed, such as Web page,[60] a video,[61] and two CDs[62]. Many of the actors involved in these initiatives participate in the Environmental Education Council of the Californias, which is currently designing materials and a workshop focused on guidelines and best practices for organizing field trips as a fundamental part of environmental education. CESPTE has an ongoing educational program on water conservation in Tecate public schools.

Recommended future steps to implement this action:

- BWAC should develop an outreach strategy for educators and *promotoras* about the importance of the watershed focus in environmental education.
- Develop a handout for educators about the TRW, stressing the importance of keeping a watershed focus while teaching/learning about the environment and with information about the Web page and other TRW information sources.
- Attend meetings where environment is being addressed and present the importance of watershed focus.
- Develop materials for government officials, such as the Executive Summary of this document, so that decision makers begin using a watershed focus.

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[60] See http://trw.sdsu.edu

[61] Produced by SWIA and SDNHM

[62] One produced by SDNHM and another by SDSU Department of Geography

- Develop other materials through which information about the TRW can be communicated (plastic models, murals, etc.).
- Contact more teachers and educators to become stakeholders in the TRW
- Encourage CESTPE to include watershed education in its water conservation outreach programs.

When should implementation start? How long will it take?
Immediately and ongoing.

Where should this action be implemented?
Pilot projects in cities within the TRW, eventually throughout the region.

What agency, organization, or individual should be the lead in implementing this action?
BWAC, the Environmental Education Council of the Californias, PROBEA, SDNHM, Border 2012 Education Task Force, Border 2012 Water Task Force, and CESPTE.

Action plan: Connect conservation areas across the border

Current status of the proposed action—What has happened in the past? What is going on now?
In 2003 Pronatura helped negotiate an ecological easement of Rancho La Puerta, A.C., Mexican lands that are contiguous with BLM lands of Cerro Cuchumá, or Tecate Peak, on the U.S. side of the border. In effect, this created a transborder ecological easement. Pronatura acts as a third party for the easement contract, and monitors and protects the terms of the easement, which include no development or activities harmful to the environment (Ochoa 2004; Vargas Téllez 2004). There are also current attempts to create a park in Tijuana called "Matadero" that would be developed adjacent to the existing Tijuana River Estuary Research Reserve in San Diego, with a fence separating them. There have been unsuccessful attempts to gain UNESCO Man and the Biosphere (MAB) Reserve status for the TRW from UNESCO (Metzner and McCoy 1994). There are detailed draft plans for a in the Las Californias Binational Conservation Initiative for a binational protected area network to include much of the TRW (CBI, Pronatura, and TNC 2004).

Recommended future steps to implement this action:

- In general, create a network of nodes of biodiversity that are buffered and interconnected by relatively intact land, in a matrix of lands with various degrees of human uses (CBI, Pronatura, and TNC 2004).
- Use regional plans, such as the TRW Vision and the Las Californias Initiative and the South Coast Ecoregion plan to identify critical corridors and conservation areas along the border
- First, seek small, simple, "do-able" strategies (The Nature Conservancy 2000) within country
- Create a binational or trinational (with indigenous involvement) NGO to promote and guide the direction of transborder protected areas.
- After land is protected within country, weld conservation areas across the border using MOUs, easements (such as Cuchumá), or land purchases/donations (Comer 2004)
- Create *fidecomisos* in Mexico to financially manage the land. A contract on rights of use can be drawn and land/money can be donated and sold via a *fidecomiso* (financial responsibility). The terms of the contract are monitored carefully (White, et al. 2004).
- Create a conservancy (or use an existing one) in the United States to financially manage the land.

- Obtain international recognition and support from an institution, such as UNESCO.

When should implementation start? How long will it take?

Implementation should start immediately. The plans may take 5-10 years to implement.

Where should this action be implemented?

- The Otay Corridor between Tecate and Tijuana
- The riparian corridor from Campo to Tecate and westward
- Matadero-Goat Canyon in Tijuana

What agency, organization, or individual should be the lead in implementing this action?

- For the Otay Corridor, Pronatura and TNC have been involved in biological surveys and studies. There are various land trusts that have the financial and land resources to dedicate land for open space and green areas as recommended by the Las Californias Binational Conservation Initiative.
- In Tecate, the municipality and Fundación La Puerta, A.C., have been working on a Tecate River Park and could initiate the binational riparian corridor from Campo to Tecate, along with participation from SEDUE, CNA, Mexican conservation NGOs, BLM, and the County of San Diego.
- For Matadero Park, the Tijuana River National Estuarine Research Reserve, and the Municipality of Tijuana, along with the landowner, should take the lead in implementation. An NGO should be created to guide and monitor the park.

References:

Comer, K. 2004. A potential riparian protected area: the Kumiai Corridor. In *SCERP Monograph Series,* Border Institute, Rio Rico AZ. Forthcoming.

Pronatura. 2003. "Las Californias Binational Conservation Initiative Localities Portfolios." Prepared for the International Community Foundation, Ensenada, B.C.: Pronatura, A.C., prepared for the International Community Foundation.

(TNC) The Nature Conservancy. 2000. "The Five-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success." Vol 1 (2).

UNESCO. 2004a. *"Man in the Biosphere Programm"*. http://www.unesco.org/mab/nutshell.htm#selected. Accessed 3/1/04.

White, M. D., Stallcup, J. A., Comer, K., Vargas, M. A., Beltran-Abaunza, J. M., et al. 2004. Designing and establishing conservation areas in the Baja California-Southern California border region. In *SCERP Monograph Series,* Border Institute, Rio Rico AZ, forthcoming.

Action plan: Expand water reuse

Current status of the proposed action—What has happened in the past? What is going on now?
The South Bay Water Reclamation Plant in the City of San Diego has the capacity to produce 15 mgd of tertiary effluent with the potential for reuse. The South Bay plant is negotiating improvements to its delivery system in order to sell water to the Otay Water District for irrigation purposes, and to the International Wastewater Treatment Plant (IWTP) for cleaning purposes. There is a proposal to build the secondary treatment sludge ponds required of the IWTP across the border, in the Alamar district. One benefit of this location is that reclaimed water could be used to recharge the aquifer, and irrigate vegetation in the riparian zone. Upgrades have been approved so that Tijuana will have its own secondary treatment plants that will produce effluent suitable for use under NOM-003.

Recommended future steps to implement this action:

- Market reclaimed water from the South Bay Water Reclamation Plant.
- Create a public outreach campaign to dispel myths about reused water.
- Find uses for the secondary treated water that is currently going into the ocean.
- Designate uses of the reclaimed water for aquifer recharge; Rodríguez Dam replenishment; landscape irrigation; agricultural uses; irrigation for golf courses, parks, airport yards, industrial parks, and street cleaning; commercial uses, such as car washing; use in swamp or evaporative coolers; fire protection; and use in bathrooms in commercial and industrial facilities, and so forth.
- Create greenbelt areas that will allow the reuse of large volumes of treated effluent, in addition to enhancing the environment and landscape.
- Perform a detailed assessment of the potential health risks of indirect potable uses that are not for consumption but rather skin contact.
- Consideration must be made of the potential public health impacts from microbial and chemical contaminants found or likely to be found in wastewater.
- Support the desalination plant proposed for Tijuana to supply coastal zones and indirect potable uses.
- Support treatment plants that produce water for reuse, such as Ecoparque.

When should implementation start? How long will it take?

The marketing and outreach campaigns should start immediately. The upgrades and reuse infrastructure may start next year and take several years.

Where should this action be implemented?

Tijuana, San Diego, and Tecate

What agency, organization, or individual should be the lead in implementing this action?

The IBWC-CILA, CNA, CASWRCB, City of San Diego, Otay Water District, CESPT, and CESPTE.

References:

(CESPT) Comisión Estatal de Servicios Públicos de Tijuana. 2002. Potable water and wastewater master plan for Tijuana and Playas de Rosarito, draft.

Action plan: Facilitate cross-border vehicular traffic flow and reduce impacts in adjacent communities

Current status of the proposed action—What has happened in the past? What is going on now?
Planning is underway with the federal General Services Administration (GSA) to improve the San Ysidro port of entry through reorganization strategies, including the reuse of the Virginia Avenue-El Chaparral gate. Similarly, plans are underway to modernize the Tecate port of entry and its related transportation infrastructure. Commercial crossing improvements at Tecate have recently improved flow. New technologies and long-term strategies are also being evaluated to improve northbound and southbound truck access at the Otay Mesa-Mesa de Otay commercial port. The development of a new port of entry at East Otay Mesa (Mesa de Otay II) is underway. This port will be linked to State Routes 905 and 125 through the construction of State Route 11. This port will also connect to the Tijuana–Rosarito corridor, a new highway under construction in Baja California from the coastal area of Rosarito to the U.S.-Mexican border to the east of the Otay Mesa port of entry. An additional port of entry is being planned in the long term in the area of Jacumba-Jacumé east of Tecate (SANDAG 2004).

Local governments and authorities responsible for transportation infrastructure have also begun to plan or construct new projects to link the ports of entry infrastructure with local transportation systems and trade corridors. The completion of State Route 905 will connect Interstates 5 and 805 to the Otay Mesa port of entry. The completion of State Route 125 (South Tollway) will improve regional mobility in the South Bay and access for residents and businesses to the employment centers on both sides of the U.S.-Mexican border. SANDAG is pursuing funding for needed transportation infrastructure in the region's border areas and coordinating the implementation of border-related capital and operating improvements with the GSA. The completion of the Tijuana-Rosarito Corredor 2000 may help channel traffic to the perimeter of Tijuana. All these transportation improvements run the risk of choking off wildlife corridors and facilitating urban sprawl and associated pollution.

Recommended future steps to implement this action:

- Open the new ports of entry.

- Enforce zoning restrictions associated with the new transportation plans, especially in Mexico.
- Encourage the U.S. Department of Homeland Security (DHS) to improve its system for entry/exit by attending the Ports Working Group monthly stakeholder meetings.
- Send TRW representatives to the San Diego Alliance for Border Efficiency (SDABE) stakeholder working groups to advocate for reforms in the use of technology and needed infrastructure improvements.
- Develop formal transportation planning committees with U.S. and Mexican participants
- Roads should have wildlife underpasses.

When should implementation start? How long will it take?
Immediately and ongoing.

Where should this action be implemented?
Mainly the San Diego-Tijuana interface.

What agency, organization, or individual should be the lead in implementing this action?
The U.S.-Mexico Binational Group on Bridges and Border Crossings addresses ports of entry issues, California Department of Transportation (Caltrans), and local jurisdictions such as the City of San Diego, can also initiate border projects. The GSA is responsible for the construction of infrastructure, while the DHS is responsible for operations. SANDAG has regional transportation plans and some resources.

References:
(SANDAG) San Diego Association of Governments. 2004. www.sandag.org (Borders Program link). Accessed October 2004.

(SANDAG) San Diego Association of Governments 2004. *Factibilidad de Instalar un Cruce de la Frontera Internacional en Jacumba-Jacumé*. San Diego, July. Pg.102.

(SANDAG) San Diego Association of Governments. 2004. Regional Comprehensive Plan (RCP) Final Draft, July 23.Adopted in July of 2004.

Action plan: Implement binational point and non-point pollution prevention programs

Current status of the proposed action—What has happened in the past? What is going on now?
The principal sources of pollution in the watershed are industrial discharges, animal feedlot operations, urban runoff during storm events, sewer system overflows, and poorly designed septic systems. In the United States, the National Pollutant Discharge Elimination System (NPDES) permit program has initiated programs, such as the Watershed Urban Runoff Management Program in San Diego. Some binational initiatives have been undertaken to control water pollution, including an industrial pretreatment program through Cal EPA, CEA, the City of San Diego, and the International Wastewater Treatment Plant (IWTP) constructed under a minute of IBWC-CILA.

Recommended steps to implement this action:

- There is a need to develop a comprehensive water pollution prevention program for the Tecate-Tijuana section of the TRW. This program would aim to eliminate pollution at the source locations. It would also involve expanding the aerial coverage of the Tecate and Tijuana sewer systems and upgrade the sewage processing capability of the IWTP from advanced primary to secondary.
- A comprehensive non-point source pollution program should be implemented for the entire TRW. Elements of a program to control runoff pollution have already been implemented in San Diego County, for example, requiring large construction sites to use runoff and erosion-control technologies through a General Construction Permitting Process.

When should implementation start?
Immediately. It may take as long as ten years to fully implement the comprehensive water pollution prevention program.

Where should this action be implemented?
The elimination of water pollution at the source should take place in the Tecate-Tijuana area. In San Diego, the IWTP needs upgrading. Non-point source pollution needs to be controlled throughout the watershed, in both urban and rural areas.

What agency, organization, or individual should be the lead in implementing this action?
The municipalities of Tecate and Tijuana should take the lead in developing and implementing a program of point-source pollution prevention, IBWC and the State of California Regional Water Control Board should take the lead in upgrading the IWTP. *Consejos de cuenca* of the CNA and the CARWQCB can work on the non-point source pollution control. The Border 2012 Water Task Force can convene water quality experts and stakeholders from both sides of the border.

Action plan: Develop an integrated trash management system with recycling components

Current status of the proposed action—What has happened in the past? What is going on now?
Currently, waste in Tijuana is a problem, but a new landfill will help the deal with municipal waste and offer recycling, including a tire shredder. A new landfill in Tecate is approved, although the location remains to be determined. The proposed Campo landfill is also controversial and is delayed. The Otay Landfill has not yet reached capacity. The transport of recycled materials from Mexico to the United States occurs as part of a binational market. Hazardous materials generated by U.S. companies in Mexico are transported across the border. Used goods, such as tires, are transported from the United States to Mexico, generating additional waste volume. The Haztrack database for tracking hazardous materials along the U.S-Mexican border was inefficient and has been abandoned. Illegal dumping of solid, chemical, and biological waste occurs on both sides of the border, but more so in Mexico. No binational planning for waste disposal has been initiated to date, although the City of San Diego Environmental Services Division has close ties with the Muncipality of Tijuana on waste issues.

Recommended future steps to implement this action:

- Form a binational waste planning committee.
- Form emergency plans for hazardous waste spills.
- Make hazardous waste receptacles more available throughout the watershed.
- Enforce the laws in Mexico against clandestine dumping.
- Train industries and commercial sectors on the proper disposal of waste.
- Clean up the dumps, or *yonkes.*
- Restructure the municipal trash pickup routes in Tijuana.
- Offer recycling in Mexico, including bins that the municipality can pick up and sell to U.S. companies, generating revenue.
- Plan to build recycling plants on the Mexican side of the border.
- Conduct a binational educational campaign to reduce, reuse, and recycle.

When should implementation start? How long will it take?
Immediately.

Where should this action be implemented?
Mainly Tijuana and Tecate.

What agency, organization, or individual should be the lead in implementing this action?
The Departamento de Limpia in the Municipalities of Tijuana and Tecate, Dirección de Ecología of Baja California, Dirección Municipal de Ecología of Tijuana and Tecate, the City of San Diego Environmental Services Division and General Services, and U.S. EPA.

References:
Moreno, D., Muñoz, V. 2003. El reto de la basura en Tijuana. *Tijuana Trabaja. Tijuana, B.C. 156. Cuadernos para el diálogo.*

Action plan: Develop a binational water quality monitoring program

Current status of the proposed action—What has happened in the past? What is going on now?
There has been no continual binational water quality testing of surface and groundwaters in the TRW. However, there are, and have been, many unconnected programs and projects on either side of the border. IBWC tests water quality for the Tijuana River on the U.S. side. The U.S. EPA tracks surface and groundwater quality nationally. USGS and the CASWRCB also have data on surface waters. CASWRCB had a long-term State Mussel Water program at the Tijuana Estuary that ended in 1986. CNA and PROFEPA irregularly test the wells, rivers, and dams in Mexico. The County of San Diego Department of Environmental Health monitors runoff to the Tijuana River and the beach waters. The County of San Diego has two dry-weather monitoring sites and one mass-loading station for storm events in the TRW. The Cities of Imperial Beach and San Diego also have dry-weather monitoring sites. The City of San Diego Water Department monitors the Barrett and Morena Reservoirs and their contributing tributaries. The City of Imperial Beach monitors storm water quality. The County of San Diego regularly monitors beach waters. The CESPs of Mexico monitor their wells and their effluent from the wastewater treatment plants into open bodies of water. The TRNERR conducts water testing of the Estuary on an ongoing basis. The former Tia Juana Valley County Water District also has performed testing which has been assumed by the City of San Diego Water Department. Ja Jan reports that it conducts a monthly beach water quality testing program implemented by a consortium of NGOs and volunteers in the region and tests ocean waters almost monthly. The San Diego Stream Team has tested the Campo Creek and the Tijuana River sporadically in recent years. Quality controlled data can be found for certain locations and time periods from academic studies at UABC, SDSU, and COLEF.

Recommended future steps to implement this action:

- Establish a California-Baja California regional water quality testing lab.
- Until funding is available for the regional lab, university and local government labs should be convened to agree on methods for sampling and analysis for a binational program. Equipment at the U.S. and Mexican institutions should be calibrated.

- A preliminary recommended sampling scheme for surface water is to sample at least monthly during the dry season and at least three to six storm events a year. In addition to quality, data on streamflow are needed.
- More stream gauges are needed at the major tributaries.
- For groundwater, well sampling should occur monthly and depth reported. The program should be low cost and continual. Aquifers should be mapped and characterized, because some aquifers cross the border and their extent is not known. Wells should be sampled by an independent agency and results reported to the users and the appropriate regulatory agencies on both sides of the border.
- Coastal water quality should be monitored at more beaches in Mexico. Ja Jan should adopt strict quality assurance/quality control methods, and a regular sampling scheme, and make its data available to the public. The CNA and CESPT beach water sampling should be regularized.
- All data—coastal quality, stream flow, stream quality, well depth, and well quality—should be input to a centralized database. A bilingual Web site should allow citizens and government agencies to view data and analysis. A water quality warning system, such as the flood warning system (Wright, et al. 2000), should be established to alert officials to high levels of contaminants. The definition of “high levels” differs between the two sovereign nations’ laws. Therefore, both countries’ limitations should be reported in the warning system since the waters traverse the two countries.

When should implementation start? How long will it take?
Immediately. Because the program will be costly, it will take from two to four years to find funding to sample on a consistent basis.

Where should this action be implemented?
Tijuana River at Hollister Street in Imperial Beach, Río Tecate, Campo Creek, Cottonwood Creek, Río Alamar, Río de las Palmas, and Arroyo El Florido.

What agency, organization, or individual should be the lead in implementing this action?
IBWC, the San Diego Regional Water Quality Control Board, CNA, Campo EPA, City of San Diego Water Department, the San Diego County Water Authority, and local universities in San Diego and Tijuana.

References:

Gersberg, Rick. 2004. Conversation with author. San Diego, CA.

Piñón Colín, Teresita de Jesús, Patricia Sirena López Gil, Libia J. Bernal Eng, Martínez Huato Sebastián, and Jerome Pitt. 1998. "Analysis of Water Quality in the Tijuana Watershed." In *The Tijuana River Basin: Basic Environmental and Socioeconomic Data*, edited by Fernando Wakida and Karen Riveles, 59-105. San Diego, CA: IRSC.

Action plan: Develop mechanisms for transborder watershed management

Current status of the proposed action—What has happened in the past? What is going on now?
Water management in Mexico is the responsibility of the federal government with some aspects delegated to state agencies. In the United States, federal, state, and local governments are all involved in water management. In California, there is a strong emphasis on development of watershed management plans to control non-point source pollution and also to improve the hydraulic functioning of watersheds. Mexico's National Water Law, updated in 2004, establishes watershed councils, or *consejos de cuencas.* Neither of these efforts has the ability to engage in international planning and management of watersheds.

International management of water-related issues is undertaken by the International Boundary and Water Commission (IBWC), whose actions to date have largely been confined to allocation of surface waters according to treaty rights and addressing water quality issues, such as transborder sewage flows. Recently, the IBWC has become involved in ecological studies in the Colorado River Delta and watershed coordination projects, such as the TRW Vision project.

In addition to the Binational Vision Project for the TRW (2000—present), other local initiatives in have also been important. In 1997 a Border Water Council (BWC) was established under the Border Liaison Mechanism. Its major effort has been to launch a feasibility study for a joint Mexican and U.S. aqueduct to bring water to the west from the Mexicali-Imperial Valleys. This study was managed by IBWC with the cooperation of a number of Mexican and U.S. agencies. The Border 2012 Water Task Force for the TRW under EPA and SEMARNAT was formed in 2003. For land use and transportation planning, SANDAG has a Mexican representative on its Board of Directors and a special Borders Committee advised by the Committee on Binational Regional Opportunities (COBRO). No organizations other than IBWC currently have the capacity or legal authority to perform transborder planning, evaluate projects, develop joint information data banks, or sign agreements. However, possibilities for binational watershed management also exist under the Border Liaison Mechanism, under the 1983 La Paz Border Environmental Agreement, through the Border 2012 process, through state-to-state efforts, or through CNA and a U.S. counterpart agency.

Recommended future steps to implement this action:

Create the Tijuana River Watershed Council to ensure the binational, simultaneous harmonization of actions on both sides of the border. This council would be formed under the Border Liaison Mechanism or through a minute of the IBWC. IBWC could possibly provide ongoing oversight. The council would have the following goals:

- The council should not follow the organizational and functional administrative-planning-management fragmentation of existing agencies.
- The council should adopt a proactive approach that involves projecting scenarios, preventing problems, and establishing goals.
- The council should relate water quality and allocation management to the watershed unit.
- The council should take into account the relationship between water quality, allocation management, and land use management, including infrastructure.
- Coordination of water, land use, and environmental issues at a subbasin or regional level will be necessary.
- Sustainability principles in relation to the use of natural resources, the environment, economic development, and socioeconomics should be monitored.
- Non-monetary costs and benefits should be included in policies and evaluations.
- The private and public sectors should be included as stakeholders in council decision making.

Responsibilities:

- The council should maintain the proper staff, as well as the necessary financial and legal resources.
- The council should provide planning staff support for both the United States and Mexico.
- The council should provide regulatory enforcement capabilities for both countries.
- The general professional fields of expertise for the staff are engineering (hydrological engineers, specifically), regional planners, physical planning (land use planning, transportation, and design), environmental planning, economists and financial experts, international law experts, and supporting administrative personnel.
- The council will need to conduct research to define water quality in the transborder context, on appropriate planning approaches and methods, on the council's management system, on assessing new technological changes related to water management, and on physical planning, particularly on sustainable environmental infrastructure.

- The council will need to help develop regulatory standards that are homogeneous on both sides of the watershed to ensure a consensual and clear definition of water quality and pollution, as well as an effective system of enforcement of the regulations.
- The council should require and help review environmental impact reports for all projects in the watershed.
- The council should be able to implement measures related to improving water quality.
- The council should be able to address flow regulation, groundwater recharge, regional treatment plants, river rehabilitation, and so forth.
- The council will have to evaluate transborder projects that affect the watershed.

When should implementation start? How long will it take?
Implementation should begin immediately. The council's work will be ongoing.

Where should this action be implemented?
Watershed-wide. The council's office could be located at an existing agency, such as IBWC, CESPs, or other.

What agency, organization, or individual should be the lead in implementing this action?
CNA, SEMARNAT, EPA, Secretaria de Desarrollo Urbano y Ecología (SEDUE), U.S. Housing and Urban Development (HUD), IBWC-CILA, and the consuls general of both Mexico and the United States. Funding to support council staff can come from IBWC-CILA or another existing agency. The funds to enforce effluent and other standards could originate from taxes. The charges imposed on dischargers of pollution could create revenue to fund the regional-binational council.

References:

Brown, C., Castro Ruiz, J., Lowery, N., Wright, R. 2003. Comparative analysis of transborder water management strategies: case studies on the U.S.-Mexican border. In *The U.S.-Mexican border environment: binational water management planning*, ed. Suzanne Michel, p. 279. San Diego: In SCERP Monograph Series, No. 8.

Graizbord, Carlos. 2004. "Potential mechanisms for transborder watershed management in the Tijuana River Watershed." Report to IRSC-SDSU.

Regulatory framework

In order to implement the actions described in the Time line section of this report, general understanding of the regulatory and policy framework in both the United States and Mexico is necessary. This section is an overview of some of the laws and programs that could be used to implement the actions desired by stakeholders. Historically, planning processes on both sides of the border have not recognized the shared resources and complementary conservation opportunities of the border region. By utilizing a mosaic of tools and programs in each country, the common goal of watershed protection can be achieved in the short term. There is growing recognition of the need for a binational legal mechanism to manage the binational watershed resources for the longterm.

U.S. regulatory framework[63]

The EPA is the lead federal agency responsible for water quality management, under the Clean Water Act. A regional office (EPA Region 9) is located in San Francisco and delegates authority for waste discharge permitting to the CASWRCB. The CASWRCB, located in Sacramento, is the agency with jurisdiction over-water quality issues in California. The CASWRCB is governed by the Porter-Cologne Water Quality Act (Division 7 of the California Water Code), which establishes the legal framework for water quality control activities by the CASWRCB. Much of the implementation of the CASWRCB's responsibilities is delegated to nine regional water quality control boards (Fig. 46). Region 9 is the CARWQCB for the County of San Diego, which covers the U.S. portion of the TRW.

[63] Adapted from (U.S.D.O.I. Bureau of Reclamation 2003)

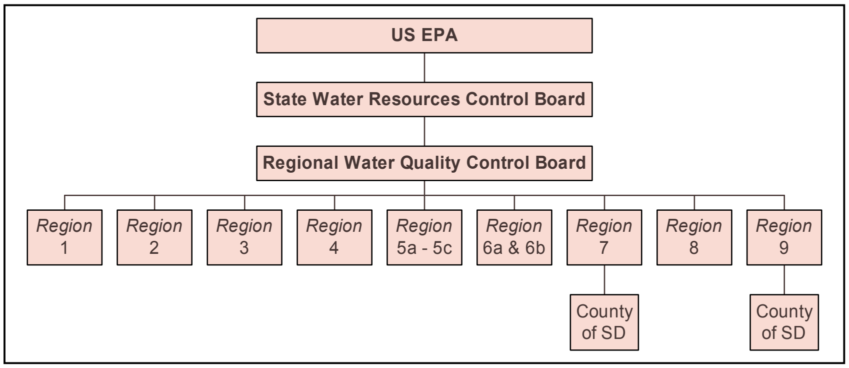

Fig. 46
Hierarchy of U.S. regulators for water quality.

San Diego Basin Plan

The regional water boards adopt and implement water quality control plans (Basin Plans) that recognize the unique characteristics of each region with regard to natural water quality, actual and potential beneficial uses, and water quality problems. The CARWQCB uses planning, permitting, and enforcement authorities to meet this responsibility (CASWRCB 1994).

NPDES Permit for Discharge

The National Pollutant Discharge Elimination System (NPDES), issued by the CARWQCB, details permit conditions include discharge prohibitions, treated water limitations, receiving water limitations, pretreatment specifications, infiltration/inflow and spill prevention program requirements, and other provisions intended to protect the beneficial uses of the receiving water body. Monitoring and reporting requirements are also detailed for influent, effluent, receiving waters, pretreatment, and biosolids.

Total Maximum Daily Load

Under the Clean Water Act Section 303(d), California has identified the lower Tijuana River in the United States as an impaired water body. Once the water body or segment is listed, the state is required to establish a “total maximum daily load” (TMDL) for the pollutant causing the conditions of impairment. The TMDL is the quantity of a pollutant that can be safely assimilated by a water body without violating water quality standards.

Storm water permits

The San Diego Regional Water Quality Control Board issued the Municipal Storm Water Permit Order (Municipal Permit) in 2001 to control waste discharges in urban runoff from the Municipal Separate Storm Sewer Systems that drain into the watersheds of the County of San Diego. In part, the Municipal Permit requires that the jurisdictions within a watershed collaborate on the development of a Watershed Urban Runoff Management Program (WURMP) for each watershed, which addresses high-priority storm water quality issues found within the various watersheds. The WURMP for the U.S. portion of the Tijuana River Water has been submitted as of 2004.

Ocean Plan

Water quality and discharges are also subject to regulation by the Water Quality Control Plan, Ocean Waters of California ("Ocean Plan") prepared by the CACASWRCB. The Ocean Plan regulates point-source discharges to the ocean, with the goal of protecting beneficial uses. The CARWQCB takes the provisions of the Ocean Plan (as well as the Basin Plan) into account when establishing permit conditions.

Construction activity permitting

The CARWQCB also administers the NPDES General Permit for Discharges of Storm Water Runoff Associated with Construction Activity (General Construction Permit). Construction activities on 5 acres or more are subject to the permitting requirements. The permit requires the preparation and implementation of a Storm Water Pollution Prevention Plan (SWPPP). The plan would include specifications for best management practices (BMPs) that would be implemented during project construction to control degradation of surface water through measures to prevent the potential erosion of sediments or discharge of pollutants from the construction area. Additionally, the plan would describe measures to prevent or control runoff after construction is complete and identify a plan to inspect and maintain these facilities or project elements.

Recycled water regulations

There are no federal standards governing wastewater reclamation and reuse in the United States, although the EPA has sponsored the preparation of *Guidelines for Water Reuse*. California has adopted Title 22, Division 4, Chapter 3, of the California Code of Regulations (CCR) Water Recycling Criteria. The CARWQCB and the Department of Health Services (CADHS) have the responsibility of reviewing proposed recycled water projects and for issuing water recycling requirements through the waste discharge permit process. The existing Water Recycling Criteria address treatment requirements for three main types of recycled water uses: landscape irrigation, recreational impoundments, and industrial uses. The CADHS has also produced *Guidelines for Use of Reclaimed Water*, which applies to recycled water. The guidelines focus on application and management specifications for various recycled water uses, including groundwater recharge/seawater intrusion barrier, cleaning, dual water system (toilet flushing and landscape irrigation), firefighting, and wetlands creation/restoration. Some examples of specifications in Title 22 are the requirement to use purple recycled water piping to indicate recycled water and the prohibition of irrigation of disinfected tertiary recycled water within 50 feet of any domestic water supply well (unless specific technical analyses are conducted).

Mexican regulatory framework

The following are some of the regulations and regulators that affect water quality in Baja California.

Ley Nacional de Aguas (National Water Law)

The 2002 Ley Nacional de Aguas (LAN), updated in 2004, stipulates the water quality requirements for drinking water and wastewater, and for open national waters (lakes, rivers, oceans). It requires the treatment of all waters prior to discharge into national water bodies. Enforceable regulations under this law are called *normas*. The principle *normas* are NOM-001 that specifies limits for constituents of concern discharged into open bodies of water. NOM-002 stipulates maximum concentrations for discharge into sewers or other treatment facilities. Mexico's water recycling regulations are detailed in NOM-003. Agencies responsible for monitoring potable and open water resources are SEMARNAT, CILA, COSAE, CNA, CESPs, DGE, and the Dirección General de Planeación de Desarrollo Urbana y Ecología. Several organizations are responsible for the enforcement of the LAN (Table 27).

Function	National open water (lakes, rivers, oceans)	State wastewater collection
Water quality standards	CNA	CNA
Permits	CNA	DGE
Collection and treatment		CESP/SAHOPE
Monitoring	CNA/PROFEPA	DGE/CESP
Enforcement	PROFEPA/CNA	PROFEPA/DGE

Table 27
Baja California wastewater regulators.
Source: (R and G Associates 2002).

Consejos de Cuenca (Watershed councils)

Under LAN, *organismos de cuenca* or watershed councils, make recommendations to CNA. Their objective is to implement programs and actions to improve the administration of waters, the development of hydraulic infrastructure, and the preservation of the resources of the watershed. The Consejo de Cuenca for Baja California is number 12 in Fig. 47. The group is a mix of stakeholders from federal, state, and municipal agencies, water users, and societal organizations. In the case of binational watersheds, a U.S. representative can attend meetings and give voice, but no vote. *Comisiones de cuenca* work at the regional scale, *Comités de Cuenca* work at the regional scale and *Comités Técnicos de Aguas Subterráneas* (COTAS) work on aquifers.

An *organismo de cuenca* is being proposed by several states (Yucatan, Oaxaca, and Baja California) to manage water within watershed boundaries. Baja California's *organismo de cuenca's* plan includes a department of *asuntos fronterizos* (border issues) that will deal with discharges and water treatment issues, as well as border-related issues.

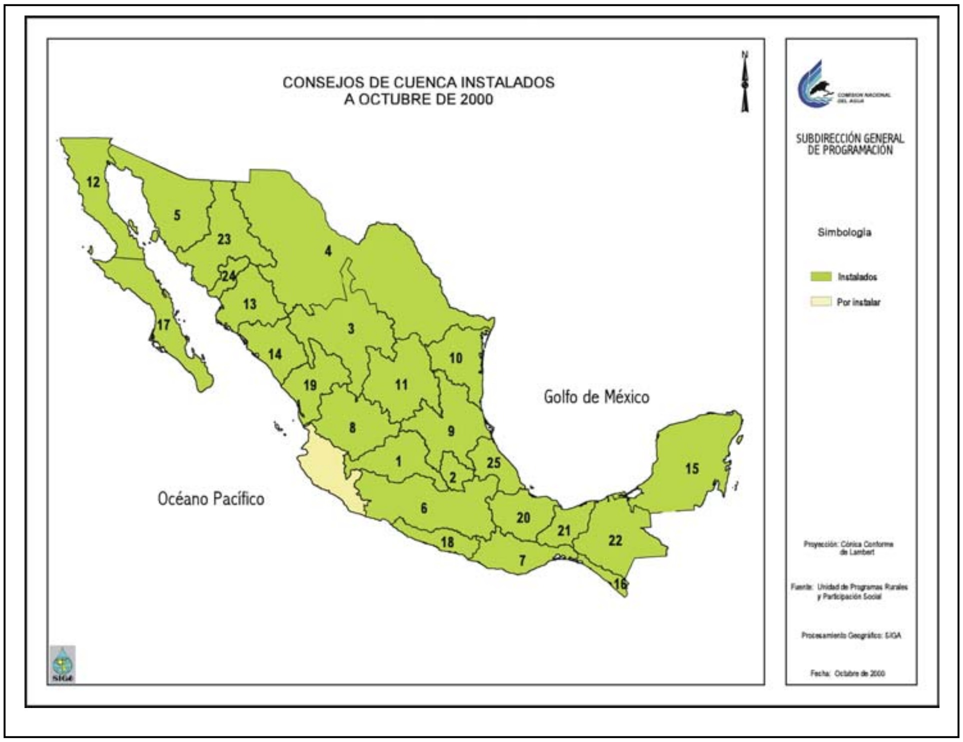

Fig. 47
Watershed councils in Mexico.
Source: CNA

International legislation[64]

International minutes

The Comisión Internacional de Límites y Agua (CILA) in Mexico and its counterpart International Boundary and Water Commission (IBWC) in the United States, are in charge of dealing with binational water resources and sanitation under the 1944 Treaty and a series of subsequent minutes. There are currently no watershed management projects under IBWC-CILA, so a minute would have to be created to expand the mandate of the IBWC-CILA in order to deal with binational watersheds (see Time line section). The IBWC-CILA minutes that are relevant to the TRW are presented in Table 28.

[64] Excerpt from (CESPT 1999)

Minute	Date	Description
270	April 30, 1985	In this minute, the governments of Mexico and the United States, in accordance with their current national laws, agree to cooperate in anticipatingand considering the environmental effects and consequences of planned projects to address the border sanitation problem in the Tijuana-San Diego area. This problem results from untreated sewage discharges from Tijuana, which cross the international border and contaminate the coastline. Both governments agreed to actions that include the development of bilateral consultations on the development, operation, and maintenance of projects as well as specific actions related to ongoing sewer spillages in the area.
283	July 2, 1990	This minute establishes and describes the obligation, contracted by the United States, to provide secondary treatment in an installation built on U.S. territory for 1100 l/s of wastewater from Tijuana, the cost of which bothgovernments shall share. The agreement includes the construction of an ocean outfall, located approximately 3.5 miles offshore in the PacificOcean.
297	April 16, 1997	This minute establishes the distribution of construction, operation, and maintenance costs for the international wastewater treatment plant, constructed under the agreements in Minute 283 for the international solution of the San Diego-Tijuana border sanitation problem. It also establishes monitoring activities related to wastewater projects in Tijuana; the construction by the United States of a binational plant and ocean outfall; and additionally, steps aimed at solving operational and environmental contingencies.
298	December 2, 1997	This minute establishes recommendations for the construction of works parallel to the city of Tijuana wastewater pumping and disposal system as well as the rehabilitation of the San Antonio de Los Buenos Wastewater Treatment Plant. This renovation would increase the level of treatment to the secondary stage and the total treatment capacity to a volume of 1100 l/s. The treated water final discharge would occur at a point approximately 9 km south of the international border.
299	December 3, 1998	This minute authorizes IBWC-CILA financial support to the Border Environment Cooperation Commission in Development of Projects for the Solution of Border Sanitation Problems for wastewater infrastructure projects.
301	October 14, 1999	This minute authorizes a Joint Colorado River Water Conveyance Planning Level Study for the San Diego, CA-Tijuana, B.C. Region. To explore options for water supply and generate basic information for authorities in each country.
310	July 28, 2003	This minute ensures emergency delivery of Colorado River Water for use in Tijuana, B.C. extends minute 240 to sell CESPT with emergency water while infrastructure improvements are being made until 2008.
311	February 20, 2004	This minutes authorizes funds for the secondary treatment of sewage in Tijuana that discharges into U.S. waters. The project will treat waste not treated by the IWTP's capacity of 25 mgd (2,570 l/s).

Table 28
IBWC-CILA minutes affecting the TRW.
Source: (CESPT 1999) and IBWC Minutes.

