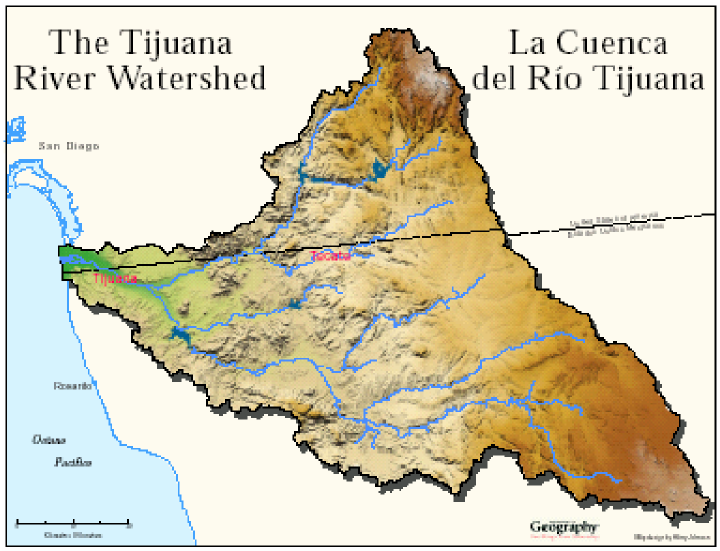
Addendum to the Binational Vision for the Tijuana River Watershed



Prepared for the
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by
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August 2005

Integrated water resources management can help reconcile conflicting water uses, address environmental and social concerns stemming from unsustainable water consumption, strengthen water-related disaster prevention, and help ensure equitable access (U.N. Department of Economic and Social Affairs 2005c).

Photos from the December 2004 Stakeholder meeting.

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Introduction

This addendum supplements the Binational Vision for the Tijuana River Watershed (TRW), version January 2005, approved by Binational Watershed Advisory Council (BWAC) on March 4, 2005. It contains comments and additional data from BWAC and other interested parties submitted after November 2004. Comments submitted before November 2004 were incorporated into the main document.[1] They are also available on the TRW website.[2] This addendum contains data from additional research, updates on projects, and recent events in the watershed. This addendum is not a stand alone document, rather it is a series of comments referring to the sections in the main Vision document. The addendum is organized by subject according to the structure of the original Vision document. Items in the addendum vary in length from once sentence to several pages are separated from each other in sections with asterisks (***). The addendum is intended to help keep the Vision a "living document." Comments on this addendum are welcome and may be incorporated into future addenda of the Vision.[3]

[1] Complete version available online at http://trw.sdsu.edu.

[2] http://trw.sdsu.edu/English/Projects/Task_Force/Portal/Spanish_Home_Page/Meetings/Minutes/BWAC_commentsENG6-8-05.pdf

[3] Send to kcomer@projects.sdsu.edu or call 619-594-5423.

The TRW Binational Vision Project

Stakeholder input

In December of 2004, 60 interested persons from both sides of the border gathered in Tijuana for a TRW stakeholder meeting. Activities included a presentation on the Vision document, presentations by a panel of experts on potential binational watershed management mechanisms the TRW, and the formation of working groups from different sectors that listed potential participants in a possible future watershed council. Minutes from the meeting are included in Appendix 13 of the main Vision document.

Water quantity

Hydrology

The channelization of the Tijuana River received international attention. With its construction in the 1970s, it was a well-received project because it aimed to create 160 ha (395 acres) of developable land from the flood plain for the municipality of Tijuana, connect the city with bridges, provide housing for approximately 1,600 squatter families in places like *Centro Urbano 70-76* and the Industrial Zone, provide street lighting, provide water and wastewater services, beautify the city with approximately 120 m^2 (1,291 ft^2) of green space, and provide sports fields (UABC 1974). An unforeseen recreational opportunity is that the channelized river is sometimes used as an automobile drag race course during the dry season.

Water supply and demand

Between 1999 and 2003, water production costs for CESPTe increased from MN$12 to 46 million (US $1.04 to 4.0 million). The rapid increase in water production costs is partly caused by a modest increase in demand but primarily from a shift from groundwater to aqueduct water dependency. Currently, more than 80% of Tecate's water supply comes from the Colorado-Tijuana River Aqueduct. Aqueduct water is significantly more expensive than groundwater production because aqueduct water carries both a higher federal tax rate and higher treatment costs (Holsher 2005).

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Three dams control 75% of the surface water flows of the TRW: Barrett, Morena, and Rodríguez. The average annual discharge of the Tijuana River from 1926 to 1981 was about 33,000 acre-ft (40,704,901 m^3) per year, and the median discharge was 659 acre-ft (812,864 m^3) per year. The highest flow recorded during that period was during 1979-80 with 586,000 acre-ft (722,820,367 m^3) (Izbicki 1985 from Rempel 1992). Las Auras reservoir, a 40 million m^3 (32,428 acre-ft) surface reservoir in Tecate, is slated for completion in 2013.

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In the United States, household indoor water use averages 2,62l (69 gal) per person per day. Since 1997, all toilets, faucets and showerheads installed in the United States must meet water efficiency standards established by law in 1992, designed to lower water consumption by one-third, saving millions of dollars (U.N. Department of Economic and Social Affairs 2005).

Precipitation

Figure 1 shows that 50-year plus averages of monthly precipitation rates observed at Campo and Tecate, Mexico consistently show higher from January to March.

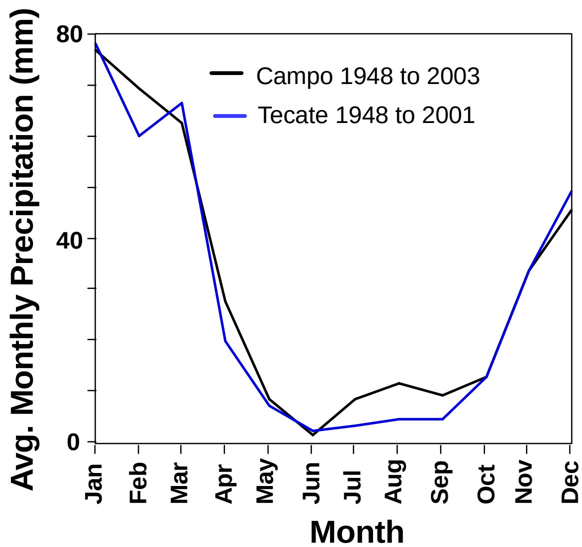

Figure 1
50-year plus averages of monthly precipitation rates.
Source: (Forster 2005).

Flooding and landslides

A flood control study for the Tijuana Valley River basin was completed in 1994 and evaluated control measures for up to a 25-year frequency flood with flow rates of 0.67 acre-ft/s (30,000 cfs) (Dudek and Assoc. 1995). The Tecate River 10-yr flood has been estimated at 79 m^3/s (15,850 gal/s) (Ponce 2004).

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The floods of 1980 and 1993 in the Tijuana River Valley each caused approximately $25 million in damages (U.S. Army Corps of Engineers 1999).

Stream flow

There has been a wide variation in Campo Creek stream flows since 1948 compared to the relatively narrow variation in precipitation (Figure 2). This suggests that storm events and human management of reservoirs and dams may play an important role in streamflow (Forster 2005).