Ecosystem conservation laws and tools

Aside from water, many of the action items referred to in the Time line section of this document deal with habitat and open space conservation, as well as protection of culturally significant places. This section is an overview of 1) laws protecting habitat, species, and culturally significant areas, and 2) tools for land acquisition that are available in the United States and Mexico.

Laws in the United States[65]

There are many of federal, state, and local regulations that restrict adverse impacts to the environment, including air, water, land, cultural resources, and socioeconomic impacts. Some of these regulations provide mechanisms by which natural resources and open spaces are protected. The following discussion summarizes a few of the laws that affect conservation of natural resources on the U.S. side of the TRW.

National Environmental Policy Act (NEPA), Habitat Conservation Plan (HCP), National Historic Preservation Act (NHPA), and Endangered Species Act (ESA)

Federal projects, projects on federal lands, and projects receiving federal funding are subject to environmental review under these acts. One exception to the environmental review requirements is for construction of the triple fence along the international boundary and related road infrastructure. This exception was provided in congressional legislation. Non-federal projects that may affect federally listed threatened or endangered species are subject to federal ESA regulations. Projects that may cause significant adverse impacts to natural resources or jeopardize the continued existence of federally listed species must mitigate these impacts, often by establishing conservation areas as mitigation. Where there are incidental, adverse impacts to listed species by nonfederal projects, an HCP must be prepared to demonstrate that habitat and species conservation actions, including long-term biological management and monitoring, that will mitigate impacts and contribute to the recovery of those species. The NHPA requires a review of the projects expected impacts by the NHPA Council before excavation of land.

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[65] Excerpt from (White et al. 2004)

Clean Water Act

The U.S. Army Corps of Engineers administers this act, with oversight from the U.S. EPA and the U.S. Fish and Wildlife Service. The Clean Water Act regulates adverse impacts to "waters of the U.S." and wetlands. It can require mitigation for permitted impacts in the form of wetland and aquatic habitat conservation and restoration.

California Environmental Quality Act (CEQA), California Endangered Species Act, and Natural Community Conservation Planning (NCCP) Act

Development projects are subject to environmental review under the CEQA and must comply with a host of other environmental regulations and permitting requirements. Cultural and historical resources must be evaluated for importance, and mitigation measures consisting of preservation or recovery must be applied. Projects that may cause significant adverse impacts to natural resources or jeopardize the continued existence of state-listed endangered or threatened species must mitigate these impacts to a level that is less than significant. The project can do this by modifying the project or by providing long-term conservation and management of natural resources that would be affected by the project. For example, land developers and other project proponents often purchase or establish conservation easements on land as "mitigation" for project-related biological impacts. Historically, open space mitigation was accomplished on a project-by-project basis; the result was a fragmented patchwork of conserved land that does little to sustain biological resources over the long term. In 1991, California adopted the NCCP Act, which provides for comprehensive land use planning to comply with California ESA regulations. The NCCP Act allows local jurisdictions to plan for conservation of ecosystems and ecosystem processes while allowing for reasonable economic growth. Compliance with the NCCP Act and California ESA is often coordinated with federal ESA compliance, resulting in the preparation of joint NCCP/HCP plans that specify reserve systems of natural open space. This proactive approach attempts to protect currently listed species and preclude the need for the listing of currently unlisted species in the future.

Local jurisdictions in Southern California, including the City and County of San Diego, were among the first to undertake joint NCCP/HCP planning. NCCP/HCP planning is conducted on a subregional basis, where a sub region consists of a group of local jurisdictions within an ecoregion (e.g., South Coast ecoregion). In southern San Diego County, conservation planning in the coastal jurisdictions has been completed, and inland portions of the county will have planning initiated in the near future. Both the City and the County of San Diego must annually appropriate funds for acquisition, management, and monitoring of this open space. The Sweetwater Authority and Otay Water District are in the process of completing NCCP/HCP plans that will formally designate watershed lands they own as conserved open space. NCCP/HCP plans have resulted in a significant amount of open space conservation in San Diego County and are an important conservation tool for local governments.

National Fish and Wildlife Refuges

Within the border region, federal funding is being used to purchase private lands within the Otay-Sweetwater Unit of the San Diego National Wildlife Refuge near Otay Mountain and to develop a management and land use plan for the South Bay Unit of the San Diego National Wildlife Refuge. These lands are considered federal contributions to the MSCP preserve system in southwestern San Diego County.

Recovery Land Acquisition Grants Program

Funding from this program (subsidized through Section 6 of the Endangered Species Act) is available to purchase land benefiting federally listed threatened and endangered species.

Forest Legacy Program

The USFS administers this voluntary program in cooperation with the California Department of Forestry by purchasing qualified private properties and conservation easements to maintain forest integrity.

Farm Bill 2002

The Natural Resources Conservation Service branch of the USDA works with private landowners to manage land for natural resource values, under provisions of the Farm Bill 2002.

State conservation programs

Multiple State of California departments and agencies have programs for habitat conservation, including the Department of Parks and Recreation, Department of Fish and Game, State Lands Commission, California Coastal Commission, and Wildlife Conservation Board, which is a source of funding for acquisition of important natural resource areas. In addition, several state propositions have been enacted by California voters in recent years that authorize bonds for conservation of natural open space, water resources, and parklands. These bond measures have provided substantial funding for natural resources conservation that is often used to leverage additional funding from private foundations and non-governmental conservation organizations.

General plans and zoning

In California, general plans describe policies that guide land uses within a city or county jurisdiction, generally over a 20-year planning horizon. A conservation element is a mandatory element of a general plan that provides guidance regarding the conservation, development, and use of natural resources. Once a general plan is approved, the local jurisdiction then "zones" the type and intensity (density) of land uses that are allowed. Certain land uses are compatible with natural resources protection, while many are not. Thus, while general plans can provide important conservation implementation mechanisms, they often reflect the political sentiments of individual boards of supervisors or city councils and, in many instances, facilitate urban sprawl rather than effective conservation. The County of San Diego is currently revising the General Plan for the unincorporated part of San Diego County. If adopted, the County of San Diego General Plan Update 2020 would encourage lower density development in the border region than the current general plan.

County of San Diego Biological Mitigation Ordinance

The County of San Diego enacted the Biological Mitigation Ordinance to legally implement the MSCP. The ordinance establishes criteria for avoiding impacts to important resource areas and outlines mitigation requirements for all discretionary permit projects.

County of San Diego Resource Protection Ordinance (RPO)

The County of San Diego initiated the RPO program in 1991 to preserve wetlands, floodplains, steep slopes, sensitive geological habitats, and prehistoric and historic sites that contribute to society's welfare. The RPO is the primary mechanism used in the unincorporated County of San Diego lands to protect sensitive areas and minimize land development impacts. The county's Resource Protection Ordinance applies in unincorporated areas where the MSCP has not yet been adopted. It establishes development controls on environmentally sensitive lands, including wetlands, floodplains, steep slopes, and sensitive biological habitats (e.g., habitats that support rare or endangered species or function as a wildlife corridor).

City of San Diego Environmentally Sensitive Lands Regulations, Resource Protection Ordinance, and Associated Guidelines

As part of adopting the MSCP, the City of San Diego enacted these regulations to legally implement the MSCP. The guidelines stipulate the biological standards that must be followed to receive a development permit from the city and the amount and location of lands to be conserved as mitigation.

Local conservation programs

Local municipalities have a variety of ways to raise money for conservation purposes. These can include property taxes, sales and use taxes, transportation taxes, special assessment districts, impact fees (one-time cost to developer), general obligation bonds, revenue bonds, and so forth. Currently, SANDAG is discussing the parameters for a transportation tax that would not only pay for transportation improvements, but would also support acquisition, management, and monitoring of lands for open space as mitigation for transportation projects.

Laws in Mexico[66]

Ley General de Equilibrio Ecológico y la Protección al Ambiente (General Law of Ecological Balance and Environmental Protection)

In 1988, the General Law of Ecological Balance and Environmental Protection (LEGEEPA) was passed which for the first time governed environmental protection. This establishes the framework and authority for all environmental regulation in Mexico. SEMARNAT is responsible for the enforcement of the LEGEEPA.

Decreto Federal o Estatal (Federal or State Decree)

Federal, state, or municipal government agencies can decree parks or natural protected areas (*áreas naturales protegidas*). However, land within these areas may be privately owned, and landowners within natural protected areas often are not compensated for economic losses associated with the decreed land use limitations. Consequently, these private lands may not be managed in a manner consistent with the protection of natural resource values. Incentives and land management guidelines are needed to supplement this designation.

Plan de Desarrollo Urbano del Municipio (Municipal Master Plan)

This municipal plan for urban development, which is updated every two years, establishes strategies, policies, and actions that will support sustainable growth (see, for example, El Plan de Desarrollo Urbano del Centro de Población de Tijuana 2025 (IMPlan 2002 as cited by White, et al. 2004). One drawback is that the plan can change when government changes.

Plan de Ordenamiento Ecológico Territorial (State Ecological Master Plan)

This is a governmental policy tool whose purpose is to regulate and control land use and production activities, provide for environmental protection, and allow for preservation and sustainable use of natural resources. They are similar to the Plan de Desarrollo Urbano but were created for rural areas. Plans can be regional, state, municipal, or for specific areas (Ojeda 2002). This tool lacks legal enforcement capability when land uses are changed

[66] Excerpt from (White et al. 2004)

from conservation to development (Gobierno de Baja California 1995 as cited by White, et al. 2004).

Scientists from the Universidad Autónoma de Baja California are assisting the City of Tijuana with the identification of important natural resource areas (*áreas verdes*) as part of the *ordenamiento ecológico* for Tijuana. Baja California is one of the few states where a regional *ordenamiento*, based on ecological data, has been decreed (Ojeda 2002).

Other land use policies or zoning

A *declaratoria* is a special zoning tool that could be used by the state or municipality to conserve woodlands. *Declaratorias* have proven to be ineffective in Baja California because of the poor enforcement capability of the public sector (Graizbord and De la Fuente in prep.). A municipal land bank allows municipalities to designate lands they own for special uses, such as low-income housing or conservation. They can also sell land cheaply. *Permutas* allow cities to exchange land in ecologically sensitive areas for areas of equal monetary value though less sensitive. The policy of *Manejo Sostenible del Uso de Vida Silvestre* (UMA) under the *Ley de Vida Silvestre*, or Management and Sustainable Use of Wildlife under the General Law of Wildlife, is an incentive that allows for the development of productive alternatives compatible with protection of natural resources and biodiversity. The objective is to provide for conservation of managed species while improving quality of life for the community (M. Cariño pers. comm. 2004). This tool has been successfully used for gray whale protection in Laguna San Ignacio, B.C., and could be used for the conservation, reproduction, and commercialization of bighorn sheep within the TRW.

Land acquisition tools

Because government resources in both countries are limited and restricted by law, the protection of private land in the United States and Mexico has become a major tool for land conservationists. The tools can by used for total conservation (no use) to partial conservation (mixed use). The tools may be useful when implementing the TRW Vision's recommendations to identify important conservation areas for restoration and rehabilitation, protect sensitive habitat and cultural areas, evaluate and protect groundwater supplies, and connect conservation areas across the border. Table 29 (at the end of this section) summarizes and compares tools in the United States and Mexico.

Tools in the United States[67]

Mitigation banks—If approved by federal and state wildlife agencies, a property owner can sell "mitigation credits" on his land to other property owners or developers requiring mitigation land for development impacts. The number and value of credits depend on the level and location of impact and the type of resources affected.

Private land conservancies—In Southern California, many private nonprofit organizations conserve land for natural and cultural resources protection, scenic beauty, recreation, community open space, and agricultural resources. These organizations vary in size and scope, from very large organizations with a global influence (e.g., TNC), to small, community-based land conservancies focused on a particular area or watershed. In the border region, a few small land trusts are conserving and/or managing natural open space areas.

Land transfers—The main use of this mechanism is to avoid the bureaucratic delays that governments experience when buying land. A land trust typically holds the land until the government is ready to pay for the land.

Land exchanges—Landowners can exchange property for other property without having to incur a capital gain on the transaction. This allows a landowner to continue to own valuable real estate, but transfer ecologically significant property to a land trust.

Land donations—There are federal income tax deductions that serve as incentives for land donations for conservation.

Bargain sale—A landowner can sell his property for less than fair market value and claim a charitable deduction for income tax purposes for the difference between the bargain sale price and fair market value.

Conservation easements—A landowner can voluntarily place a conservation easement on his property that legally restricts the uses within the easement to protect the natural resources. The

[67] Excerpt from (White et al. 2004)

easement is typically transferred to a conservation organization or government agency. The easement is specific to each property and stays with the land in perpetuity, regardless of ownership.

There are federal income tax benefits of donating a conservation easement. The value of an easement is generally the difference between the value of the land with the easement (i.e., with land use restrictions specified by the easement) and the value of the land without the easement (i.e., without the easement restrictions).

Tools in Mexico[68]

Individuals, indigenous groups, and NGOs, such as Pronatura and Terra Penisular have been working to develop mechanisms for the protection of natural resources on private lands (Pronatura 2002). Legal conservation tools that allow landowners to voluntarily restrict the type and amount of development to protect natural resources are relatively new in Mexico (Pronatura 2002). Some examples are described below.

Donation or purchase—This is the most complete and secure way of protecting land, but it is rare in Mexico. There are legal restrictions on the amount of land a person can buy or own. Tax-exempt NGOs are restricted from owning more land than "their immediate goals require" (Corcuera, Steiner, and Guhathakurta 2000) and administering the land requires resources beyond the capabilities of most NGOs. Foreigners are not allowed to own land in the 100 kilometer (km) strip along the border and 50 km strip along the coast, unless through a bank trust (*fideicomiso*). Income tax deductions are allowed for donations, although one must petition the Secretaría de Hacienda y Crédito Público. Many reassess land to decrease its value to development, and thus protect it. However, current low land values in Mexico negate this as an incentive. This practice works best on large, poor *ejidos*.

Bequest—This is the same as a land transfer or donation, but stipulated in a will and transferable after death (Corcuera, Steiner, and Guhathakurta 2000).

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[68] Excerpt from (White et al. 2004)

Parques privados—The establishment of private parks in Mexico occurs mostly without legal guarantees (Corcuera, Steiner, and Guhathakurta 2000). The first private conservation donation was El Eden Research Station in Quintana Roo in 1990.

Usufructo (right of use)—An *usufructo* is a written agreement for a stipulated time that gives a third party the right to use the resources on a property for certain purposes (in this case, conservation). The contract is not tied to the land and expires with death of the landowner. The owner also retains the right to use, sell, donate, or pass on the land to heirs (Pronatura 2002). In this situation, an NGO could acquire lands from the owner and grant a restricted *usufructo* back to the landowner, or landowners could rent the *usufructo* land to private companies for specified purposes, such as camping or ecotourism.

Fideicomiso (property trust)—A person can grant property through a financial institution (usually a bank) for conservation purposes, documented by a contract on rights of use. *Fideicomisos* even allow foreigners to own property within the restricted areas, although the title is held by the financial institution. *Fideicomisos* are easy to create under the Ley de Operaciones de Crédito and allow many people to invest land, money, and services. There is a limit to the contract period, depending on the kind of *fideicomiso*. Nationally, the tourism department of Mexico, FONATUR, uses this system to develop land (Pronatura 2002). This tool was used locally by PRODUTSA in Tijuana to develop the Río Tijuana 3a. Etapa, Corredor Tijuana-Rosarito 2000, and San Antonio del Mar development (Lemus 2004 as cited by White, et al. 2004), but can be used for conservation as well.

Servidumbre (easement)—There are many types of *servidumbres*. The *servidumbre ecológica* (conservation easement) is a voluntary legal agreement between two or more property owners in which the rights of one are restricted in the type or intensity of land use allowed on the property, with the objective of preserving natural resources, scenic beauty, or historical and cultural values of the land for a designated period of time or in perpetuity. The *servidumbre* stays with the land and not with the property owner. The property that receives the benefit is designated the *predio dominante,* and the property that confers the benefit is the *predio sirviente*. There are also *servidumbres ecológicas recíprocas* in which there are reciprocal restrictions on each property. The properties can be contiguous or non-contiguous. *Servidumbres ecológicas* can be used to conserve areas of biological richness, protect endangered species, and allow use as wildlife movement corridors, or maintain sustainable land use practices. Restrictions that may be placed on properties can vary by property and include hunting, cutting, or clearing trees and other vegetation, impeding wildlife movement, burning, construction, subdividing the property, or housing density. Many of these restrictions on public recreation can benefit ecotourism in Mexico, which depends on the conservation of threatened or unique ecosystems. Rancho Cuchumá is the only example of a *servidumbre ecológica* in the border region. Pronatura recommends the *servidumbre ecológica* with monetary compensation to the landowner as one of the best tools because it provides seed money to start sustainable practices on their land, thus ensuring management and monitoring of ecosystems.

Transfer or Purchase of Development Rights—With the transfer or purchase of development rights, a landowner has the right to sell the development rights to his land. The seller gives up the development rights (emitting zone), and the buyer uses them to build on a more appropriate piece of land (receiving zone). This tool is proposed for use as part of the County of San Diego General Plan Update 2020.

Tool	United States	Mexico
Land donation	Can be stipulated in wills, land gifts by corporations, and living proprietors. The government offers estate tax breaks and charitable tax deductions.	Not common due to lack of incentives; the donor pays for the transfer of title and development rights, and the receiver pays property taxes.
Land purchase	Land trusts or governments buy or transfer lands.	Has recently been exercised by U.S. and Mexican NGO teams (see Coahuila, for example). Costs of property taxes and management of the donated land are high for land trusts. There are limits on how much land can be owned.
Easement donation	Landowners can donate conservation easements that for a stipulated time period (usually perpetuity), restrict some specific uses but maintain title to the land. Charitable deductions and estate tax breaks apply.	Must be signed between two plots of land (dominant and servient). The dominant party can be NGO which receives a gift of land (1 ha) as a gift from the landowner. For an "easement in gross," there is only one landowner. In general, there are insignificant tax incentives. An NGO can be a third-party overseer with legal power to defend the land, a more economic option.

Tool	United States	Mexico
Easement purchase	Same as above with monetary compensation for the development rights.	Most highly recommended by Pronatura. Economic compensation or other assistance is the immediate incentive, but management and title of the land stay in the hands of locals (see Bahia de los Angeles, for example).
Land transfers	Land trusts are intermediaries for the government organizations while they work on acquiring land. Incentives are that trusts avoid monitoring and enforcement costs, and free up monies to purchase other land, and it's a faster process in emergency situations.	Land could be incorporated by the *Instituto Nacional de Ecologia (INE), Comisión Nacional de Áreas Protegias (CONAP)* or similar government institutions. Political swings cause this to be risky. Also, laws allow "compatible development" in biosphere reserves. Attempts are being made to incorporate private lands into reserves. Generate transfer fees and taxes for the holder.
Transferable development rights, Derechos transferibles de desarrollo	Owner sells the development rights in a sensitive area in exchange for a development rights in a more biologically appropriate site, termed a "receiving area."	A government agency offers landowners a parcel of equal monetary value in a more appropriate site. Zoning laws are weak and therefore there are few incentives. Has been used in Mexico City for historic preservation.
Usufructo		"Life estate" includes the rights to use and enjoy land or resources are sold to an NGO. The previous owners are given a parcel on which to live and work, and the contract expires with the landowner's death.
Fideicomiso	Similar to a conservancy's ability to manage funds and land	A contract on rights of use is drawn and land/money can be donated and sold via a financial institution (usually a bank). The terms of the contract are monitored.
Bequest	Donation after death. Avoids estate taxes.	Donation after death.

Table 29
Summary and comparison of land conservation tools in the United States and Mexico.
Source: (Corcuera, Steiner, and Guhathakurta 2000; Pronatura 2002; Comer 2004; Ochoa 2004; Guitiérrez 2004; Vargas Téllez 2004).

Integration with other planning documents

When implementing the recommendations of the Vision, it is important to consider that many of the recommendations may already be policy or law on one side of the border or the other. Also, some of the recommendations may conflict with current plans and laws. Therefore, the following sections give a general overview of some of the important regional plans and regulations for California, Baja California, and the municipalities and cities. Areas are highlighted where the Vision coincides with or compliments existing or proposed plans to show how the Vision supports and is supported by other regional efforts.

The TRW Vision follows the general strategic planning framework of the ***Regional Comprehensive Plan for San Diego County*** (SANDAG 2004). It focuses on sustainability and "smart growth," or reinvestment into existing communities principles, taking into account the economy, environment, and social equity. The plan calls for:

- Improving connections between land use and transportation plans using smart growth principles
- Using the same plans to guide decisions regarding environmental and public facility investments
- Focusing on collaboration and incentives to achieve regional goals and objectives. Specific incentives for implementing smart growth plans are SANDAG transportation funds as a permit streamlining, reduced parking standards, flexibility for mixed use development, increased densities, and fee reductions for redevelopment.

The TRW Vision integrates well with the ***Mountain Empire Subarea Plan*** for the San Diego General Plan (County of San Diego 1995) recommendations for conservation and binational cooperation. The following policies and recommendations are in line with the Vision's recommendation to protect cultural and natural resources:

- All development shall demonstrate a diligent effort to retain as many native oak trees as possible. Sewer districts should implement a wastewater reclamation program in areas where groundwater is not abundant. Natural channels and streambeds should be used for drainage and runoff should be for groundwater recharge where applicable.
- Development shall not adversely affect the habitat of sensitive plant and wildlife species or those areas of significant scenic value.
- The exportation of more than 1 acre-foot of groundwater from the Potrero basin to areas outside the Potrero watershed should be discouraged.
- Floodways shall be maintained in their natural state unless findings can be made that a threat to public safety exists.

- The Jacumba Hotel should be restored if at all possible.

Recommendations from ***SANDAG's Water Quality Element of its Regional Growth Management Strategy for 2020*** to SANDAG and the San Diego County Water Authority (SANDAG 2002) coincide with the Vision recommendations in the following areas:

- Plan for a safe and reliable supply.
- Pursue a legislative program that follows and takes positions on bills consistent with the quality of life standards and objectives and recommended actions for water availability.
- Continue implementation of the existing and proposed BMPs to obtain water conservation savings.
- Provide loans for studies of potential local supply projects.
- Local jurisdictions should require water conservation mechanisms, such as separate irrigation meters for commercial and large residential common-use areas, to better manage landscape water use, installation of high-efficiency dishwashers and coin-operated clothes washers in commercial businesses, and encourage the use of recycled water when this supply is available and meets all regulatory requirements.
- Complete by 2010 the regional Emergency Storage Project, a system of reservoirs, pipelines, and other facilities that will provide water to the county during prolonged interruption of imported water due to earthquake, drought, or other disaster.
- Review and adopt, as appropriate, drought allocation plans to cope with potential future shortages within the region.

The General Plan for the City of Imperial Beach is supported by the Vision in terms of water quality goals for point and non-point pollution (City of Imperial Beach, City of San Diego, and County of San Diego 2002):

- To the extent feasible, preserve, and where possible, create or restore areas that provide water quality benefits, such as riparian corridors and wetlands, and promote the design of new developments to protect the natural integrity of drainage systems and water bodies.

- Avoid conversion of areas particularly susceptible to erosion and sediment loss, and/or establish development guidelines that identify these areas and protect them from erosion and sediment loss.
- To the extent feasible, minimize the amount of impermeable surfaces in areas of new development and redevelopment, and maximize on-site infiltration of runoff. Where this is not feasible, encourage runoff management practices that minimize the volume of urban runoff discharged to receiving waters.
- In watershed planning, pollution prevention should be the first priority, to be followed by source control (only when pollution prevention is not technologically feasible), and pollution control.
- Reduce pollutants associated with vehicles and increasing traffic resulting from development. Coordinate local traffic management reduction efforts with the San Diego County Congestion Management Plan.
- Implement SANDAG's recommendations as found in the Water Quality Element of its Regional Growth Management Strategy for 2020.
- Post-development runoff from a site shall not contain pollutant loads, that cause or contribute to an exceedance of receiving water quality objectives. Developments shall be designed to protect water quality and provide for water protection.
- New development and redevelopment shall implement pollution prevention methods supplemented by pollutant source controls and treatment through the use of small collection strategies located at or as close as possible to the source to minimize the transport of urban runoff and pollutants offsite and into the storm water sewer system.
- Prior to making land use decisions, utilize methods available to estimate increases in pollutant loads and flows resulting from projected future development.
- New development and redevelopment shall incorporate structural and non-structu BMPs to mitigate the projected increase in pollutant loads and flows.

The Vision is consistent with the character of the ***City of San Diego's Progress Guide and General Plan*** adopted on February 26, 1979. It states that new developments shall be consistent with a community's character and meet the needs for a diverse range of ages, incomes, abilities, and lifestyles. New development shall also provide for the protection of the County's natural resources including ground-water resources, dark skies, cultural and historical resources, agriculture, natural floodplains, wetlands, environmentally sensitive lands, air quality, and water quality through the creation of greenbelts and wildlife corridors and other open space areas. The updated plan is scheduled for review in by City Council in 2005 (County of San Diego 1995).

The Vision document meshes well with the ***San Diego County General Plan*** for land use and the environment (County of San Diego 1998). The plan includes goals and policies that provide mechanisms to preserve open spaces for conservation of natural resources, recreational, and educational activities. The ultimate goal of the County of San Diego's General Plan update is to allow for efficient, economical, coordinated, and timely provision of public facilities and services including water, sewer, roads, drainage and storm-water runoff, schools, parks, libraries, police, fire protection, and emergency medical services. Adoption of the plan is expected at the end of 2005.

Land use goals included in the plan are:

- Promote wise uses of the County's land resources, preserving options for future use.
- Encourage future urban growth contiguous to existing urban areas and maximize the use of underutilized lands within existing urban areas (infill).
- Retain the rural character of non-urban lands.
- In non-urban areas, limit high-density development to existing country towns.
- Encourage continuance and expansion of agricultural uses in appropriate portions of the unincorporated County of San Diego.
- Ensure preservation of contiguous, regionally significant open space corridors.
- Protect lands needed for preservation of natural and cultural resources; managed production of resources; and recreation, educational, and scientific activities.

The Vision shares some of the same general goals as the ***Otay Subregional Plan*** of the San Diego General Plan (County of San Diego 1994). These are:

- Land use goal—Provide a land use pattern sensitive to the opportunities and the constraints of the sub region.

- It is the goal of the County of San Diego to work with the private sector in capitalizing on the unique development opportunities existing near the Mexican border while concurrently encouraging interim agricultural production as much as economically feasible.
- Circulation goal—Provide a circulation network capable of handling subregional traffic. It is the goal of the County of San Diego to plan for the orderly development of an ultimate highway, street, and rail transportation network adequate to handle subregional traffic at acceptable service levels and capable of accommodating automobile and truck as well as public and non-motorized modes of travel with the sub region.
- Conservation goal—Protect environmental resources. It is the goal of the County of San Diego to protect the environmental resources designated as "resource conservation areas" on the conservation element.
- Coordination goal—Coordinate planning and development effort with Mexican agencies and private interests involved in similar activities for the area immediately south of the border.

The Vision shares the three general goals as the ***Jamul-Dulzura Subregional Plan*** of the ***San Diego General Plan*** (County of San Diego 1995):

- Encourage development of the land in such a manner as to retain the existing rural atmosphere of the community.
- Provide for a land use pattern that accommodates the population projection with essential services, such as water, fire protection, and schools.
- Direct urban density residential and commercial land uses to the region's more level land in the imported water service area. Outside the imported water services, areas should have low density residential and agricultural land uses.

The ***Central Mountain Sub region Plan*** for the San Diego County General Plan specifies some of the same objectives as the Vision for the TRW (County of San Diego 1995):

- Encourage the protection of existing vegetation, wildlife, and other natural resources.
- Discourage high-density public and private development.
- Residential development should be designed to conserve water.

- Whenever and wherever possible, maintain the natural landforms and native vegetation around residential structures in order to preserve the overall open character and scenic quality of the sub region.
- Ensure that adequate public facilities exist to support proposed residential developments.
- Preserve the character of the existing landscape by retaining important natural features, landforms, and scenic resources.
- Establish open space corridors to maintain biological diversity and viable access for wildlife to and from water, food, and breeding areas.
- Harmoniously integrate transportation modes and ensure that access and circulation shall be provided for vehicles, bicycles, pedestrians, and equestrians in a safe manner.
- Provide and encourage the use and expansion of public transportation.
- Scenic highways/routes and scenic preservation.
- Protect and enhance scenic views, wildlife habitats, native plant materials, and historical and recreational resources within scenic highway corridors.
- Ensure the provision of adequate services and facilities to meet the educational needs of all the residents in the area.
- Ensure that waste disposal does not adversely impact groundwater quality.
- Expand solid waste recycling programs.
- Conserve resources by reducing the volume of waste generated in the central mountain sub region.
- Protect lives and property from uncontrolled flooding while protecting natural floodplain values.
- Conserve hydrological and biological resources of all lakes, rivers, streams, and other wetlands by controlling wastewater discharge and runoff.
- Preserve natural waterways for their value as recharge basins and wildlife habitat.
- Promote the establishment of emergency and preventative procedures to reduce damages from geologic hazards, medical emergencies, and other disasters.
- Ensure the careful management of environmental resources in the plan area to prevent wasteful exploitation or degradation of those resources, and to preserve them for future generations.

- Establish resource conservation areas to ensure the protection and preservation of high quality natural resources and significant cultural resources.
- Discourage the production of local air-polluting emissions in the planning area.
- Encourage a regional approach to the control and reduction of air-polluting emissions, including the support of air pollution control district policies.
- Preserve known historical and archaeological resources and provide adequate protection for new sites as they are discovered.
- Identify and preserve archaeological and historical resources through regulatory review of development projects.
- Preserve natural landforms, water resources, aesthetic resources and soils by preventing erosion due to the development process.
- Prevent the unnecessary alteration of the natural landscape and wildlife habitat within the planning area.
- Whenever possible, protect all sensitive lands and habitat, such as coniferous forests, high montane meadows, native grasslands, Diegan sage scrub, oak woodlands, montane chaparral, riparian woodlands, vernal pools, and any other wetlands.
- Create open space corridors of sufficient size to maintain biological diversity and functional access for wildlife to and from water, food, and breeding areas, and To prevent the creation of biological islands.
- Identify and preserve endangered, threatened, or sensitive habitats, and species of plants and wildlife.

The Vision supports the ***San Diego Basin Plan*** (CASWRCB 1994) submitted by Region 9 Water Quality Control Board. The Basin Plan designates beneficial uses for water bodies, and establishes water quality objectives and implementation plans to protect those beneficial uses. Both state and federal laws mandate the periodic review and update of Basin Plan water quality standards. The last review was in 2004. These goals include:

- Maximum protection of beneficial uses.
- Municipal, agricultural, and industrial wastewaters are to be considered a part of the available fresh water resource.
- Coordinate management of water and wastewater supplies on a regional basis.

- Create a balanced prevention program of source control, reuse, treatment of wastewaters, and proper disposal of effluents and residuals.
- Avoid environmental damage from disposal of residuals.
- Consolidated wastewater facilities and treatment operations to benefit the entire region.
- Institutional and financial resources must be shared throughout the region equitably
- Reclamation and reuse plans must be considered in long-range planning.
- Wastewater management systems must be designed to achieve maximum long-term benefit from the funds expended.
- Water quality control must be based on the latest scientific findings.
- Monitoring programs must assess the effects of programs on beneficial uses including aquatic life, its diversity, and seasonal fluctuations.

The Vision is compatible with the San Diego Water Department's ***Source Water Protection Guidelines for New Development*** (City of San Diego 2004). The guidelines help protect seven drinking water reservoirs located throughout San Diego County that capture local rain water runoff and supply up to 20% of the City of San Diego's drinking water. The guidelines are applicable throughout the sub-watershed areas of Barrett and Morena Reservoirs. They are intended to influence the design and construction of new residential and commercial developments in ways that will provide maximum protection of drinking source water quality. The guidelines focus on the pollutants of greatest concern for drinking water quality including nutrients, total organic carbon, and total dissolved solids. The guidelines establish three tiers of projects and recommended BMPs, such as cluster housing, landscaping that provides infiltration, vegetated swales, porous building materials, and limiting impermeable surfaces.

The TRW Vision integrates well with the objectives of the ***Potable Water and Wastewater Master Plan for Tijuana and Playas de Rosarito.*** The purpose of the study was to develop a plan to invest in projects to improve services of potable water, wastewater collection, sanitation, and wastewater reuse in the short term (5 years), medium term (10 years) and long term (20 years) (Table 30) (CESPT 2002).

Goals for the Master Plan	Criterion (Key Indicator) for Alternatives Evaluation
Water and wastewater services must be affordable [1]	Cost of alternative
Reduce environmental impacts	Level of environmental impacts
Protect human health	Adequate water and wastewater infrastructure improvements are made in time to protect human health
Develop a water culture	Number of water culture programs
Alternative has acceptable level of implementation and performance risk	Level of implementation and performance risk (high, medium, or low) [2]
Maintain flexible sources of supply	Percent contribution of the largest supply source
Conserve water and reduce leaks	Percentage of water conserved and reduction in water losses
Sustain ground water extraction	Ratio of ground water extraction to artificial groundwater recharge with water of adequate quality
Reduce wastewater discharges to transboundary waters	Reduce wastewater discharged to transboundary waters
Eliminate health and environmental risk from wastewater sludge	Efficient sludge management
Maximize wastewater reuse	Percentage of effluent volume reused

Table 30
Goals for the Tijuana-Playas de Rosarito Water Master Plan.
Source: (CESPT 2002).

The TRW Vision is supported by the ***Carta de la Tierra***, a global agreement to protect the earth's natural resources for future generations recently signed by the Municipality of Tecate.

The TRW Vision project follows and implements some of the goals for water and ecology for the ***Border 2012 Program*** under EPA and SEMARNAT. Specifically these are:

- Reduce water contamination.
- Reduce air pollution.
- Reduce land contamination.
- Improve environmental health.

- Improve environmental performance through compliance, enforcement, pollution prevention, and promotion of environmental stewardship.

The TRW is consistent with recommendations by the ***Good Neighbor Environmental Board***, a U.S. federal advisory panel that reports each year to the president and congress on border issues (GNEB 2001). For example, the fifth annual report includes the following recommendations:

> *Surface Water:* 1) Support United States-Mexico discussions concerning compliance with water treaty obligations and encourage greater binational cooperation directed at more effective surface water supply management.
> *Groundwater:* 2) Support efforts for increased collection and sharing of data about border region groundwater resources and encourage greater binational cooperation in border groundwater management.
> *Watersheds:* 3) Support partnerships at all levels that promote strategic watershed principles and watershed management.

The Vision coincides well with the Baja California State ***Plan de Ordenamiento Ecológico Territorial*** (State's Master Plan)*,* which is a governmental policy tool whose purpose is to regulate and control land use and natural resource production activities, provide for environmental protection, and allow for preservation and sustainable use of natural resources. In addition, the municipalities of Tijuana and Tecate each have an ***Ordenamiento Ecológico*** that will be used to guide land development. This tool lacks legal enforcement (Gobierno de Baja California 1995).

The Vision integrates goals and objectives from the ***Plan de Desarrollo Urbano del Municipio de Tijuana*** *(Municipal Master Plan),* updated every two years, that establishes strategies, policies, and actions that will support sustainable growth. There is also the ***Plan de Desarrollo Urbano del Municipio de Tijuana*** (Municipio de Tecate 2003) the latest version of which covers 2001-2012. One drawback is that the plan can change when government changes. The Vision has the advantage of longevity, a long-term vision, and stakeholder input.

The water goals from the ***Plan Estatal Hidráulico adopted by the State of Baja California*** in 2004 (Gobierno del Estado de Baja California, et al. 2004a) coincide with the goals of the Vision project developed in 2003. One member of the BWAC Research Team helped develop this plan. These goals are:

- Promote the efficient use of water in the agricultural sector.
- Foster total coverage of quality potable water and sewage service.
- Strive for integrated sustainable management of water within watershed boundaries and aquifers.
- Promote the technical, administrative, and financial development of the hydraulic sector.
- Consolidate the participation of water user and organized society in the management of water and the promotion of a culture of proper water use.
- Minimize the risks and effects of floods and droughts.

The ***Plan Estatal de Rehabilitación de Microcuencas for Baja California*** (Gobierno del Estado de Baja California, et al. 2004b) shares the following objectives with the Vision:

- Rehabilitate, conserve, and protect the natural resources within the subbasin to ensure the ongoing autonomous integrated regional development
- Generate opportunities for the rural residents in the planning and implementation of projects to ensure stakeholder involvement and sustainability.
- Strengthen actions and coordination of institutions of different levels of the government and NGOs
- Promote an education campaign on watershed ecology
- Form multidisciplinary technical teams.

Potential sources of funding to implement the Vision

Throughout this Vision document, many sources of support for individual projects have been mentioned. For water supply and quality issues, some sources include U.S. Bureau of Reclamation Title XVI Grant Program, California Proposition 13, and MWD Local Resources Program and Seawater Desalination Funds Program, the Financial Assistance Program, and the Reclaimed Water Development Fund. For land conservation the following sources were mentioned: Recovery Land Acquisition Grants Program (subsidized through Section 6 of the ESA), the Forest Legacy Program of the USFS and the California Department of Forestry Natural Resources Conservation Service, an the USDA Farm Bill 2002. For habitat conservation, the Department of Parks and Recreation, Department of Fish and Game, State Lands Commission, California Coastal Commission, and Wildlife Conservation Board, state propositions bonds, private Foundations, and non-governmental conservation organizations. Transportation improvements have used GSA funds. Wastewater improvement projects have used funds from NADBANK-BECC, CNA, and IBWC-CILA. There may be ways to implement conservation that are synergistic with the goals of the U.S. Department of Homeland Security. To implement a watershed council, two main sources of funding are feasible: California Proposition 50 and/or resources from IBWC-CILA (see Action Plan: Create a mechanism for transboundary watershed management).

Proposition 50, the Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002, was passed by California voters. The intent of the IRWM grant program is to encourage integrated regional strategies for the management of water resources and to provide funding, through competitive grants, for projects that protect communities from drought, protect and improve water quality, and improve local water security by reducing dependence on imported water. The Grant Program is administered jointly by the California Department of Water Resources (DWR) and the CASWRCB and is intended to promote a new model for water management. Approximately $380 million is anticipated to be available for IRWM grants during Senate bills and Assembly bills (DWR and CASWRCB 2004). To be eligible, groups must have an Integrated Regional Water Management Plan (IRWM) that is adopted or will be adopted by January 1, 2007. An eligible group consists of at least three local public agencies, two of which have statutory authority over water (such as the San Diego County Water Authority, City of San Diego Water Department, or County of San Diego). At a meeting of the Technical Advisory Committee (TAC) for Project Clean Water started by the County of San Diego County, the idea of applying for funding was discussed. It is envisioned that the TAC would be a useful forum to keep updated on all Proposition 50 and other funding processes. The following focuses were recommended for submission:

- Programs for water supply reliability, water conservation, and water use efficiency
- Storm water capture, storage, treatment, and management.

- Removal of invasive non-native plants, the creation and enhancement of wetlands, and the acquisition, protection, and restoration of open space and watershed lands.
- Non-point source pollution reduction, management, and monitoring
- Groundwater recharge and management projects
- Contaminant and salt removal through reclamation, desalting, and other treatment technologies.
- Water banking, water exchange, water reclamation, and improvement of water quality
- Water quality, storm water capture and percolation
- Protection or improvement of wildlife habitat.
- Watershed management planning and implementation.
- Demonstration projects to develop new drinking water treatment and distribution methods.

Future of the Vision document

In order to ensure that the Binational Vision for the TRW remains a "living document" and does not go out of date, the Research Team has created a web form on the Vision Web site (http://trw.sdsu.edu) for users to add bibliographic references relating to the TRW, and to add projects that are occurring in or around the TRW. Interested persons can register as stakeholders on the Web page.

Important future steps are to circulate the Vision to the community and the decision makers in the TRW. The stakeholders and BWAC should ensure that the Vision is integrated into urban and ecological plans in California, Baja California, San Diego, Tijuana, Tecate, Ensenada, and the basin plans and *organismos de cuenca*. The Border 2012 Water Task Force for the TRW is an EPA-SEMARNAT sponsored group that meets quarterly. Eventually it will assume many of the functions of the BWAC established as part of this TRW Vision Project. The objectives of the group are to update the Vision document, and find ways to implement the Vision recommendations on the ground. One of the primary tasks of the group will be to find formal watershed-planning mechanisms that can be legally applied in both the United States and Mexico. The group's focus will be on water quality, although other issues will be discussed and projects will be developed that deal with air, waste, socioeconomic conditions, and the environment and natural resources. Representatives from other Border 2012 Task Forces may be invited to participate in the Water Task Force in order to maintain the holistic approach to watershed management that this Vision promotes.

Conclusions

The TRW is a complex mix of terrain, ecological systems, jurisdictions, and cultures. It is a large, arid, and urbanizing watershed with many environmental problems. However, this watershed should be treasured as a hot spot of biodiversity, a place of rich cultural heritage, and a model for transborder cooperation. Collaborative efforts to achieve the goals and objectives of the binational Vision detailed in this document will have long-lasting implications for transborder cooperation along the U.S.-Mexican border and other watersheds around the world. The Vision should be revisited and updated as the stakeholders and decision makers in the TRW meet the Vision's goals and create new ones.[69]

[69] Information on recent accomplishments of the Binational Vision Project can be found at http://trw.sdsu.edu.

Glossary of Acronyms

Acronym/Acrónimo	**Full Name/Nombre Completo**	**Translation/Traducción**
ASU	Arizona State University	Universidad Estatal de Arizona
BECC	Border Environmental Cooperation Committee	Comisión de Cooperación Ecológica Fronteriza (COCEF)
BLM	U.S. Bureau of Land Management	Ofinina de Administración de Tierras de los EE. UU.
BMPs	Best Management Practices	Las mejores prácticas administrativas
BOD	Biological Oxygen Demand	Demanda de oxígeno biológico
BPTCP	Bay Protection and Toxic Cleanup Program	Programa de protección de la bahía y limpuieza total de residuos tóxicos
BWAC	Binational Watershed Advisory Council	Consejo Consultivo de la Cuenca Binacional
BWC	Border Water Council	Consejo de aguas fronterizas
CADHS	California Department of Health Services	Secretaría de Salud de California
CARWQCB	California Regional Water Quality Control Board	Consejo Regional para el Control de la Calidad. del Agua de California
CASWRCB	California State Water Resources Control Board	Consejo Estatal para el Control de la Calidad. del Agua de California
CBI	Conservation Biology Institute	Instituto de Conservación Biológica
CCR	California Code of Regulations	Código de regulaciones de California
CEA	Comisión Estatal del Agua de Baja California	Baja California's Water State Commision
CEC	Commission on Environmental Cooperation	Comisión para la Cooperación Ambiental (CCA)
CEQA	California Environmental Quality Act	Ley de Calidad Ambiental de California
CESPs	Comisiones Estatales de Servicios Públicos	Public Service State Commission

Acronym/Acrónimo	Full Name/Nombre Completo	Translation/Traducción
CESPT	Comisión Estatal de Servicios Públicos de Tijuana	Tijuana Public Service State Commission
CESPTE	Comisión Estatal de Servicios Públicos de Tecate	Tecate Public Service State Commission
CFU	Colony Forming Unit	Unidades de formación de colonias
CH2M HILL	private consulting firm	una empresa privada de consultoría
CICA	Centro de Información Sobre Contaminación de Aire	Information Center on Air Pollution
CILA	Comisión Internacional de Límites y Aguas	International Boundary and Water Commission
CITES	Convention on International Trade of Endangered Species	Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres
CNA	Comisión Nacional del Agua	National Water Commission
COBRO	Committee on Binational Regional Opportunities	Comité de oportunidades binacionales regionales
COD	Chemical Oxygen Demand	Demanda de oxígeno químico
COLEF	El Colegio de la Frontera Norte	The College of the Northern Frontier
CONAP	Comisión Nacional de Áreas Protegidas	National Commission of Protected Areas
COSAE	Comisión de Servicios de Agua del Estado de Baja California	Baja California State Water Utilities Commission
COTAS	Comités Técnicos de Aguas Subterráneas	Underground Water Technical Committees
CRETIB	corrosive, reactive, explosive, toxic, flammable, infectious materials	Características Corrosivas, Reactivas, Explosivas, Tóxicas, Inflamables y Biológico-Infecciosas
CUNA	Instituto de Culturas Nativas	Native Cultures Institute
CWA	County Water Authority (San Diego)	Agencia de Agua del Condado de San Diego
DGE	Dirección General de Ecología del Estado	State Office of the General Director of Ecology
DHS	U.S. Department of Homeland Security	Departamento de Seguridad Nacional de EE.UU.

Acronyms

Acronym/Acrónimo	Full Name/Nombre Completo	Translation/Traducción
DWR	Department of Water Resources	Departamento de Recursos de Agua
ESA	Endangered Species Act	Ley de Especies en Peligro de Extinción
FC	Fecal coliforms	Coliformes fecales
FTP	File Transfer Protocol	Protocolo de Transferencia de Archivos
GIS	Geographic Information System	Sistemas de Información Geográfica
GSA	U.S. General Services Administration	Administración de Servicios Generales de los EE. UU.
HCP	Habitat Conservation Program	Programa de Conservación del Hábitat
HUD	U.S. Department of Housing and Urban Development	Departamento de Vivienda y Desarrollo Urbano de EE.UU.
IBWC	International Boundary and Water Commission	Comisión Internacional de Límites y Agua
ICF	International Community Foundation	Fundación de la Comunidad Internacional
INAH	Instituto Nacional de Anthropología e Historia	National Institute of Anthropology and History
INE	Instituto Nacional de Ecología	National Institute of Ecology
INEGI	Instituto Nacional de Estadística, Geografía e Informática	National Startistics, Geography and Informatics Institute
INI	Instituto Nacional Indigenista	National Indigenous Institute
IWRM	Integrated Water Resource Management	Manejo Integrado de Recursos de Agua
IRSC	Institute for Regional Studies of the Californias	Instituto de Estudios Regionales de las Californias
IRWM	Integrated Regional Water Management Plan	Plan Integral Regional de Administración del Agua
ISESALUD	Servicios de Salud Pública del Estado	State Public Health Services Institute
IUCN	World Conservation Union (previously known as International Union for the Conservation of Nature and Natural Resources)	La Unión Mundial para la Naturaleza

Acronym/Acrónimo	**Full Name/Nombre Completo**	**Translation/Traducción**
IWTP	International Wastewater Treatment Plant	Planta Internacional de Tratamiento de Aguas Residuales
LAN	Ley Nacional de Aguas	National Water Law
LEGEEPA	Ley General del Equilibrio Ecológico y Protección al Ambiente	General Law of Ecological Balance and Environmental Protection
MAB	Man and the Biosphere	El hombre y la biosfera
MOU	memorandum of understanding	Memorándum de entendimiento
MSCP	Multiple Species Conservation Program	Programa de Conservación de Especies Múltiples
MWWD	Metropolitan Wastewater District	Distrito Metropolitano de Aguas Residuales
NADBANK	North American Development Bank	Banco de Desarrollo de America del Norte
NAFTA	North American Free Trade Agreement	Tratado de Libre Comercio de América del Norte (TLCAN)
NCCP	Natural Community Conservation Planning Act	Ley de Planificación de Conservación de la Comunidad Natural
NEPA	National Environmental Policy Act	Ley de Política Nacional Ambiental
NGO	Non Governmental Organization	Organizaciones no gubernamentales (ONG)
NHPA	National Historic Preservation Act	Ley Nacional de Preservación Histórica
NOAA	National Oceanic and Atmospheric Administration	Administración Nacional del Océano y la Atmósfera
NPDES	National Pollutant Discharge Elimination System	Sistema Nacional de Eliminación de Descarga de Contaminantes
PAHs	Polycyclic Aromatic Hydrocarbons	hidrocarburos policíclicos aromáticos

Acronyms

Acronym/Acrónimo	**Full Name/Nombre Completo**	**Translation/Traducción**
PCBs	Polycholorinated Biphenyls	bifenilos policlorinados
PROBEA	Proyecto Bio-regional de Educación Ambiental	Bio-regional Environmental Education Project
PROFEPA	Procuraduría Federal de Protección al Ambiente	Federal Attorney General for Environmental Protection
PTAR	Planta de tratamiento de aguas residuals	wastewater treatment plant
RCP	Regional Comprehensive Plan	Plan Regional Integral
RPO	Resource Protection Ordinance	Ordenanza para la Protección de Recursos
SANDAG	San Diego Association of Governments	Asociación de Gobiernos de San Diego
SBWRP	South Bay Water Reclamation Plant	Planta de Tratamiento para Reuso del Agua de South Bay
SDABE	San Diego Alliance for Border Efficiency	Alianza para la Eficiencia Fronteriza
SDNHM	San Diego Natural History Museum	Museo de Historia Natural de San Diego
SDSU	San Diego State University	Universidad Estatal de San Diego
SEDUE	Secretaria de Desarrollo Urbano y Ecología	Secretariat of Urban Development and Ecology
SEM:AVS	simultaneous extractable metal: acid volatile sulfide	proporción entre los metales extraídos simultáneamente (SEM), y los sulfuros volátiles ácidos (AVS)
SEMARNAT	Secretaría del Medio Ambiente y Recursos Naturales	Secretariat of Environment and Natural Resources
SMW	State Mussel Watch	Programa Estatal de Observación de Mejillón
STATSGO	State Soil Geographic Database	Base de Datos Geográfica de tierras del Estado
SWIA	Southwest Wetlands Interpretive Association	Asociación Interpretativa de Humedales del Suroeste
SWPPP	Storm Water Pollution Prevention	Prevención de la Contaminación de Agua de Tormenta

Acronym/Acrónimo	**Full Name/Nombre Completo**	**Translation/Traducción**
TAC	Technical Advisory Committee	Comité Técnico Consultivo
TC	Total coliforms	Coliformes Totales
TMDL	total maximum daily load	Carga diaria total máxima
TNC	The Nature Conservancy	Conservación de la Naturaleza
TRNERR	Tijuana River National Estuarine Research Reserve	Reserva Estuarina Estuarina para la Investigación del Río Tijuana
TSM	Toxic Substances Monitoring	Monitoreo de Substánceas Tóxicas
TWR	Tijuana River Watershed	Cuenca del Río Tijuana
U.N. FAO	U. N. Food and Agricultural Organization	Organización de las Naciones Unidas para la Agricultura y la Alimentación
U.S. EPA	U. S. Environmental Protection Agency	Agencia de Protección al Ambiente de los EE. UU.
U.S. FWS	U.S. Fish and Wildlife Service	El Servicio de Pesca y Silvestre de EE.UU
UABC	Universidad Autónoma de Baja California	Autonomous University of Baja California
UMAs	Unidades de Manejo y Aprovechamiento de la Vida Silvestre	Units for the Conservation off WildLife
UNESCO	United Nations Educational, Scientific and Cultural Organization	Organización de las Naciones Unidas para la Educación, la Ciencia y la Cultura
USACE	U.S. Army Corps of Engineers	Cuerpo de Ingenieros del Ejército de los EE.UU.
USDA	U. S. Department of Agriculture	Departamento de Agicultura de los EE. UU.
USFS	U. S. Forest Service	Servicio Forestal de los EE. UU.
USGS	U.S. Geological Survey	Servicio Geológico de los EE. UU.
WURMP	Watershed Urban Runoff Management Program	Programa de Administración de flujo urbano de la cuenca

References

Aguado, E. 2005. "Precipitation". In *Tijuana River Watershed Atlas*. Eds. SDSU, IRSC and Department of Geography and Colegio de la Frontera Norte. Publ. Institute for Regional Studies of the Californias and San Diego State University Press. San Diego, CA.

American Forests and U.S.F.S. 2003. *Urban ecosystem analysis San Diego, CA: calculating the value of nature*. 47. July.

(BECC) Border Environment Cooperation Commission. 2000. *Improvement and Expansion of the Water and Wastewater Systems for Tecate, Baja California*. Border Environment Cooperation Commission.

Beck, L., Lamke, G. 1998. Tourism and Recreation. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 34-35. San Diego: IRSC.

Berstein, B., and Schiff, K.C. 2003. "The stormwater monitoring coalition: stormwater research needs in southern California" in Southern California Coastal Water Research Project Biennial Report 2001-2002. Weisberg, S.B., Elmore, D. 2003 (eds). Relizon, Santa Ana, CA (May), pp 310-323.

Bleier, C. 2004. Principles for integrated planning in watersheds. Proceedings from the Integrated Planning Work Group of the California Watershed Council, Oct. pp. 54.

Bolger, D., Allison A. C., Soule, M. E. 1991. Occurrence patterns of bird species in habitat fragments: Sampling, extinction, and nested species subsets. *The American Naturalist* 137(2):155-66.

Brodine, S., Gresham, L. 1998. Human Health. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 29-33. San Diego: IRSC.

Brooks, H., Gersberg, R., Dhar, A. 2005. Detection and quantification of hepatitis A virus in seawater via real-time RT-PCR. Journal of Virological Methods. Accepted 17 March. 9705: 1–10.

Brown, C. 2003. "New directions in binational water resource management in the U.S.-Mexico borderlands" the Social Science Journal 40:555-572.

Cagle, F., Esepejel, I. 1998. Protected Areas of the Tijuana Watershed. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 43-48. San Diego: IRSC.

(CASWRCB) State Water Resources Control Board. 1994. San Diego Basin Plan for Region 9. http://www.swrcb.ca.gov/rwqcb9/programs/basinplan.html. Accessed 10/14/04.

(CASWRCB) State Water Resources Control Board. 1996. *Chemistry, Toxicity, and Benthic Community Conditions in Sediments of the San Diego Bay Region: Final Report of the Bay Protection and Toxic Cleanup Program*. Division of Water Quality. Sacramento.

(CASWRCB) State Water Resources Control Board. 2000. Nonpoint source program strategy and implementation plan, 1998-2013. California Coastal Commission. January. pp. 166.

Calavita, N. 1998. Housing. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, p. 21. San Diego: IRSC.

California Air Resources Board. 2003. Air quality data. http://www.arb.ca.gov/aqd/aqdpage.htm. 5-24-04.

California Association of Realtors. 2004. www.car.org/index.php. 7-15-04.

California Department of Fish and Game. 2004. San Diego Multiple Species Conservation Program. www.dfg.ca.gov/nccp/mscp/sd_mscp.htm. 6/2/04.

California Department of Water Resources. 1965. *Groundwater Conditions in the San Diego River Valley*. A Report to the San Diego Regional Pollution Control Board (No. 9). Project Code No. 59-9-1.

California State Poly Technical University, Pomona Studio 606. 2003. *A framework for an urban river environment: Tecate, Mexico*. Fundación la Puerta, A.C. Irvine, CA, June.

Camp Dresser and McKee. 2003. *Environmental Assessment Tijuana and Playas de Rosarito Potable Water and Wastewater Master Plan*. Prepared for U.S. Environmental Protection Agency Region 9. February 10, 88 pp.

Cantlupe, J. 2003. "Tracking of toxic wastes is found outdated." *San Diego Union Tribunen*, March 30. San Diego.

Case, T., Fisher, R. 1998. Fauna. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 57-58. San Diego: IRSC.

Castro Ruíz, J. L. 1998. Tecate's water supply. In *Tecate, Baja California: realities and challenges in a Mexican border community*, eds. Institute for Regional Studies of the Californias, pp. 177-86. San Diego: IRSC.

(CEC) Commission for Environmental Cooperation. 2000. Biodiversity Conservation: Conservation of Migratory and Transboundary Species. In *Commission for Enviromental Cooperation*. Montreal, Canada. October 18, pp. 79.

(CEC) Commission for Environmental Cooperation. 2002. Metales y Derivados Final Factual Record. Québec: ISBN:2-89451-549-9. pp.154.

(CESPT) Comisión Estatal de Servicios Públicos de Tijuana. 2002. *Potable water and wastewater master plan for Tijuana and Playas de Rosarito, draft*.

City of Imperial Beach, City of San Diego, County of San Diego. 2002. *The Watershed Urban Runoff Management Program: Tijuana River Watershed*. Draft document. Prepared in partial fulfillment of the requirements of the Regional Water Quality Control Board, San Diego Region, Municipal Storm water Permit Order No: 2001-01.

City of San Diego. 2004. *Source Water Protection Guidelines for New Development*. San Diego, CA. 27. January.

Comer, K. 2004. "Case study of a Potential Trinational Protected Area: the Campo-Tecate Creek Kumiai Corridor" presented at the Border Institute, Rio Rico, AZ. ed. SCERP Monograph Series, in press.

(CNA) Comisión Nacional del Agua. 1995. *Programa Estatal Hidráulico*. Gerencia Estatal en Baja California. Mexicali, B.C.: CNA.

CONCUR, Inc. 2000. *Comprehensive Management Plan for Tijuana River National Estuarine Research Reserve and Tijuana Slough National Wildlife Refuge*. Prepared for California Dept. of Parks and Recreation, US Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration.

Connolly, M. September 1997. The Campo Band of Kumeyaay: Diabold Creek Restoration Project Success Story Presentation. San Diego, CA.

(CBI, Pronatura, and TNC) Conservation Biology Institute, Pronatura, and The Nature Conservancy. 2004. *Las Californias binational conservation initiative: a vision for habitat conservation in the border region of California and Baja California*. Prepared for the San Diego Foundation, Resources Legacy Fund Foundation, and the International Community Foundation. San Diego, CA, Sept.

Conservation Biology Institute, Pronatura, The Nature Conservancy. 2004. *Las Californias binational conservation initiative: a vision for habitat conservation in the border region of California and Baja California*. Prepared for the San Diego Foundation, Resources Legacy Fund Foundation, and the International Community Foundation. San Diego, CA, Sept.

Conservation International. 2004. http://www.biodiversityhotspots.org/xp/Hotspots/california_floristic/. Biological hotspots. 7/6/04.

Corcuera, E., Steiner, F., Guhathakurta, S. 2000. Land Trust Mechanisms for Conservation. *Journal of Borderlands Studies* XV(Fall):1-21.

County of San Diego. 1994. *Otay subregional plan*. County of San Diego Dept. of Planning and Land Use.

County of San Diego. 1995. *Central Mountain Subregional plan*. County of San Diego Dept. of Planning and Land use.

County of San Diego. 1998. *General Plan 2020*. County of San Diego Dept. of Planning and Land use.

County of San Diego. 2003. http://www.co.san-diego.ca.us/cnty/cntydepts/land use/planning/mscp/. County of San Diego Multiple Species Conservation Program Web Site. 12-12-02.

County of San Diego. 2003b. 2003 Beach Closure and Advisory Report. Report by the Department of Environmental Health. http://www.sdcounty.ca.gov/deh/lwq/beachbay/pdf/2003_beach_closure-advisory_report_0704.pdf. Accessed 6/9/05.

County of San Diego. 2004. *2002-2003 Urban Runoff Report*. San Diego, CA: MEC Analytical Systems, Inc.

Cuevas, T., CESPT. February 2004. Tijuana, B.C. Personal communication with the author.

Delgadillo, J. 2000. Floristica y ecologia del norte de Baja California. *Divulgare* 29 Y2 - enero-marzo:46-63.

Desmond, J. 1998. Estuarine Ecology. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 59-63. San Diego: IRSC.

(DGE) Dirección General de Ecología. 2003. *Resolución de impacto ambiental para el relleno sanitario en Tijuana*. Tijuana, B.C., November. DGE-TIJ-2293/03 expediente 4.3.0129-MIA/03.

Diamond, J. 1975. The island dilemma; lessons of modern biogeographic studies for the design of natural reserves. *Ecol. Conservation* 7:129.

Dudek and Associates, Inc. 1995. Groundwater management plan for the Tijuana River Basin summary report. Prepared for the Tia Juana Valley County Water District (May) pp. 14.

(DWR and CASWRCB) Department of Water Resources and State Water Resources Control Board. 2004. http://www.swrcb.ca.gov/funding/irwmgp/. Sacramento, CA. 12/4/04.

Environmental Law Institute. 2003. Legal tools and incentives for private lands conservation in Latin America: building models for success. Environmental Law Institute. Washington, D.C. ISBN# 1-5876-059-5. pp. 206.

Ezcurra, E.M. 1998. "Conservation and sustainable use of natural resources in Baja California: an overview." Prepared for the San Diego Dialogue's Forum *Fronterizo* policy luncheon series, (0ct.) pp. 15.

Forster, C. 2005 "Tecate Hydrogeology Assessment" Final Report to IRSC-SDSU. Salt Lake City, Utah. Mar 28. pp. 23

Ganster, P. 1996. Environmental Issues of the California-Baja California Border Region. *Border Environment Reports* June (1):1-14

June (1):1-14.

Ganster, P. 2004. NAFTA at 10 years: the California-Baja California border region. Working draft 4/14. pp. 9. unpublished.

Gersberg, R. M., Wakida Kusunoki, F. T. 1998. Water Quality and Quantity. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 64-68. San Diego: IRSC.

Gersberg, R., Dodge, D., Parsons, L., Zedler, J. 1994. Microbiological Water Quality of the Tijuana Estuary. *Journal of Border Health* 10 (3):16-27.

Gersberg, R., Trindade, F., Nordby, C. 1989. Heavy Metals in Sediments and Fish of the Tijuana Estuary. *Journal of Border Health* 5:5-15.

Gobierno Estatal de B.C. 2002. *Programa sectoral de vivienda 2002*

Gobierno del Estado de Baja California, SEDUE, SFA, CEA. 2004a. *Plan Estatal Hidráulico*. Mexicali, B.C. 174

Gobierno del Estado de Baja California, SAGARPA, FIRCO. 2004b. *Plan estatal de rehabilitación de microcuencas*. Mexicali, B.C.

Gómez, R., Lozano, A. 1998. Health services in Tecate. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 29-33. San Diego: IRSC.

(GNEB) Good Neighbor Environmental Board. 2000. Fourth Report of the Good Neighbor Environmental Board to the President and Congress of the United States. http://www.epa.gov/ocem/gneb/pdf/annrpt900eng.pdf. San Diego: EPA, December. 10/14/04.

(GNEB) Good Neighbor Environmental Board. 2001. Fifth Report of the Good Neighbor Environmental Board to the President and Congress of the United States. http://www.epa.gov/ocem/gneb/pdf/english2001gneb.pdf (English) and http://www.epa.gov/ocem/gneb/pdf/spanish2001gneb.pdf (Spanish). Accessed 3/13/03.EPA. December.

(GNEB) Good Neighbor Environmental Board. 2005. Eighth Report of the Good Neighbor Environmental Board to the President and Congress of the United States. http://www.epa.gov/ocem/gneb. Accessed 6/29/05. San Diego: EPA 130-R-05-001. February. pp.55.

Gosselin, P., Furgal, C., Ruiz, A. 2001. Environmental public health indicators for the U.S. – Mexico border region concept document. Presentation to members of the Environmental Health Working Group, El Paso, Texas. July 26-27.

Graizbord, C., De la Fuente, E. in prep. Preservation of lands in the Border Region. In *SCERP Monograph Series*. Border Institute, Rio Rico AZ: forthcoming.

Greenwood, N. 2005. "Soils". In *Tijuana River Watershed Atlas*. Eds. SDSU, IRSC and Department of Geography and Colegio de la Frontera Norte. Publ. Institute for Regional Studies of the Californias and San Diego State University Press. San Diego, CA.

Guitiérrez, M. 2004. Presentation to stakeholders of the Tecate Urban River Park in Tecate, B.C., April.

Herzog, L., Graizbord, C. 1998. "Urban Structure". In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 14-18. San Diego: IRSC.

Holser, A. 2005. Exploring Water Supply Alternatives for Tecate, Mexico using a System Modeling Approach Master's thesis. University of Utah (March 23). Pp. 112.

IMPlan. 1999. *Propuesta alternative de desarrollo para la cuenca del Arroyo Alamar*. Tijuana, B.C.: IMPlan.

(INEGI) Instituto Nacional de Estadística e Geografía. 2004. "Baja California" http://www.inegi.gob.mx/est/default.asp?c=697. Accessed 7-29-04.

(IRSC) Institute for Regional Studies of the Californias. 1997. "BorderLink". In *The Tijuana River Basin: Basic Environmental and Socioeconomic Data*, ed. F. Wakida, K. Riveles. San Diego: Institute for Regional Studies of the Californias, SDSU.

(IRSC) Institute for Regional Studies of the Californias. 2000. *International border area planning atlas*. San Diego: IRSC-SDSU.

Ja Jan. 2004. "Biweekly U.S.-Mexico border beach report monitoring of September 30th and October 1st , 2004" sent to author.

Jerrett, M., Rey, S. Dufournaud, C., Jones, D. 2003. Accounting for the environmental "bottom line" along the U.S.-Mexico border. Annals of the Assoc. of Amer. Geog. 93(1) pp. 67-88.

(JPL/SCERP-SDSU) Jet Propulsion Laboratory/Southwest Center for Environmental Research and Policy-San Diego State University. 1994. "Transboundary environmental assessment and monitoring (TEAM) system for the U.S.-Mexico border region". Project proposal. Unpubl.

Kilpatrick, A. 1998. An Environmental Assessment Study of Indian Tribes Living in the U.S.-Mexico border Region (Planning Phase). *Final Report SCERP Project Number: IT98-1*.

Kilpatrick, A., Wilken, M. 1998. Border Tribes. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 41-42. San Diego: IRSC.

Kjos, K., de la Rosa, M. 1998. Social Indicators. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 22-25. San Diego: IRSC.

Klein, J.M., Buckler, D.R. Osborn, K.J. 2002. Watershed approaches in the U.S.-Mexico border region—a focused effort to ensure consistent and comparable information. Absract: UCOWR annual conference.

Leyva Aguilera, C., Aceves Calderón, P., Wilken-Robertson, M. Date unknown. Culrutal resources as a tool for conservation and management. Unpublished report.

Line, D., Wu, J., Arnold, J., Jennings, G., Rubin, A. 1997. Water Quality of First Flush Runoff From 20 Industrial Sites. *Water Environmental Research* 69::305-10.

Lozano, M. 1995. *Physiochemical Characteristics of the Tecate River*. Universidad Autónoma de Baja California.

Luderitz, V., Gerlach, F., Jupner, R., Calleros, J., Pitt, J., Gersberg, R. 2005. Biological Assessment of Tecate Creek (U.S.-Mexico) with special regard to self-purification. Bull. Southern California Acad. Sci. 104 (1): 1-13.

MacArthur, R. H., and Wilson. 1967. The Theory of Island Biogeography. Princeton, NJ.: Princeton University Press.

Martínez, R., and Espejel, I. Date unknown. Conservation and management of ecosystems within and without protected natural areas in Baja California. Environment 27(3). Pp. 10.

McPherson, M., Cliffton, C., Lupena, F. 2004. San Diego County 2004 Beach Closure & Advisory Report. County of San Diego, San Diego, CA. pp. 31.

Medina, M. 2002. Municipal and hazardous waste management in Tecate. In *Tecate, Baja California: Realities and Challenges in Mexican Border Community*, ed. P. Ganster, F. Cuamea, J. Castro Ruiz, A. Villegas, pp. 227-34. IRSC-SDSU.

Merkel and Associates. 2004. *Draft San Diego River Watershed Assessment*. Prepared for San Diego River Watershed Workgroup. San Diego. 97.

Metzner, C., McCoy, M. 1994. *Man and the Biosphere Reserve System for the San Diego Border Region*. Final report to SCERP.

Meyer, S., Gersberg, R. 1997. Heavy Metals and Acid-volatile Sulfides in Sediments of the Tijuana Estuary. *Bulletin of Environmental Contamination and Toxicology* 59:113-19.

Michel, S., Graizbord, C. 2002. Urban Rivers in Tecate and Tijuana: Strategies for Sustainable Cities. Tertiary Urban Rivers in Tecate and Tijuana: Strategies for Sustainable Cities. San Diego.

Minnich, R., Vizcaino, E. 1998. *Land of Chamise and Pines: Historical Accounts and Current Status of Northern Baja Californias Vegetation*. Berkeley, CA: University of California Press.

Montgomery, D. G., Sullivan, K. 1995. Watershed Analysis as a Framework for Implementing Ecosystem Management. *Water Resources Bulletin* 31(3):369-86.

Moreno, D., Muñoz, V. 2003. *El reto de la basura en Tijuana.* Tijuana Trabaja. Tijuana, B.C. 156. Cuadernos para el diálogo.

(MSCP) Multiple species conservation plan. 1996. MSCP Plan. San Diego.

Mumme, S. 2001. Minute 242 and beyond: challenges and opportunities for managing transboundary groundwater on the U.S.-Mexico-Border. *Natural Resources Journal* 40.

Municipio de Tecate. 2003. *Program de desarrollo urbano de centro de poblacion Tecate B.C. 2001-2022*. Tecate, B.C., October. 122.

Naeem, S. C., Robert, Ehrilich, Golley, F., Hooper, D., et. al. 2000. Biodiversity and ecosystem functiong: maintaining natural life support processes. *Issues in Ecology*, pp. 1-11.

(NAEPC) Native American Environmental Protection Coalition. 2005. "Accomplishments". http://www.naepc.com. Accessed 8/12/05.

Ney-Nifle, M., Marc, M. 1999. Habitat loss and changes in the species-area relationship. *Conservation Biology* 14(3): 893-98.

Oberbauer, T. 1999. La vegetacion del noreste de Baja California. *Fremontia Edicion especial*, Julio, pp. 16-22.

Ochoa, F. April 1, 2004. *pers. comm. to author*. Ensenada, B.C.

O'Connor. 1999. New strategies for America's watersheds. National Academy Press, Washington, D.C. pp. 311.

Ojeda Revah, L. 2000. Land use and the conservation of natural resources in the Tijuana River Basin. In *Shared Space: Rethinking the U.S.-Mexico Border Environment*, ed. L. A. Herzog, pp. 211-32. La Jolla, CA: Center for U.S.-Mexican Studies, UCSD.

Ojeda, L. R. 2001. Changing land use patterns in the Tijuana River Watershed and the conservation of transborder natural resources. In *Is globalization overpowering democracy? The challenge for ecology, economy and culture*. June 12- 16, 2001, Prague, Villa Lanna.

Ojeda, L. 2002. Habitat fragmentation in the Tijuana River Watershed 1953-1994. In *Tecate, Baja California: Realities and Challenges in Mexican Border Community*, ed. P. Ganster, F. Cuamea, J. Castro Ruiz, A. Villegas, pp. 163-76. IRSC-SDSU.

O'Leary, J. 2005. “Vegetation”. In *Tijuana River Watershed Atlas*. Eds. SDSU, IRSC and Department of Geography and Colegio de la Frontera Norte. Publ. Institute for Regional Studies of the Californias and San Diego State University Press. San Diego, CA.

Peach, J., Williams, J. S. 2003. Population Dynamics of the U.S.-Mexican Border Region. San Diego: SCERP/SDSU Press: *SCERP Monograph series*, forthcoming.

Parsons, California. 2004. Draft supplemental environmental impact statement for the Clean Water Act Compliance at the South Bay International Wastewater Treatment Plant. Prepared for IBWC in cooperation with U.S.EPA. Pasadena, CA. December.

Ponce, V. M. 2000. *Sustainable management of water in the Ojos Negros Valley, Baja California*. San Diego State University, Universidad Autónoma de Baja California, Instituto Nacional de Investigaciones Agrícolas, Forestales y Pecuarias.

Ponce, V. M. 2003. *Flood hydrology of the binational Cottonwood Creek - Arroyo Alamar, California and Baja California*. SDSU.

Ponce, V. M. 2004. *Hydrology and hydraulics for the Tecate Creek corridor restoration (2004-05)*. Report to IRSC-SDSU. Accessed 7/15/05.
http://www.ponce.sdsu.edu/tecate_rio_parque_report_september2004.html#conclusions

Pronatura. 2002. Herramientas Legales para la Conservación de Tierras Privadas y Sociales, p. 145. Tertiary Herramientas Legales para la Conservación de Tierras Privadas y Sociales. Mexico, D.F.

Pronatura. 2003. Las Californias Binational Conservation Initiative Localities Portfolios. Tertiary Las Californias Binational Conservation Initiative Localities Portfolios. Ensenada, B.C.

Pronatura. 2004. Iniciativa binacional de conservatión "Las Californias". Phase 1 (June).

R and G Associates. 2002. *California/Baja California Industrial Wastewater Monitoring Pretreatment and Minimization Program Needs Assessment*. Prepared for CalEPA Border Affairs Unit. Sacramento, CA, Feb.

Ramírez, P., Director, CESPTE. March 2004. Tecate, Baja California. Pers. comm. to author.

Ramos, J.M. 2003. “Managing transborder cooperation on public security: the Tijuana-San Diego Region” Paper presented at Research Seminar on Mexico and U.S. –Mexican Relations, The Center for U.S.-Mexican Studies, UCSD, La Jolla, CA. (October 15), pp. 23.

Rangel Pérez, G. G., García Vega, B., Gene Jacobson, M., Ramos Jaramillo, W., Téllez Girón, T. 1998. Politics of Water Management in the Tijuana River Watershed. In *The Tijuana River Basin: Basic Environmental and Socioeconomic Data*, ed. F. Wakida, K. Riveles, pp. 29-55. San Diego: IRSC.

Regional Water Quality Control Board. 1994. *Water quality control plan for the San Diego basin*. http://www.waterboards.ca.gov/sandiego/programs/basinplan.html. Accessed 5/11/05.

Rempel, R. 1992. Hydrogeoglical assessment of the Tijuana River Valley. Report to the CASWRCB. Feb 26. pp.18.

Rey, S., Clement, N. 1998. Economy. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 5-7. San Diego: IRSC.

Rey, S., Ganster, P., del Castillo, G., Alvarez, J., Schellhammer, K., et al. 1998. The San Diego-Tijuana region. In *Integrating cities and regions: north american faces globalization*, ed. J. W. Wlikie, C. E. Smith, pp. 105-64. Guadalajara: Universidad de Guadalajara.

Salinas, D. 2005. "Planean que Arroyo Alamar sea proyecto ambientalista" Frontera newspaper (6 July).

San Diego County Water Authority. 1997. *Water Resources Plan: Groundwater Report (Executive Summary)*.

San Diego County Water Authority. 2000. *Urban Water Management Plan*. San Diego, CA.

San Diego County Water Authority. 2003. *San Diego County Water Authority fact sheet*. San Diego County Water Authority. 2 pg.

San Diego Metropolitan Wastewater Department. 2004. Facilities: SBWRP. http://www.sannet.gov/mwwd/facilities/southbay.shtml. 6/1/04.

(SANDAG) San Diego Association of Governments. 1999. *2020 Cities/County forecast for the San Diego region*. SANDAG Info. San Diego. Sept-Oct No. 5.

(SANDAG) San Diego Association of Governments. 2002. *SANDAG's Water Quality Element of its Regional Growth Management Strategy for 2020*. SANDAG. January.

(SANDAG) San Diego Association of Governments. 2003. *Regional comprehensive plan technical appendix: water supply and delivery system*. San Diego.

(SANDAG) San Diego Association of Governments. 2003. Conference Proceedings from the *2003 Binational Annual Conference - Homeland Security, Challenges and Opportunities for the San Diego-Northern Baja California Region.* San Ysidro, CA. July 11.