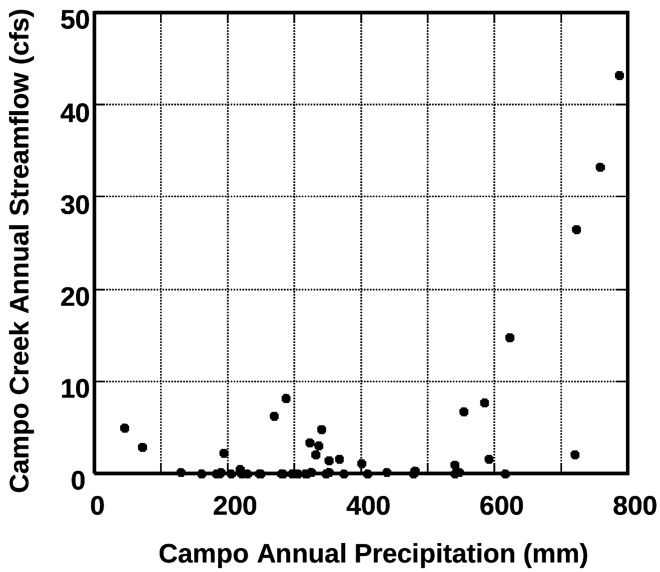

Figure 2
1948 to 2002 history of average annual Campo Creek streamflow plotted against average annual precipitation measured at Campo.
Source: (Forster 2005).

Groundwater quantity

Tijuana River Valley

A hydrogeological assessment of the Tijuana River Valley in 1992 included an extensive ground water monitoring system over 12 water wells and Shelton's Pond (Remel 1992). Results showed that groundwater levels would not show a measurable decline because of the diversion of sewage flows to the IWTP starting in 1997. The research team determined that the basin was full, and spilling out, with a natural recharge from precipitation of 6,784,189 m^3/yr (5,500 acre-ft/yr) and losses from evapotranspiration and agricultural pumping of about 2,000 acre-ft/yr. The team also estimated a subsurface flow of 1,430,847-1,850,233 m^3/yr (1,160-1,500 acre-ft/yr) coming from the alluvial fill upstream in Mexico and sediments bearing water from east of Highway 5. Groundwater adds to the surface flow of the river west of the Dairy Mart Bridge, and the surface flow would not be decreased by the diversion of Tijuana sewage to the IWTP (Remel 1992).

The Tijuana River Valley can maintain balanced groundwater tables if the maximum levels of well pumping are set from 6,784,189-7,400,934 m^3/yr (5,500-6,000 acre-ft/yr) (IBWC 1976 from Rempel 1992) to 9,744,563 m^3/yr (7,900 acre-ft/yr) (Ellis and Lee 1919 from Rempel 1992). Groundwater was over drafted during the 1950s with extractions of up to 22,202,802 m^3/yr (18,000 acre-ft/yr) for agricultural uses. Beginning in 1930s salts were accumulating in the soils. By the early 1960s seawater intrusion became a problem, decreasing the quality of the well water. As consumption decreased, the groundwater levels recovered (Remel 1992).

Tecate

In 2004, most high-production wells in the Tecate and San José basins were pumping from relatively small, shallow, high-yield unconfined aquifers that are separated by narrows. The geologic materials consist of moderate-to-high permeability sands deposited in depressions eroded into the underlying low-permeability bedrock. The shallow high-yield aquifers achieve their maximum depth of up to ~35 m (115 ft) beneath major stream channels and can be up to 300 m (960 ft) wide (Forster 2005).

Because Tecate's population has grown rapidly since 1993, CESPTe had been delivering increasing volumes of water to customers consistently until the year 2000 when the annual water use stabilized at about 7.5 x 10^6 m^3 (6,080 acre-ft) per year. During the year 2000, well production dropped rapidly from 4.5 x 10^6 m^3 (3,648 acre-ft) to 2.5 x 10^6 m^3 (2,027 acre-ft) per year (from about 100% to 50% of total water use). Continued declines in groundwater levels since 2000 have caused additional wells to be taken out of service. Only about 25% of CESPTe's water deliveries are now derived from groundwater wells (Figure 3). As of 2004, about 80% of the water delivered to CESPTe's customers is imported to the basin by pipeline and the Colorado River aqueduct. This trend is apparently related to decreasing precipitation levels that recharge the well fields of Tecate of Tecate (Forster 2005).

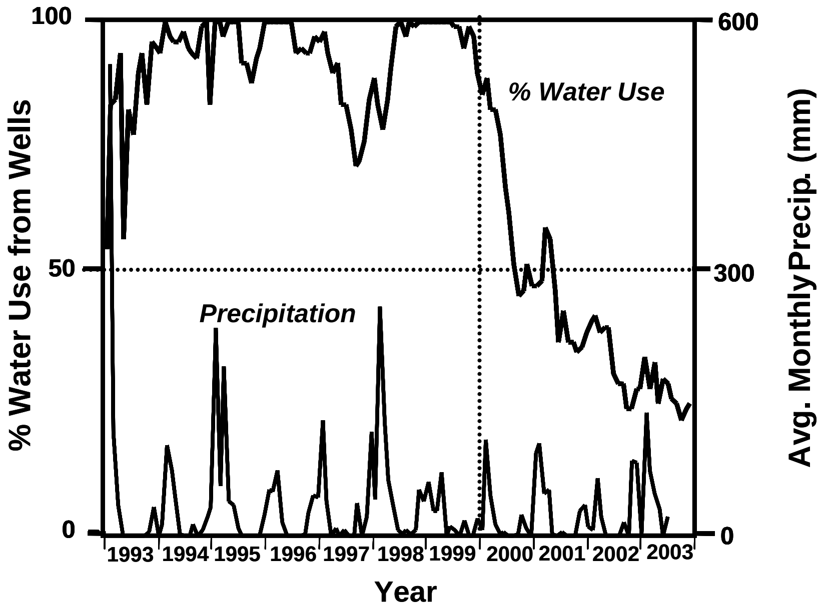

Figure 3
10-year history of total monthly water use in Tecate produced by CESPTe from groundwater wells, and average monthly precipitation as measured in Tecate.
Source: (Forster 2005).

Current pumping rates reported by CESPTe suggest approximate annual recharge rates of 2 million m^3 (1,621 acre-ft) per year, mostly from precipitation, and some bedrock recharge. If monthly precipitation rates follow the trends of the last 50 years, it seems reasonable to expect that current pumping rates are in equilibrium. Recent rains of early 2005 are expected to help stabilize the balance between recharge and current pumping rates. However, pumping has caused groundwater levels to fall about 20 m (66 ft) in the Río well field in the El Centro district of Tecate. Higher levels are desirable for emergency situations during drought years (Forster 2005).

Unless precipitation increases dramatically, raising Tecate's groundwater levels may require artificial recharge technologies. One alternative is to build recharge ponds on the river floodplain to enable natural seepage into the shallow aquifer, primarily during the winter season when evaporation rates are at a minimum. Recharge ponds are recommended over artificial injection wells because they are less expensive and if the bottoms of the seepage ponds become plugged with sediments or mineral precipitates, they can be easily removed by plowing the pond bottoms. Under ideal conditions, recharge could happen in one month to a year with a discharge rate of 60 l/s (16 gal/s) while groundwater pumping continues (Forster 2005).[4]

[4] 60 l/s (16 gal/s) for one month was derived from a simple calculation of the minimum volume of water required to cause a water level rise of 20 m (197 ft) in a 2 km^2 (0.77 mi^2) area (representing an aquifer 400 m (1,312 ft) wide and 5 km (3.2 mi long) and a porosity of 20%.

Based on suggestions to recharge the Tecate aquifer with treated wastewater, a study was performed in 2004 assessing the feasibility of such an approach considering the current channel conditions (Ponce 2004). Results show that given the high to very high hydraulic conductivity of the streambed material, the water will be absorbed. Under normal flood conditions, the infiltrated water is very likely to join the groundwater and augment the volume of the Tecate aquifer. The aquifer lies at a depth of at least 3 m (10 ft) along the Tecate River. Water that remains in the vadose zone between the land surface and the water table for extended periods of time, and under conditions of high hydraulic conductivity, may benefit the establishment of riparian vegetation. A 2-m (6.6 ft) wide pilot channel would optimize the permanence of surface water to serve the purposes of a future Tecate Urban River Park. In this case, a substantial portion of the pumped water may be evapotranspired and only a small fraction may reach the groundwater. All pumped water will benefit the ecosystem either as surface water, vadose-zone water, or groundwater. To maximize specific beneficial uses, the following sites for pilot ponds were recommended (Figure 4):

- To benefit surface water and associated riparian vegetation, the pumped flows should be delivered to in the vicinity of RP-2 in El Descanso.
- To benefit groundwater, the pumped flows can be delivered at RP-1 or RP-6 in El Centro.
- To benefit vegetation directly, the pumped flows could be delivered anywhere in the river park.