(SANDAG) San Diego Association of Governments. 2004. *Regional comprehensive plan for the San Diego region*. San Diego, July.

(SANDAG) San Diego Association of Governments. 2005. "About SANDAG". http://www.sandag.org. Accessed 6/21/05.

(SANDAG) San Diego Association of Governments. 2005. "Borders Committee Agenda Item No 2: Overview of lanning efforts in the Otay Mesa corridor". http://www.sandag.org. Accessed 6/29/05.

(SDNHM) San Diego Natural History Museum. 2005. San Diego Natural History Museum website. http://www.sdnhm.org. Accessed 7/15/05.

Saxod, E. 2004. San Diego, CA, October. Conversation with author.

(SDSU and COLEF) San Diego State University and Colegio de la Frontera Norte, eds. 2002. *San Diego-Tijuana Border Area Planning Atlas*. San Diego: SDSU Press, IRSC.

(SDSU and COLEF) San Diego State University and Colegio de la Frontera Norte, eds. 2005. *Tijuana River Watershed Atlas*. Eds. SDSU, IRSC and Department of Geography and Colegio de la Frontera Norte. Publ. Institute for Regional Studies of the Californias and San Diego State University Press. San Diego, CA.

SDSU, UABC, COLEF. in prep. *Quality of life in the greater San Diego-Tijuana-Tecate-Playas de Rosarito region*. San Diego, CA: IRSC.

Secretaria del Patrimonio Nacional. 1974. Canalización del río de Tijuana. In Calafia Revista de la Universdad. publ. UABC. pp 23-25.

(SEMARNAT) Secretaria del Medio Ambiente y Recursos Naturales. 2002. *Diario oficial*, Miércoles 6 de marzo de 2002*NOM-059-ECOL-2001*. In *(Segunda Sección) 1*. Protección ambiental-Especies nativas de México de flora y fauna silvestres-Categorías de riesgo y especificaciones para su inclusión, exclusión o cambio-Lista de especies en riesgo. Mexico City.

Serrano González, J. 2002. Sitios con evidencias culturales en el municipio de Tecate, Baja California. Centro del INAH en Baja California, November. pp. 46.

Southern California Coastal Water Research Project. 1998. Southern California Bight 1994 Pilot Project: Executive Summary. Westminster, CA. http://www.sccwrp.org. pp. 21

State of California. 2005. "California waste stream profiles". http://www.ciwmb.ca.gov/Profiles/County/. Accessed 5-5-05.

Svejkosky, J. 2004. Satellite and aerial coastal water quality monitoring in the San Diego/Tijuana. Two year summary report. Ocean Imaging, Inc. Solana Beach, CA. July 24.

Sweedler, A. 1998. Air Quality of the Tijuana Basin. In *The State of the Environment of the Tijuana River Basin, Working Draft*, eds. Institute for Regional Studies of the Californias, pp. 69-71. San Diego: IRSC.

Sweedler, A. 2005. "Air Quality". In *Tijuana River Watershed Atlas*. Eds. SDSU, IRSC and Department of Geography and Colegio de la Frontera Norte. Publ. Institute for Regional Studies of the Californias and San Diego State University Press. San Diego, CA.

(SWIA) Southwest Wetlands Interpretive Association. 1999. Draft Goat canyon/ Cañon de los Laureles enhancement plan. Prepared for the State Coastal Conservancy, the Ca. Dept. of Parks and Recreation, The U.S. EPA with consulting services of Philip Williams and Assoc., Land Restoration Assoc., and Tierra Environmental Services. (June), pp 94.

The Nature Conservancy. 2000. The Five-S Framework for Site Conservation: A Practitioner's Handbook for Site Conservation Planning and Measuring Conservation Success. 2 Y2 - June.

Tolinson, R.V., Christensen, B., Hickman, JD. 1995. Preliminary border environment needs assessment report. Prepared by CalEPA (April 20), pp. 267.

U.N. Department of Economic and Social Affairs. 2005. Changing unsustainable patterns of consumption and production: human settlements and water. Background paper no.4. Division for Sustainable Development. Thirteenth Session. New York, April 11-12. pp. 27.

U.N. Department of Economic and Social Affairs. 2005b. Catalyzing Change: A handbook for developing integrated water resources management (IWRM) and water efficiency strategies. Background paper no.5. Commission on Sustainable Development. Thirteenth Session. New York, April 11-12. pp. 51.

U.N. Department of Economic and Social Affairs. 2005c. Freshwater management: policy options and possible actions to expedite implementation. Report of the Secretary-General. Commission on Sustainable Development.

Thirteenth Session. New York, April 11-12. pp. 19.

(UNESCO) United Nations Educational, Scientific, and Cultural Organization. 2004. "World heritage fund." Accessed 3/1/04. http://whc.unesco.org/toc/mainf8.htm.

U.S. Army Corps of Engineers. 1999. Tijuana River Watershed management study, San Diego County, California: draft project study plan. Los Angles District, Planning Division, Water Resources Branch (March), pp. 49.

U.S. Army Corps of Engineers. 2005. "Regulatory program Overview" http://www.usace.army.mil/inet/functions/cw/cecwo/reg/oceover.htm. Accessed 7/11/05.

U.S. Census Bureau. 2004. http://factfinder.census.gov. Accessed 7/1/04.

U.S. Department of Energy. 2002. Conceptual model for the Tijuana River aquifer southwest border project. Grand Junction, Colorado: DOE. GJO-2002-367-TAC OP 13.3-1 (Sept).

U.S. Department of Energy. 2003. *Groundwater flow model for the Tijuana River Basin*. Southwest border project. Grand Junction, Colorado: DOE. GJO-2003-408-TAC.

U.S.D.O.I. Bureau of Reclamation. 2003. *Pajaro Valley Water Management Agency Revised Basin Management Plan Environmental Impact Study.* Aug.

(U.S.EPA) U.S. Environmental Protection Agency, Office of Water. 1998. "Wastewater Primer". Accessed 7/15/05. http://www.epa.gov/npdes/pubs/primer.pdf. pp. 16.

(U.S. EPA and IBWC) U.S. Environmental Protection Agency and International Boundary and Water Commission. 1999. Fact sheet: about the International wastewater treatment plant. http://www.epa.gov/region09/water/iwtp/ibw

(U.S.EPA) U.S. Environmental Protection Agency. 2000. "Cottonwood watershed profile". www.epa.gov/surf3/hucs/18070305/index.html. Accessed 11/2001.

(U.S. EPA) U.S. Environmental Protection Agency. 2004. "Ozone Trends". http://www.epa.gov/ozonedesignations/ozonetrends.htm. Accessed 5/25/04.

(U.S.EPA) U.S. Environmental Protection Agency, Office of Water. 2004. "Drinking Water Contaminants". http://www.epa.gov/safewater/hfacts.html. Accessed 5/25/04.

(U.S.EPA) U.S. Environmental Protection Agency. 2005. "First Border 2012 Binational Site Stabilization Action" http://www.epa.gov/region09/waste/features/metales/. Last updated on Monday, June 20th, 2005 Accessed 8/12/05.

(U.S. EPA and SEDUE) U.S. Environmental Protection Agency and Secretaría de Desarrollo Urbano y Ecología. 1992. Integrated Environmental Plan for the Mexican-U.S. Border Area, First Stage (1992-1994). A92-171.1 pp.

(USFWS) U.S. Fish and Wildlife Service. 1996. *Draft environmental assessment of proposed vernal pools stewardship project*. San Diego National Wildlife Refuge. San Diego, CA: USFWS, November.

(USDA and U.S.F.S) U.S. Department of Agriculture and U.S. Forest Service. 2004. *Southern California Land Management Plan Revisions Draft*. San Diego, May. R5-MB-052-cd.

(USGS) U.S. Geological Survey. 2004. Calendar Year Streamflow Statistics for California. http://nwis.waterdata.usgs.gov. Accessed 5/30/04.

University of Idaho. 2004. http://soils.ag.uidaho.edu/soilorders/orders.htm. Accessed 10-5-04.

Valdez Flores, J.R. 2001. Levantamiento de datos Zona Kumiai. Available at CUNA. August.

Vargas Téllez, M. April 1, 2004. Tertiary. Ensenada, B.C.

Vázquez, R. August 2004. Tecate, B.C. *pers comm. to author.*

Villarino, A. 2004. City of San Diego Metropolitan Wastewater Department. San Diego, CA, October. conversation with author.

Vizcaino, E. R., Bredceda, A., Castellon, J. de J., de la Cueva, H., Hinojosa, A., Minnich, R. (eds.). 2005. “Workshops to set conservation priorities for the terrestrial portion of the Baja California peninsula f the Baja California peninsula” unpubl.

Wakida, F., Riveles, K. 1997. *Borderlink 1997*. San Diego: Institute for Regional Studies of the Californias, San Diego State University.

Water Environment Federation. 1998. “Watershed management: moving from theory to implementation” conference proceedings. Denver, Colorado (May 3-6).

Westman, W. E. 1985. Ecology, Impact Assessment, and Environmental Planning. New York: John Wiley and Sons.

White, M. D., Stallcup, J. A., Comer, K., Vargas, M. A., Beltran-Abaunza, J. M., et al. 2004. *SCERP Monograph Series,* Border Institute, Rio Rico, AZ, p. 23.

Winters, Mayda. February 2005. San Diego, CA. pers. comm. with the author.

Wildernet. 2004. “Destination locator: San Diego County” http://areas.wildernet.com/pages/area.cfm?areaID=0502andCU_ID=1. 10-12-04. Accessed 5/18/05.

Wilken-Robertson, M., Valdez Flores, J.F., Gonzalez, J.S. 2002. *Indigenous Cultural Heritage Resource Study of the Tecate-Nejí-Rumerosa Region: Part 1 Overview*. Prepared for the International Community Foundation. Ensenada, B.C. 18.

Wilken, M. 2005. Border 2012 fund update. Report to the Water Task Force (May 26).

Willoughby, M.R. 2005. GIS-based land use suitability modeling for open space preservation in the Tijuana River Watershed. Masters thesis, Geography Dept. San Diego State University, San Diego, Ca. (Spring). Pp. 134.

Wright, R. 2005. “Hydrography”. In *Tijuana River Watershed Atlas*. Eds. SDSU, IRSC and Department of Geography and Colegio de la Frontera Norte. Publ. Institute for Regional Studies of the Californias and San Diego State University Press. San Diego, CA.

Wright, R., Ries, K., Winckell, A. 1995. *Identifying Priorities for a Geographic Information System (GIS) for the Tijuana River Watershed: Applications for Land Use, Planning, and Education*, p. 93. San Diego, CA: Institute for Regional Studies of the Californias, San Diego State University.

Wright, R. D., Baron, K., Conway, K., Warner, R. 2000. Flood hazard and risk assessment modeling with GIS in the transborder Tijuana River watershed, p. 15. Watershed 2000. Vancouver, BC, Canada.

Zúñiga, W. 2003. “Holistic vision and ecosystemic approach on basins and water” presentation to BWAC (24 April).

Appendices

Appendices

1. Appendix: BWAC responsibilities and members

The Binational Watershed Advisory Committee (BWAC) provides guidance for the Binational Vision for the Tijuana River Watershed. The duties of members BWAC are to:

- Attend quarterly meetings
- Help develop the Vision Documents
- Review and add to the website and its databases
- Help identify stakeholders
- Facilitate outreach to stakeholders
- Network with decision makers
- Represent the Binational Tijuana River Watershed Advisory Council

BWAC Co-Chairs:

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Comisión Internacional de Límites y Aguas

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Loponti Holdings, Inc.

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Executive Director and Co-founder of PROBEA

Zavala, José Carmelo

Nacional de la Industria de Transformación (CANACINTRA)

Zepeda Berrelleza, Hugo

Secretaria de Medio Ambiente y Recursos Naturales (SEMARNAT)

RESEARCH TEAM

The Binational Vision for the Tijuana River Watershed working team consists of researchers from San Diego State University, el Colegio de la Frontera Norte, and the Secretaria de Fomento y Agropequaria. The team drafts documents, facilitates stakeholder involvement, and coordinates meetings and events, among other duties. Ultimately, the team will produce a Binational Vision document that reflects stakeholders' views of the desired state of the watershed for the near and distant future.

Dr. Paul Ganster, San Diego State University
Dr. Richard Wright, San Diego State University
Dr. José Luis Castro Ruiz, el Colegio de la Frontera Norte
M.C. Walter R. Zúñiga, Universidad Autónoma de Baja California
Katherine Comer, San Diego State University

2. Appendix: Stakeholder responsibilities, meeting dates, and member organizations

Stakeholder responsibilities:

- Attend two annual meetings
- Comment on watershed goals and objectives
- Identify activities and actions needed in the watershed
- Prioritize the activities and actions
- Review final Vision document

Stakeholder organizations and meeting dates for fall 2003:

Estuary (Silver Strand Aquatic Center—Thursday, September 4th 1:00 pm-4:30 pm
19 *Participants*. Tijuana River National Estuarine Research Reserve (TRNERR); Conservation Biology Institute (CBI); California Environmental Protection Agency (Cal/EPA); Dirección de Protección Civil, Tijuana; Southwest Wetlands Interpretive Association (SWIA;, San Diego State University (SDSU); California Sea Grant, Cleveland National Forest;El Colegio de la Frontera Norte (COLEF); Instituto de Culturas Nativas de Baja California (CUNA); Regional Water Quality Control Board (RWQCB); County of San Diego; San Diego Audubon Society; San Diego Natural History Museum (SDNHM) y la Oficina del Senadora Denise Moreno Ducheny.

Tijuana I (Hotel Camino Real)—Thurs., September 18th 10:30am-2:00 pm
37 Participants. Comisión Estatal de Servicios Públicos de Tijuana (CESPT); Cámara Nacional de la Industria de la Trasformación (CANACINTRA); Dirección Municipal de Ecología; Comisión Estatal del Agua (CEA); International Boundary and Water Commission (IBWC-CILA); Dirección General de Ecología (DGE; County of San Diego; Fundación la Puerta, A.C.; Surfrider Foundation, Instituto de Culturas Nativas de Baja California (CUNA), Tijuana Trabaja, A.C.; Universidad Autónoma de Baja California (UABC); San Diego State University (SDSU);

El Colegio de la Frontera Norte (COLEF); Indiana University; Centro de Enseñanza Técnica y Superior (CETYS); Ecológico, S.C.; Baja Environmental de México, S.C.; Centro de Estudios Urbanos (CEUSS); ALAR, S.C.; Rancho Ontiveros/Loponti Holdings, Inc.

Tijuana II (Hotel Camino Real)—Saturday, September 20th 10:30am-2:00 pm
26 Participants. Universidad Tecnológica de Tijuana (UTT); la Universidad Autónoma de Baja California (UABC); Dirección Municipal de Ecología; Instituto Municipal de Planeación (IMPLAN); Comisión Estatal de Servicios Públicos (CESPT); Dirección General de Ecología (DGE); Protección Civil de Ensenada; Administración Urbana Tijuana; Instituto de Culturas Nativas de Baja California (CUNA); El Colegio de la Frontera Norte (COLEF); San Diego State University (SDSU); Arc-Vic

Tecate (Hotel Dorado)—Thursday, September 25th 6:00 pm-9:30 pm
59 *Participants*. Fondo Regional de Mujeres Nativas, Baja California, San Antonio Necua; Proyecto Fronterizo de Educación Ambiental (PFEA); Comunidad Kumiai de Peña Blanca; Comunidad Kumiai de Juntas de Neji; Fundación La Puerta, A.C.; Lluvia del Sur de Colosio; Proyecto Paz y Dignidad A.C.; Defensa Ciudadana Comité de Participación; INEH; Secretaría de Fomento Agropecuario (SFOA); Riod-Mex; Durán y Asociados; Terra Peninsular; Proyecto Autosustentable El Tecolote; CODAPEC; Municipio de Tecate (Presidencia Municipal, Dirección de Administración Urbana, Obras Públicas, Regidores, Relaciones Públicas del Ayuntamiento); SIDUE Delegación Tecate; Presidencia Municipal Valle de las Palmas; Colonia Valle de las Palmas; Consejo de Administración del Valle de las Palmas; Cervecería Cuauhtémoc Moctezuma; Rancho Ojai Tecate KOA; Asociación de Ganaderos Tecate; PACCSA Ingeniería; Solarios, Arena Consultores Ambientales; Colegio de Ingenieros Civiles de Tecate; Universidad Autónoma de Baja California (UABC); Centro de Enseñanza Técnica y Superior, Tijuana (CETYS); Universidad Iberoamericana Noreste; Instituto de Culturas Nativas de Baja California (CUNA); San Diego State University (SDSU).

Campo (Mountain Health Community Services Center)—Monday, October 6th

6:00pm- 9:30pm

32 Participants. Mountain Empire Historical Society; Lake Morena Village Council; Mountain Health and Community Services; Backcountry Against Dumps; Boulevard Sponsor Group; Mountain Empire Resources Information Taskforce (MERIT); Campo/ Lake Morena Planning District; Bureau of Land Management (BLM); the Guardian Newspaper; Campo EPA; City of Imperial Beach, City of San Diego Water District, Instituto de Culturas Nativas de Baja California (CUNA), Comisión Estatal de Servicios Públicos de Tecate (CESPTE); residents/*ciudadanos*; ranchers/*ganaderos*; well drillers/*perforistas*; San Diego State University (SDSU); Arc-Vic Construction.

3. Appendix: Resources, Agencies, and NGOs in the Tijuana River Watershed

The resources listed below are organized as follows: Background on Watersheds, Education and Outreach Programs; Centers for Environmental Education; Programs for Community Involvement; Environmental Networks; and Policy, Regulation and Research. These resources are organized for the programming needs of formal and informal educators, citizen outreach program designers and in some cases municipal outreach educators.

Background on Watersheds

Groundwater and Wetlands (U.S.) - a watershed science interactive website, includes an introduction to the hydrologic cycle, rock properties, groundwater systems, high plains aquifers, human modifications to groundwater systems, an introduction to wetlands, destruction of wetlands and quizzes and exercises. Additional weblinks.
http://www.mhhe.com/earthsci/geology/mcconnell/demo/index.html

Communicating Ecosystem Services (U.S.) - The Union of Concerned Scientists (UCS) and the Ecological Society of America (ESA) project Communicating Ecosystem Services focuses on the valuable but under-appreciated services that nature provides. The purpose of the project is to increase the public awareness of the importance of ecosystem services, and the promotion of the extension of our country's biological resources. It includes a series of tool kits and a website to help achieve the goal. http://www.esa.org/ecoservices/

U.S. Environmental Protection Agency, EPA (U.S.) - About water by regions and state (linked to water resources offices of each state), historical perspectives about water, summaries of water conferences sponsored by the EPA. http://www.epa.gov/water/. http://www.epa.gov/surf

San Diego and Tijuana Education and Outreach Programs

Aquatic Adventures (U.S.) - provides educational programs that connect underserved youth to science, inspire environmental action, and increase exposure to marine habitats. These programs engage youth in unique experiences that reveal new opportunities and engender valuable skills, empowering each individual to fulfill their potential. Aquatic Adventures facilitates five programs as well as large community events. Programs integrate language arts, math, and social studies and are aligned with California State Standards.*http://www.aquaticadventures.org*

Communities Alive In Nature (U.S.) - is an applied science, math, language arts and technology program. It uses the natural and surrounding school environments as a framework for learning or EIC (see the State Education & Environment Roundtable). It is dedicated to improving academic achievement and developing environmental literacy in students and teachers. CAN process focuses on the science concept, clarifies the concept with hands-on activities, followed by concept application in field studies and restoration activities. Curriculum is augmented with the adopted text and correlated to state content standards. The Adopt a Watershed curriculum is incorporated in the program, with customized field assessment and restoration features of the San Diego environment. CAN is a Best Practices Program recognized by The Chamber Foundation's Business Roundtable for Education. mailto:comalive1@aol.com

The Nature School (U.S.) - promotes environmental awareness and education by offering programs on coastal creeks, fresh water habitat, stream ecology, fishery conservation and water quality monitoring. The School is involved in coastal creek and fresh water habitat advocacy; stream ecology and fishery conservation education; in class fish hatchery and field science, and water quality monitoring. Contact: 619.224.2003.

Project Clean Water (U.S.) - represents a collective effort by the municipalities of San Diego County. More than 100 stakeholders are involved and committed to make a collective effort to assure Clean Water in the San Diego region. There is a strategic plan for the region, updates from each of the Technical Advisory Committees (TAC) in science/technology, legislative/funding and education/outreach. There is an inventory of education and outreach programs in the Region and in California. http://www.projectcleanwater.org/index.html

Project SWELL - *Stewardship: Watershed Education for Lifelong Leadership* (U.S.) -The beginnings of watershed curriculum written for San Diego Schools consisting of worksheets addressing urban runoff originating from school grounds for grade 5. There is a set of worksheets addressing runoff from different areas, effects to groundwater, rivers and ocean. Contact: San Diego City Schools, Science Department

Proyecto Bio-regional de Educación Ambiental, PROBEA (MEX) - a program of the San Diego Natural History Museum, PROBEA is a binational, inter-institutional, multidisciplinary collaboration between partners who seek to inspire teachers and community workers through environmental education. It focuses on strengthening communities through trainings and active involvement in our bio-region, as well as builds relationships between neighbors through collaborations and sharing ideas and resources. Founded in 1991, PROBEA has been facilitating environmental education programs and events in San Diego and the Baja California peninsula since 1993. PROBEA designs innovative curricula to facilitate environmental education workshops and to spur enthusiasm for education among scientists, conservationists, volunteers and teachers. The program uses innovative methodology to introduce environmental themes and activities promoting an earth stewardship ethic. PROBEA unites communities in conservation efforts through education and training and strengthens the relationships between Mexico and the U.S. by collaborating on projects and sharing ideas and resources. PROBEA supports citizens in caring for their environment to create a more sustainable future. mailto:probea@ hotmail.com. http://www.sdnhm.org/education/binational

Proyecto Fronterizo de Educación Ambiental A.C., PFEA (MEX) - is a civil organization dedicated to the development of change-generating processes in environmental practice and policy, at the local and international levels. Their goal is to promote efficiency in social participation based on partnership building and facilitating citizens' access to environmental information. PFEA seeks to strengthen the institutional framework to achieve the development of a sustainable society. PFEA is a non-profit, non-political organization with the following principles: ecosystems determine the quality of life; the community is co-responsible for environmental preservation; and each individual has the right to access information that guarantees his right to a healthy environment. Only a democratic, informed and participatory society is able to prevent and face present environmental challenges. http://www.proyectofronterizo.org

San Diego County Office of Education Outdoor Education (U.S.) -

The Splash Van: A mobile science lab featuring five different stations where kids use computers, microscopes, chemistry experiments and living creatures to learn about water quality and insect life. The lab teaches students the connection between human activities and the health of the environment.

The Green Machine: An interactive exploration program that teaches agricultural awareness at three stations: a soils research station with live earthworms, the water cycle station with dramatic role play scenarios and costumes, and an integrated pest management station with interactive role play and insect puppets. Both the Green Machine and the Splash Van are operated by the San Diego County Office of Education. Contact: 858.694.7000

The San Diego National Wildlife Refuge Complex (U.S.) - along with partners Chula Vista Nature Center and Tijuana Estuary Visitor Center, offers three environmental education experiences for grades K-6 that explore plants, animals, sea life and their habitats in the classroom and in the field. They include: Sweetwater Safari, Tijuana Estuary Explorers and Habitat Heroes. All materials meet state standards, and some transportation grants are available. "The Pelican Van" depicts area ecosystems and wildlife and is available to visit Orange County schools. Other environmental education opportunities are available at several of our San Diego and Orange County Refuges. Contact: 619.691.1262. http://sandiegorefuges.fws.gov

San Diego County Water Authority Education for Teachers & Students (U.S.) - The San Diego County Water Authority provides FREE educational programs and materials for grades K-12 to San Diego County educators. Some materials require an in-service at your school. To schedule an in-service or classroom presentation, or order materials, please call the School Education Program. Mini grants are also available for school based water projects. http://www.sdcwa.org/education/teachers.phtml

Solana Center for Environmental Innovation (U.S.) - formerly known as Solana Recyclers, dedicated to environmental education, resource conservation, and sustainable agriculture. The Solana Center provides information and opportunities for citizens and businesses to take responsible action toward conserving natural resources and building a sustainable future. The Center will provide interactive class presentations which focus on pollution prevention, watershed education, composting, and natural resource conservation in English & Spanish. http://www.beresourceful.org/. http://www.solanacenter.org

The TidePool Cruiser (U.S.) - The sixteen-foot TidePool Cruiser addresses the critical issue of non-point source (NPS) pollution and its effect on the marine environment in an exciting, innovative, and hands-on way. Participants are given the tools they need to decide for themselves the type of impact they will have on the beaches and coastal waters of southern California. The TidePool Cruiser travels to schools and parks around southern California from Santa Barbara County to the Mexican border. http://www.windowsonourwaters.org/wow/tidepoolcruiser.shtml

State, National, Global Programs

Adopt-A-Watershed, (U.S.) - a K-12 watershed science curriculum and leadership institute for educator teams to support the implementation of project based learning units. These curriculum units are teacher created, attested and resource agency reviewed for accuracy and neutrality. Many units have been adapted to the urban environment by San Diego County teachers. The curriculum is easily augmented with adopted text and meets California content standards. http://www.adopt-a-watershed.org/

Cal Alive! (U.S.) - The California Institute for Biodiversity (CIB), the creators of the Cal Alive! Project, is a Bay Area-based non-profit organization. CIB is dedicated to improving science literacy, environmental education, and the appropriate use of technology in classrooms throughout the state. Since its inception by executive director Carol J. Baird, Ph.D. in 1995, CIB has helped thousands of teachers introduce their students to the biological diversity of California. As one of the world’s ten biodiversity “hotspots,” California offers its citizens and students a remarkable opportunity to learn important scientific concepts and environmental values in the context of the natural world around them. By providing high-quality software for students as well as support materials and in-depth professional development opportunities for educators, CIB has improved science education in California schools. http://www.calalive.org.

Environmental Education Exchange (U.S.) - is a nonprofit 501(c)(3) organization established to enhance and expand the environmental literacy of inhabitants and visitors in the unique desert regions of the southwestern United States and northwestern Mexico.

The *Exchange* offers expertise in environmental education to a wide range of public agencies, private organizations, school districts and businesses. The *Exchange* works to provide individuals with the knowledge, values, and skills necessary to actively contribute to a healthy and sustainable environment in this culturally diverse area of rapid population growth and urban development.

The *Exchange* is committed to developing programs and materials that present a fair, balanced approach to environmental issues and strives to design programs which are ecologically sound, culturally appropriate, and sensitive to regional considerations. http://www.eeexchange.org

GLOBE (U.S.) - is a worldwide hands-on, primary and secondary school-based science and education program. Globe provides students the opportunity to learn by taking measurements in the fields of atmosphere, hydrology, soils, and land cover. They then report this data on the Internet. Students communicate with other students and scientists about the studies they are undertaking. GLOBE is a cooperative effort of schools, led in the United States by a Federal interagency program supported by NASA, NSF, EPA, and the State Department, in partnership with over 140 colleges and universities, state and local school systems, and non-government organizations. Internationally, GLOBE is a partnership between the United States and 97 other countries. Available in Spanish. http://www.globe.gov/fsl/welcome.html

National 4-H (U.S.) - Curriculum in English and Spanish: Environmental Education and Earth Sciences, Citizenship & Civic Education, Science & Technology, Plants & Animals, Wildlife Habitat Evaluation program for urban and rural habitats.
http://www.national4-hheadquarters.gov/4h_curric.html

NSTA Journal Articles (U.S.) - Elementary & Intermediate School Resources, sorted by grade level to provide ideas for classroom activities and lessons related to the earth's environment and ecosystems. http://science.nsta.org/enewsletter/2003-01/elementary.htm
http://science.nsta.org/enewsletter/2003-01/intermediate.htm

National Wildlife Federation, NWF (U.S. & MEX) - is the largest member-supported conservation organization in the United States. It was founded in 1936 to help stem the loss of wildlife habitat during the dust bowl era. NWF has nine regional offices, over 1.1 million individual members, and state-wide affiliates in 45 states, as well as in the Virgin Islands and Puerto Rico. NWF is known for its award winning publications for children and adults, its high quality educational training courses for teachers, its popular web site and its "common sense" approach to wildlife and habitat conservation.

NWF's signature environmental education training courses, such as Schoolyard Habitats, have been presented to thousands of teachers in almost every state in the U.S. Through the *Alianza para la Vida Silvestre* project, NWF is working with partners in Mexico to make these training courses available to Mexican teachers in a culturally appropriate manner. http:// www.nwf.org

Project Learning Tree, PLT (U.S.) - is an award winning, broad-based environmental education program for educators and students in PreK - grade 12. PLT helps students learn HOW to think, not WHAT to think, about the environment. PLT, a program of the American Forest Foundation, is one of the most widely used environmental education programs in the United States and abroad. PLT materials bring the environment into the classroom and students into the environment. The program covers topics ranging from forests, wildlife, and water, to community planning, waste management and energy. Some materials are available in Spanish. http://www.plt.org/about/index.cfm

Project Wild (U.S.) - is a K-12 interactive, interdisciplinary wildlife conservation and environmental education program supported by natural resource agencies. It provides information about and sample materials from an interactive, interdisciplinary wildlife conservation perspective. http://www.projectwild.org/

Schools Online (U.S.) - Website for K-12 educators that features brief text or animated presentations on such subjects as planting, tending gardens, helping students to become more aware of plants, animals & humans interact with the ecosystems. Some activities are available on CD ROM & in Spanish. http://www.ultralab.anglia.ac.uk/pages/schools_online/Contents.html

TreePeople (U.S.) - The mission of TreePeople is to inspire the people of Los Angeles to take personal responsibility for the urban forest, training and supporting them as they plant and care for trees and improve the neighborhoods in which they live, learn, work and play. The mission reaches beyond the simple act of planting a tree. The K-12 education programs raise environmental awareness and they also enrich academic lessons and teach potent life skills. While the forestry programs restore watersheds and fragile habitats, they also heal inner-city communities, bring neighbors together, cool and green campuses, and address serious urban issues such as water and energy conservation, flood prevention and storm-water pollution. The Transagency Resources for Environmental and Economic Sustainability (T.R.E.E.S.) project is changing the nation's approach to urban watershed management, motivating other cities to adopt "best management practices" and follow our lead. The project demonstrates the technical and economic feasibility (and desirability) of retrofitting the city to function as an urban forest watershed. It promotes strategic landscaping and other sustainable watershed management practices for residential and commercial properties. These practices can conserve water, reduce pollution, create open space and recreational opportunities, and provide jobs for youth in their own communities. Contact: 818.623.4884. http://www.treepeople.org/trees

Union of Concerned Scientists, UCS (U.S.) - An interactive module that looks at the impacts of global warming on the California habitats and ecosystems. http://www.ucsU.S.a.org/climatechange/california.html

U.S. EPA Environmental Education (U.S.) - Activities by grade level and by region, professional development, grant opportunities and events. *Email requests for information can be made in Spanish.* http://www.epa.gov/enviroed/

U.S. Fish and Wildlife Service (U.S./Global) - Activities include distance learning programs for students of all ages, materials, curricula, on-line programs and events. http://www.fws.gov/kids/educators

United States Geological Survey USGS Learning Web (U.S.) - Dedicated to K-12 learning and life long learning about people, places, plants and animals and how to find balance. Teacher resource site provides lesson plans, project scenarios, hands on activities to understand mapping, faults, land formations, etc. Project site offers interactive modules. One scenario is an environmental study of Los Angeles. Students are given an opportunity to study real environmental dilemmas concerning geologic and hydrologic hazards and provide solutions to these dilemmas. http://www.U.S.gs.gov/education/

Water Education Foundation (U.S.) - is a non-profit organization whose mission is to create a better understanding of water issues and help resolve water problems through educational programs. Example: *Where Does Your Water Come From*? http://www.watereducation.org

Waves Wetlands and Watersheds (U.S.) - A science activity guide for students in formal and informal settings to assist in learning about California coastal issues from upstream pollution to sand and cliff erosion on the California coast. Free workshops available. California Coastal Commission Science activity Guide, Julia Copple Davenport, Curriculum Developer 2003. Contact: 415.904.5400. http://www.coastforyou.org

Centers for Environmental Education in the San Diego/Tijuana Region

The Birch Aquarium (U.S.) - has a range of different outreach and on-site programs and exhibits dealing with the ocean and its inhabitants for grades K-12. All the programs require a fee and are either classroom or on-site presentations. To find out more about the programs and to reserve a presentation visit their website. http://www.aquarium.ucsd.edu/education/education.html

The Chula Vista Nature Center (U.S.) - Its mission involves educating the public on the importance of coastal resource conservation at Sweetwater Marsh National Wildlife Refuge. This is accomplished through collaboration with the Refuge on Sweetwater Safari, a science and language arts based field experience as well as off-refuge field trips, guided walks, classes, tours, and special projects. Its program includes a full-time Science Resource Teacher who works closely with the Nature Center staff to provide environmental education programs which are integrated in their science and social studies curricula. Contact: 619.476.7836 (Chula Vista Elementary School District teachers) Contact: 619.409.5903 (Teachers and organizations outside the district) http://www.chulavistanaturecenter.org

Ecoparque (MEX) - is a program of El Colegio de la Frontera Norte. Its mission is to raise environmental awareness in visitors and the community at large. It was designed to contribute to the goal of achieving urban sustainability. *Ecoparque* has in place an ambitious environmental education program that serves thousands of students, educators and volunteers in the city of Tijuana by using its water treatment plant and other resources as a demonstration of what can be done to improve our environment. http://www.colef.mx

Las Piedras Environmental Education Center (MEX) - founded by Fundación La Puerta, a magical and inspiring site at the foot of Mount Cuchama in Tecate, Baja California, Mexico. Its mission is to encourage a love for nature through environmental education by teaching knowledge of natural processes and understanding the relationship between man and nature. Its main goals are to link the Tecate community to their natural environment and to support teachers with training, materials and activities to integrate environmental education into their curriculum. mailto:laspiedras@fundacionlapuerta.org. http://www.fundacionlapuerta.org

National Park Service – Cabrillo National Park (U.S.) - is responsible for the conservation of scenery and natural and historic objects of its parks for the enjoyment of future generations. Cabrillo National monument offers educational programs for 2rd through 5th grade students. Programs include the history of Cabrillo's 1542 expedition along the California coast; the ecology and adaptation of plants and animals; Native American use of plants found in the coastal sage scrub habitat. http://www.nps.gov/cabr/

Quail Botanical Gardens (U.S.) - Quail Botanical Gardens is dedicated to the conservation of rare and endangered plants from across the globe. San Diego visitors and residents are invited to experience this spectacular collection of flora. Tours, nature walks, lectures, landscape advice and instructional programs are offered to advance public awareness of plant diversity. http://www.qbgardens.com/

***The San Diego Natural History Museum* -** (U.S./MEX) offers a variety of programs for grades K-6. They offer grade appropriate workshops presented by the museum's staff at the Museum, or as an outreach program conducted at your school. There is a fee required for the programs.
Contact: 619.255.0210, Museum Education Department
Contact: 619.255.0228, Binational Education, PROBEA/Mexico project.
http://www.sdnhm.org. http://www.sdnhm.org/education/binational

The Tijuana Estuary Visitor Center (U.S.) - Managed by California State Parks and the U.S. Fish and Wildlife Service, the Visitor Center offers a variety of hands-on, interactive activities for visitors of all ages as well as a collection of videos (including videos in Spanish) that are shown upon request. The educational videos are intended to educate the public about estuaries and watersheds, including estuary flora and fauna, estuarine ecology and natural processes. The Tijuana Estuary has exciting, hands-on education programs for students as well as tours, informative lectures and other outreach opportunities for adult audiences. In addition to ongoing programs, the Tijuana Estuary also puts on special events throughout the year, such as Batmania in October and Earth Day activities in April. Contact: 619.575.3613

Ongoing activities and special events support the estuary's mission to provide interactive, hands-on, thematic, bilingual, environmental education to local and regional students and the community, working in partnership with local schools, community groups and government agencies. See programs diagramed below:

School Groups:
Estuary Explorers or M.A.R.S.H.

Adult Programs:
Speaker Series or Coastal Training Program

Other Programs for Kids:
Jr. Rangers or Scout Groups

http://www.tijuanaestuary.com/calendar

Programs for Community Involvement

Earth Force, Protecting Our Watersheds, POW (GLOBAL) - is a program for middle school students to study their watersheds and work on projects to improve the health of their watersheds. It can be used in a variety of settings. This site is a part of the GREEN site and provides a free activity download. http://www.earthforce.org/pdf/uploaded/Sample.pdf

Fundación Esperanza de México, A.C., FEM (MEX) - is a non-profit, non-sectarian, social service civil association. Formally incorporated in 1990, the foundation implements programs focused on initiating community development and promoting communities´ self autonomy. It has developed a program for self-construction of housing that does not require a skilled workforce, but depends primarily on volunteer labor. FEM has successfully worked in collaboration with other social organizations and community groups. Since 1994, it has promoted the creation of *Fondos de Ahorro para la Vivienda* (FAV), Housing Savings Groups. To date, 110 families have participated in the FAV with the aim to gain dignified housing, not only for themselves, but other families. http://esperanzademexico.org

Give Water A Hand (U.S.) - is a highly acclaimed national watershed education program designed to involve young people in local environmental service projects. It is applicable to formal and informal applications and it engages and empowers students to understand and the find solutions to water quality issues in different settings. http://www.uwex.edu/erc

Global Rivers Environmental Education Network, GREEN (GLOBAL) - was created to improve the water lifelines of the world, thereby the lives of all people. Like a river, GREEN crosses political, cultural and economic boundaries to help participants share information and ideas for positive action in defense of their local rivers and watersheds. People from 133 nations are linked through an international network of students, teachers and institutions.

The new *GREEN* website can help you make the lasting improvements to your watershed by offering an online monitoring database and community action tool. Designed for monitoring groups and interested browsers alike, the site contains a national database of locally generated data for biological, chemical, physical and land use information; special project pages for registered users to create customized records of their watershed monitoring and action projects. Detailed Action Steps and Checklist systems to lead users through a step-by-step monitoring and problem-solving process; extensive resources to support monitoring and action taking ability for large watershed monitoring groups to review and coordinate monitoring data from affiliated monitoring groups; it offers concise summaries and curricular resources for educators. http://www.earthforce.org/green/

I Love A Clean San Diego (U.S.) - is dedicated to empower the community to act in ways that are economically viable and ecologically sustainable. It offers a wide range of community education programs and clean-up events. http://www.ilacsd.org/

Isaak Walton League of America (U.S.) - one of the oldest conservation organizations in America was founded in 1922, in response to the noticeable degradation of the stream conditions in America. It supports many conservation programs for citizen monitors, youth programs and more. Save Our Streams is a well known program originated by the League. http://www.iwla.org/

Ja Jan (MEX/U.S.) - keeps the border communities of California and Baja California informed about coastal water quality conditions, promotes water pollution prevention and encourages constructive community participation in addressing the region's water pollution. *Ja Jan* monitors water quality at various high-use public beaches in the U.S.-Mexico border region and then distributes the results of the tests to the public in English and Spanish. *Ja Jan*'s monitoring work is geared towards the creation of a permanent, accessible and reliable source of water quality data for the inland and coastal watersheds of the region. Current monitoring sites include: Imperial Beach, Playas de Tijuana, Baja Malibu, Rosarito, San Miguel, El Sauzal and other important locations. *Ja Jan* also trains and organizes citizens on both sides of the border so that they can participate in beach water quality monitoring, and conducts bilingual environmental education campaigns to inform students and the community about the impacts of water pollution and pollution prevention. http://www.jajan.org

Los Niños (U.S./ MEX) - has as its mission to improve the quality of life by creating opportunities for children and their families to realize their human potential through participation in the development of their communities. *Los Niños* defines Community Development as a participatory process through which community members identify community needs and organize themselves to take the actions necessary to improve their quality of life. *Los Niños* believes that sustainable communities with healthy children are the foundation of a strong civil society. It provides opportunities to nurture human potential through self-reliant activities that promote community development, food security, social justice, and human dignity. http://www.losninosinternational.org

Project Wet International (GLOBAL) - The Discover a Watershed Series is comprised of publications for children and adults, diverse community education events (e.g., expeditions, festivals, and workshops), and networking services. Focused on major watersheds in North America and Mexico. http://www.discoverawatershed.org/

San Diego Baykeeper (U.S.) - is dedicated to the principal that protecting California's precious coastal waters is the job of every citizen. As such, we have developed programs that involve the community directly in stewardship of local waters. It offers many activities and training opportunities including: citizen monitoring, kelp monitoring and restoration, beach clean-ups, internships, pollution hotline and more. http://www.sdbaykeeper.org/programs/programs.htm

San Diego National Wildlife Refuge Complex (U.S.) - San Diego's Refuges offer a variety of environmental education programs in the field and in the classroom in collaboration with its partners, the Chula Vista Nature Center, Tijuana Estuary and with the Friends of San Diego Wildlife Refuges and other partners. http://sandiegorefuges.fws.gov

Surfrider Foundation (GLOBAL) - is dedicated to the preservation and conservation of coastlines and beaches. The Foundation is international. Website allows access to current ocean water quality by county and state. http://beach.com/beachwaterquality/

Environmental Networks and Collaboratives

Binational Watershed Advisory Council (U.S./MEX) - A binational team of researchers and practitioners, the Binational Watershed Advisory Council (BWAC), has been organized by the Institute for regional Studies of the Californias and the Department of Geography at San Diego State University (SDSU). Funding sources include the State of California, the County of San Diego, and SDSU. The Avisory Council has developed baseline information about the watershed and identified stakeholders from various sectors. The stakeholders meet periodically to develop a binational vision for the Tijuana River Watershed. The vision will contain stakeholders' views about the ideal state for their watershed in the near and distant future and will recommend strategies and alternatives for achieving that vision. http://www.trw.sdsu.edu

Border Environmental Education Web (MEX/ U.S.) - A resource directory of organizations in Mexico and U.S. involved in Environmental Education. This site has been made possible through generous assistance from the USDA Forest Service- Region III, and the U.S. Environmental Protection Agency's San Diego Border Liaison Office. This site offers comprehensive and up-to-date information on environmental education programs and providers along the U.S.-Mexico border. Search our easy-to-use database for resources, programs, or people. We invite you to provide us with information on your organization, or update an existing organizational entry. http://www.bordereeweb.net

The Border EcoWeb (U.S./MEX) - is designed to facilitate public access to environmental information for the U.S.-Mexican border region. The Border EcoWeb INVENTORY provides brief descriptions and links to various datasets available on the Internet. These links are organized by media, organization, and region. Also developed is a DIRECTORY that contains contact information and project descriptions for government agencies and other groups involved in activities dealing with the border environment. http://www.borderecoweb.sdsu.edu/

California Regional Environmental Education Community Network, CREEC **(**U.S.) - The State of California has organized itself into 11 regions throughout the state and established local contacts for EE resources, events and opportunities pertinent to those regions. Each region can be accessed through the following website as well as the regions website. http://www.creec.org

California Native Plant Society (U.S.) - is dedicated to increase the understanding and appreciation of native plants of California and to preserve them in their natural habitats through science activities, education and conservation. http://www.cnps.org/

Sierra Club (U.S.) - is dedicated to exploring, enjoying and protecting the planet. Its website provides an update on local environmental issues, rare plant list for San Diego County, photographs, environmental links and links to local decision makers.
http://www.sierraclub.org/ca/

Consejo de Educación Ambiental para las Californias, CEAC; Environmental Education Council for the Californias, EECC (MEX/ U.S.) - A cross border organization of environmental education and border environmental organizations whose purpose of advancing a culture of sustainability in the region by addressing the environmental, economic, and social access issues surrounding environmental education in the Californias. It focuses on increasing environmental awareness and understanding and the subsequent behavior leading to responsible action for the environment. http://www.ceac.net. http://www.eecc.net

EE Link (GLOBAL) - A project of the North American Association of Environmental Education, NAAEE, the link is a primary source for environmental education resources, for school based and outreach applications. http://www.eelink.net/

Environmental Education and Training Partnership, EETAP (U.S.) - The EETAP Project was designed to assist educators, by helping them learn how to incorporate environmental education into their curriculums through quality training and related support services. The goal of the EETAP Resource Library is to provide access to quality resources and information through a virtual library, various publications, and instruction on using EE databases to find information. http://www.eetap.org/

Policy, Regulation and Research

Association for Borderland Studies (MEX/ U.S.) - The comparative study of international boundaries and border regions has gained new urgency and vitality in the post-Cold War, 21st century world. Contemporary issues include regional economic integration, the emergence of new post-Communist nation states, the proliferation of ethnic conflicts, security versus openness of borders, and the need to institutionalize management of trans-boundary problems ranging from immigration to shared environmental problems to public health and economic development concerns. http://www.absborderlands.org/

Project Clean Water (U.S.) - represents a collective effort by the municipalities of San Diego County and more than 100 stakeholders dedicated, committed to make a collective effort to assure Clean Water in the San Diego region. Includes a strategic plan for the region to attain the vision of PCW, updates from each of the Technical Advisory Committees (TAC) in the science/technology, legislative/funding and education/outreach. Includes and inventory of education and outreach programs in the Region and in California. http://www.projectcleanwater.org/index.html.

Proyecto Fronterizo de Educación Ambiental A.C., PFEA (MEX) - is a civil organization dedicated to the development of change-generating processes in environmental practice and policy, at the local and international levels. Their goal is to promote efficiency in social participation based on partnership building and facilitating citizens' access to environmental information. PFEA seeks to strengthen the institutional framework to achieve the development of a sustainable society. PFEA is a non-profit, non-political organization with the following principles: ecosystems determine the quality of life; the community is co-responsible for environmental preservation; and each individual has the right to access information that guarantees his right to a healthy environment. Only a democratic, informed and participatory society is able to prevent and face present environmental challenges. http://www.proyectofronterizo.org

The Center for Sponsored Coastal Ocean Research - Coastal Ocean Program, CSCOR/COP (U.S.) - is an important federal-academic partnership providing predictive capabilities for managing coastal ecosystems. CSCOR/COP seeks to deliver the highest quality science in time for important coastal policy decisions by supporting high-priority research and interagency initiatives related to NOAA's mission in three goal areas: Coastal Fisheries Ecosystems, Cumulative Coastal Impacts, Harmful Algal Blooms/Eutrophication. http://www.cop.noaa.gov/Fact_Sheets/CSCOR_Gen.html

El Colegio de la Frontera Norte, COLEF (MEX) ***COLEF – ORSTROM joint Digital Mapping Project*** (MEX/U.S.) - In this project, the partners propose to evaluate the uses and dynamics of renewable resources in relation to economic and demographic activities. The evaluations will allow the diagnosis of certain aspects of management of the Mexican Border environment between the mouth of the Colorado River and the Pacific Coast and do a comparative analysis with the system north of the border. http://govinfo.ucsd.edu/maps/colef/colef.html.

Institute for the Regional Studies of the Californias, IRSC (U.S./MEX) - The Institute for Regional Studies of the Californias (IRSC) provides San Diego State University with a forum for the investigation, discussion, and dissemination of information about the United States-Mexican border region. The Institute focuses on the border region of California and Baja California and is also concerned with important issues of the United States-Mexican interface and monitors border regions elsewhere in the world. Created in 1983, the Institute has undertaken multidisciplinary applied research projects on important regional concerns including trans-border environmental issues, policy perspectives of the California-Mexico relationship, quality of life, and sustainable development. IRSC also plays an active role in Mexico-related professional organizations and is frequently consulted on trans-border issues by the media, nongovernmental organizations, the public sector, and other border stakeholders. Other Institute activities include conducting binational symposia; improving communication between public and private sector representatives on both sides of the border; serving as a clearinghouse for information on trans-border events, issues, and institutions; and encouraging the effective use of educational resources among the region's universities. The Institute serves as a major link between SDSU and Mexican institutions. IRSC has an ongoing publications program that includes books, monographs, and shorter items. Many titles are co-published with SDSU Press. IRSC has under way major applied research projects on border environmental issues and policy, regional economic issues, and trans-border planning issues. IRSC serves as the SDSU link to the *Southwest Center for*

Environmental Research and Policy, a congressionally established consortium of Mexican and U.S. universities for research and policy studies on environmental issues of the border. http://irsc.sdsu.edu.

National Library for the Environment (U.S.) - Issues covered include global climate change, population and environment, ocean and coastal resources and biodiversity. The site also accesses environmental virtual libraries and congressional research reports. It is a project of the National Council for Science and the Environment. http://www.ncseonline.org/NLE/

ProPenínsula (MEX) - is an organization dedicated to the preservation of natural resources of Baja California through the strengthening of local organizations. http://www.propeninsula.org

The Southwest Center for Environmental Research and Policy, SCERP (U.S./MEX) - is a consortium of five U.S. and five Mexican universities which serves U.S.-Mexican border residents by applying research information, insights, and innovations to environmental challenges in the region. http://www.scerp.org

Comisión Estatal de Servicios Públicos de Tijuana, ***CESPT*** (MEX) - Their mission is to guarantee the efficient delivery of potable water and clean-up services to the municipalities of Tijuana and Playas de Rosarito so that they can contribute to improve the residents' quality of life, the development of the region and environmental conservation. Their staff is committed with their mission's essence and their calling for service which exceeds user expectations. http://www.cespt.gob.mx

Comisión Nacional del Agua, CNA (MEX) - Their mission is to manage and conserve national waters with the community's participation in order to achieve a sustainable use of the resource. For CAN, managing and conserving national waters is to assess them for quantity and quality, estimate their availability, grant concessions, assignments and reserves for a fairer and more efficient use. It also encourages user participation in watershed boards to maintain a hydrological balance and satisfactory water quality. Community participation will be achieved by establishing a water culture which is the set of habits, behaviors and manners in which people use this resource efficiently and rationally. http://www.cna.gob.mx

U.S. EPA Region IX (U.S.) - EPA's commitment to environmental protection includes providing educational services for educators, students, youth groups, the community and environmental organizations. Competitive grants are offered to support environmental education, environmental education publications for classroom use, and youth awards program. The U.S.-Mexico Border XXI Program is an innovative binational effort that brings together U.S. and Mexican entities to work toward sustainable development. http://www.epa.gov/region09/water/

USDA Forest Service – Cleveland National Forest (U.S.) - The mission of the Forest Service (FS) is to achieve quality land management under the sustainable land use multiple use concept in order to meet the diverse needs of people. The Cleveland National Forest, a unit of the U.S. Forest Service, offers Project Learning Tree, Wilderness Education and Fire Ecology education programs to students and teachers. A binational children's educational camp was recently sponsored in Baja California. http://www.fs.fed.U.S./r5/cleveland/

U.S. Fish & Wildlife Service (U.S.) - The Service is the principal federal agency responsible for conserving, protecting, and enhancing fish and wildlife and their habitats for the continuing benefit of the American people. The Service manages the 93-million-acre National Wildlife Refuge System comprised of more than 500 national wildlife refuges, thousands of small wetlands, and other special management areas. San Diego County is home to several wildlife refuges: South San Diego Bay, Tijuana River Estuary, Sweetwater Marsh, and San Diego National Wildlife Refuges (NWR). A variety of educational programs are offered from interactive exhibits, nature hikes and youth programs depending on location. http://sandiegorefuges.fws.gov. http://www.fws.gov/kids/educators

Also the U.S. Fish & Wildlife Service Division of Education Outreach provides training and support for conservation professionals to develop and implement collaborative outreach, education and heritage programs that achieve conservation goals. Library resources, training courses, maps, pictures and videos can be accessed through this site. http://training.fws.gov/deo/education.html.

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meeting

Actions	Locations	# Votes	Subject	Meeting
Recognition and respect for the Kumiai people	Watershed wide	24	Socio-econ	Tecate
Integrated management of trash (education, incentives, bins, recycling, penalties, citizen participation)	Region	21	Waste	Tecate
Create a new border crossing	Jacumba	15	Ecosystem	Campo
Interagency Bracero program to control undocumented immigration (coyotes) and drug traffic	Ranches and roadways along the border	14	Socio-econ	Campo
Water re-use, new and appropriate technologies, investments	Valle de las Palmas, Arroyo Alamar, Tijuana River	13	Water	Tijuana Fri.
Indientify critical points such as deforested, over exploited sand mines, and stream meanders, that are risks	Watershed wide	13	Water	Tecate
Wildlife corridors	Backcountry, La Posta Corridor, La Rumorosa to Cuyamaca Mountains (with Federal open lands and includes La Gloria and Smith Canyons) all the way to Joe Bill Canyon	12	Ecosystem	Campo
Enforce the ordenamiento del territorio municipal	Tecate	11	Ecosystem	Tecate

Actions	Locations	# Votes	Subject	Meeting
Research on ground water quality, including bacteria, and nitrates	Watershed wide	11	Water	Campo
Enforce the laws that regulate urban planning	Tijuana, Tecate	10	Ecosyste m	Tijuana Sat.
Create a culture of water conservation	Mexico	9	Water	Tecate
Promote a culture of better municipal solid waste generation and management	Schools, Universities, work centers	9	Waste	Tijuana Sat.
Analyze, monitor, and identify water sources	Watershed wide	9	Water	Tijuana Sat.
Create green areas: areas naturales protegidas, parks, and gardens	Watershed wide	9	Air	Tijuana Sat.
Evaluate the aquifers	Alamar River, Tijuana River, and watershed wide	8	Water	Tijuana Sat.
Convince Campo Band to abandon proposed 400 acre landfill	Campo Reservation near Jardines de Rincon	8	Waste	Campo
Encourage greater use of Mexican roads over U.S. roads (reduce tolls?) and make them easier to use for truckers	Mexico	8	Socio-econ	Campo
Create incentives for conservation and development of natural areas: economic, training, assessment, technical, fiscal	Watershed wide	8	Socio-econ	Tecate
Use scientific studies for landuse planning	Campo and Backcountry	7	Socio-econ	Campo
Apply treatment to 100% of the wastewater	Critical points of discharge	7	Water	Tecate
Diversification of water sources	Dams upstream, Rodr¡guez Dam	7	Water	Tijuana Fri.

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Market current recreational opportunities and expand infrastructure for cross-border vacations, driving loops, ecotourism, camping. Lengthen Pacific Crest Trail to the Sierra Juárez. Facilitate cross-border field visits, training, planning.	Laguna Mountain (Cleveland National Forest, Laguna Hanson, Sierra Juárez	7	Socio-econ	Silver Strand
Adopt an environmental training program in poor communities in Mexico regarding native vegetation and its importance for quality of life	Mexico	7	Ecosystem	Campo
Encourage use of school-based environmental curriculum on recycling, proper waste disposal	Mt. Empire and San Diego Schools and Mexico	7	Waste	Campo
Identify ecologically sensitive zones to preserve the dynamics of the watershed ecosystem	Riparian areas, with a rich variety in flora and fauna species, and erosion sensitive zones	7	Ecosystem	Tijuana Fri.
Build/enhance GIS-based surveys of cultural and historic sites (i.e.. Bird Alas SDNHM)	Watershed wide	7	Socio-econ	Silver Strand
Create planning and regional coordination mechanisms for the watershed	Watershed wide	7	Socio-econ	Tijuana Fri.
Delimit streams (right of ways)	Watershed wide	7	Water	Tijuana Fri.
Implement and give value to the environmental legislation in all branches of government	Watershed wide	7	Waste	Tijuana Sat.
Legally protect areas for aquifer refill (management of natural and artificial recharge)	Watershed wide	7	Water	Tijuana Fri.
Revegetate to reduce dust	Watershed wide	7	Air	Tecate
Survey to identify important areas	Watershed wide	7	Ecosystem	Silver Strand

Actions	Locations	# Votes	Subject	Meeting
Regulate land use development permits in Mexico that have the potential to impact watersheds through Binational cooperation	San Pablo, Tecate, Well fields, and National Areas	6	Ecosystem	Campo
Demarcate streams and tributaries	Watershed wide	6	Water	Tecate
Implement activities such as channelization, desasolve y limpieza de las cauces	Watershed wide	6	Water	Tecate
Provide education and training for teachers, students, parents, promotoras	Watershed wide	6	Waste	Silver Strand
Reduce waiting time for border crossing		6	Air	Tijuana Fri.
Increase local green space using low-tech infrastructure, local skills, community groups, including wetlands restoration, hiking trails, river flood plains, recreation areas, habitat linkages, earthen flood control berms	Alamar River, Tecate Creek, Cottonwood Creek, Las Palmas (future Tijuana bedroom community), upper watershed creeks, small villages, ejidos	5	Socio-econ	Silver Strand
Create a "procuracuría de la defensa" for public spaces	Mexico	5	Socio-econ	Tecate
Regulate power plant emissions at local, regional, and national levels	Northern Baja	5	Air	Campo
Official recognition for the Kumiai people of Baja California	San José Tecate, Juntas de Neji, Tamamá, San José de Lazorra	5	Socio-econ	Tijuana Sat.
Educate children on ecosystems with the goal of educating the parents	Schools	5	Water	Tecate
Ask for the new sewage treatment plants project to analyze and discuss	Tijuana	5	Water	Silver Strand
Create congruent and collateral public policies	U.S./Mexico	5	Air	Tijuana Fri.

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Distribute information about the natural capital benefits of the watershed and cultural responsibilities	Urban zones	5	Socio-econ	Tijuana Sat.
Reforest urban areas not appropriate for development	Urban zones	5	Ecosystem	Tecate
Educate people so they are aware of their actions with water	Watershed wide	5	Water	Silver Strand
Enforce air quality laws without impunity	Watershed wide	5	Air	Tecate
Improve infrastructure for waste transport treatment, storage, disposal	Watershed wide	5	Waste	Silver Strand
Promote effective reforestation	Watershed wide	5	Socio-econ	Tecate
Promote reforestation through adoption programs with native species	Watershed wide	5	Ecosystem	Tecate
Provide legal protection to land owners	Watershed wide	5	Socio-econ	Tijuana Fri.
Subdivide the TRW in "sub-basins" for purposes of planning and local "task forces"	Watershed wide	5	Water	Silver Strand
Create a natural parks to treat social problems as well	Alamar River, Tecate Creek, Cottonwood Creek, Las Palmas (future Tijuana bedroom community), upper watershed creeks, small villages, ejidos	4	Water	Silver Strand
Create green areas and recreation areas	Arroyo Alamar, Tecate River, Corredor Campo, Tijuana River	4	Socio-econ	Tijuana Fri.
Promote old stone house and historic site preservation. Offer tours.	Campo	4	Socio-econ	Campo

Actions	Locations	# Votes	Subject	Meeting
Control urban growth as water availability dictates	Campo and backcountry	4	Socio-econ	Campo
Develop management plans for specific areas: set priorities, goals, adaptive management approaches for projects	Canyon de los Laureles, Canyon Mataderos	4	Ecosystem	Silver Strand
Control flooding by protecting habitat	Cottonwood Creek upstream from Lake Morena	4	Water	Campo
Create economic incentives for users to get smog checks	Mexico	4	Air	Tijuana Sat.
Monitor and inspect fish farms and cattle ranchers	Mexico	4	Air	Tijuana Sat.
Encourage more recycling opportunities: let them be predictable, have a tire amnesty day, large item pick ups, C & D, Appliances	rural U.S. and Mexico	4	Waste	Campo
Perform an environmental risk assessment for dump sites	Tijuana Tecate, Campo Indian Reservation	4	Waste	Silver Strand
Campaign for continuing environmental education through formal education and media	Watershed wide	4	Socio-econ	Tecate
Form neighborhood watches (community environmental inspectors)	Watershed wide	4	Ecosystem	Tijuana Fri.
Generate a watershed vision to secure socio-environmental and political stability	Watershed wide	4	Socio-econ	Tijuana Fri.
Generate employment through conservation and maintenance	Watershed wide	4	Socio-econ	Tijuana Fri.
Identify opportunities for restoration and rehabilitation	Watershed wide	4	Ecosystem	Silver Strand

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Incorporate social groups in the replanting of the watershed	Watershed wide	4	Socio-econ	Tijuana Fri.
Integrate public and private organizations into one binational project	Watershed wide	4	Socio-econ	Tecate
Professionalize the Public Servants for the Environment	Watershed wide	4	Socio-econ	Tecate
Promote a water culture, efficient use, re-use	Watershed wide	4	Water	Tijuana Fri.
Promote knowledge of cultural, historical and ecological resources in the region	Watershed wide	4	Socio-econ	Tecate
Study air quality by air basin	Watershed wide	4	Air	Tecate
Reduce erosion that contributes to flooding	2355 Buckman Sp. Rd. and areas, all landowners: Campo, Buckman Springs Rd., Lake Morena, Pine valley Bridge- upstream from Lake Morena	3	Water	Campo
Create marine indicators to monitor watershed health and ecosystems	Around the Estuary	3	Ecosystem	Tijuana Sat.
Enforce anti-burning laws	Baja California	3	Air	Tecate
Carry out an inventory of all the historic cultural resources and make them known	Campo	3	Socio-econ	Tijuana Fri.
Identify areas of erosion to prevent their deterioration	cauces de arroyos y laderas	3	Ecosystem	Tecate
Create a program to install desalinization plants	Coast	3	Water	Tecate
Encourage cross border cooperation on power plants, land fills, land use	entire border, Boulevard, Tijuana, Tecate	3	Ecosystem	Campo

Actions	Locations	# Votes	Subject	Meeting
Create fiscal incentives for wastewater treatment	Mexico	3	Water	Tecate
Monitor and inspect industrial and commercial emissions with competent authorities who will enforce the law	Mexico	3	Air	Tijuana Sat.
Create incentives to recycle in the community	Municipal and state governments. Watershed wide	3	Waste	Tijuana Sat.
Improve waste collection (to separate cases of heavy waste) Provide special equipment.	Neighborhoods near the river and streams	3	Waste	Tijuana Fri.
Decentralize the waste processing plants	New developing areas	3	Water	Tijuana Fri.
Integrate with other watersheds and establish means of communication and cooperation	Region	3	Ecosyste m	Tecate
Removal of exotic species with high impact to the ecosystems	Riparian areas	3	Ecosyste m	Tijuana Fri.
Protect pristine areas	Riparian zones, Mountainous zones, Rio Alamar, Valle de las Palmas, urban/ruraltTransition zones	3	Ecosyste m	Tijuana Sat.
Rehabilitate already existing natural areas	Tecate River and Alamar	3	Socio-econ	Tijuana Fri.
Look for ways for the government to obtain funding for total sewage coverage	Tijuana/San Diego County	3	Water	Silver Strand
Increase the infrastructure in the wastewater treatment plants so they are more efficient	Urban zones in Mexico	3	Water	Tijuana Sat.
Support ecotourism projects that protect cultural resources	watershed	3	Socio-econ	Tecate

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	**Locations**	**# Votes**	**Subject**	**Meeting**
Create a ground/surface water budget	Watershed wide	3	Water	Campo
Create a joint development plan between the U.S. and Mexico	Watershed wide	3	Socio-econ	Tijuana Sat.
Enforce strictly the law	Watershed wide	3	Socio-econ	Tijuana Fri.
Establish more stringent policies for environmental impact assessments and monitoring	Watershed wide	3	Ecosystem	Tijuana Fri.
Greater observation of land use laws at all levels of government	Watershed wide	3	Ecosystem	Tijuana Fri.
Increase cargo truck restrictions	Watershed wide	3	Socio-econ	Campo
Promote training in sustainable management practices	Watershed wide	3	Socio-econ	Tijuana Sat.
Restrict use of Hazmat in groundwater dependent areas by commercial and industrial facilities	Watershed wide	3	Waste	Campo
Support local efforts for the conservation of the cultural heritage	Watershed wide	3	Socio-econ	Tijuana Fri.
Survey and prioritize sediment sources	Watershed wide	3	Ecosystem	Silver Strand
Educate and campaign on the value and natural need of green areas	Watershed wide and all educational centers	3	Socio-econ	Tijuana Fri.
Aquifer research (quality and quantity)		3	Water	Tijuana Fri.
Implement rehabilitation projects such as: reforestion, control of sand extraction, and anti-erosion barriers	Areas identified as critical	2	Water	Tecate

Actions	Locations	# Votes	Subject	Meeting
Equip air authorities in order to verify reported information	Baja California	2	Air	Tecate
Require smog checks	Baja California and border crossing	2	Air	Tecate
Create an education campaign to raise awareness for the relationship between trash, toxic waste, and children's and ecosystem's health	Campaign promotion in schools, churches, public charity centers, business, etc.	2	Waste	Tijuana Fri.
Regulate activities that cause erosion	Campo Hills development,	2	Ecosystem	Campo
Review "Community Character" document for Campo/Lake Morena Planning group	Campo/Lake Morena	2	Socio-econ	Campo
Restore vegetation (native species)	Construction sites on slopes and canyons	2	Water	Silver Strand
Use railroad to reduce traffic	East County	2	Socio-econ	Campo
Train personnel on the receipt and treatment of water	Industrial parks, hotels, department de industriales	2	Water	Tijuana Sat.
Support and creation of community centers	Marginalized or underserved zones	2	Socio-econ	Tijuana Fri.
Create legislation "marco juridico" and programs for emission controls	Mexico	2	Air	Tijuana Sat.
Reform and apply the Ecological Law of Mexico	Mexico	2	Socio-econ	Tecate
Work visas for Mexican Nationals. Reduce need for immigration by increasing the standard of living in Mexico.	Mexico	2	Air	Campo

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Fencing around riparian habitat for cattle and horses	Pine Valley Creek, CWD Creek, Hauser Canyon	2	Water	Campo
Offer alternatives to invasive exotic species, pesticides, and herbicides	Stores	2	Ecosystem	Tijuana Sat.
Control the effluent from running from treatment plants	Tecate River, Alamar River	2	Water	Tijuana Sat.
Recycle waste water	Tecate, Tijuana, Major Border Cities	2	Ecosystem	Campo
Utilization of agricultural byproducts, wastewater treatment to produce energy	Tecate, Tijuana, Major Border Cities	2	Ecosystem	Campo
Apply urban development plans	Tijuana and Tecate	2	Socio-econ	Tijuana Fri.
Localized grassroots riparian restoration efforts to address grazing, exotic vegetation, stream bank stabilization	Upper watershed areas and Sweetwater River, Bonita	2	Ecosystem	Campo
Establish percentages of required green areas related to housing development	Urban areas	2	Ecosystem	Tijuana Fri.
Protect sacred areas and paintings	Watershed wide	2	Socio-econ	Tecate
Avoid overgrazing	Watershed wide	2	Air	Campo
Control the use of pesticides	Watershed wide	2	Air	Tijuana Sat.
Create fiscal incentives so that land-owners are encouraged to designate green areas for recreational and conservation uses	Watershed wide	2	Socio-econ	Tijuana Fri.
Development of public will and funding	Watershed wide	2	Ecosystem	Silver Strand
Distribute air quality results from the communities	Watershed wide	2	Air	Tijuana Sat.

Actions	Locations	# Votes	Subject	Meeting
Distribute information on air quality to the community	Watershed wide	2	Air	Tecate
Ecological grading for erosion	Watershed wide	2	Air	Campo
Encourage the use of cleaner fuels	Watershed wide	2	Air	Tijuana Fri.
Harmonize laws binationally	Watershed wide	2	Socio-econ	Tecate
Improve public transportation infrastructure and develop a collective transportation network	Watershed wide	2	Socio-econ	Tecate
Look for alternative water sources: geohydrology studies	Watershed wide	2	Water	Tecate
Pollution prevention programs	Watershed wide	2	Waste	Silver Strand
Rechare the aquifers with waste water from households and industries	Watershed wide	2	Ecosystem	Tijuana Fri.
Restrict development to create green areas	Watershed wide	2	Socio-econ	Tecate
Water reuse	Watershed wide	2	Water	Tijuana Sat.
Characterize the type and quantity, and geography locations of toxic waste	Watershed wide with focus on the streams	2	Waste	Tecate
Conduct an ongoing campaign for anti-burning education	Baja California	1	Air	Tecate
Create urban parks and corridors	Between Canyon Matadero, and Laureles	1	Ecosystem	Tijuana Sat.
More support for local museums	Campo and Backcountry	1	Socio-econ	Campo
Establish local waste transfer sites with supplemental funding	Campo, Potrero/Tecate	1	Waste	Campo

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Develop rules and regulations to control cross border sale of sand, oaks, and Jeffery Pines to the U.S.	Enforcement checkpoints and border crossings	1	Ecosystem	Campo
Obtain economic resources for the equipment and operation of the wastewater treatment plants	Mexico	1	Water	Tecate
Zone for gas stations, gas/power plants, and industries	Mexico	1	Air	Tijuana Sat.
Establish heritage sites and market them for recreation, Create a sense of place. Instill pride in Tijuana River Watershed through school programs	Neji tribe, Mexico	1	Socio-econ	Silver Strand
Create environmental emergency groups and drills	Protección Civil (Mexico) and at the 3 levels of Mexican government	1	Waste	Tijuana Sat.
Offer environmental/social programs in 3 languages in the region (Spanish, English, Kumiai dialects)	Region	1	Socio-econ	Tecate
Apply an unloading fee for acquiring used tires and the dollars should go to BC	Regional	1	Waste	Tijuana Fri.
Apply the currently available regulations. Governmental organizations require funding for enforcement	Regional	1	Waste	Tijuana Fri.
Revise, expand, and enforce the list of prohibited exotic and invasive species	Rios, wetlands, deserts	1	Ecosystem	Tijuana Sat.
Restrict transportation of hazardous materials on inadequate rural roads and railroads	Rural U.S. and Mexico	1	Waste	Campo

Actions	Locations	# Votes	Subject	Meeting
Environmental planning for urban and industrial development	San Diego, Tijuana, Tecate	1	Air	Tijuana Fri.
Formal and informal educational outreach with focus on the family and multiplying outcomes. Organize workshops to raise public awareness.	San Diego, Tijuana, Tecate	1	Air	Tijuana Fri.
Reforest with vegetation of low water consumption	Streams - watershed wide	1	Water	Tijuana Fri.
Inventory of source emissions (point and non-point)	Tijuana	1	Air	Tijuana Fri.
Analyze the location of the new garbage dump in Tijuana to find out if the basin will be affected	Tijuana Muncipality	1	Water	Silver Strand
Remove the concrete from the Tijuana River and find a way to deal with the social problems of squatters	Tijuana River	1	Water	Silver Strand
Increase Air Quality Monitoring Network	Tijuana, South SD Bay	1	Air	Silver Strand
Create an air quality index	Tijuana, Tecate, Ensenada	1	Air	Tijuana Sat.
Harmonize the criteria and laws for air quality	Tijuana-San Diego, Tecate, Tecate, Mexicali-Calexico	1	Air	Tijuana Sat.
Educate Border Patrol to not create new roads or overuse roads	U.S.	1	Air	Campo
Better road plans	Watershed wide	1	Air	Campo
Conduct health studies related to air pollution	Watershed wide	1	Air	Tecate
Control wastes from domestic animals	Watershed wide	1	Waste	Tecate

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Create a culture of water conservation	Watershed wide	1	Water	Tijuana Sat.
Create natural gas and hydrogen alternatives to gasoline	Watershed wide	1	Air	Tijuana Sat.
Create support between sectors for green areas	Watershed wide	1	13	Tijuana Sat.
Educate elected officials and public utilities on waste issues	Watershed wide	1	Waste	Silver Strand
Ensure that green areas donated by private parties are complying with their terms	Watershed wide	1	Air	Tijuana Sat.
Explore and finance renewable sources of energy: solar, wind, human, hydrogen fuel cell	Watershed wide	1	Air	Campo
Identify important ecosystem functions	Watershed wide	1	Ecosystem	Silver Strand
Identify the natural capital and services of the environment and enact legislation	Watershed wide	1	Ecosystem	Tecate
More inter-institutional coordination	Watershed wide	1	Air	Tecate
Promote family planning	Watershed wide	1	Air	Campo
Promote law enforcement on construction practices	Watershed wide	1	Water	Silver Strand
Promote the idea of building infiltration basins	Watershed wide	1	Water	Silver Strand
Recover natural water courses (remove barriers that impede the flow). Preserve the existing courses.	Watershed wide	1	Ecosystem	Tijuana Fri.
Reforest with native plants	Watershed wide	1	Socio-econ	Tecate

Actions	Locations	# Votes	Subject	Meeting
Reforestation with native species	Watershed wide	1	Ecosystem	Tijuana Fri.
Regulate the regional transportation system rules; adjust schedules of heavy load transportation at night.	Watershed wide	1	Socio-econ	Tijuana Fri.
Research to reach an understanding of impacts of air quality on water quality	Watershed wide	1	Air	Silver Strand
Restore native plants	Watershed wide	1	Air	Campo
Use gray water for irrigation of green areas	Watershed wide	1	Air	Tijuana Sat.
Construct more reservoirs		1	Water	Tijuana Fri.
Enforce buildings regulations in streams. Control and monitoring		1	Water	Tijuana Fri.
Regulate cutting of Jeffery Pines	La Rumorosa and El Hongo	0	Ecosystem	Campo
Training transit police	Baja California	0	Air	Tecate
Pave dirt roads	Baja California, Valle de las Palmas	0	Air	Tecate
Provide fiscal incentives for business to promote creation and maintenance of natural areas	By municipality	0	Socio-econ	Tijuana Fri.
Pave heavily used roads to reduce MP10	Campo	0	Socio-econ	Silver Strand
Preserve rural lifestyle	Campo and Backcountry	0	Socio-econ	Campo
Create binational conservation areas	Cerro San Ysidro to Otay Mountain Wilderness area	0	Ecosystem	Tijuana Sat.

Actions	Locations	# Votes	Subject	Meeting
Proper design of waste water pretreatment systems at factories.	Critical points of discharge	0	Water	Tecate
Provide air quality diagnostics	Current Tijuana	0	Air	Tijuana Fri.
Research related to source of waste, i.e.,US donations of clothing, TVs, etc.	Customs	0	Waste	Tijuana Fri.
Control the transport of invasive exotics	Customs agencies	0	Ecosystem	Tijuana Sat.
Promote the involvement of egresados de cameras related to the environmental verification in the three levels of government	Dirección de Ecología Municipal, DGE, SEMARNAT	0	Waste	Tijuana Sat.
Create a restricted confinement area for toxic wastes	Far from urban areas with no development plans	0	Waste	Tijuana Sat.
Campaign to retire useless autos	Mexico	0	Air	Tijuana Sat.
Create economic aid for smog checks	Mexico	0	Air	Tijuana Sat.
Create incentives such as loans to buy new or refurbished cars	Mexico	0	Air	Tijuana Sat.
Economic incentives for garages and used car dealers to retire old cars	Mexico	0	Air	Tijuana Sat.
Inspect for clandestine dumps	Mexico	0	Air	Tijuana Sat.
Pressure PEMEX to improve the quality of their gas	Mexico	0	Air	Tijuana Sat.
Identify groundwater quantity/quality	Mt. Empire source aquifer	0	Socio-econ	Campo
Better links between waste campaigns. Utilize neighborhood promotoras (community leaders), agents, funds from the private sector, equipment, equipment loans for oil, paint, cleaning	Regional	0	Waste	Tijuana Fri.