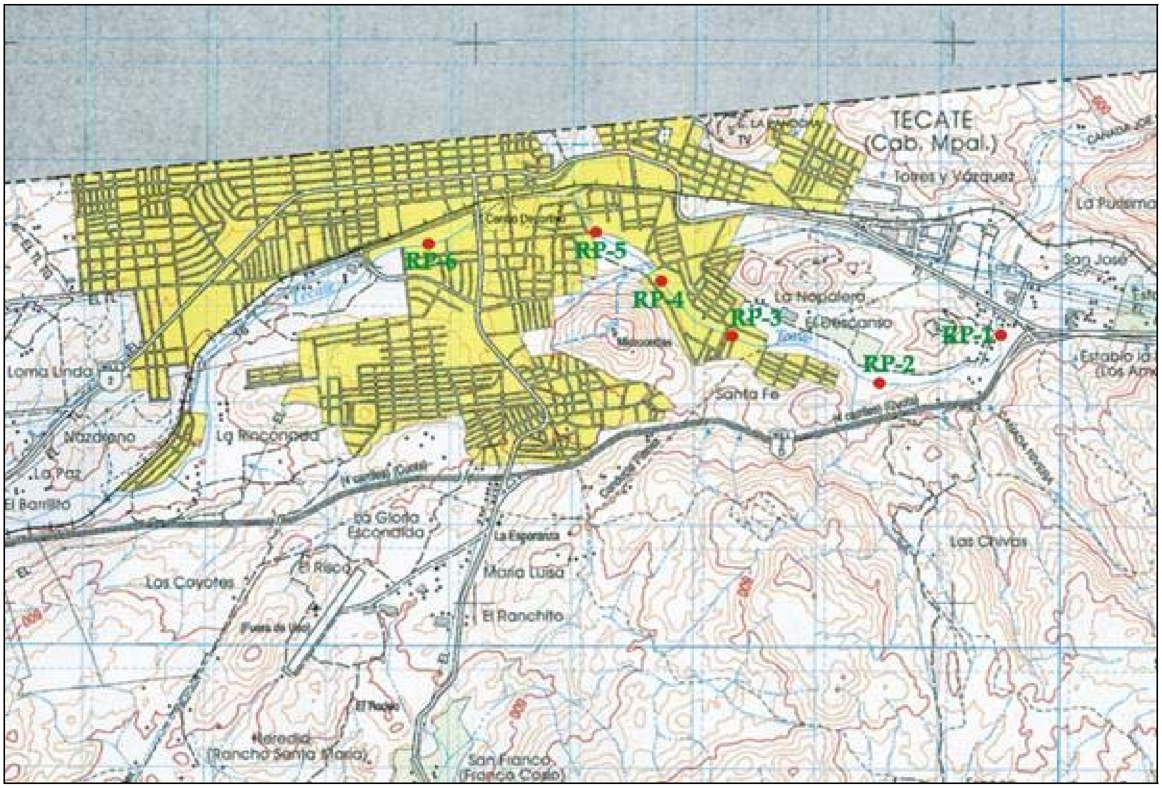

Figure 4
Locations studied for potential groundwater/surface water/riparian replenishment in the Tecate aquifer.
Source: (Ponce 2004).

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Colorado River quantity

Under the terms of the 1945 water treaty, Mexico gained the right to 1.5 million acre-feet of Colorado River water annually, which is about 10% of the flow. There are serious concerns about protecting the Colorado River's ecology and the quality of water delivered to Mexico as population pressures rise (Treat 2001).

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A water budget model for Tecate was built through an internship between the University of Utah and CESPTe to compare the efficacy and associated costs of different water management strategies (Holsher 2005). It quantified both surface and groundwater inflows and outflows over 14 years of history and various climate futures over a 26 year period. The alternatives analyzed in the study included a proposed new surface reservoir, wastewater recycling, conservation measures, and additional water treatment capacity.

All alternatives fell short of maintaining a water supply capable of meeting the projected water demand through 2030. Explorations with the model reveal the difficulty of using excess aqueduct water to fill the proposed Las Auras Reservoir. Results also show that to avoid a shortfall in supply through 2030, Tecate will need to increase its aqueduct capacity by 300 lps (79 gps) sometime between 2016 (assuming the driest precipitation future) and 2021 (assuming the wettest precipitation future). Current well management practices seem destined to maintain about 30% to 40% of the shallow aquifer volume as storage. Recycling water and bolstering conservation programs both help to delay the onset of a supply-demand gap in the model, but additional strategies appear necessary. Capturing more of the precipitation through aquifer recharge strategies such as pumping treated wastewater into the aquifer and rainwater harvesting may help ensure a sustainable water supply for Tecate's future (Holsher 2005).

Water quantity recommendations

For future sources of local water supplies in Tecate. Forster (2005) recommends:

- Do not invest in drilling new wells in the shallow aquifers of Tecate, Joe Bill, or San Jose watersheds.
- When future wetter weather and floods occur, monitor water levels in all shallow aquifers (while holding pumping rates constant) to document aquifer recharge rates.
- Explore the technical feasibility of recharging the Tecate basin aquifer (perhaps in the vicinity of El Descanso) by discharging recycled wastewater, or controlled infiltration of flood water, to artificial recharge ponds or injection wells. Such a study would require: 1) geophysical surveys to determine the stratigraphy, width and depth of the shallow high-yield aquifers, 2) pumping tests in existing pumping wells to determine hydraulic conductivity and storativity, and 3) groundwater modeling to assess future water levels and potential for in situ treatment of the wastewater.
- Consider maintaining the shallow high-yield aquifers with higher than necessary levels so that an emergency reserve of water is available as a buffer against aqueduct failure or reduced supplies of aqueduct water.
- Continue exploring the possibility of developing additional groundwater supplies in Valle de Las Palmas.
- Explore the possibility of accessing additional groundwater supplies with one or more bedrock wells by initiating a field-based study of bedrock faults and fracture zones. The most promising locale is east of Rancho Escondido near the Rio Tecate west of La Puerta.
- Combine several alternatives such as (Holsher 2005):

- Recycling treated wastewater
- Increasing aquifer saturation
- Actively reducing water demand

The following general recommendations from recent publications apply to the TRW (GNEB 2005):

- Create a binational groundwater withdrawal policy, or encourage data sharing of the pumping rates in binational aquifers.
- Fully exploit institutional missions and the current legal framework to overcome different legal structures between the United States and Mexico.
- Increase institutional flexibility about crossing the border and inviting binational stakeholder participation.
- Require buildings to utilize rainwater harvesting technologies where appropriate (U.N. Department of Economic and Social Affairs 2005).
- Extend the current CESPT gray water recycling incentives program for hotels in Tijuana to San Diego, resulting in lower water bills and usage.
- Public water utilities need strengthened governance and enforcement capability to achieve better cost recovery for upgrades and additional connections to the unserved populations (U.N. Department of Economic and Social Affairs 2005c).
- Geotechnical investigations are needed for proper flood management in the Tijuana River Valley. The U.S. Army Corps of Engineers (1999) recommends research on existing data, and site specific field investigations including drilling, sampling, and testing of soils.

Water quality

Based on support from stakeholders in June 2005, the Consejo de Cuenca de Baja California agreed to form the Comisión de Cuenca del Río Tijuana. These user groups will work closely with CNA to make decisions on, for example, water quality, supply, and extraction rates (Zuñiga 2005).