Actions	**Locations**	**# Votes**	**Subject**	**Meeting**
Support an industry that recycles used tires (CEMEX). We have to give a value to the used tire	Regional	0	Waste	Tijuana Fri.
Control of improper disposal of Hazmat from drug labs, etc.	Rural U.S. and Mexico	0	Waste	Campo
Provide affordable housing and Public Transit	San Diego	0	Air	Campo
Regulate cutting of oak woodlands	San Pablo San Jose	0	Ecosyste m	Campo
Control the quality of water distributed in trucks (pipas)	Small communities in Mexico	0	Water	Tijuana Sat.
Delimit air sub-basins to establish quality rates	Starting with Tijuana	0	Air	Tijuana Fri.
Develop Tecate to ease migration to U.S.	Tecate	0	Socio-econ	Campo
Regulate sand mining	Tecate	0	Ecosyste m	Campo
RestoreTecatito ghost town depot	Tecate, U.S.A.	0	Socio-econ	Silver Strand
Educate industries and maquiladoras on waste standards and alternatives	Tijuana and San Diego	0	Waste	Silver Strand
Avoid the establishment of irregular settlements in zones of steep slopes or of high risk	Tijuana and Tecate	0	Socio-econ	Tijuana Fri.
Continuously update the emissions inventories	Tijuana, Tecate, Ensenada	0	Air	Tijuana Sat.
Control wastewater discharges (infrastructure)	Urban and rural areas	0	Water	Tijuana Fri.
Better urban planning	urban areas	0	Water	Tijuana Sat.

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Clean streams and stormdrains	urban areas	0	Water	Tijuana Sat.
Create common standards for classifying waste	US/Mexico	0	Waste	Silver Strand
Create uniformed protocol for emergency response and treatment of waste	US/Mexico	0	Waste	Silver Strand
Create uniformed waste legislation	US/Mexico	0	Waste	Silver Strand
Find funding to educate emergency response personnel to respond to Hazmat incidents	Volunteer Fire Dept. at Hartland, Law enforcement, and Border patrol offices	0	Waste	Campo
Analyze information available from the 6 current air monitoring stations	Watershed wide	0	Air	Tijuana Fri.
Cluster housing on developments with open space set aside	Watershed wide	0	Air	Campo
Collect regional data that are homogenous across boundaries (social, economic, spatial)	Watershed wide	0	Socio-econ	Tijuana Fri.
Consistency in air quality enforcement (smog checks)	Watershed wide	0	Air	Silver Strand
Contract a binational lab to control air quality	Watershed wide	0	Air	Tijuana Sat.
Develop appropriate best management practices	Watershed wide	0	Ecosystem	Silver Strand
Educate emergency response teams: fire fighters, police officers, local governments	Watershed wide	0	Waste	Silver Strand
Educate farmers and cattle ranchers about invasive exotic species	Watershed wide	0	Ecosystem	Tijuana Sat.
Eliminate open burning	Watershed wide	0	Air	Silver Strand
Eliminate unnecessary easements so they can be vegetated	Watershed wide	0	Air	Campo

Actions	Locations	# Votes	Subject	Meeting
Encourage extraction activities of low water consumption that suit the conditions of the watershed	Watershed wide	0	Ecosystem	Tijuana Fri.
Enforce the law (public informants are essential).	Watershed wide	0	Air	Tijuana Fri.
Facilitate the legal removal of the "chatarra"	Watershed wide	0	Waste	Tecate
Find funding for waste education	Watershed wide	0	Waste	Silver Strand
Idenify areas inappropriate for development	Watershed wide	0	Ecosystem	Silver Strand
Identify threats: erosion, exotics, connectivity/fragmentation	Watershed wide	0	Ecosystem	Silver Strand
Interface with Binational Air Quality Alliance (BAQA)	Watershed wide	0	Air	Silver Strand
Live within energy budget	Watershed wide	0	Air	Campo
Locate sand and clay extraction sites and determine their impact on the aquifers	Watershed wide	0	Ecosystem	Tijuana Fri.
Locate sites where sediment traps should be laid	Watershed wide	0	Ecosystem	Tijuana Fri.
Maintain and protect existing parks	Watershed wide	0	Air	Tijuana Sat.
Mange industrial and domestic toxic wastes	Watershed wide	0	Waste	Tecate
Promote environmental supervision at all levels of government	Watershed wide	0	Waste	Tijuana Sat.
Promote the adoption of green areas by private parties	Watershed wide	0	Air	Tijuana Sat.
Require new and used car vendors to give education to their buyers	Watershed wide	0	Air	Tijuana Sat.

4. Appendix: 266 Priorized Actions for the TRW from Stakeholder Meetings

Actions	Locations	# Votes	Subject	Meeting
Research on relative contribution of point and non-point sources to basin air quality	Watershed wide	0	Air	Silver Strand
Set up programmatic meetings, task forces, binational agency partnerships by program areas, and professional relations. Train firefighters and emergency response personnel collectively on both sides	Watershed wide	0	Socio-econ	Silver Strand
Sign agreements between the counties to meet toxic waste emergencies	Watershed wide	0	Waste	Tijuana Sat.
Strengthen/build binational functioning efforts (fire management, botanical surveys, water quantity/stream gauging (state, federal, local, university, NGO's transborder groups	Watershed wide	0	Socio-econ	Silver Strand
Follow up to actions on air quality control. Encourage systematic work.		0	Air	Tijuana Fri.
Fortify steep slopes with vegetation to prevent flooding		0	Water	Tijuana Sat.
Identify problem areas in streams and rivers		0	Water	Campo
Implementat of solutions for water quality and quantity		0	Water	Campo
Improve and document communication with Department of Public Works		0	Water	Campo
Train and equip emergency response teams for earthquakes, explosions, fires "fugas"		0	Waste	Tijuana Sat.

5. Appendix: Significant cultural and historical monuments in the TRW

Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Mojonera 258	International border marker built in 1884 by the International Commission of Limits. It marks the exact boundary between the United States and Mexico. The marker, made of stone and marble, is inserted in the border metal fence that separates Tijuana, B.C. from Imperial Beach, Ca.	Mexico and United Statesshared federal jurisdiction	Near the Pacific Ocean in Colonia Playas de Tijuana in front of the bullring	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles, Municipio de Tijuana. Mexico, p. 651.
Avenida Revolución	A popular tourist street for adult entertainment and curio shopping. There are many historical landmarks such as the Jai Alai or Frontón, Hotel Caesar's, Villa Colonial Curious Store, Hotel Nelson, etc.	Tijuana City government	Avenida Revolución, in downtown Tijuana	Castillo Udiarte, Carlos; García Cortez, Alfonso; Morales Lira, Ricardo. 1996. La Revolución También es una Calle. 15vo Ayuntamiento de Tijuana, Universidad Iberoamericana. Tijuana, B.C..
Parque Los Encinos	A park cherished as a place for family gathering and remembrance for many Tecatenses. Parties, barbecues facilities, and a stage for music are available. There is a skateboard ramp and play areas for children. The Tecate Feria takes place in the park every year in the summer.	Tecate City government	One block south of Defensores de Tijuana Boulevard	Sierra, Olga A. 2002. "Culture, Recreation and Sports in Tecate." In Tecate, B.C.: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp. 100, 101.
Parque Hidalgo	A downtown park created in the 1920s and known as the main plaza. It is a symbolic public area where people gather to socialize, eat, buy arts and crafts, listen to music, or to celebrate civic events. It has a gazebo in the center for musicians.	Tecate City government	Between Avenida Hidalgo and Avenida Juárez in downtown Tecate city	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, B.C.: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.12, 13.

Name of monument or place	**Historical or cultural importance**	**Legal status**	**Location or address**	**Bibliographic reference for further reading**
Desert Tower	Built by hand by Bert Vaughn (1922-1928), who owned the town of Jacumba. The stone tower is 70 feet tall and is a tribute to the pioneers who made the treacherous trek west through Arizona and CA..	Private property	Interstate 8/In-Ko-Pah exit/Jacumba, Ca	Retz, Mike. "The Desert View Tower." In Mountain Heritage.The Back Country's Historical Digest.Volume 18 Number 2. San Diego, CA, pp.1,3,5.
San Diego and Arizona Railroad	Built from 1914-1919 for sugar magnate John D Spreckels. It is a 146 mile binational route that connects San Diego-Tijuana-Tecate-El Centro. The route was envisioned as an American railroad but crossed through Mexico as a result of topography. This railroad allows a unique view of both nations.	Mexico and United Statesfederal governments	Tijuana, San Diego, Tecate,B.C. and Tecate Ca.	Kirchner, John. 1988. B.C. Railways. San Marino, Ca.: Golden West Books. And Hanft, M. Robert. 1984. San Diego&Arizona: The Impossible Railroad. Glendale, Ca.: Trans-Anglo Books.
Cuchumá Mountain	Sacred mystical mountain of the Kumiai Indians. Half of this peak is in the U.S. and the other half in Mexico. The metal border fence can be seen in the mountain from Rancho la Puerta.	Mexico and United Statesfederal governments	Tecate and San Diego border	Summers, June Nay. 1972. Good Morning Tecate: History of a Border Town. Lakeside, Ca.: Sunlight Press Inc., p. 15.
Border Field Park	Last portion of the Tijuana River Estuary. This park was created as a friendship area of encounter with neighboring Mexico. The dividing fence that separates this portion of the border is a metal grid that allows viewing of Playas de Tijuana, B.C.. The park is used for tourists as well as by social activists to celebrate binational events. It has 2 miles of sandy beach as well as horseback and walking trails.	Ca. State Parks	Southeastern end of the United States in Imperial Beach, bordering Mexico and the Pacific Ocean	Schulte-Peevers, Andrea. 2001. San Diego & Tijuana. Australia: Lonely Planet Publications, pp. 107, 113.
Tijuana River Estuary	Natural reserve of 2,530 acres that encompasses the largest remaining salt marsh in Southern Ca., ending in the Pacific Ocean. This coastal estuary is home to some 370 species of native and migratory birds and has 8 miles of walking and horseback trails.	Ca. State Parks, United StatesFish and Wildlife Service	Southwest end of Imperial Beach Bordering with Mexico and the Ocean	www.tijuanaestuary.com

5. Appendix: Significant cultural and historical monuments in the TRW

Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Tecate Old Industrial District	Formed by traditional industries that surround the railroad station. They are an ex-malt factory built in 1929, an ex-oil factory built in 1933, a brewery built in 1943 and an ex-coffee-milling plant built in the 1960s.	Federal and private properties	By the railroad tracks	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles, Municipio de Tecate. Mexico, pp. 551-555.
Plaza Monumental	Bull ring by the sea built in 1960. One of the biggest in the world with 25,000 seats with views to two nations, a binational beach, the border fence, and the Pacific Ocean.	Private property	In Playas de Tijuana, bordering with the United States	Guzmán Soto, Antonio. July 2000. "La Monumental de Playas Celebra su XL Aniversario." In Fundadors. Tijuana, pp. 23-26.
Abelardo Rodríguez Dam	Built from 1927 to 1934 by an American Company with American materials (steel and concrete). Named after a B.C. governor.	Federal government	Km 18 of the Tijuana-Tecate Railroad	Padilla, Antonio. 1989. "La Presa Abelardo Rodríguez, Modelo de Ingenieria Hidráulica." In Jesús Ortiz Figueroa/ David Piñera Ramírez coord. Historia de Tijuana. Tijuana: UABC, pp. 93-110.
Agua Caliente Former Casino	Built between 1927-1929 by American architects Wayne Douglas and Corine MacAllister to serve the booming gambling industry during U.S. Prohibition era. Remnants of the casino still exist (chimney, bungalows, fountain, swimming pool). The site is now occupied by five federal schools.	Federal government	Between Paseo de los Heroes and Rodolfo Sanchez Taboada Avenidas	Lugo Jr., Alejandro.1985. "El Casino de Agua Caliente." In Piñera Ramírez, David. Historia de Tijuana, Semblanza General. Tijuana: UNAM-UABC, pp. 114-117.
Boulevard Agua Caliente	One of the oldest streets in the city that conducted to one of the entrances of the Agua Caliente Casino. Along this street are some historical structures such as the race track, the bull ring, a sombrero-shaped restaurant and motels from the 1940s, the replica of the casino tower, the golf course and a modern two tower hotel.	City of Tijuana government	Parallel to Paseo de los Heroes and perpendicular to Ave. Revolución	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, pp. 320, 322.

Name of monument or place	**Historical or cultural importance**	**Legal status**	**Location or address**	**Bibliographic reference for further reading**
Parque Teniente Guerrero	A popular park built in the 1920s as a community initiative. Named after Lieutenant Guerrero who defended Tijuana during the 1911 filibuster invasion. Considered a place of memory for many Tijuanenses who celebrate each July 11 the "virtual" foundation of the city. It has a gazebo, a fountain and a monument to its founder a school teacher.	City of Tijuana government	Tercera and F streets in downtown Tijuana	Automobile Club of Southern Ca.. 1995. Baja California. Los Angeles, Ca., pp. 48,49.
Escuela Alvaro Obregón	Brick building constructed in 1929 as an exact copy of another school in Yuma, Arizona. Named after ex-president Alvaro Obregón. It hosts the City "House of Culture."	City of Tijuana government	Corner of Lisboa and Buenos Aires Streets in a hill of Colonia Altamira	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles. Municipio de Tijuana. Mexico, pp. 621, 622.
Calle Segunda	This street appears in the 1889 city map. Some of the oldest buildings built in the 1920s are located here: the cathedral, Mercado el Popo, the former municipal palace, Edificio Aldrete, the Francis Hotel, etc.	City of Tijuana government	Downtown Tijuana	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles. Municipio de Tijuana. Mexico.
Light House	This structure guides the ships that navigate in front of Playas de Tijuana-Imperial Beach border.	Federal Government	Playas de Tijuana next to Border Field State Park in Imperial Beach	Secretaria de Marina official files.

5. Appendix: Significant cultural and historical monuments in the TRW

Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Border fence	The border metal fence that separates B.C. and Ca. is a symbolic monument that divides and unites the two nations. It is used for artistic expressions, binational events, as well as for grassroots protests.	United Statesfederal government	U.S.-Mexican border	Schulte-Peevers, Andrea. 2001. San Diego & Tijuana.Australia: Lonely Planet Publications, pp. 256, 257.
Gaskill's Stone Store	Built in 1885 by Silas and Luman Gaskill, it was used as a bank, a post office, a stage station, and as the social center of the community. Today is a museum store.	Mountain Empire Historical Society	State Hwy 94 at Campo Circle, Ca.	S. MacGill, Ruth (compiled and edited).1998. True Tales from Historic Campo and the Mountain Empire of San Diego County. Campo, Ca.: Mountain Empire Historical Society, pp. 9-14.
Old Campo Road-Hwy 94	In 1870 a regular stage coach known as The Campo-San Diego State ran on this road. The stage left San Diego in the morning changed horses in Dulzura and then drove to Campo the same day. Later it became Hwy 94 and connected to Yuma.	United Statesfederal government	East County, Ca.	http://www.hwy94.com
Pacific Southwestern Railroad Museum	The San Diego Railroad Museum is a non-profit educational organization dedicated to the preservation and interpretation of railroads as they existed in the Pacific Southwest. It has a train station, visitors center, nine locomotives, and a collection of passenger cars, freight cars, and cabooses. Volunteers provide excursions to Miller Creek and to Tecate Mexico on weekends.	Pacific Southwest Railway Museum Association	Campo Depot 31123-1/2 Highway 94 Campo, Ca. 91906	http://www.sdrm.org/

Name of monument or place	**Historical or cultural importance**	**Legal status**	**Location or address**	**Bibliographic reference for further reading**
Camp Locket (proposed State Park)	This was the original site where troops of the last cavalry units in the U.S. Army were stationed. The troops stayed until the United States entered World War II. There were all-black cavalry units in the camp known as "Buffalo Soldiers." The camp also housed thousands of military personnel from 1942 to 1945.	San Diego County	Campo, Ca.	Challberg, Roger. "Camp Lockett State Park?" In Mountain Heritage.The Back Country's Historical Digest.Volume 15 No. 4. San Diego, Ca, pp. 1, 6.
Campo Mill	This 1920 structure, where feldspar from Campo mines was milled, is now occupied by the Motor Transport Museum. The museum houses a collection of vintage trucks.	Motor Transport Museum	Highway 94, two miles east of Campo Creek	Sutro, Dirk. 2002. "East County." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 305.
Paseo de los Héroes	The main business district, monuments to national and international heroes and the Tijuana Cultural Center are located in this avenue.	City of Tijuana government	Zona Rio	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, pp.319, 322.
Monumental Flag	Built in the 1997 as a federal program to celebrate national symbols in border cities. The flag is 86 x 150 feet in size and is flown at a height of 310 ft.	Federal government	Military camp in Colonia Morelos just passing the south end of Revolucion	Rodríguez Barajas, Julio. 2004. La Ruta de los Monumentos Históricos de Tijuana. Tijuana: ILCSA Ed., p. 119.
Tijuana Tercer Mileni (La Mona)	House built with a woman's shape by sculptor Armando Muñoz García in 1990 to celebrate the 100 anniversary of Tijuana. It is a naked, 50 ft-tall, sexy woman made of concrete, steel, fiberglass and clay located in the middle of a popular low-income neighborhood.	Private property	A canyon in Colonia Aeropuerto	Rodríguez Barajas, Julio. 2004. La Ruta de los Monumentos Históricos de Tijuana. Tijuana: ILCSA Ed., p. 102, 105.

5. Appendix: Significant cultural and historical monuments in the TRW

Name of monument or place	**Historical or cultural importance**	**Legal status**	**Location or address**	**Bibliographic reference for further reading**
Cristo Rey	This monumental Jesus Christ (72 feet tall) made of fiberglass and resin, aims to compete with another one in Brazil. It is surrounded by 28 angels.	Federal government in conjunction with a church	Colonia los Alamos next to San Martín de Porres church	Rodríguez Barajas, Julio. 2004. La Ruta de los Monumentos Históricos de Tijuana. Tijuana: ILCSA Ed., p. 119.
Plaza Santa Cecilia	This is the old Olvera Street that appears in the 1889 map of the city. Made a walking street in the 1980s and renamed as Plaza Santa Cecilia. There are restaurants, bars, street vendors, and a Mariachi stage. The 1950s Nelson Hotel is in the corner of the Plaza and Avenida Revolución.	City of Tijuana government	Between Revolución and Second Streets	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 318.
Parque del Profesor	A 28-acre park built in 1999 by Fundación la Puerta and designed by Hubbell and Hubbell. It hosts the Cuchumaá Ecological Center, an interactive educational center whose buildings resemble natural boulders that camouflage with the landscape.	Fundación la Puerta	Left side of the entrance to Tecate (coming from Tijuana non-toll road)	La Cuenca del Río Tijuana. CD created by Digital Contact as a co-production of San Diego Natural History Museum, EPA, USFS.
Plaza de Toros de Tijuana	Built in 1938 entirely on wood construction. Rebuilt with steel after a fire in 1957.	Private property	Boulevard Agua Caliente	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 314, 320.
Jacumba	This city was a stopping place for travelers between Phoenix and San Diego. The hotel at Jacumba Hot Springs, built in the 1920s burned down in 1942. Visited by movie stars, now is a ghost town with a train station.	San Diego County	Old highway 80	Sutro, Dirk. 2002. "East County." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 306.
Rancho la Puerta	Old ranch adapted in the 1940s as a health resort and considered one of the world's most highly rated.	Private property	In the Tecate Valley a the bottom of Cuchuma Mountain	http://www.rancholapuerta.com/

Name of monument or place	**Historical or cultural importance**	**Legal status**	**Location or address**	**Bibliographic reference for further reading**
Kumiai Region	Archeological sites with rock carvings, mortars, Indian trials, cemeteries from Kumiais, Pai-pais, and San Dieguinos groups (Junta de Nejí, Peña Blanca, El Aguaje de la Tuna, Lázaro Cárdenas, Valle de las Palmas, el Hongo, Campo sites).	Federal, state and local governments	Urban zones in Tecate, Parque los Encinos, rural area of Campo and Tecate	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, B.C.: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.5-10.
Panteon #2	The second cemetery built in Tijuana in the 1940s. Famous because Juan Soldado's tomb is there. There is controversy about whether he was a martyr or a criminal. He is venerated as the saint of the migrants by popular tradition.	Municipality of Tijuana	Calle Segunda and Cañón K	García, Hamlet. "La leyenda de Juan Soldado." In Periódico Frontera. Tijuana: Nov 1, 2004, p.14.
U.S. Border Inspection Station in Tecate	Built in 1933-34 by the U.S. Treasury Department in Spanish Colonial Revival Style as interpreted by the Depression-era federal building program.	Federal government	Ca. State Hwy 188, Tecate, Ca. on the border	Historic American Buildings Survey/Historic American Engineeering Record. 2003. Survey Number CA 2782. Unprocessed Item. Also with Marshall, David. Heritage Inc. San Diego, CA.
Tijuana Border Gate Building	Only building inspired in architect Félix Candela style in Tijuana. Designed in the 1960s in a shell form with several vaults.	Federal government	In Tijuana, bordering with San Ysidro	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p.322.
Thing Brothers' Store	Wooden store built at the end of the nineteenth century to sell foodstuffs and other merchandise and to offer postal services to both Tecate, B.C. and to Tecate, Ca. residents.	Private property	Tecate, Ca. a few feet from the Mexican border	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, B.C.: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.12, 13.

5. Appendix: Significant cultural and historical monuments in the TRW

Name of monument or place	**Historical or cultural importance**	**Legal status**	**Location or address**	**Bibliographic reference for further reading**
Adobe store ruins	In the 1 920s the Port of Tecate stood 1/2 mile east of its present location. The Mountain Commercial Company operated a store opposite to the Port. Its adobe walls are still visible.	Federal government	Tecate, Ca. a few feet from the Mexican border	Summers, June Nay. 1972. Good Morning Tecate:History of a Border Town. Lakeside Ca.: Sunlight Press Inc.pp. 27, 41.
Johnson's General Merchandise Store	It stood opposite U.S. Port of Entry from 1892 until 1934, when the port was moved to its present location. The wood building store still exists but is abandoned.	Private property	In Tecate Califorrnia A few feet from the Mexican border and the United States Inspection Station	Summers, June Nay. 1972. Good Morning Tecate:History of a Border Town. Lakeside Ca.: Sunlight Press Inc.p. 18.
Playas de Tijuana	Urban beach encompassing a portion of the Binational Friendship Park, a lighthouse, a bullring, and modern houses and restaurants. Place of celebration of cultural and social events.	Federal and private properties	Bordering with the United States and the Pacific Ocean	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p.321.
Race Track	Built in 1929 to serve the gambling and sports boom of Tijuana.	Federal government	Boulevard Agua Caliente	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 323.
Ranches	Established in 1833 to raise cattle, corn, wheat and other vegetables. Some still have remnants of barns, houses, and warehouses such as Neji, Jacumé, and Las Juntas.	Private properties	North of Tecate, B.C. and Campo, Ca.	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, B.C.: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.8, 9.

Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Colonia Libertad	This colonia (neighborhood) was established in 1927-1928 with Mexican migrants returned from the U.S during the recession. The train depot from the Tijuana-Tecate railroad sits in this neighborhood next to a border marker and to the San Ysidro depot on the U.S.-side both divided by the border fence.	Municipality of Tijuana	In Tijuana, bordering San Ysidro, Ca.	Bustamante Fernández, Jorge.1985. "Surgimiento de la Colonia Libertad." In Piñera Ramírez, David. Historia de Tijuana: Semblanza General. Tijuana: Centro de Investigaciones Históricas UNAM-UABC. pp. 316-331.
Tijuana Cultural Center (CECUT)	Cultural complex built by famous architect Pedro Ramírez Vázques. It has the Museum of las Californias, an art gallery, shops with books and hand-crafted goods, cafeteria, offices, a 1,000 seat concert hall, and an Omnitheater (a spherical theater) that presents large-format three dimensional cultural and scientific films.	Federal of Tijuana government	Paseo de los Héroes and Avenida Independencia	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, pp.315, 319.
Avenida Hidalgo	An old stagecoach road urbanized and named Calle Libertad in the 1920s. Many of the oldest houses of Tecate as well as the Virgin of Guadalupe church are located on this street.	City of Tijuana government	Parallel to the railroad tracks on the north	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles, Municipio de Tecate. Mexico.
Cordillera de arboles de Encino	Corridor of oak trees identified as an area of natural beauty and part of the cultural patrimony of B.C. by the Commission of Preservation in Tecate (not yet designated).	Federal Government	Neji-Valle Redondo Sierra	Comisión de Preservación del Patrimonio Cultural de Tecate. 1999. "Diagnóstico del Patrimonio Cultural del Municipio de Tecate." In Diagnóstico del Patrimonio Cultural de B.C..Mexicali: ICBC, p.41.
Neji Cemetery	This indigenous cemetery is considered a potential cultural patrimony site by the Commission of Preservation in Tecate.	City/federal government	Neji	Comisión de Preservación del Patrimonio Cultural de Tecate. 1999. "Diagnóstico del Patrimonio Cultural del Municipio de Tecate." In Diagnóstico del Patrimonio Cultural de B.C..Mexicali: ICBC, p. 41.

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Camino Nacional	This old road was built in 1915 under the government of Coronel Esteban Cantú in order to link Mexicali-Rumorosa-Tecate and Tijuana.	Federal Government	Mexicali-Tecate-Tijuana	Meade, Adalberto Walther. 1993. Tecate Cuarto Municipio. Mexicali: Universidad Autónoma de B.C.
Mojonera 258	International border marker built on 1884 by the International Commission of Limits. It marks the exact boundary between the United States and México. The marker made on stone and marble is inserted in the border metal fence that separates Tijuana, Baja California from Imperial Beach, California.	México and U.S. shared federal jurisdiction.	Near the Pacific ocean in Colonia Playas de Tijuana in front of the bullring.	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles, Municipio de Tijuana. México, p.651.
Avenida Revolución	A popular tourist street for adult entertainment and curious shopping. There are many historical landmarks such as the Jai Alai or Frontón, Hotel Caesar's, Villa Colonial Curious Store, Hotel Nelson, etc.	Tijuana City government.	Avenida Revolución, in downtown Tijuana, B.C.	Castillo Udiarte, Carlos; García Cortez, Alfonso; Morales Lira, Ricardo. 1996. La Revolución También es una Calle. 15vo Ayuntamiento de Tijuana, Universidad Iberoamericana. Tijuana, Baja California.
Parque Los Encinos	A park cherished as a place for family gathering and remembrance for many Tecatenses. Parties, barbecues facilities, and stage for music are available. There is a skateboard ramp and areas for children to play. The Tecate Feria takes place in the park every year in the summer.	Tecate City government.	One block south of Defensores de Tijuana Boulevard.	Sierra, Olga A. 2002. "Culture, Recreation and Sports in Tecate." In Tecate, Baja California: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.100, 101.
Parque Hidalgo	A downtown park created in the 1920s and known as the main plaza. It is a symbolic public area where people gather to socialize, eat, buy arts and crafts, listen to music or to celebrate civic events. It has a gazebo in the center for musicians.	Tecate City government.	Between Avenida Hidalgo and Avenida Juárez in downtown Tecate city.	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, Baja California: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.12,13.

Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Desert Tower	Built by hand by Bert Vaughn (1922-1928), who owned the town of Jacumba. The stone tower is 70 feet tall and is a tribute to the pioneers who made the treacherous trek west through Arizona and California.	Private property.	Interstate 8/In-Ko-Pah exit/Jacumba, California.	Retz, Mike. "The Desert View Tower." In Mountain Heritage.The Back Country's Historical Digest.Volume 18 Number 2. San Diego, CA, pp. 1,3,5..
San Diego and Arizona Railroad	Built from 1914-1919 for sugar magnate John D Spreckels. It is a 146 mile binational route that connects San Diego-Tijuana -Tecate-and El Centro. The route was envisioned as an American railroad but crossed through Mexico as a result of topography. This railroad allows a unique view of both nations.	México and U.S. federal governments.	Tijuana, San Diego, Tecate,Baja California and Tecate California.	Kirchner, John. 1988. Baja California Railways. San Marino, California: Golden West Books. And Hanft, M Robert. 1984. San Diego&Arizona:The Impossible Railroad. Glendale, California: Trans-Anglo Books.
Cuchuma Mountain	Sacred mystical mountain of the Kumeay Indians. Half of this peak is in the U.S. and the other half in México. The metal border fence can be seen in the mountain from Rancho la Puerta.	Mexico and U.S. federal governments.	Tecate and San Diego border.	Summers, June Nay. 1972. Good Morning Tecate:History of a Border Town. Lakeside California: Sunlight Press Inc.p. 15.
Border Field Park	Last portion of the Tijuana River Estuary. This park was created as a friendship area of encounter with neighboring Mexico. The dividing fence that separates this portion of the border is a metal grid that allows viewing Playas de Tijuana, Baja California. The park is used for tourists as well as by social activists to celebrate binational events. It has 2 miles of sandy beach as well as horseback and walking trails.	California State Parks. U.S.	Southeastern end of the US in Imperial Beach. Bordering with Mexico and the Pacific Ocean,	Schulte-Peevers, Andrea. 2001. San Diego & Tijuana. Australia: Lonely Planet Publications, pp. 107,113.

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Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Tijuana River Estuary	Natural Reserve of 2530 acres that encompasses the largest remaining salt marsh in Southern California, ending in the Pacific Ocean. This coastal estuary is home to some 370 species of native and migratory birds and has 8 miles of walking and horseback trails.	California State Parks, U.S. Fish and Wild Life Service.	Southeastern end of the US in Imperial Beach. Bordering with Mexico and the Ocean	www.tijuanaestuary.com
Tecate Old Industrial District	Formed by traditional industries that surround the railroad station. They are an ex-Malt factory built in 1929, an ex-oil factory built in 1933, a Brewery built in 1943 and an ex-coffee-milling plant built in the 1960s.	Federal and Private properties.	By the railroad tracks.	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles, Municipio de Tecate. México, pp. 551-555.
Plaza Monumental	Bull Ring by the sea built in 1960. One of the biggest in the world with 25,000 seats with views to two nations, a binational beach, the border fence and the Pacific ocean.	Private property.	In Playas de Tijuana, bordering with the U.S.	Guzmán Soto, Antonio. July 2000. "La Monumental de Playas Celebra su XL Aniversario." In Fundadores. Tijuana, pp. 23-26
Abelardo Rodríguez Dam	Built from 1927 to 1934 by an American Company with American materials (steel and concrete). Named after a Baja California governor.	Federal Government.	Km. 18 of the Tijuana-Tecate railroad.	Padilla, Antonio. 1989. "La Presa Abelardo Rodríguez, Modelo de Ingenieria Hidráulica." In Jesús Ortiz Figueroa/ David Piñera Ramírez coord. Historia de Tijuana. Tijuana:UABC, pp. 93-110.
Agua Caliente Ex-Casino	Built in 1927-1929 by American architects Wayne Douglas and Corine MacAllister to serve the booming gambling industry during US Prohibition era. Some remains of the casino still exist (chimney, bungalows, fountain, swimming pool). The site is now occupied by five federal schools.	Federal Government	Between Paseo de los Heroes and Rodolfo Sanchez Taboada Avenidas.	Lugo Jr., Alejandro.1985. "El Casino de Agua Caliente." In Piñera Ramírez, David. Historia de Tijuana, Semblanza General. Tijuana: UNAM-UABC, pp. 114-117.

Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Boulevard Agua Caliente	One of the oldest streets in the city that conducted to one of the entrances of the Agua Caliente Casino. Along this street are some historical structures such as the Race Track, the Bull Ring, a Sombrero shaped restaurant and motels from the 1940s, the replica of the Casino tower, the Golf Course and a modern two tower Hotel.	City of Tijuana government	Parallel to Paseo de los Heroes and perpendicular to Revolucion street	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, pp. 320,322
Parque Teniente Guerrero	A popular park built in the 1920s as a community initiative. Named after Lieutenant Guerrero who defended Tijuana during the 1911 filibuster invasion. Considered a place of memory for many Tijuanenses who celebrate each July 11 the "virtual" foundation of the city. It has a gazebo, a fountain and a monument to its founder a school teacher.	City of Tijuana government.	Tercera and Fstreets in downtown Tijuana.	Automobile Club of Southern California. 1995. Baja California. Los Angeles, California, pp. 48,49.
Escuela Alvaro Obregón	Brick building constructed in 1929 as an exact copy of another shool in Yuma Arizona. Named after ex-president Alvaro Obregón. It hosts the City "House of Culture."	City of Tijuana government.	Corner of Lisboa and Buenos Aires Streets in a hill of Colonia Altamira.	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles. Municipio de Tijuana. México, pp. 621, 622.
Calle Segunda	This street appears in the 1889 city map. Some of the oldest buildings built in the 1920s are located here: The Cathedral, Mercado el Popo, Ex-Municipal Palace, Edificio Aldrete, Francis Hotel etc.	City of Tijuana government.	Downtown Tijuana	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles. Municipio de Tijuana. México.
Light House	This structure guides the ships that navigate in front of Playas de Tijuana-Imperial Beach border.	Federal Government	Playas de Tijuana Bordering with the Field State Park in Imperial Beach.	Secretaria de Marina official files.

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Border Fence	The border metal fence that separates Baja California and California is a symbolic monument that divides and unites the tow nations. It is used for artistic expressions, binational events as well as for grassroots protests.	U.S. federal government	Mexico-US border.	Schulte-Peevers, Andrea. 2001. San Diego & Tijuana. Australia: Lonely Planet Publications, pp. 256,257.
Gaskill's Stone Store	This building was built in 1885 by Silas and Luman Gaskill. It was used as a bank, a post office, a stage station and as the social center of the community. Today is a museum store.	Mountain Empire Historical Society.	State Hiwy 94 at Campo Circle, California.	S. MacGill, Ruth (compiled and edited).1998. True Tales from Historic Campo and the Mountain Empire of San Diego County. Campo: Mountain Empire Historical Society, pp. 9-14.
Old Campo Road-Hwy 94	In 1870 a regular stage coach known as The Campo San Diego State, ran on this road. The stage left S.D. in the morning changed horses in Dulzura and then drove to Campo the same day. Later it became Hwy 94 and connected to Yuma.	U.S. federal government	East County	http://www.hwy94.com
Pacific Southwestern Railroad Museum	The San Diego Railroad Museum is a non-profit educational organization dedicated to the preservation and interpretation of railroads as they existed in the Pacific Southwest. It has a train station, visitors center, nine locomotives and a collection of passenger cars, freight cars and cabooses. There are excursions to Miller Creek and to Tecate Mexico on weekends ran by volunteers.	Pacific Southwest Railway Museum Association.	Campo Depot 31123-1/2 Highway 94 Campo, California 91906.	http://www.sdrm.org/
Camp Locket (proposed State Park)	This was the original site where troops of the last cavalry units in the U.S. army stationed. The troops stayed until the United States entered World War II. There were all-black cavalry units in the Camp known as "Buffalo Soldiers". The Camp also housed thousands of military personnel from 1942 to 1945.	San Diego County.	Campo, California.	Challberg, Roger. "Camp Lockett State Park?" In Mountain Heritage.The Back Country's Historical Digest.Volume 15 Number 4. San Diego, CA, pp. 1,6.

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Campo Mill	This 1920 structure, where feldspar from Campo mines was milled, is now occupied by the Motor Transport Museum. The museum houses a collection of vintage trucks.	Motor Transport Museum.	Highway 94, two miles east of Campo Creek.	Sutro, Dirk. 2002. "East County." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 305.
Paseo de los Héroes.	The main business district, monuments to national and international heroes and the Tijuana Cultural Center are located in this avenue.	City of Tijuana government.	Zona Rio.	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, pp.319,322
Monumental Flag	Built in the 1997 as a federal program to celebrate national symbols in border cities. The flag is 86 x 150 feet in size and 310 feet tall.	Federal Government	Military camp in Colonia Morelos just passing the south end of Revolucion.	Rodríguez Barajas, Julio. 2004. La Ruta de los Monumentos Históricos de Tijuana. Tijuana: ILCSA Ed., p. 119.
Tijuana Tercer Milenio (La Mona)	House built with a woman's shape by sculptor Armando Muñoz García in 1990 to celebrate the 100 anniversary of Tijuana. It is a naked 50 feet tall sexy woman made of concrete, steel, fiberglass and clay located in the middle of a popular low-income neighborhood.	Private property.	A canyon in Colonia Aeropuerto.	Rodríguez Barajas, Julio. 2004. La Ruta de los Monumentos Históricos de Tijuana. Tijuana: ILCSA Ed., p. 102,105.
Cristo Rey	This monumental Jesus Christ (72 feet tall) made of fiber glass and resin, aims to compete with another one in Brazil. It is surrounded by 28 angels.	Federal Government in conjunction with church.	Colonia los Alamos next to San Martin de Porres church.	Rodríguez Barajas, Julio. 2004. La Ruta de los Monumentos Históricos de Tijuana. Tijuana: ILCSA Ed., p. 119.
Plaza Santa Cecilia	This is the old Olvera Street that appears in the 1889 map of the city. Made a walking street in the 1980s and renamed as Plaza Santa Cecilia. There are restaurants, bars, street vendors and a Mariachi stage. The 1950s Nelson hotel is in the corner of the Plaza and Avenida Revolución.	City of Tijuana government.	Between Revolución and Second Streets.	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 318.