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Based on recommendations from the Vision document and recommendations from the 2004 stakeholder meeting for the Binational Vision Project, the Tijuana River Watershed Technical Subcommittee was formed under the Border Liaison Mechanism and meets regularly. The Technical Subcommittee consists of a small number of water agency authority representatives with technical and other backgrounds who work on researching and implementing specific projects recommended by stakeholders in the Vision. They agreed to be advised by the BWAC. The Subcommittee's work includes:

1) Evaluation of the action plans in the Binational Vision for the TRW.

2) Analyze the cost of the action plans proposed in the Vision document (CalEPA may be able to support this project).

3) Analyze the legal and institutional context of water laws in Mexico, the United States, California, and Baja California.

4) Exploration of the existing legal mechanisms for long-term transborder watershed management and proposal of some alternatives for the TRW.

5) Be advisor to the Comisión de Cuenca del Río Tijuana for be formed with CAN in the future.

Surface water quality

Ecoparque in Tijuana, a model wastewater treatment facility, is currently closed due to e.coli. contamination.

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In December 2004, a draft supplemental environmental impact statement for Clean Water Act compliance at the South Bay IWTP was published. The alternative preferred by IBWC was to continue to provide advanced primary treatment for Tijuana wastewater and all effluent would be piped to Mexico for secondary treatment in a new treatment plant. Through new piping, the secondary effluent would be returned to the United States and discharged through the South Bay Ocean Outfall (SBOO) pipe. This alternative would treat an additional 34 million gal (104 acre-ft) per day of wastewater originating from Mexico to be discharged through the SBOO or possibly Punta Bandera in Tijuana. There are some adverse environmental impacts related to this alternative (Parsons 2004).

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As part of the IBWC Federal Court settlement for non-compliance of NPDES permits at the IWTP, CAWRCB, IBWC-CILA, and various consultants held technical workshops during 2005 to discuss options for removing total suspended solids (TSS) and possibly removing toxicity from the IWTP discharge.

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CAWRCB is working with CESPT and the City of San Diego on a mini-toxicity study of Tijuana wastewater to determine if the source of effluent toxicity is domestic, commercial, or industrial. This study should be completed in 2005, and will be available to the public.

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Border Field State Park, the TRNERR, and Imperial Beach were closed by the County Department of Environmental health for urban runoff and sewage from the Tijuana River for 219 days in 2003 (County of San Diego 2003b).

Summary of surface water quality testing projects for the TRW

Water-borne illness is most often associated with viruses rather than bacteria. However, current water quality monitoring is based on levels of fecal bacterial indicators rather than viruses. A recent study by a team of German scientists and SDSU used a new laboratory method[5] to evaluate the presence of the hepatitis A virus. Eight ocean water samples were taken at the Tijuana River mouth and Imperial Beach pier following four separate rain events, and all showed the presence of hepatitis A. Additionally, the samples were not linearly correlated with fecal coliform counts. The authors believe fecal coliform levels may not be the best indicator of ocean water quality for human health risk assessment and that the methods developed in this study will be useful for evaluating risks to human health at other recreational beaches (Brooks et al. 2005).

[5] SYBR green real-time RT-PCR.

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Groundwater quality in the Tijuana River aquifer is poor, with high concentrations of total dissolved solids and a sodium chloride signature because of its proximity to the ocean (DOE 2002). Lead sampling from 25 wells showed < 0.001 mg/l, which is less than the U.S. federal and California maximum levels. No volatile organic compounds, pesticides, herbicides, semi-volatile compounds, or coliforms, were detected from two deeper production wells. Manganese was found at 940 ug/l, which exceeds the maximum contaminant level for drinking water in the United States. Demineralization with reverse osmosis or some other membrane separation technology was recommended prior to potable uses (Dudek and Assoc. 1994).

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The Southern California Bight is the 300 km (186 mi) of recessed coastline between Point Conception in Santa Barbara County and Cabo Colnett, south of Ensenada, Mexico. In 1994 a water quality testing project by the Southern California Coastal Water Research Project sampled the Southern California Blight at 261 U.S. locations for: 1) the extent of pollutant exposure, or the condition of the physical and chemical environment in which biota live; 2) the status of biological resources, or the existence of healthy, diverse, and sustainable biological communities; and 3) the presence of marine debris, which addresses concerns about aesthetic conditions. The sampling should be replicated and should be extended south into Mexico (Southern California Coastal Water Research Project 1998).

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The Southern California Blight Stormwater Monitoring Coalition was formed and has the following goals (Bernstein and Schiff 2003):

1. Integrate and evaluate available stormwater data
2. Standardize sampling and analysis protocols
3. Develop a regional data infrastructure
4. Measure best management practice (BMP) effectiveness
5. Develop a system-wide conceptual model for the transport of contaminants and sediments
6. Determine appropriate reference or baseline conditions
7. Stratify beneficial uses into benchmarks for water quality in order to rate the status of beneficial uses.
8. Identify relative contributions of non-point sources to urban runoff loads
9. Identify the causes of impacts to receiving water

10. Develop bioassessment indicators and protocols
11. Develop improved toxicity testing procedures
12. Develop microbial source tracking protocols
13. Evaluate BMP effects on receiving water impacts
14. Develop improved indicators of peak flow impacts

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A team of German scientists and SDSU sampled 29 km of the Tecate and Alamar Rivers in California and Baja California several times during 1999-2002. The study included chemical, microbiological, hydrobiological, and ecomorphological assessments. Results from heavy metals tests are shown in Figure 5. With the exception of cadmium, the toxicity of metals in the Tecate River was higher than other freshwater bodies tested in Germany and other parts of the world. However, except for nickel, the metals did not exceed Mexican standards. In addition, because the morphology of the river is relatively natural, by the time the stream reaches the Alamar River toll bridge about 24 km (15 mi) downstream, self-purification through nitrification and denitrification is shown to occur, and metals are reduced (see Figure 5). Levels of BOD and ammonium-N at the Alamar River remained high. The authors recommend reducing the organic input from the Tecate Brewery and the wastewater treatment plant (PTAR) in Tecate because organic wastes are overloading the river system. Additionally, they recommend building relatively low-cost wetlands with stable, rough, inorganic surfaces on which biofilms and macroinvertebrates will grow that would aid the natural self-purification process (Luderitz et al. 2005).

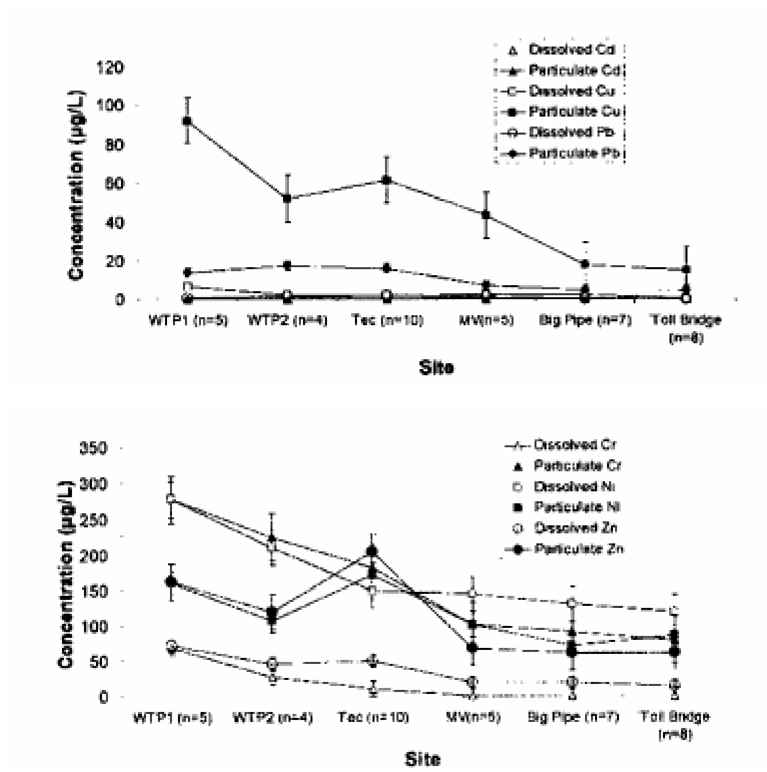

Figure 5
Heavy metal results from the Tecate River to the Alamar River.
Source: (Luderitz et al. 2005).

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Studies of aerial imagery of the ocean plume discharge from the Tijuana River between 1980s and 2002 were conducted by UCSD Scripps Institution of Oceanography, San Diego Coastal Ocean Observing System, and Ocean Imaging Inc., with support from various government agencies (McPherson et al. 2004; Svejkosky 2004). Results indicate that during storm events greater than 13 mm (0.5 in.), the changes in the spectral signatures (reflectance) of the plume correspond with high bacteria samples on the coast. Therefore, in the future, aerial imagery could be used to try to predict contamination events. Initial results of the study show a northward trend for the plume due to currents and wind, a weakening of plume after 2 to 3 days, and support the idea that the Tijuana River continues to be the most polluted river in the region and is the primary source of contamination for South County beaches during wet weather (Svejkosky 2004). The 2004 Beach Closure report noted that the Tijuana River was responsible for about 70 % the South County beach closures for all years except 2002 (**Error! Reference source not found.**) (McPherson et al. 2004).

Imagery studies of the South Bay Outfall from the IWTP also correlate bacteria counts and spectral signatures, and are helping improve in-water sampling techniques by boat which sometimes miss the plume completely (Svejkosky 2004). The imagery can possibly be used as a detector of emergency breaks (Svejkosky 2004) and also confirms San Diego County's protocol to issue closures at beaches north of the Tijuana River outlet (Imperial Beach, Silver Strand State Beach, and Coronado) following significant rainfall, and other times when data indicate northward moving currents (McPherson et al. 2004).

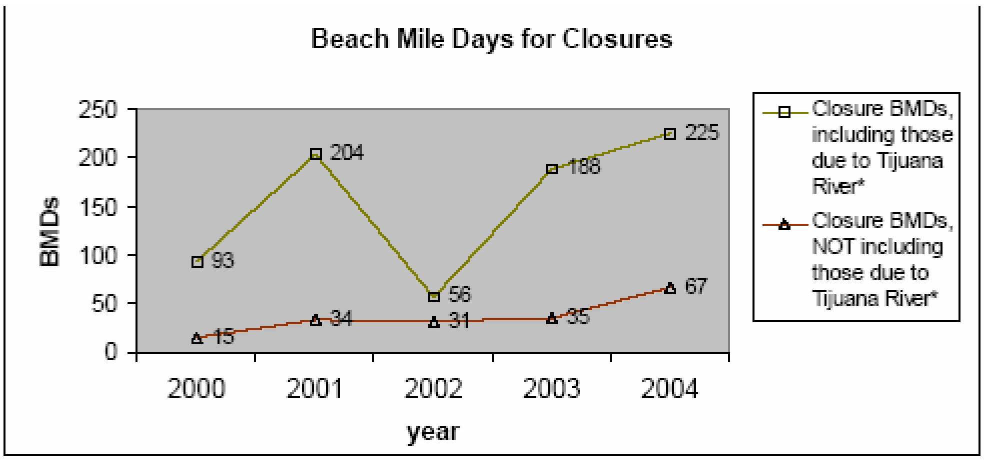

Figure 6
Contribution of Tijuana River to closure Beach Mile Days.
Source: McPherson et al. 2004
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The NGO Ja Jan tests for Enterococci coliforms, which can cause human health illnesses, at 14 beaches along the San Diego and Baja California coasts. The latest reported data are for October 1, 2004 and are presented in Table 1.[6]

Beach	Water Quality Conditions	Enterococci (MPN/100-ml)
Imperial Beach Pier	Acceptable	10
Imperial Beach (end Seacoast Dr.)	Acceptable	<10
Tijuana River Beach (mouth)	Acceptable	<10
Playas de Tijuana (265 yd or 242 m) south of border fence)	Acceptable	<10
Laboratory Control		<10

MPN=most probable number of bacteria <10 = below detection level

Table 1
Volunteer ocean water quality program data 2004.
Source: www.jajan.org.

6 More data are available at www.jajan.org.

Groundwater quality

In June 2005 *comités técnicos de aguas subterráneas* (COTAS) for Tijuana, Valle de Las Palmas, and Tecate were formed (Zúniga 2005). These user groups will work closely with CNA to make decisions on water quality, supply, and extraction rates, for example. After these groups are established, there are plans to form a watershed council for the Mexican portion of the Tijuana River Watershed.

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The Tia Juana Valley County Water District prepared a groundwater management plan for the Tijuana Valley River basin in 1995. Groundwater studies in 1994 included a three-dimensional computer model of the lower alluvial aquifer and the analysis of 16 groundwater extraction and treatment alternatives. Some alternatives considered reclaimed wastewater injection from the South Bay Treatment Plant and the IWTP into the aquifer as a long-term, cost-effective future water supply. The alternative would not only replenish the San Diego formation, but also create a hydraulic barrier against sea water intrusion. Excess water from Barrett and Morena reservoirs was also considered as a source of aquifer injection, although the construction of a pipeline would be necessary. The consultants also considered a desalination and disinfection plant that would produce 3,083,704 m^3/yr (2,500 acre-ft/yr) from 1998-2002. This alternative would require 0.87 ha (2.14 acres) of sandy river bottom (Dudek and Assoc. 1995).

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The NGO CUNA headed a water quality testing project of indigenous community wells in Baja California during 2004-2005. [7] The Nejí community uses hand dug wells and the stream for water supply. The e. coli counts ranged from 11.4-86.5 mpn/100ml. Although Mexican law NOM-001-ECOL-1996 establishes a maximum fecal coliform count of 500 mpn/100ml for drinking water, CUNA recommends treating this well water (Wilken 2005).

Water quality recommendations

- Continue the Southern California Bight coastal water sampling project and extend it through the Mexican portion of the TRW and beyond.
- Include the Mexican portion of the TRW in the research program plan for the Southern California Blight Stormwater Monitoring Coalition.
- Expand the Tijuana-Rosarito Master Plan (CESPTE 2003) and integrate it with other plans in the TRW.

[7] funded by Border 2012

- Elevate the low priority the RWQCB has placed on the TRW and development of binational TMDLs.
- Reinstate the State Mussel Watch program and the Toxic Substances Monitoring (TSM) program.
- Summarize existing industrial wastewater monitoring data.
- Develop a continuous monitoring program for all surface waters crossing the international boundary including Tecate River, Cottonwood Creek, the Tijuana River, and the 5 canyons and drains that also cross the border into the Tijuana River Valley in California (Goat Canyon, Smugglers Gulch, Silva Drain, Canon del Sol, and Sewarts Drain).
- Test the quantity and quality of groundwater in the Tijuana River aquifer using City of San Diego and IWTP wells.
- Research relating property values to ocean water quality in Imperial Beach is needed.
- Sediment data are needed for the watershed. The Army Corps of Engineers (1999) recommends the following steps: identify reaches of aggradation and degradation; estimate the average depths of scour and deposition that would cause failure of bridges and bank protection; estimate past, present and future delivery of sand to the estuary; evaluate causes of change in rates of delivery over time; prepare a sediment budget analysis; and determine average annual aggradation/degradation.
- Find full funding for the infrastructure improvements needed in Los Laureles Canyon to protect the residents and the Tijuana Estuary from further harm. This would include: sewage infrastructure, enforcement for trash disposal and stream discharges, BMP for roads construction, BMPs for new development, additional reforestation/vegetation on slopes and in riparian areas.