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Parque del Profesor	28 acre park built in 1999 by Fundación la Puerta and designed by Hubbell and Hubbell. It hosts he Kuchuma Ecological Center, an interactive educational center whose buildings resemble natural boulders that camouflage with the landscape.	Fundación la Puerta.	Left side of the entrance to Tecate coming from Tijuana non-toll road.	La Cuenca del Río Tijuana. CD created by Digital Contact as a Coproduction of San Diego Natural History Museum, EPA,US Forestry.
Plaza de Toros de Tijuana	Built in 1938 entirely on wood construction. Rebuilt after a fire in 1957 with steel.	Private property.	Boulevard Agua Caliente.	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 314, 320.
Jacumba	This city was a stopping place for travelers between Phoenix and San Diego. The hotel at Jacumba Hot Springs, built in the 1920s burned down in 1942. Visited by movies stars, now is a ghost town with a train station.	San Diego County.	Old highway 80.	Sutro, Dirk. 2002. "East County." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p. 306.
Rancho la Puerta	Old ranch adapted in the 1940 as a health resort and considered one of the world's most highly rated.	Private property.	In the Tecate valley next to a river and the Cuchuma Mountain	http://www.rancholapuerta.com/
Kumeyaay region	Archeological sites with rock carvings, mortars, Indian trials, cemeteries from Kumiais, Pai-pais, and San Dieguinos groups (Junta de Neji, Peña Blanca, El Aguaje de la Tuna, Lázaro Cárdenas, Valle de las Palmas, el Hongo, Campo sites)	Federal, state and local governments.	Urban zone in Tecate, Parque los Encinos, rural area of Campo and Tecate.	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, Baja California: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.5-10.

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Panteon #2	Second cemetery built in Tijuana in the 1940s. Famous because Juan Soldado tomb is there. There is controversy about whether he was a martyr or a criminal. Venerated as the saint of the migrants by popular tradition.	City of Tijuana government.	Calle Segunda and Cañón K.	García, Hamlet. "La leyenda de Juan Soldado." In Periódico Frontera. Tijuana: Noviembre 1, 2004, p.14.
U.S. Inspection Station in Tecate.	Built in 1933-34 by the U.S. Treasury Department in Spanish Colonial Revival Style as interpreted by the Depression-era federal building program.	Federal Government.	California State Hwy 188, Tecate, California in the border with Tecate, México.	Historic American Buildings Survey/Historic American Engineeering Record. 2003. Survey Number CA 2782. Unprocessed Item. Also with Marshall, David. Heritage Inc. San Diego, CA.
Tijuana Border Gate Building	Only building inspired in architect Félix Candela style in Tijuana. Designed in the 1960s in a shell form with several vaults.	Federal government.	In Tijuana, bordering with San Ysidro.	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p.322.
Thing Brothers Store	Wood store built at the end of the nineteenth century to sell foodstuffs and other merchandise and to offer postal services to both Tecate Baja California and to Tecate, California residents.	Private property.	Tecate, California a few feet from the Mexican border..	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, Baja California: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.12,13.
Adobe store ruins	In the twenties the Port of Tecate stood one half mile east of its present location. The Mountain Commercial Company operated a store opposite to the Port. Its adobe walls are still visible.	Federal government	In Tecate Califorrnia. A few feet from the Mexican border and the U.S. Inspection Station	Summers, June Nay. 1972. Good Morning Tecate:History of a Border Town. Lakeside California: Sunlight Press Inc.pp. 27, 41.

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Playas de Tijuana	Urban beach with a portion of a binational friendship park, a lighthouse, a bullring, modern houses and restaurants. Place of celebration of cultural and social events.	Federal and private properties.	Bordering with the U.S. and the Pacific Ocean	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p.321.
Race Track	Built in 1929 to serve the gambling and sports boom of Tijuana.	Federal government	Boulevard Agua Caliente.	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, p.323.
Ranches	Established since 1833 to raise cattle, corn, wheat and other vegetables. Some still have remains of barns, houses, and warehouses such as Neji, Jacume and Las Juntas.	Private properties	North of Tecate, Baja California and Campo, California	Santiago Guerrero, Leticia Vibiana. "Profile of the Origins of Tecate's Population." In Tecate, Baja California: Realities and Challenges in a Mexican Border Community. Paul Ganster, Felipe Cuamea Velázquez, José Luis Castro Ruiz, and Angélica Villegas, eds. San Diego: SDSU Press, pp.8,9.
Colonia Libertad	This colonia (neighborhood) was established in 1927-1928 with Mexican migrants returned from the U.S during the recession. The train depot from the Tijuana-Tecate railroad sits in this neighborhood next to a border marker and to the San Ysidro depot on the US side both divided by the border fence.	City of Tijuana government	In Tijuana, bordering with San Ysidro California	Bustamante Fernández, Jorge.1985. "Surgimiento de la Colonia Libertad." In Piñera Ramírez, David. Historia de Tijuana: Semblanza General. Tijuana: Centro de Investigaciones Históricas UNAM-UABC. pp. 316-331.

Name of monument or place	Historical or cultural importance	Legal status	Location or address	Bibliographic reference for further reading
Tijuana Cultural Center (CECUT)	Cultural complex built by famous architect Pedro Ramírez Vázques. It has the Museum of las Californias, an art gallery, shops with books and hand-crafted goods, cafeteria, offices, a 1000 seat concert hall and an Omnitheater (a spherical theater) that presents large-format three dimensional cultural and scientific films.	Federal of Tijuana government.	Paseo de los Héroes and Avenida Independencia	Sutro, Dirk. 2002. "Tijuana." In San Diego Architecture. San Diego: San Diego Architectural Foundation, pp.315, 319.
Avenida Hidalgo	An old stagecoach road urbanized and named Calle Libertad in the 1920s. Many of the oldest houses of Tecate are located in this street as well as the Virgin of Guadalupe church.	City of Tijuana government.	Parallel to the railroad tracks on the north.	Instituto Nacional de Antropología e Historia. 1986. Catálogo Nacional de Monumentos Históricos Inmuebles, Municipio de Tecate. México.
Cordillera de arboles de Encino	Corridor of oak trees identified as an area of natural beauty and part of the cultural patrimony of Baja California by the Commission of Preservation in Tecate (not designated yet)	Federal Government	Neji-Valle Redondo Sierra	Comisión de Preservación del Patrimonio Cultural de Tecate. 1999. "Diagnóstico del Patrimonio Cultural del Municipio de Tecate." In Diagnóstico del Patrimonio Cultural de Baja California.Mexicali: ICBC, p.41.
Neji Cemetery	This indigenous cemetery is considered a potential cultural patrimony by the Commission of Preservation in Tecate.	City/federal government	Neji	Comisión de Preservación del Patrimonio Cultural de Tecate. 1999. "Diagnóstico del Patrimonio Cultural del Municipio de Tecate." In Diagnóstico del Patrimonio Cultural de Baja California.Mexicali: ICBC, p.41.
Camino Nacional	This old road was built in 1915 under the government of Coronel Esteban Cantú in order to link Mexicali-Rumorosa-Tecate and Tijuana.	Federal Government	Mexicali-Tecate-Tijuana-	Meade, Adalberto Walther. 1993. Tecate Cuarto Municipio. Mexicali: Universidad Autónoma de Baja California.

6. Appendix: Simple things residents can do in their homes, schools, and businesses to improve the environmental and social conditions of the TRW

Water quality and quantity

1. Avoid opening manholes during flood events or storms. Find other means to control flooding, such as building culverts and storm ditches. The wastewater treatment plants in Mexico currently do not have the capacity to treat the quantity of storm water, nor the storm water pollutants. The addition of storm waters to the wastewater causes overflow of wastewater into the estuary and ocean.

2. Never throw anything (trash, chemicals, oil, even organic materials) down the storm drains. These items clog the system, pollute streams and oceans, and harm wildlife. Clogging storm drains can also cause more flooding problems in city streets when it rains.

3. Pick up your animal waste. The bacteria from animal droppings can seep into the ground and contaminate ground and surface waters.

4. Detect water leaks. Check your water meter before and after leaving your home vacant to see if there is a leak that needs to be reported to the landlord or water agency.

5. Reduce water consumption. Water is a limited and costly resource in this region. Do not run water when washing dishes, clothes, brushing your teeth, or shaving. Use a bucket to wash your car. Take short showers. Collect dishwater for watering plants and lawns. To reduce water consumption by 1 to 2 gallons per flush, place a 1 gallon plastic milk jug full of rocks and water in the tank of the toilet.

6. Report all sewage and water leaks immediately to your city’s Comisión Estatal de Servicios Públicos or the San Diego County Water Authority.

Environment and Natural Resources

7. Plant native shrubs and drought-resistant trees and shrubs in your yard. This will decrease water use, increase habitat area, and attract local birds, insects, reptiles, and mammals. The shade provided by native trees cools your house and yard. The roots of the trees help retain soil in your yard.

8. Avoid exotic plants. Avoid using grass—you will help the environment and heavily-watered lawns are attractions for skunks, opossums, and other unwanted guests. If you have a grass lawn, place tin cans around the lawn and time how long the sprinklers take to fill the can 1 inch. That is how long the sprinklers should run.

9. Place bird feeders and baths in your lawn. The TRW is a migratory stopover for birds in the Americas. The wetlands they have used for centuries are diminishing, but households can help in small ways until our local wetlands recover.

10. Cut up plastic beverage six-pack holders and never let helium balloons go—these can strangle wildlife.

11. Bring your own bags to the store, or avoid using bags. Plastic bags are increasingly seen as a major threat to the environment, wildlife, and our landfills.

Solid and Hazardous Waste

12. Avoid the use of household cleaning products and insecticides with chemicals. Never throw unused chemical products into the sink or rivers. Remember, these chemicals can end up in your well water, streams, and oceans.

13. Use water-based paint. Chemicals and heavy metals in lead-based paint can harm humans and the environment.

14. Use rechargeable batteries; can save you money. Dead batteries should not be thrown away or burned, because they leak hazardous materials into the soil and water, and can

explode. Deliver them to the San Diego Household Hazardous Waste Transfer Facility (858-694-7000).

15. Reduce, Reuse, Recycle. Aluminum foil, glass jars, plastic containers and other items can be rinsed and reused. If an item is unusable, rinse it and recycle it.

16. Chidren should educate their parents about litter. When hiking in the hills, at the beach, or along the streams and rivers, carry a trash bag and pick up trash.

17. Start a recycling program. Children should ask their teachers to start a recycling center at their schools. Recyclables can bring in money.

18. Take toxic household products to the appropriate hazardous waste centers. Examples of toxic products are pesticide containers, used motor oil, gasoline, paint thinner, batteries, paint containers, and so forth. Studies in the TRW show that residential pollutants in wastewater are even more of a problem than industrial pollutants.

19. Compost your organic waste in a corner of your yard. In addition to helping reduce bulk in the landfills, this compost is excellent fertilizer. Sprinkle the compost pile with ash or lime (*cal*), and turn the compost pile so that the sun “cooks” the compost for about a month before using it in plant beds. Lightly watering the compost pile helps speed up the decomposition process.

20. Report illegal dumping to DGE, EPA, or similar authority.

21. Never dump unwanted items in public places like rivers or arroyos. Take them to recycling centers, donation centers, or landfills that have liners proventing leakage into the groundwater and soil.

22. Donate your old car to charity. This will keep cars out of the landfills and prevent automobile fluids from leaking into the soil and groundwater. Car donations can be tax deductible in the United States.

Air Quality

23. Bike, carpool, and take the bus or trolley as much as you can. Apply for a SENTRI border crossing pass to help alleviate border area traffic and pollution.

24. Turn off your lights and appliances when not in use. This practice saves money and reduces the power plants' use of fossil fuels.

25. Use incandescent lightbulbs or higher wattage lightbulbs for the above reasons.
26. When building your house, calculate how much money could be saved by installing solar panels.

27. Avoid using styrofoam products. The production process contributes to ozone depletion. In addition, styrofoam is slow to biodegrade and takes up much landfill space.

Socioeconomic Issues

28. Vote in elections, and write or call your representatives. Demand that politicians be responsible with your watershed resources. Put your local issues on their agenda.

29. Volunteer for a local charity, NGO, orphanage, senior center, etc. Community involvement and pride can increase the quality of life for many.

30. Buy local. Try to buy local produce, nursery plants, and household products; avoid larger chains. Transportation of goods from outside the watershed can have negative effects on the TRW's air quality, environment, traffic, and local economy.

31. Take a vacation in your own neighborhood. Enjoy the local beauty of the TRW by hiking in the Otay Mountain Wilderness Area; bird watching at the Tijuana Estuary; visiting Playas de Tijuana, tourist districts in Tijuana, tourist ranches in Tecate; and camp in the upper watershed near El Compadre, La Hechicera, or Valle de Las Palmas.

7. Appendix: Available data for water quantity

Data for water quantity in the United State	Data for water quantity in Mexico
United States Geological Survey (USGS). 1990. Information about the amount of water used and how it is used on 18070305 - Cottonwood-Tijuana that is the classification of the watershed in the USA side. http://water.usgs.gov/cgi-bin/wuhuc?huc=18070305	Comisión Nacional del Agua. 2004. Situación de los recursos hídricos. Estadísticas del Agua en México 2004. Capítulo 3. http://www.inafed.gob.mx/wb2/ELOCAL/ELOC_Estadisticas_del_Agua_en_Mexico_2003
United States Geological Survey (USGS). Daily updates on surface and ground water quanity for the Cottonwood Creek, Tijuana Rivers, and Campo Creeks in the U.S. Parameters available off Discharge, cubic feet per second and Gage height, feet. Historical data are available. http://waterdata.usgs.gov/ca/nwis/uv	Cartografía en Línea del Atlas del Ordenamiento Ecológico General del Territorio http://mapas.ine.gob.mx/website/atlas/
Office of Hydrologic Development of the National Weather Service. Hydro meteorological Automated Data System is a real-time data acquisition and data distribution system operated by the Tijuana River at International Watershed. IBTC1. http://dipper.nws.noaa.gov/nexhads/servlet/DecodedData?sinceday=7&nesdis_ids=0093D140&hsa=nil&state=nil&of=0	Instituto Nacional de Ecología. Cuencas Hidrográficas, Ángulo de la Pendiente, Red de Drenaje y Disección Vertical del Estado de Baja California. http://mapas.ine.gob.mx/website/cuencas/bc/viewer.htm Comisión Nacional del Agua. Subregiones Hidrologicas.SIGA-SGP-CNA. Mapas Temáticos en Sistema Geográfico de Agua. Pagina de Comisión Nacional del Agua. http://sgp.cna.gob.mx/ArcIMS/Website/Sub_reghidro/viewer.htm
Boyle. February 20, 2002.Regional Colorado River Conveyance Feasibility Study. Final Report. Table 5-1: Population Growth in Tijuana and San Diego, Table 5-2: Projected Water Demands for the Tijuana Municipality.	Comisión Nacional del Agua. 1996. Clasificación de agua superficial de acuerdo a la concentración de coliformes fecales, 1996. Mapas Temáticos en Sistema Geográfico de Agua. Pagina de Comisión Nacional del Agua. http://mapas.ine.gob.mx/website/natural/Colfecsu/viewer.htm

http://www.sdcwa.org/news/pdf/Binational/Boyle2002/05near-termoptions.pdf	García Cueto, O. R. 1993. La variabilidad de la precipitación y el fenómeno ENSO. *Divulgare, UABC*, No. 2, Marzo-Mayo 1993 (Recursos Agua), May: 4.
VICTOR MIGUEL PONCE . 1997. Flood Hydrology Of The Binational Cottonwood Creek/Arroyo Alamar, California And Baja California. SCERP Project Number: W-00-5. , San Diego State University. - Topology of Cottonwood Creek-Arroyo Alamar Draingage Basin. Page 13. - Average and Maximum Historic Monthly Levels in Lake Morena. Page 14 - Average and Maximum Historic Monthly Levels in Lake Barrett. Page 15. - Flood Discharges (m^3/s) calculated for the Basin of Arroyo Alamar with Statistical Methods. Page 16. - Hydrologic Characteristics of the Subbasins. Page 17. - Design Storms (cm) for Return Periods of 2 years to 1000 Years. Page 21. - Historic Levels (in ft, relative) in Morena Reservoir at the Beginning of the Month. Page 24. - Historic Levels (in ft, relative) in Barrett Reservoir at the Beginning of the Month. Page 27. - Funtions of Elevation -stored Volume-spilled Discharge for Morena Reservoir. Page 29. - Functions of Elevation-stored Volume-spilled Discharge for Barrett Reservoir. Page 31. - Calculation of Runoff Curve Number for Pine Valley Creek 2 Lateral Subbasin (topological number 30602). Page 33. - RAINFLO Input File Corresponding to the 100-year Return Period. Page 35. - Flood Discharges (m3 s-1) Calculated for Cottonwood Creek - Arroyo Alamar by Rainfall Runoff Modeling. Page 45. - Flood Discharges (m3 s-1) Calculated for Arroyo Alamar With and Without Infiltration in the Channelization Project	Álvarez Valdez, G. 1973. Cuencas de Captación en el Estado de Baja California. *CALAFIA, UABC*, Vol. II No. 3 (Cuenca), Diciembre: 5. Paredes Arellano, E. 1973. Disponibilidad de los recursos hidráulicos en el Estado de Baja California. *CALAFIA, UABC*, Vol. II No. 3 (Hidráulicos), Diciembre: 10. Segovia Zavala, J. A., Gutiérrez Galindo, E. A., & y Flores Muñoz, G. 1996. El agua en Baja California. Divulgare, UABC, No. 15, Año 4, Julio -Septiembre 1996 (Abastecimiento de Agua), Jul.: 5. CESPT. Información de Hidrometría de Agua Potable y Alcantarillado (Fólder). Plano con diagrama de flujo del sistema de agua potable, ubicación de tanques, rebombeos y los puntos donde se han realizado los aforos, lectura de macromedidores promedios mensuales del año 2001, aforos realizados en alcantarillado, indicadores de gestión del programa de control de pérdidas, plano de 32 circuitos hidrométricos. CESPT. Cobertura Total de Agua Potable y Alcantarillado. Contiene la población beneficiada de los sistemas de agua potable y alcantarillado. CESPT. Programa Hidráulico de Gran Visión Región I, Península de Baja California. Presentación, programa hidráulico, resumen ejecutivo, resumen sintético, síntesis básicas, documento de divulgación, libro del agua. CESPT. Información de Cuencas Hidrológicas del 2001. CD

Reach (40117). Page 47. http://www.scerp.org/projs/00rpts/W-00-5.pdf	Información de cuencas hidrológicas, fraccionamientos, coberturas, límite municipal, división de distritos.
USGS California Hydrologic Data Report. 1996. Cottonwood Creek 11012000Above Tecate Creek, Near Dulzura, CA http://ca.water.usgs.gov/archive/waterdata/96/11012000.html	Sistema Hidráulicos y Ambientales S.A. de C.V. (Dos Tomos de 1999-2025). Estrategia de Gran Visión para Abastecimiento y Manejo de Agua en las Ciudades y Cuencas de la Frontera Norte
USGS California Hydrologic Data Report. 1995. Cottonwood Creek 11012000Above Tecate Creek, Near Dulzura, Ca. http://ca.water.usgs.gov/archive/waterdata/96/11012000 http://ca.water.usgs.gov/archive/waterdata/95/sw/sw11012000.st	CESPT. CD Base de Datos de los sobre los consumos por tipo de usuario.
	Gobierno del estado de Baja California. Plan Estatal Hidráulico 1994-2015. Documento oficial de diagnóstico de las necesidades futuras de agua en el medio urbano del estado y se establecen las acciones de gobierno que se requieren para satisfacer la demanda de agua.
USGS California Hydrologic Data Report. 1994. Cottonwood Creek 11012000Above Tecate Creek, Near Dulzura, Ca. http://ca.water.usgs.gov/archive/waterdata/96/11012000.html http://ca.water.usgs.gov/archive/waterdata/94/sw/sw11012000.html	COLEF. Year? Plan Estatal de Desarrollo Urbano. Establece lineamientos y estrategias de ordenamiento urbano en el Estado.
	Gobierno del estado de Baja California y COLEF. Plan Estatal de Desarrollo 2002-2007. Documento oficial que contempla las acciones que se llevarán a cabo durante la presente administración para el estado de Baja California.
USGS. 1999. California Data Report: Discontinued Lakes & Reservoir Sites. Volume 1. Southern Great Basin from Mexican Border to Mono Lake Basin, and Pacific Slope Basins from Tijuana River to Data Maria River. http://ca.water.usgs.gov/archive/waterdata/99/disc_lakes.html	CESPT. Plano con Límite de Distritos de Agua Potable y Colonias (Copia a Colores) esc: 1: 50,000. Límites de los distritos, presa, Río Tijuana, nombres de las colonias.
USGS 1999 California Data Report: Discontinued Gaging Stations.	CNA. 1997. Diagnóstico Actual y Propuesta de Explotación y Tratamiento de los Pozos

Volume 1. From the Southern Great Basin from Mexican Border to Mono Lake Basin, and Pacific Slope Basins from Tijuana River to Data Maria River. http://ca.water.usgs.gov/archive/waterdata/99/disc_sw.html	de Agua Potable de la Ciudad de Tijuana (Tomo II). Planos de (localización de pozos, profundidad de niveles estáticos, evolución del nivel estático en el periodo 87-97)
Richard M. Gersberg, and, Fernando T. Wakida Kusunoki. 1998. “Water Quality and Quantity”. UABC and SDSU. Page 80. In State of the Enviroment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University An overview of the existing literature of the Water Quality and Quantity of the Tijuana River area.	Proyectos, Estudios y Consultaría, S.A. de C.V. (2 tomos YEAR?). Definición de Nuevas Fuentes de Abastecimiento Diagnóstico de agua potable, elaboración de alternativas, para planeación de un horizonte al año 2015, propuesta de esquemas de solución viables desde el punto de vista técnico-económico que consideren la disponibilidad del recurso de agua.
	CESPT. YEAR? Situación Actual del Sistema de Abastecimiento de Agua Potable para la Ciudad de Tijuana B.C.3 Comportamiento del sistema de abastecimiento de agua potable a la ciudad de Tijuana.
	CESPT. CD con Información de Curvas de Nivel en Mosaico de Catastro. Información de curvas de nivel, inventario de redes, red primaria.
	CESPT. Histogramas de Consumo (2000-2001). Disquete Información de lo últimos dos años 2000-2001.
	CESPT. Resumen General del Consumo Promedio por Cuenta. Consumo promedio por cuenta en el año clasificado en residencial, comercial, industrial, y de gobierno, incluye también el promedio por mes del servicio.

	CESPT. Diciembre 1999.Análisis Preliminar para el Abastecimiento de Agua a Tijuana Tecate, Rosalito, Mediante Ampliación del Acueducto Rió Colorado Tijuana. Es un estudio con el objeto de analizar la posibilidad de ampliar la capacidad de conducción del acueducto rió colorado-Tijuana, determinando las obras necesarias para este propósito y sus posibles costos, todo esto en el ámbito de factibilidad.
	CESPT. Definición de Políticas de Servicio de Agua Potable, a Corto, Mediano, y Largo Plazo (2004, 2009, 2038). Análisis de demanda de agua potable para zonas con infraestructura de distribución actual, para zonas con distribución y red primaria actual incluyendo baldíos intraurbanos, fraccionamientos en proceso, colonias incluidas en el crédito japonés, ampliación de la mancha urbana donde existe red primaria.
	La Conferencia COBRO Anual de 1997. Conferencia: Retos y oportunidades binacionales del Agua. Comité Regional de Oportunidades Fronterizas (COBRO) de la Asociación de Gobiernos de San Diego (SANDAG). Reporte que provee un acercamiento a las demandas de agua y fuentes en las regiones de San Diego y Tijuana. Resumen de las sesiones.
	CESPT.5 de marzo del 2002. Propuestas de DOE para Recarga de Acuífero

8. Appendix: Availble data for water quality

Data for water quality in the United States	Data for water quality in Mexico
City of San Diego. 1996. Watershed Sanitary Survey: Volume 5, the Cottonwood Watershed. Dry weather bioassessment and chemical monitoring of creeks and rivers. Available from the City Water Dept.	Comisión Nacional del Agua.1996. Clasificación de agua superficial de acuerdo a la concentración de coliformes fecales. Mapas Temáticos en Sistema Geográfico de Agua. http://mapas.ine.gob.mx/website/natural/Colfecsu/viewer.htm
City of San Diego. 2001. Watershed Sanitary Survey: Volume 3, the Cottonwood-Otay System. Dry weather bioassessment and chemical monitoring of creeks and rivers. Available from the City Water Dept.	Comisión Estatal de Servicios Públicos de Tijuana. February 2003. Potable Water and Wastewater Master Plan for Tijuana and Playas de Rosarito. Datos de calidad de agua. http://www.epa.gov/region09/water/tijuana/masterplan/
SD County department of Health. May 2003. Coastal monitoring, dry weather monitoring program, general characterization and raw data. 2 sites in Tijuana. Excel spreadsheet. Field testing with 9 parameters Graphs on Tijuana data. Available from the County Water Dept.	COLEF. Programa Regional de Desarrollo Urbano, Turístico y Ecológico del Corredor Costero Tijuana-Rosarito-Ensenada. (Versión Abreviada y Completa) Antecedentes, Diagnóstico (Pronóstico Integrado), Modelo de Ordenamiento Territorial, Acciones de Desarrollo, Instrumentos (Comité Técnico de Administración del COCOTREN, planeación y normatividad, instrumentos jurídicos, instrumentos financieros, índice de figuras, índice de tablas, anexos).
San Diego Water Department has an archive of over one hundred years of stream flow, rainfall, evaporation, and other hydrographic data at Morena and Barrett Reservoirs on Cottonwood Creek. Available from Jesus Meda, jmeda@sandiego.gov.	Comisión Nacional del Agua. Situación del Agua en México Se presentan los avances logrados en México en el Cumplimiento de la agenda 21 en materia de agua.
Earth 911. Daily updates on beach closures for Border Field State Park. http://www.earth911.org/WaterQuality/default.asp?beach_id=32&station_id=108&cluster=1	CESPT. Procedimientos de Agua Potable. Procedimientos para telemetría y automatización, tratamiento de agua potable en planta

San Diego County. 2003. 3 Year Summary (2000-2002) and San Diego County 2003 Beach Closure & Advisory Report. Beach Closure Report—locations under a chronic status for all or part of the year.

http://www.co.san-diego.ca.us/deh/lwq/beachbay/pdf/2003_bcr-summary.pdf

K Riveles, RM* Gersberg.1999. Toxicity Identification Evaluation of Wet and Dry Weather Runoff from the Tijuana River. Bulletin of Environmental Contamination and Toxicology Volume 63, Number 5 Springer-Verlag New York, LLC .Pages: 625 - 632 ISSN: 0007-4861.

Order at http://dx.doi.org/10.1007/s001289901026.

EPA. 1999. Final Supplemental Environmental Impact Statement -- Long Term Treatment Options. Tables with Influent and Effluent TCDD-Equivalent Concentrations (pg/L) .3-6. Average Daily Sludge Quantities and Number of Truck Loads per Alternative (from Appendix B-3)

http://www.epa.gov/region09/water/iwtp/supp.pdf

City of San Diego Metropolitan Wastewater Department Environmental Monitoring & Technical Services Division Industrial Waste Laboratory .Sampling And Analysis Of Tijuana Wastewater from June 1 To December 31, 2002.

http://www.ibwc.state.gov/Files/TJRpt8.pdf

Boyle. 2002. The Regional Colorado River Conveyance Feasibility

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potabilizadora Abelardo Rodríguez y El Florido, análisis de parámetros físico-químicos en agua potable, análisis bacteriológico
de muestras de la red de distribución de agua potable. Análisis de plaguicidas por cromatografía de gases, análisis químico.

CESPT. Información del Reporte Mensual del Laboratorio de agua potable. Seis Disquetes
Contienen información sobre el tratamiento de agua por mes desde enero del 2001 hasta enero del 2002.

CESPT. Información Sobre Agua Potable.
Almacenamiento de agua Presa Carrizo (1997-2000) y Presa Rodríguez (2000-2001). Volumen de agua tratada en la planta Florido (1998-2001) y planta Rodríguez (1998-2001). Producción de agua en (potabilizadora Rodríguez, pozos la Misión y Rosarito, rió Tijuana año 99-2001). Lluvias en (Presa Carrizo y Rodríguez y Planta Florido). Temperatura en Presa Carrizo y Planta Florido. Disquete.

CESPT. Memoria de Gestión (1995-2001).
Contiene antecedentes, innovaciones tecnológicas, eficiencia operativa, eficiencia administrativa, calidad de agua, oferta y demanda, cobertura, informática, cultura de agua, infraestructura desarrollada, atención al usuario, participación ciudadana, tratamiento de aguas residuales, tareas de proceso.

CESPT. Bitácoras de Telemetría y Niveles de Tanques.Una parte en electrónico y copias. Información sobre el monitoreo y control de niveles de tanques y acueductos (reportes mensuales de 2 años), además información sobre el monitoreo de cloro residual en los tanques (reportes mensuales de 2 años).

CESPT. Acueducto de la Presa Abelardo L. Rodríguez, planta potabilizadora "El Florido".
Historia breve del agua en Tijuana, las obras y los beneficios.

8. Appendix: Availble data for water quality

Study Final Report. Prepared for the San Diego Co. Water Authority. TABLE 6-9: Comparison of Colorado River Water Quality to Recommended Water Quality Standards. http://www.sdcwa.org/news/pdf/Binational/Boyle2002/06waterquality treatment.pdf	CESPT. Información de Potabilización del Agua y plano con los sitios de donde se extraen las muestras. Seis disquetes Contiene información sobre los análisis físico-químicos, análisis de cloración de los años (2000-2001) y los estándares de la norma oficial mexicana.
USGS 1999 California Data Report: Discontinued Water-Quality Stations.Volume 1. Southern Great Basin from Mexican Border to Mono Lake Basin, and Pacific Slope Basins from Tijuana River to Data Maria River. http://ca.water.usgs.gov/archive/waterdata/99/disc_wq.html	CESPT. Expedientes de Monte Olivos. Copias. Información de calidad de agua que es extraída en los pozos de Tijuana.
Richard M. Gersberg C. Brown. 1996.Monitoring and Modeling Of Water Quality In The Tijuana River Watershed (SCERP Project Wq Pp96ii-10). San Diego State University. Compare industrial, urban, and rural early and late storm samples for heavy metals. http://www.scerp.org/scerp/projects/Gersberg.pdf	CESPT. Información de muestra del cloro residual y puntos establecidos por la CNA para monitoreo, propuestos desde el año 2000. Fólder. Relación de muestras que se realizan en los puntos de la CNA, por día de comportamiento de cloro.
Richard M. Gersberg, and, Fernando T. Wakida Kusunoki. “Water Quality and Quantity”. UABC and SDSU. Page 80. In State of the Enviroment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University 1998. An overview of the existing literature of the Water Quality and Quantity of the Tijuana River Watershed http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm	CESPT. Dic 2001. Manejo y Disposición de Lodos PITAR, 5 Tomos.
San Diego Water Department. 1940-present. Water quality monitoring	17 Disquetes con Información del Laboratorio PTAR de San Antonio de los Buenos (Punta Bandera), Rosarito, Plantas de Bombeo y Canal Río Tijuana.
	CESPT. Mayo de 1994.Emisor de Aguas Residuales de la Ciudad de Tijuana. CD PTSAB Estudio de la rehabilitación que se realizo en la rampa el Soler del emisor de aguas residuales.
	CESPT. Preliminary Study of the Feasibility of Using a Pond.
	CESPT. Información Mensual de Tratamiento de Agua Residual Correspondiente al Mes de Mayo (Fólder). Análisis físico-químicos del mes de mayo en el tratamiento de las aguas residuales.

at Barrett and Morena Reservoirs and several creeks tributary to these reservoirs. Sporadic monitoring from 1940s. Routine data collected since 1989 are archived in the San Diego Water Department's Laboratory Information Management System, and can be access by contacting Jeffery Pasek, jpasek@sandiego.gov.	CESPT. Información de Caudales, Calidad de Agua y Eficiencia de Funciones de las Plantas de Tratamiento de Aguas Residuales. CD. Agua producida en los años (2000, 2001, 2002), calidad de agua, caudales y volúmenes históricos, información de la EPA, ampliación de la planta de tratamiento de aguas residuales de Punta Bandera, Volumen de la Planta de Tratamiento de Aguas Residuales.
	Gobierno del Estado de Baja California; SIDUE; SFA; CEA. 2004. Plan Estatal Hidráulico. 174 PG. Pdf Available from IRSC. Datos básicos, mapas, planes para el estado.

9. Appendix: Avaible data for ecosystems and natural resources

Data for ecosystems and natural resources in the United States	**Data for ecosystems and natural resources in Mexico**
Checklist of Birds. Recorded in San Diego County, California. From San Diego Natural History Museum. http://www.sdnhm.org/research/birds/sdbirds.html Bird Checklists of the United States. Naval Outlying Landing Field. Imperial Beach, California. From Northern Prairie Wildlife Research Center. USGS. http://www.npwrc.usgs.gov/resource/othrdata/chekbird/r1/ibeach.htm	Principales Ecosistemas, en Guía Oficial Turística de Tijuana. Flora y Fauna. http://www.tijuanaonline.org/espanol/acerca_tijuana/infogeneral/infogeneral.htm
Zedler, Joy B. and Norby, Cristopher S. 1986. Ecological Communities at Tijuana Estuary. The Ecology of Tijuana Estuary, California: Chapter 3 in An estuarine profile.	Instituto Nacional de Ecología. Cambio de Uso de Suelo y Vegetación, Baja California. http://mapas.ine.gob.mx/website/c_us/bc/viewer.htm
Plants and Habitat Types at the Tijuana Estuary. On Tijuana Estuary Visitor Center Web page. http://www.tijuanaestuary.com/native_plants.asp	José Delgadillo R. 1998..”Flora y Vegetación de la Cuenca del Río Tijuana”. Page 49.In State of the Environment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University Describe la flora y vegetación a lo largo de la cuenca del Río Tijuana. http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm
Pryde, Philip R., ed. 1992. San Diego: An Introduction to the Region: An Historical Geography of the Natural.	Roberto Martínez-Gallardo and Ricardo B. Eaton González.1998. “Mamíferos Terrestres de la Cuenca del Río Tijuana”.UABC-Ensenada, Page 64. In State of the Environment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University Presentan una revisión general de las especies existentes de mamíferos terrestres. Basada en trabajos que se han realizado en la cuenca en este tema. http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm

Environments and Human Development of San Diego County. San Diego: Department of Geography, San Diego State University.

Ted Case and Robert Fisher. 1998."Fauna". In State of the Environment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University

Presents an overview of the spices and studies that had been done for the Tijuana River.
http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm

Julie Desmond. 1998. "Estuarine Ecology" SDSU, Page 74. In State of the Environment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University

An overview of the Estuarine Environment, Existing literature, Datasets, and Available Studies.

http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm

Fred Cagle. Ileana Espejel. 1998. "Protected Areas of the Tijuana Watershed", Universidad Autónoma de Baja California, Ensenada, Page 56. In State of the Environment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University
Watershed in San Diego County is represented by many different types of protected areas.

This paper contains protected area descriptions and some of the species.

http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm

Marcelo Rodríguez Méraz, and Salvador González.1998. "Las Aves de la Cuenca del Río Tijuana".UABC, Page 66. In State of the Environment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University

Presentan una revisión general de las especies de aves encontradas en la Cuenca del Río Tijuana. Basada en trabajos que se han realizado en la cuenca en este tema.

http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm

Ponce, V,M., 1989. Management Strategies for Base flow Augmentation. In Base flow Augmentation by Stream bank Storage, Research and Development. Report PgyE. 91 pp.

Una revisión de los diversos enfoques para lograr un aumento del flujo base, entre los que menciona una amplia literatura de los factores y la importancia de los habitas riparios, con miras a proponer su conservación, restauración y manejo integral.