Ecosystems and Natural Resources

In 2005 the USFWS and the Border 2012 Water Task Force for the TRW created an Ecology subgroup to the Water Task Force to address gaps in knowledge and lack of harmonization in ecological research and data standards. The group's objectives are to:

1. Create a communication network focused on ecological and conservation opportunities
2. Review the las Californias Binational Conservation Initiative and seek opportunities for implementation
3. Review the Binational Vision for the TRW and seek opportunities for implementation
4. Create a list of research priorities in ecology and conservation for the TRW
5. Create a directory of TRW researchers in the area of ecology and conservation
6. Identify sources of funding for ecology research and conservation in the TRW
7. Inventory the flora and fauna of the TRW to provide authorities with baseline data for enforcement of related regulations
8. Create a border-region sensitive species list

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During the 1990s, six new reserves were established in the Baja California and Sea of Cortez region totaling 2,612,126 ha (6,454,704 acres). This movement is an indicator of the growing awareness of the need to act fast to protect resources from population pressures (Ezcurra 1998).

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Experts on flora and fauna in Baja California were convened during four workshops during 2001-2003, to prioritize key regions of the peninsula that need conservation (Vizcaino et al. 2005). During the first round of workshops, the participants were asked to agree on geographic areas of conservation need and score them on a scale of 1-10 using six categories: degree of endemism, biological diversity, degree of conservation, potential for inhabitants to use the natural resources, degree of threat, and cultural importance. The sense of the workshop's participants was that these "objects of conservation" should be considered as belonging to these larger corridor regions so as to maintain ecosystem integrity. Valle de las Palmas fell within one of these corridors and is also within the TRW. Experts gave this area a conservation need score of 40/60 in Table 2.

Endemism	Diversity	Degree of Conservation	Potential for use of Natural resource	Degree of Threat	Cultural Importance	Total
9	8	6	5	8	4	40

Table 2
Valle de las Palmas conservation need.
Source: (Vizcaíno et al. 2005).

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The Alamar River Park Master Plan was presented to the Cámara de la Industria de la Construcción (Chamber of the Construction Industry) by the Municipality of Tijuana. The municipality estimated a cost o MN$500 million (US$ 50 million) with a cost return on sand of MN$200-250 million (US$20-25 million). Rock could also be mined. There would be a need to remove some 800 families over the 10 km (6.2 mi) stretch to make room for ecohydrological flood control structures and a recreational complex (Salinas 2005).

***

A recent study on open space in the Tijuana River Watershed (Willoughby 2005) examined a stakeholder-driven approach for prioritizing open space areas for preservation. A GIS-based land use suitability analysis was conducted using environmental, economic, and recreational factors gathered from existing literature and expert opinion. The first objective of the study was to indicate which areas in the watershed were most valuable to stakeholders. The second objective was to compare the results of the study to the Las Californias Binational Conservation Initiative (CBI, Pronatura, and TNC 2004) which used a biological model for designing protected areas, and identify overlapping areas of value to both biologists and stakeholders. The responses from the questionnaires administered to stakeholders indicate that the environmental value of the watershed is of primary importance, specifically flora, fauna, and water. Recreational and economic values were both considered to be far less important than environmental concerns. Three separate geography areas were identified: the Mount Laguna area, the Otay region, and a south central zone of the watershed (Figure 7). These specific areas vary in terms of elevation, slope, and relative relief, but all contain sensitive vegetation and some riparian habitat. These areas are comprised mostly of undeveloped lands and have varying degrees of road access. While these areas have great value for stakeholders, they are also of biological value according to the *Las Californias Binational Conservation Initiative* (CBI, Pronatura, and TNC 2004), which ranked areas according to biological importance (Figure 8).

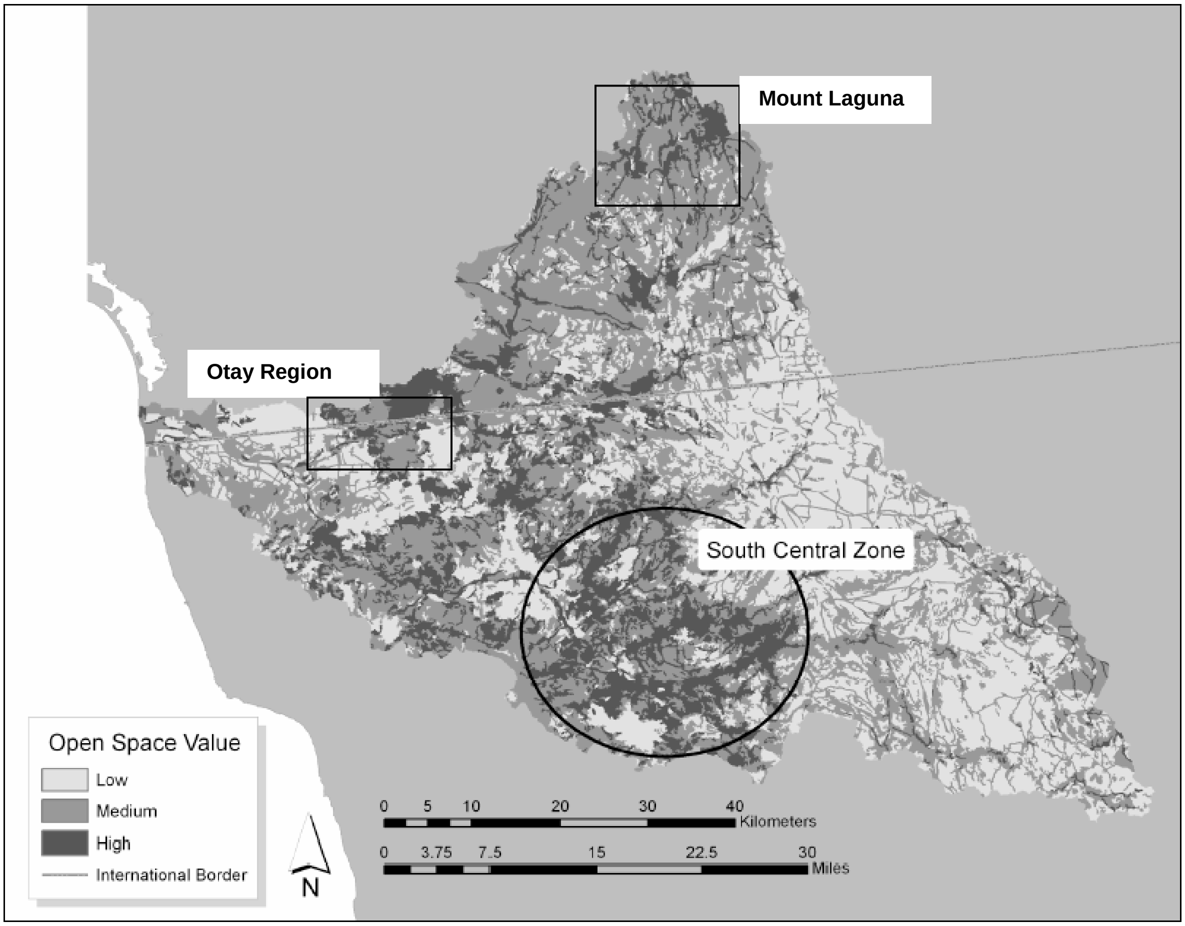

Figure 7
Areas of high priority for open space preservation based on stakeholders’ opinions of environmental, economic, and recreational resources.
Source: (Willoughby 2005).

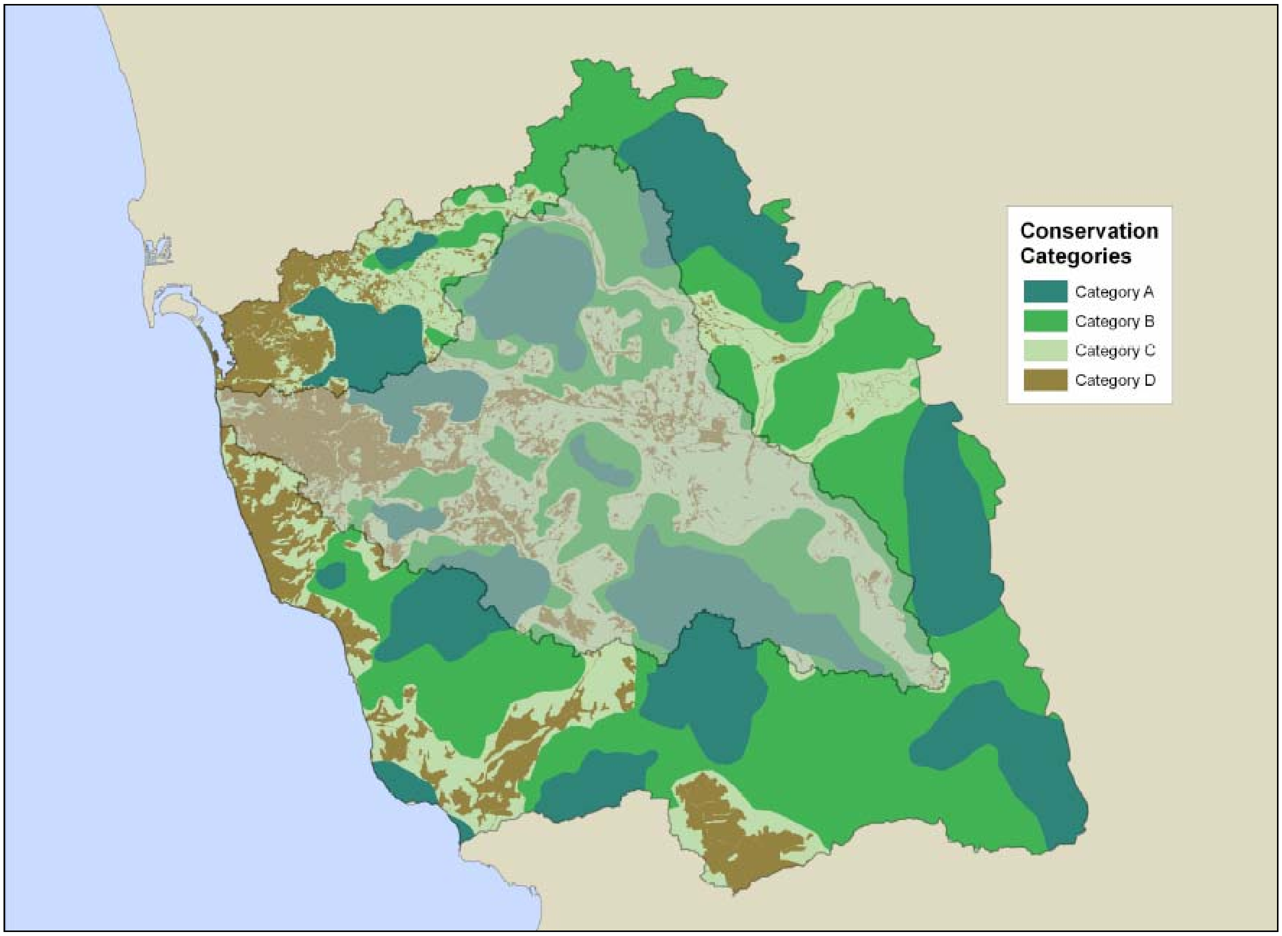

Figure 8
Areas of high priority for preservation based on biological resources. Category A is the highest priority. Source: (CBI, Pronatura, and TNC 2004).

The Tijuana Estuary

In 2005, the TNERR was added to the List of Wetlands of International Importance, RAMSAR. The designation encourages international research, conservation, and helps ecotourism.

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Three exotic invasive plant species are causing problems in the Tijuana River Valley: giant reed (*Arundo donax*); castor bean (*Ricinus communis*); and salt cedar (*Tamarix ramosissima*) (Concur, Inc. 2000). The Tijuana River Valley Invasive Plant Control Program[8] began in 2002 and controls invasive, non-native species in riparian, salt marsh, and upland habitats in order to enhance those habitats for native species. The valley was divided into spatial units and prioritized, then grouped into four temporal phases (see Table 3). Environmental

[8] With initial funding from the State Coastal Conservancy and the U.S. Fish and Wildlife Service.

permits have been obtained for all phases, and phases 1 and 2 have been completed. Funding is been sought for phases 3 and 4 (Winters February 2005).

Phase	Description	Acres total	Acres of invasives targets
Permitting	CEQA, NEPA, Streambed Alteration	-	-
Phase 1	Demonstration sites	302	10
Phase 2	Highest priority sites	911	113
Phase 3	Medium priority sites	1,231	59
Phase 4	Lowest priority sites	1,166	15
	Total	3,610	197

Table 3
Phases of the Tijuana River Valley Invasive Plant Control Program.
Source: (Winters February 2005).

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Goat canyon studies and experience building the Goat Canyon sediment basins are invaluable to erosion control efforts watershed-wide. A 1999 study on enhancement for Goat Canyon recommended sediment basins to control the filling of the Tijuana Estuary with debris and sediments. Preliminary steps recommended for designing the basins included hydrologic modeling, a 1-D unsteady flow model, and sediment transport modeling to refine sediment basin sizes for storage, deposition, and efficiency. Other alternatives that were explored in the studies may be implemented in other parts of the watershed: create a watershed-based community development plan, protect existing vegetation, minimize impervious surfaces, collect rainwater in rooftop cisterns, build check dams, build subterranean basins, restore vegetation, and seed collection and use projects (SWIA 1999).

Soils

The floodplain soils of the Tijuana River Valley are typically greater than 1.5 m (5 ft) in depth and are from Tujunga series, which are noted by their high infiltration rates of about 160-508 mm/hr (6.3-20 in./hr) and Chino series, a finer silty loam with infiltration rates of about 5-17 mm/hr (0.2 to 0.63 in/hr) (Izbicki 1985 from Rempel 1992). The shore soils are clay and fine sand tidal flats and have excess soluble salts (US Soil Conservation Service 1973 from Rempel 1992).

Flora

The riparian phreatophyte plants in the Tijuana River Valley, namely willows and mule fat, can thrive in arid areas because they tap subsurface water flows from 3-27 m down (10-90 ft.) (Daveis and DeWeist 1966 from Rempel 1992), and water consumption rates average 0.41 m/acre (1.33 ft/acre) (Bouwer 1978 from Rempel 1992).

Fauna

The *San Diego Natural History Museum Bird Atlas* is an example of collection of comprehensive bird surveys and a historical records review that will help scientists monitor populations. Four hundred volunteer observers spent over 55,000 hours in the field from February 1997 to February 2002. The observers recorded their results in a framework of 479 grid squares across San Diego County, generating databases of nearly 400,000 records. The San Diego County Mammal Atlas and Plant Atlas are ongoing projects designed to complement the Bird Atlas. More should be done in this arena watershed-wide, perhaps with herptofauna, insects, and fishes (SDNHM 2005).

Ecosystems and Natural Resources Recommendations

- Zone Jesús María Mesa, which has Quino Checkerspot Butterfly habitat, as “no development” and create a conservation easement.
- Zone Cerro Ysidro, which can be linked to the MSCP and Otay Mountain for a north-south flora/fauna movement corridor, as “no development” and create a conservation easement.
- Update the Baja California Regional Plan to protect large areas such as desert and mountains that do not have large human populations. Create small reserves and wildlife corridors within the urban/agricultural matrix (Martínez and Espejel, n.d.).

Solid and Hazardous Waste

Trash

Annual municipal waste generation averages 800 kg (1,763 lbs) per person in the United States (U.N. Department of Economic and Social Affairs 2005).