Jorge Alaniz García, and Gatica Colima. 1998. "Herpetofauna de la Cuenca del Río Tijuana". UABC, Page 70. In State of the Enviroment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University

Presentan una revisión general de la Herpetofauna en la Cuenca del Río Tijuana. Basada en trabajos que se han realizado en la cuenca en este tema.

http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm

10. Appendix: Available data on solid and hazardous waste

Data for solid and hazardous waste in the United States	**Data for solid and hazardous waste in Mexico**
EPA. (1998-2002) Toxics Release Inventory (TRI) is a publicly available EPA database that contains information on toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities. The annual Public Data Release contains fact sheets, trend information, and the State Data Files. http://www.epa.gov/triexplorer/	Vaca Mier, Mabel. (1996). Corona Gallardo Maribel, Monroy Mendieta Ma Magdalena. Evaluación del riesgo ambiental en un sitio contaminado por las emisiones de una fabrica de acumuladores. Se evaluó el riesgo ambiental de un sitio contaminado por las emisiones no controladas de plomo y cadmio provenientes de una empresa fabricante de acumuladores en Tijuana, B. C.. http://www.cepis.org.pe/bvsaidis/resisoli/mexico/03125e14.pdf
SANDAG. (1997-1998) INFO - Managing Solid Waste in the San Diego Region. This report provides an overview of how the region disposes of its trash and the region's waste management structure. It describes historic and projected solid waste management trends and provides information on the region's existing solid waste facilities. http://www.sandag.cog.ca.us/uploads/publicationid/publicationid_159_571.pdf	Perez Ruesga, Benigno. 1987. Niveles ambientales de plomo en el poblado de "La Gloria", B.C..Facultad de Ciencias Químicas, UABC, Tabla Num. 5 :Resultados obtenidos en los análisis de Plomo en Suelo y en Plantas. Tabla Num. 6 :Resultados de los análisis del contenido sanguíneo de Plomo en voluntarios, residentes del poblado en estudio. Tabla Num. 8 :Distancia de los puntos de muestreo al foco hipotético de contaminación. Temores Peña, Juan y Reyes Rodríguez, Eduardo Raymundo. Enero 2003. Salud BC, Año 1 , No. 1, Mexicali, Baja California Tabla 1 :Niveles de plomo en La Gloria, durante los dos periodos de muestreo 1987 y 1997. Plomo en el suelo y plomo en sangre. Tabla 2 :Niveles de plomo en muestra de suelo colectado en las inmediaciones de la ex empresa Alco Pacifico (Carretera Tijuana-Tecate. Km. 11.5).
Jurisdiction Profile for City of Imperial Beach. From Integrated Waste Management Board. (1999). Data on household Disposal by of materials. http://www.ciwmb.ca.gov/Profiles/Juris/JurProfile1.asp?RG=C&JURID=209&JUR=Imperial+Beach SANDAG , Jan-Feb 1999Managing solid waste in the San Diego region. INFO no. 1.	Temores Peña, Juan. 1995. Acumulación de Metales de Traza en Suelo de la Ciudad Industrial Otay Nueva Tijuana y Regiones Aledañas. Facultad de Ciencias Químicas, UABC. Tabla 4.1.1. Descripción de los sitios de mustreo de Ciudad Industrial Otay Nueva Tijuana y regiones aledañas. Figura 4.1.1. Plano de ubicación de las zonas de muestreo. Tabla 5.1.1.a Concentración de metales traza (mg/Kg) en muestras de suelo en la zona

The report contains tables and graphics. http://www.sandag.org/uploads/publicationid/publicationid_159_571.pdf	industrial Otay y regiones aledañas. Tabla 5.1.1.b Concentración de metales traza (mg/Kg) en muestras de suelo en la zona industrial Otay y regiones aledañas. Tabla 5.1.1.c pH y porcentaje de carbono orgánico en muestras de suelo en la zona industrial Otay y regiones aledañas. Tabla 5.2.1.a Concentración promedio (mg/Kg) y desviaciones entandar de metales traza en muestras de suelo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Tabla 5.2.1.b Promedio s y desviaciones estándar de pH y porcentajes de carbono orgánico en muestras de suelo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Gráfica 5.2.1.d Niveles promedio (mg/Kg) de Cromo en los diferentes sitios de muestreo la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Gráfica 5.2.1.e Niveles promedio (mg/Kg) de Zinc en los diferentes sitios de muestreo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Gráfica 5.2.1.f Niveles promedio (mg/Kg) de Cobre en los diferentes sitios de muestreo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Gráfica 5.2.1.g Niveles promedio (mg/Kg) de Plomo en los diferentes sitios de muestreo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Gráfica 5.2.1.h Niveles promedio (mg/Kg) de Cadmio en los diferentes sitios de muestreo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Gráfica 5.2.1.i Niveles promedio (mg/Kg) de Níquel en los diferentes sitios de muestreo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Tabla 5.2.1.c Indices de geoacumulación (I.G.) de metales traza en muestreo de suelo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. Gráfica 5.2.1.j Indice de geoacumulación de metales traza en los diferentes sitios en muestreo de suelo de la ciudad industrial Otay Nueva Tijuana y regiones aledañas. APÉNDICE 1 CARACTERÍSTICAS FISICOQUÍMICAS DEL SUELO DE MESA DE OTAY APÉNDICE 4 CARGA DE ECOTÓXICOS EN DESCARGAS DE LA ZONA FRONTERIZA TIJUANA B.C. MÉXICO Y SAN DIEGO CA. E.U.A. APÉNDICE 5 Tabla I. Datos de metales traza en aguas residuales de Ciudad Industrial Otay en mg/L, durante 1982. Tabla II. Datos de metales traza en aguas residuales de Ciudad Industrial Otay en mg/L,
San Diego Regional Technology Alliance (RTA) (May 2002) The San Diego-Tijuana High Tech Waste Prevention & Recycling Workbook. Is one of a series of reports developed by San Diego Regional Technology Alliance (RTA) aimed at supporting the development ad competitiveness of high technology companies in San Diego and the surrounding region. Data from the 1990s with projections to 2015. http://www.crossborderbusiness.com/publicdocs/PromoReports/Ewaste-0205.pdf	
Juan Ojeda Robles, Gerente General. Advanced biological waste treatment for the city of Tijuana Baja California, México. Test conducted by Comision Estatal de Servicios Publicos de Tijuana, Baja California. http://www.bugsatwork.com/Wasteline/TIJUANA.HTM	
Produced by el Instituto Tecnológico y de Estudios Superiores de Monterrey (ITESM) and el Instituto de Información Fronteriza México-Estados Unidos (InfoMexus). 1998. Report on Environmental Conditions and Natural Resources on Mexico's Northern Border. Municipal Solid Waste data in Appendix 7. http://americaspolicy.org/rep-envt/ http://www.americaspolicy.org/rep-envt/pdf/appendix_seven.pdf	
San Diego-Tijuana Border Waste Wi$e Recycling Centers. 2004. List of Tijuana Area Recyclers Serving Businesses in Tijuana/Otay Mesa.	

http://www.borderwastewise.org/busassist/recy2.htm	durante 1983. Tabla III. Datos de metales traza en aguas residuales de Ciudad Industrial Otay en mg/L, durante 1984. Tabla IV. Datos de metales traza en aguas residuales de Ciudad Industrial Otay en mg/L, durante 1987. Tabla V. Datos de metales traza en aguas residuales de Ciudad Industrial Otay en mg/L, durante 1988. Tabla VI. Datos de metales traza en aguas residuales de Ciudad Industrial Otay en mg/L, durante 1989. Tabla VII. Datos de metales traza en aguas residuales de Ciudad Industrial Otay en mg/L, durante 1993.
	Bocco, G., Sámchez, R. A., & y Reimann, H. 1993. Evaluación del impacto de las inundaciones en Tijuana (Enero de 1993). Uso integrado de percepción remota y sistemas de información geográfica. *Frontera Norte, COLEF*, Vol. 5, No. 10, Jul-dic. 1993, Jul-Dic. 1993: 17.
	Ojeda Benítez, M. L., Rubén. 1998. Análisis estadístico del comportamiento de los residuos sólidos domiciliarios en una comunidad urbana. *Frontera Norte, COLEF*, Vol. 10, No. 19, 1998 (Residuos Sólidos), enero-junio 1998: 15.
	Raymundo Reyes R., and César García R..” Manejo de Materiales Peligrosos”.UABC, Page 92. In State of the Enviroment of the Tijuana River Basin. Workin Draft. Institute for Regional Studies of the California, San Diego Sate University 1998. An overview of the existing literature. Data Sets refer to the handling of toxic materials. http://trw.sdsu.edu/Spanish/WshdOvewSP/StateoftheBasinSP.htm
	Moreno, D., Muñoz, V. 2003. *El reto de la basura en Tijuana.* Tijuana Trabaja. Tijuana, B.C. 156. Cuadernos para el diálogo.

11. Appendix: Available data for air quality

Data for air quality in the United States	**Data for air quality in Mexico**
An Expanded Emission Profile of Vehicles On-the-Road, and the Willingness–to-pay Characteristics for Pollution Reduction of the Population along US-Mexican Border between Tijuana, Baja California and San Diego, California. Project Number: A98-4. Dr. Soumen N. Ghosh, New Mexico State University. Dr. Lenora Bohren, Colorado State University Other Researcher: Dr. David Molina, University of North Texas. Final Report March 31, 2000. http://www.scerp.org/projects/Ghosh98.pdf Quality Assurance Air Monitoring Site Information, updated November 11, 2002, Sites operated by SEMARNAT (Mexico): Sites: 85016 Tijuana - COLEF 85002 Tijuana-Centro de Salud 85001 Tijuana-ITT 85003 Tijuana-La Mesa/La Presa http://www.arb.ca.gov/qaweb/site.php?s_arb_code=85016 Air Quality. Air Quality Statistics contains various air quality measures for more than 600 locations throughout California. RAND California. An Online Source for California U.S. Statistics. http://ca.rand.org/stats/community/airqual.html Project Title: Sources of Air Pollution Along the Border: Analysis of	E1 Segundo Informe sobre la Calidad del Aire en Ciudades Mexicanas 1997: - Porcentaje y número de días en que se rebasan las normas de calidad del aire en general y por contaminante para 14 ciudades del país durante 1997. Tabla 2.1 - Comparación de la población, parque vehicular, número de industrias y estaciones de monitoreo entre la ZMVM, ZMG, ZMM, ZMVT, Cd. Juárez, Qro, S.L.P., Aguascalientes, Tijuana, Mexicali, Nacozari, Cananea, Manzanillo y Coatzacoalcos. Tabla 3.3. - Composición del parque vehicular en ZMVM, ZMG, ZMM, ZMVT, Cd. Juárez, Qro, S.L.P:, Aguascalientes, Tijuana, Mexicali, Coatzacoalcos y Manzanillo. Tabla 3.4. - Localización de la red de monitoreo de la calidad del aire de Tijuana. Figura 9.1. -. Estaciones de la Red de Monitoreo de Tijuana y parámetros que mide. Tabla 9.1 - Porcentaje de días con violaciones a las normas por contaminante y por mes en Tijuana durante 1997. Figura 9.2. - IMECA máximo diario en Tijuana durante 1997. Figura 9.3. - IMECA máximo mensual de ozono en Tijuana durante 1997. Figura 9.4. - IMECA máximo mensual de CO en Tijuana durante 1997. Figura 9.5. - IMECA máximo mensual de SO2 en Tijuana durante 1997. Figura 9.6. - IMECA máximo mensual de NO2 en Tijuana durante 1997. Figura 9.7. - IMECA máximo mensual de PM10 en Tijuana durante 1997. Figura 9.8. - Porcentaje y número de días en que se rebasan las normas de calidad del aire en general y por contaminante para 14 ciudades del país durante 1997. Tabla 12.1. - Porcentaje y número de días que se sobrepasan los 100, 150 y 200 puntos IMECA. Tabla D.16. - IMECA máximo por estación y por contaminante. Tabla D.17. - IMECA máximo mensual por contaminante. Tabla D.18. http://www.ine.gob.mx/descargas/descarga.html?cv_pub=113&tipo_file=pdf&url=http://www.ine.gob.mx/ueajei/publicaciones/consultaPublicacion.html?id_pub=113&id_tema=6&dir=Consultas&filename=113&id_tema=6

Data, Databases and Information SCERP Project Number: AQ94-7.7 Principal Investigator: Alan Sweedler and Paul Ganster San Diego State University.	Análisis de Tendencias de la Calidad del Aire. Área Tijuana Rosarito. En Pagina Web del Instituto Nacional de Ecología. http://www.ine.gob.mx/dgicurg/calaire/lineas/tendencias/c_tijuana.html
Database Coordination Initiative/Sources of Air Pollution Along the Border: Analysis of Data, Databases, and Information. Economic Incentives for Pollution Reduction SCERP Project Number: IS95-3 Principal Investigators: Dr. Alan Sweedler (PI), Professor of Physics, Director Center for Energy Studies San Diego State University. Dr. Paul Ganster (PI) Director Institute for Regional Studies of the Californias San Diego State University. Principal Mexican Collaborators: Dr. Margarito Quintero Nuñez Director Institute of Engineering,Universidad Autónoma de Baja California, Mexicali. Ing. Juan Alvarez Professor of Economics, Universidad Autónoma de Baja California, Tijuana.	Calidad del aire en México. Segundo Informe de la calidad del aire 1997. SEMARNAT. http://www.cepis.ops-oms.org/bvsci/E/fulltext/1encuent/mexico.pdf PROGRAMA PARA MEJORAR LA CALIDAD DEL AIRE EN TIJUANA-ROSARITO. Air Quality Management Plans. EPA. 2002. Anexo A. Monitoreo e Índice Metropolitano de la Calidad del Aire. Pag. 147. Anexo B. Tablas resumen de la calidad del aire de Tijuana-Rosarito 1997-1998. Pag. 155. Anexo C. Efectos de los contaminantes en la salud. Pag. 158. Anexo D. Memoria de cálculo de estimaciones de reducciones de emisiones y de costos e inversiones. Pag. 166. Anexo F. Normatividad mexicana de calidad del aire. Pag. 187. Anexo G. Normatividad mexicana para la verificación vehicular. Pag. 189. http://www.epa.gov/region09/border/airplans/tijuanarosaritospa.pdf
Project Title: Transborder Trucking and Air Quality in the California Border Region SCERP Project Number: AQ PP96I-14 Principal Investigators: A. Sweedler, J. Alvarez, C. Kazimi, F. Cuamea, M.Q. Nunez, M. Fertig	Laboratorio Analítico Ambiental tiene como objetivo: “ Ofrecer servicios analíticos acreditados en el área ambiental que ayuden a la toma de decisiones encaminadas al desarrollo sostenible del país, dentro de un marco de calidad total “. ITESM capus Monterrey. Dr. Porfirio Caballero Mata. http://uninet.mty.itesm.mx/cca/curric/pcaballero.html
The AirData Web site gives you access to air pollution data for the entire United States. AirData : Access to Air Pollution Data. EPA. http://www.epa.gov/air/data/index.html	
Alan Sweedler. “Air Quality of the Tijuana Basin”. SDSU Page 87. In	RESUMEN DE INDICADORES AMBIENTALES SELECCIONADOS, E P A 9 0 9 - R - 0 0 - 0 0 2 A, DEL PROGRAMA FRONTERA XXI MEXICO-ESTADOS UNIDOS:

11. Appendix: Available data for air quality

State of the Environment of the Tijuana River Basin. Working Draft. Institute for Regional Studies of the California, San Diego Sate University 1998. An overview of the existing literature, Data available Data Sets, and presents Graphics of the Air Quality of the Tijuana Basin.	REPORTE DE AVANCE 1996–2000. http://www.uacj.mx/Publicaciones/sf/vol2num6y7/comercios.htm XI.3 Contaminación del aire. Baja California hacia la Competitividad. Perspectivas de Desarrollo para el Siglo XXI. Centro de Competitividad y Estudios Estratégicos Dirección de Extensión y Vinculación. CETYS Universidad. El estudio inicia en febrero de 1994 y concluye en mayo de 1995. http://www.mxl.cetys.mx/Deptos/Vinc/BC/s00vf.htm

12. Appendix: Available data for socioeconomic issues

Data for socioeconomic issues in the United States	Data for socioeconomic issues in Mexico
Gerber, James. 1993. "Cycle and Trends in San Diego and California." In San Diego-Tijuana in Transition: A Regional Analysis, N.C. Clement and E.Z. Miramontes, eds. San Diego: Institute for Regional Studies of the Californias, San Diego State University.	INEGI, Instituto Nacional de Estadística Geográfica e Informática. Indicadores Disponibles para el Estado de Baja California. http://www.inegi.gob.mx/est/default.asp?c=&e=02
Higuera, Salvador Mendoza, Alejandro Valenzuela, and Eduardo Zepeda Miramontes. 1993. "Tijuana: Short-Term Growth or Long-Term Development." In San Diego-Tijuana in Transition: A Regional Analysis, N.C. Clement and E.Z. Miramontes, eds. San Diego: Institute for Regional Studies of the Californias, San Diego State University. Rey, Serge, Paul Ganster, Gustavo del Castillo, Juan Alvarez, Ken Shellhammer, Alan Sweedler, and Norris Clement. n.d. "The San Diego-Tijuana Region." Forthcoming in *Integrating Cities and Regions: NAFTA and the Caribbean Face Globalization*, J.W. Wilkie and C.E. Smith, eds. San Diego Association of Governments. 1998. *Evaluating Economic Prosperity in the San Diego Region: 1998 Update.* San Diego: San Diego Association of Governments.	SALUD PUBLICA EN MEXICO. NOVIEMBRE-DICIEMBRE DE 1994, VOL.36, No.6 . TITULO: EL TLC: UN RETO Y UNA OPORTUNIDAD PARA LA SALUD AMBIENTAL. EL CASO DE LAS MAQUILADORAS. AUTORES: FELIPE ESPINOSA-TORRES, M.C., M. EN S.A. MAURICIO HERNANDEZ-AVILA, M.C., D. SC. LIZBETH LOPEZ-CARRILLO, DR. EN S.P. - CUADRO I. Poblaciones de las Ciudades Hermanas de la Frontera México-EUA 1990. - Comparación de los salarios de los trabajadores estadounidenses con los salarios de los trabajadores; de las maquiladoras en México (dólares estadounidenses). - CUADRO VI. Calidad del aire en la frontera México-Estados Unidos. http://dge1.insp.mx/salud/36/366-4s.html Chávez, A. M. 1993. Encuestas demográficas de Baja California 1986. *Frontera Norte, COLEF*, Vol. 5, No. 9 (Demografía), ene-jun 1993: 17.

EPA Border XXI. 1998. *Border XXI Program Framework Document*. U.S./Mexico Border XXI/Frontera XXI.	
San Diego Association of Governments. 1998. *Evaluating Economic Prosperity in the San Diego Region: 1998 Update*. San Diego: San Diego Association of Governments.	Canales Céron, A. 1995. El poblamiento de Baja California. 1848-1950. *Frontera Norte, COLEF*, Vol. 7, No. 13 (Population), Enero-Junio 1995: 20.
Sparrow, Glen, and Marco Walshok. 1993 "Local Government and Economic Development in San Diego: Past Trends and Present Dilemmas." In *San Diego-Tijuana in Transition: A Regional Analysis*, N.C. Clement and E.Z. Miramontes, eds. San Diego: Institute for Regional Studies of the Californias, San Diego State University.	Estrella Valenzuela, G. 1995. Política de Desarrollo y Comportamiento Demográfico en la Frontera Norte de México. In *Cambio socioeconómico y población en la región fronteriza norte de México*. Política de Desarrollo y Comportamiento Demográfico en la Frontera Norte de México. UABC.
Trade Point USA. 1995. *Fact Sheet on the U.S./Mexican Agreement on the Border Environment Cooperation Commission (BECC) and the North American Development Bank (NADBANK).*	Méndez Mungaray, E. Indice de calidad de vida en la frontera. . articulos publicados por investigadores de COLEF; en Hemeroteca COLEF.
Sánchez, Roberto. 1993. "Urban Growth and Environment of Tijuana." In *San Diego-Tijuana in Transition: A Regional Analysis*, N.C. Clement and E.Z. Miramontes, eds. San Diego: Institute for Regional Studies of the Californias, San Diego State University.	Alegría O., T. 1991. Crecimiento Urbano y Servicios Públicos en la Frontera Norte de México. In III Reunión Nacional sobre Estudios Fronterizos - ANUIES. Tampico, Tamaulipas: Departamento de Estudios Urbanos y Medio Ambiente. COLEF.
Sparrow, Glen, and Marco Walshok. 1993. "Local Government and Economic Development in San Diego: Past Trends and Present Dilemmas." In *San Diego-Tijuana in Transition: A Regional Analysis*, N.C. Clement and E.Z. Miramontes, eds. San Diego: Institute for Regional Studies of the Californias, San Diego State University.	Guillen López, Tonatiuh. nd. *Gobernabilidad y gestión local en Mexico: El caso de Tijuana, B.C., 1989–1997*. Tijuana: El Colegio de la Frontera Norte (borrador preliminar).
Stone, Katherine, and Dennis Martinek. 1991. "The Economic Consequences of Unmanaged Growth." *Western City* (November).	Guillen López, Tonatiuh. 1993. "Municipal Government and Development in Tijuana." In *San Diego-Tijuana in Transition: A Regional Analysis*, N.C. Clement and E.Z. Miramontes, eds. San Diego: Institute for Regional Studies of the Californias, San Diego State University.
Griffin, Ernest, Richard Wright, Chris Brown, Steve McElroy, and Ann Obee. 1996."GIS Applications in the San Diego-Tijuana Interface." Pp. 807–17 in *Proceedings GIS/LIS '96*. (November).	Guillen López, Tonatiuh. 1996. *Gobiernos municipales en Mexico: Entre la modernización y la tradición politica*. Tijuana: El Colegio de la Frontera Norte.

12. Appendix: Available data for socioeconomic issues

Katie Ries, Richard Wright, and Alain Winckell 1995. “Identifying Priorities for a GIS for the Tijuana River Watershed: Applications for Land Use” P. 93 in *Planning and Education, Workshop Proceedings.* San Diego: Institute for Regional Studies of the Californias, San Diego State University.	Tamayo, J., and J.L. Fernández. 1983. *Zonas fronterizas*. México, D.F.: CIDE.
Arreola, D., and J. Curtis. 1993. *The Mexican Border Cities*. Tucson: University of Arizona Press.	Hiernaux, D. 1986. *Urbanización y autoconstrucción de vivienda en Tijuana*. México, D.F.: Centro de Ecodesarrollo.
Clement, N., and E. Zepeda. 1993. *San Diego-Tijuana in Transition*. San Diego: Institute for Regional Studies of the Californias, San Diego State University.	Aguila, S.O. 1996. *Seroprevalencia A Toxoplasma gondii en poblacion trabajadora de establos.* Universidad Autónoma de Baja California En el Area aledaña a la Ciudad de Tecate (zona de establos) se realizaron estudios que demostraron positividad al contacto con Toxoplasma gondii, parásito intracelular que se transmite por diferentes vias (oral, nasal, cutanea, trasplacentaria, etc..) y que causa la toxoplasmosis, enfermedad de difícil manejo y con repercusiones graves sobre la salud del individuo que la padece.
Dillman, D. 1983. “Border Urbanization.” Pp. 237–44 in *Borderlands Sourcebook*, E. Stoddard, R. Nostrand, and J. West, eds. Norman: University of Oklahoma Press.	Brito, P.M. 1997. *Etiología y frecuencia de infecciones nosocomiales en hospitales públicos de Tijuana, B.C.* Facultad de Medicina, Univeridad Autónoma de Baja California.
Gilbert, A., ed. 1989. *Housing and Land in Urban Mexico*. La Jolla: Center for U.S.-Mexican Studies, University of California, San Diego.	Herrán, P.E. 1995. *Evaluación del diagnóstico y tratamiento del paciente con Tuberculosis Pulmonar*. Universidad Autónoma de Baja California, Instituto Mexicano del Seguro Social.
Herzog, L. A. 1999. *From Aztec to High Tech: Architecture and Landscape Across the Mexico-United States Border.* Johns Hopkins University Press.	Laniado, LT., Cárdenas, M.R. 1991. Tijuana: Zona endémica de infección por Coccidioides immitis. *Revista de Salud Pública de México*, p 235-239.
Herzog, L. 1998. “Urban Planning and Sustainable Development in the Transfrontier Metropolis: The Tijuana-San Diego Region” in *Sustainable Development in San Diego-Tijuana*, M. Spalding, ed. San Diego: Center for U.S.-Mexican Studies, University of California, San Diego.	
Herzog, L. 1997. “Border Urbanism.” Pp. 1505–11 in *Encyclopedia of Mexico: History, Society and Culture,* M. Werner, ed. Chicago: Fitzroy Dearborn.	

Herzog, L. 1997. “The Transfrontier Metropolis.” *Harvard Design Magazine* Winter/Spring: 16–19. Herzog, L. 1990. *Where North Meets South: Cities, Space and Politics on the U.S.-Mexico Border*. Austin: CMAS/ILAS/University of Texas Press. Herzog, L., ed. 1986. *Planning the International Border Metropolis*. La Jolla: Center for U.S.-Mexican Studies, University of California, San Diego	
House, J. 1982. *Frontier on the Río Grande.* Oxford: Oxford University Press.	
Martinez, O. 1996. *U.S.-Mexico Borderlands*. Wilmington: Scholarly Resources.	
Martinez, O. 1994. *Border People*. Tucson: University of Arizona Press.	
Price, J. 1973. *Tijuana: Urbanization in a Border Culture*. Notre Dame: University of Notre Dame Press.	
San Diego Dialogue. 1995. *San Diego/Tijuana: Demographic Atlas*. San Diego.	
Sklair, L. 1989. *Assembling for Development*. Boston: Unwin Hyman.	
Sweedler, Alan, Margarito Quintero Nuñez, and Patricia Bennett. n.d. “Energy Sector in the California-Baja California Border Region.” In *Energy and Borders.* Durham: University of Durham, forthcoming.	
The San Diego Economic Information and Modeling Project (SDEIMP) maintains an extensive set of socioeconomic data series on	

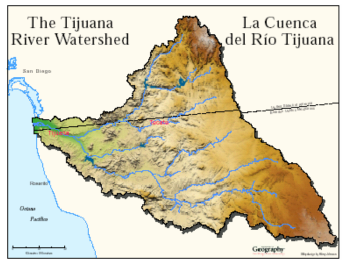
the economies of Southern California and the United States. The SDEIMP data sets contain over 2,500 series; the majority are annual, beginning in the year 1969.	
San Diego State University's Center for Energy Studies. A reasonable amount of data exist related to energy use and infrastructure in the San Diego-Tijuana region. Much of it can be found at web site at: http://www-rohan.sdsu.edu/dept/physics/CES.html	
The United Nations Centre for Human Settlements (Habitat) Indicators Programme. It provides a pertinent and realistic tool to measure the performance of the urban and shelter sector in cities, countries, and regions across the globe. The 46 indicators are divided into categories (Background; Socio-Economic Development; Infrastructure; Transportation; Environmental Management; Local Government; Housing Affordability and Adequacy; and Housing Provisions). http://www.unhabitat.org/	
Regional Growth Management Strategy. The Regional Growth Management Strategy (RGMS) was adopted by the San Diego Association of Governments (SANDAG) in 1993 SANDAG creates and maintains a tremendous quantity of demographic, economic, land use, transportation and criminal justice information about the San Diego region. http://www.sandag.cog.ca.us/index.asp?classid=26&fuseaction=home.classhome	

California/Mexico Public Health Strategic Planning Meeting. 1998. *Outcomes and recommendations. Executive Summary*.	
Ganster, Paul. 1996. "Environmental Issues of the California-Baja California Border Region." *Border Environment Research Reports*. 1 (June). San Diego: Institute for Regional Studies of the Californias, San Diego State University.	
Guendelman, S. and M.J. Silberg. 1993. "The Health Consequences of *Maquiladora* Work: Women on the U.S.-Mexican Border." *American Journal of Public Health* 83: 37–44.	
San Diego Dialogue. 1994. *Who Crosses the Border: A View of the San Diego/Tijuana Metropolitan Region*. (April).	
US-Mexico Border XXI Program. 1997. *Comment and Response Summary Report*. (June).	
Ecotourism Summit Fact Sheet. 1997. Presented at the San Diego Ecotourism Summit, 18 September, San Diego.	
Langdon, Margaret. 1970. *A Grammar of Diegueno: The Mesa Grande Dialect, No. 66*. Berkeley: Publications in Linguistics, University of California. A linguistic study	
Shipek, Florence. 1993. "Kumeyaay Plant Husbandry: Fire, Water, and Erosion Control Systems." In *Before the Wilderness: Environmental Management by Native Californians,* Thomas C. Blackburn and Kat Anderson, eds. Menlo Park: Ballena Press. An ethnoarchaeological study	
Gifford, Edward W., and Lowie. 1928. *Notes on the Akwa'ala Indians of Lower California, No.29.* Tucson: University of Arizona.	

Meigs, Peveril, III, 1939. "The Kiliwa Indians of Lower California." Ibero-Americana 15: 1–114. Langdon, Margaret. 1970. *A Grammer of Dieguено: The Mesa Grande Dialect, No. 66*. Berkeley: Publications in Linguistics, University of California.	
Owen, Roger C. 1978. "Indians of Santa Catarina." Ph.D. Diss., University of California, Berkeley.	
Information on the indigenous populations of northern Baja California.	
Land Resources and Management Plan Cleveland National Forest 1988	
Sustaining Ecosystems: A Conceptual Framework, USDA 5R-EM-TP-001, April 1995	
South Coast Resource Management Plan DOI-BLM 1994 BLM/CA/PL-94/013+1611 Protected areas which either border or cross into the watershed along the border are Bureau of Land Management (BLM) proposed wilderness areas (Hauser Mountain and Otay Mountain, the Guatay Mountain SIA, Kucchamaa Areas of Critical Environmental Concern [ACEC], Cedar Canyon ACEC, and Southern Otay Mountain).	
Border Field State Park, Unit History, Chronology 1976	
A Management Framework for the Tijuana River Valley, June 1989. Prepared for the County of San Diego Department of Parks and	

Recreation by the Graduate Program, Dept. of Landscape Architecture, California Polytechnic University, Pomona, California	
GIS data complied for Forest and Woodland Multi-Species Conservation Strategy (DRAFT) 1998 Williams, M. David. 1989. Coccidioidomicosis in Tijuana: A Spatial and Epidemiological Analysis. San Diego State University.	

13. Minutes from 2004 stakeholder meeting



Stakeholder meeting for the

Binational Vision Project for the Tijuana River Watershed

Friday December 3, 2004

Hotel Pueblo Amigo

Conference Room Premier

9:00 a.m. – 1:30 p.m.

"Resources should be managed jointly (between the U.S. and México). The Vision offers a very complete diagnostic," Luis Cabrera, Dec., 3.

Elsa Saxod welcomed 60 participants

Katherine Comer distributed a handout of the executive summary and presented a summary of the Draft Binational Vision document for the TRW.

Overview of the Draft Vision Document:

- Water quantity
- Water quality

- Ecosystems and Natural Resources
- Waste
- Air Quality
- Socio-economic issues

General Challenges:

- Merging of Tijuana and Tecate
- Reduction in the amount of safe, open and green areas for urban residents
- Decline in ecosystem health
- Increasing number of threatened and endangered plants and animals

The Binational Vision for the TRW is the stakeholder consensus of the current and desired conditions in the TRW. Complete versions can be found at: http://trw.sdsu.edu.

Send comments to kcomer@projects.sdsu.edu by Jan 3, 2005

Discussion and feedback

More recommendations for watershed education and outreach are needed.

BREAK (5 min)

Invited Panel—How can we implement the Vision?

Ing. Jorge Corrales from the Comisión Nacional del Agua *introduced the Consejos de Cuenca*

What are the different levels? The Ley de Aguas Nacional involves public participation in the administration, planning, and management of water. The levels are: *Consejos, comisiones, comités, COTAS*

What are the responsibilities of the different levels? The *consejos* have access to information such as the titles to water rights, the public register, titles of concession, assembly, and operating expenses. They can submit a complaint or "*denuncio*" if someone is breaking the law.

What are the limitations? The consejos have no legal authority, they cannot grant permits, concessions, water rights, sanctions, create *normas* (legal standard) or *reglamentos* (enforcement specifications). The major limitation is lack of political will.

How can a future *comisión de cuenca* of the TRW involve U.S. participation or input? The future *comisión* will consist of users with voting rights. The National Water Law does not contemplate the possibility of U.S participation. However, the U.S. interested parties can support and finance well-defined technical projects.

Mr. Pete Silva from the California State Water Resources Control Board *introduced California Basin Plans*

What are Basin Plans? Under California's old water pollution control act, watersheds were the unit of management starting in the 1950s. The law that mandates basin plans is the Porter-Cologne Act. The focus is on water rights and water quality.

What are the limitations? The basin plan is not an institutional tool, it is just a process tool for complying with the regulations. They describe the numerical standards for permits. Total Maximum Daily loads for water bodies or pollutant loads from point and non-point sources are examples. Legally Mexico does not have TMDLs, therefore, there are no monitoring programs similar to California's.

How can the Basin Plan process for San Diego involve Mexican participation or input for the TRW? By creating a binational TMDL, both countries would have similar point and non-point sources pollution prevention programs, and common monitoring programs. The next steps are to convince EPA and IBWC to implement and fund a binational TMDL that would be voluntary in Mexico since there is no law mandating TMDLs yet.

Lic. Luis Cabrera C., Consul General of Mexico in San Diego *discussed the Border Liaison Mechanism*

What is the BLM? The BLM was created by the Mexican Secretaría de Relaciones Exteriores and the U.S. Department of State in October 1993 as a dialogue instrument at the local level. Three levels of government participate: federal, state, and local. There are four working groups: migration, ports of entry, public safety, and the border water council.

What are the benefits?

The BLMs have contributed to better cooperation and conflict management as well as the prevention of problems. The BLM has created an atmosphere of cooperation in the Rio Bravo region, for example.

What are the limitations?

There are several agencies creating links outside the BLM. The Consul Generals need know about those relationships and facilitate cooperation among them. An *ordenamiento* is needed to create changes in the administration of the agencies.

Mr. David Stewart, Consul General of the United States in Tijuana *discussed the use of the Border Liaison Mechanism*

The San Diego –Tijuana region is different from other BLMs because it very urbanized with different competencies and complications that other parts of the border. The BLM was created in 1993 because there was no way for local governments to talk to each other, and Washington, D.C. and Mexico, D.F. added authority at the local level. The concentration of the BLM is conflict resolution.

How has the Border Liaison Mechanism (BLM) helped San Diego and Tijuana in the past?

In 1998, the BLMs Border Water Council brought together the Mexico's National Water Commission (CNA), Baja California's CEA, Comisiones Estatales de Servicios Públicos, and IBWC-CILA to conduct a joint feasibility study on water supply needs in the region. In February 2002, a studies for the feasibility of a binational aqueduct and for supplying Tijuana with water through the San Diego delivery system were completed.

What are the benefits?

The BLM is flexible. It can bring the three levels of government together, there are no technical discussions, you must do your technical homework first, and it allows agencies to get to know their counterpart. The BLM is a good mechanism to establish good relationships.

How can the BLM help with the TRW planning and implementation in the future?
Mr. Stewart talked about the importance of the BLM and how it can assist the joint Vision effort. BLM does not bring money to the table, but rather brings the actors together. He looks forward to expanding the BLM to include issues in the Vision.

Ing. Roberto Espinoza from the Comisión Internacional de Límites y Aguas discussed the IBWC-CILA mandates and minutes

What are the IBWC-CILA minutes? Mandates are the agreements by the IBWC-CILA and supported by each nation's laws. Minutes (a legal agreement) are created to legalize specific projects. Several minutes have been signed over the years.

Ing. Carlos Peña from the International Boundary and Water Commission

How IBWC and CILA have cooperated in the past to address San Diego and Tijuana water issues?
Mexico and the United States started a dialogue over an agreement to build the Southbay International Wastewater Treatment Plant. It was $2 million investment and it was built to solve a mutual problem. Minutes were created to allow that construction to happen. Minute 310 was created to allow transfers of water through the San Diego system to Tijuana. This was water that was already entitled to Tijuana. This cooperation is positive benefit to the local community.
How can minutes help with TRW watershed planning and implementation of projects in the future?
IBWC-CILA or BWAC could convene a stakeholders' meting in which IBWC could define its collaboration in the Vision project. Both commissioners could come to the stakeholders' meeting to see which action items from the Vision can be implemented by the IBWC-CILA. These types of agreements take time and coordination, but there is interest in moving this process forward.

M.C. Saúl Guzmán from the Secretaría de Medio Ambiente y Recursos Naturales discussed the Programas de Manejo de Cuenca

What is the purpose of the program?
To determine a sustainable way to manage natural resources. One agency or actor can't decide on policy.

What are the limitations?

Human resources and qualified personnel are needed. There is a need to design the institutional element to create a balance between social values of natural resources, economic values, and ecological sustainability.

How can the program work with the U.S. participation on ecological issues in the TRW?

Create a *ordenamianto territorial* or an *ordenimiento ecológico*. The Mexican law allows U.S. participation in these processes through the BLM. The Consejo de Cuenca del Delta del Río Colorado has a binational aspect. The monitoring networks between EPA-SEMARNAT are examples. We can create memorandums of understanding such as the one by EPA and SEMARNAT to transfer air quality monitors in Mexico to local governments so they continue with the air quality monitoring. The laws exists—there needs to be consensus in order to make binational management operational.

Ing. Daniel Cervantes from the Comisión Estatal del Agua *discussed cross-border cooperation on water issues*

CEA brings together the CESPs.

How has CEA worked with California in the past?

- Industrial Pre-treatment Plan
- Courses, workshops, and training programs funded by the State of California
- Monitoring of domestic wastewater program
- Groundwater study
- Study of a desalination plant to be shared between San Diego and Tijuana
- Reuse programs for discharge into the Tijuana River
- Integrated management of aquifers is a major challenge

Ms. Elsa Saxod, City of San Diego Office of Binational Affairs *discussed informal mechanisms used by NGOs, the private sector, and local governments for cooperation across the border*

Those of us living in the region need to call national attention to this region. Homeland security concerns in Washington will affect air pollution and border wait times. We need to push to implement the actions recommended in the Vision since we are far away from Mexico City and Washington, D.C. We can use the help of our consul generals and other colleagues and ask them to talk to influential persons.

V. General Discussion

Luis Cabrera: It is very important to work jointly with institutions from both countries. Feedback is crucial and the creation of good ways to convene authorities from both side of the border (such as the BLM) is necessary to maintain good communication. Firefighters are collaborating in cases of emergency.

David Stewart: There is a binational fire council that has cooperated on many issues including a cross training conference. The consuls general wish to move things forward. However, they lack staff. They can commit to identifying officials on both sides of the border and to support the effort.

VI. Working groups by sector

Participants broke into small working groups:

- Federal and State Governments
- Local Governments
- Private Sector, Businesses, and Industry
- Academia
- Non-governmental Organizations (NGOs)

The working groups listed organizations and agencies that should be included in a binational planning and implementation group for the Tijuana River Watershed Vision. There was a separate list for water quantity, water quality, air quality, ecosystems and natural resources, solid and hazardous waste, socio-economic issues, and others.

VII. Group leaders presented recommendations to the larger group

These lists are very important for creating a diverse and comprehensive represenation in a future binational watershed management council or a future *consejo de cuenca.*

VII. Paul Ganster thanked the panel and the participants for their valuable contributions to the Vision project.