Hazardous waste

Metales y Derivados, a subsidiary of a San Diego metals company, is an abandoned lead recycling plant in the Industrial zone of Tijuana located about 135 m (426 ft) from a residential neighborhood, Colonia Chilpancingo. Two environmental groups filed complaints charging that Mexico's environmental enforcement agency, PROFEPA, had failed to protect residents or the land itself from contamination and, in addition to closing the site, should have cleaned it. The Commission for Environmental Cooperation (CEC) under NAFTA developed a factual record for the site with information from PROFEPA, and an analysis by independent experts of soil samples. The pollutants detected at site included in high concentrations cadmium and lead and in lower concentrations antimony and arsenic. A study on blood lead levels in children living in the vicinity showed an average level of 6.02 + / - 2.37 ug/dl and elevated levels (> 10 ug/dl) in 4.8% of the residents sampled. The CEC concluded that there was no recorded public health and environmental effects; however, they ordered remediation of the site (CEC 2002). In June 2004, EPA and SEMARNAT hired a specialized cleanup contractor which removed and transported 300 tons of hazardous waste to a facility in the United States. Future plans are to remove an additional 2,000 tons in 2005 and to evaluate long-term cleanup remedies (EPA 2005).

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Mexico has adopted a National Omnibus Waste Law, which takes effect in January 2006. It requires producers, importers, and distributors of products containing hazardous wastes to develop waste management plans for those products. Products currently covered include mercury and NiCad batteries and other products containing mercury, cadmium, or lead (U.N. Department of Economic and Social Affairs 2005).

Waste recommendations

The following are recommendations from the U.N. Department of Economic and Social Affairs (2005) that are general in natural but relevant to the TRW:

- Develop pilot projects such as debris entrapment basins and a program to remove of trash from waterways prior to wet weather. Expand successful methods throughout the watershed.
- Design future landfills with a thick impermeable layer of clay and several inches of plastic at the base to prevent contaminated liquids ("leachate") from polluting groundwater and nearby surface water. A drainage system can collect the liquid leachate for treatment, and some of the methane generated by decomposition of organic matter can be used as a source of energy, reducing greenhouse gas releases to the atmosphere at the same time.
- Legalize scavenging activities, encourage the formation of scavenger cooperatives, award contracts for collection of mixed wastes and recyclables, and establish public-private partnerships between local authorities and scavengers. Form cooperatives so scavengers can bypass the middlemen and increase their earnings.
- Institute a landfill tax to encourage recycling.
- Reduce and recycle packaging waste, including product and transport packaging (see the "Green Dot Programme" in Europe).
- To reduce electronic waste going to landfills and incinerators, pass a law requiring producers to take responsibility for recovering and recycling electronic waste without charge to consumers (see Europe's Waste Electrical and Electronic Equipment [WEEE Directive]). On products sold before 2005, the costs of collection and recycling could be shared by all producers. This law would promote recycling and provide an incentive to product designers to reduce waste.
- Establish an internet-based Material Information Waste Exchange to allow building contractors with unwanted materials or wastes to sell them or give them away to encourage recycling, as was done with Border WasteW$se[9].

[9] http://www.borderwastewise.org/databank/index.htm

Socioeconomic issues

Economy

Ezcurra (1998) selected several indicators of economic development. Tijuana and Playas de Rosarito reported illiteracy rates of 2.8%, 83% houses with electricity, and 2.2 live offspring per female over 12 years of age. Tecate had a slightly higher illiteracy rate at 3.72%, lower electricity connections at 77%, and slightly higher number of offspring at 2.4. The number of offspring for Baja California is lower than the rest of Mexico. The State of Baja California as a whole grew at 4.77% annually from 1990 to 1995 and Tijuana grew at 6.52%, despite low birth rates. This increase is attributable to migrants moving in from the south of Mexico.

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Economic growth rate studies typically do not measure environmental and natural resources impacts. An environmental accounting study of the San Diego-Tijuana region (Jerrett et al. 2003) found that San Diego County spends about 1.23% of its gross domestic product on protection of the environment from human-induced damage (storm damage, solid waste management, water treatment, cleanups, etc.). A study of Goat Canyon/Cañón de los Laureles showed that U.S. expenditures total about $2.4 million, mostly to protect the Tijuana Estuary. Contrary to common belief, Tijuana, considering its overall economy, spends proportionally more than the United States at about $2.6 million. Also, Tijuana expenditures focus on human health and safety in the canyon. Another surprising result from the study was that San Diego has experienced an increase in agricultural lands in recent years. However, there were also agricultural to urban land use changes that represented a high economic loss. Because environmental costs represented a significant portion the economies of the jurisdictions, the authors recommend the establishment of a binational environmental accounting method. They also note the importance of spatial analysis using GIS in the framework. According to the study, the benefits of such an approach outweigh the costs because modeling economic consequences may save millions of future dollars in environmental clean ups. The framework would also useful for improving binational relations.

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The North American Free Trade Agreement (NAFTA) likely affected the TRW, although conclusive studies are difficult. Experts believe the economic benefits have largely gone to a small percentage of the population in both countries, outside the border region. Mostly low-value added jobs have widened the economic disparity between the U.S. border and the rest of the United States. In addition, as a whole, the border environment has experienced a 60% increase in truck traffic, an increase in air pollution from diesel traffic, and increases in the transport of hazardous materials. There have been positive effects from NAFTA, including improvement of transborder environmental cooperation, the establishment of the CEC, BECC, and NADBANK. Experts believe NAFTA could have been more comprehensive in its original scope, covering social and physical infrastructure investment and economic and political reform (Ganster 2004).

Infrastructure

Both Mexico and the United States are currently considering energy reform proposals at the federal level in an attempt to provide reliable energy supplies at reasonable costs. Additionally, many U.S. states have already begun energy deregulation processes. To address the issues related to creating a binational energy market that meets regional needs with minimal environmental impacts, the Border Energy Issues Group (BEIG) under SANDAG was created (SANDAG 2005).

To address transportation issues, SANDAG participates in binational planning, forecasting, and data collection. Projects include MOBILITY 2030, SANDAG's Regional Transportation Plan (RTP), and a study of the feasibility of reopening the former commercial gate at Virginia Avenue (SANDAG 2005).

Other recent examples of binational transportation planning include the implementation of programs such as the Secure Electronic Network for Travelers Rapid Inspection (SENTRI) and Free and Secure Trade (FAST) that expedite border crossings for pre-screened participants.

Human Health

In 2001, the Border XXI Environmental Health Group proposed a basic group of indicators (Table 4) that can be used to orient policies and programs on environmental and health issues in the border populations, and to measure the effectiveness of policies and programs (Gosselin 2004). Future studies in the TRW may use these to monitor environmental health.

	OBJECTIVE 1. ASSESS EXPOSURES AND RISK LEVELS (INCL. PERCEPTIONS AND BEHAVIOURS	OBJECTIVE 2. ASSESS BIOLOGICAL EXPOSURES AND LEVELS OF RELATED DISEASES (MORTALITY, MORBIDITY, PERCEPTIONS)
WATER	% access to drinking water (disinfected, connected, water quality stds, simple access to public source, rural/urban) % access to excreta disposal facilities (rural/urban, connected, individual)	Diarrhea mortality in children under 5 (Briggs) Estimated deaths rates due to intestinal infectious diseases in children under 5 y (PAHO C10) Outbreaks of waterborne disease (Briggs, CDC)
AIR	Ambient air concentrations for criteria pollutants in each sister city (Border) Number of exceedances (days) for each ambient air standard (Border) Proportion of youth 15-19 of age who smoke (PAHO D 30) Percentage of households using coal, wood or kerosene as main source of heating/cooking fuel (Briggs)	Unusual pattern of cardiovascular and respiratory events (with environmental contribution) (CDC) Temperature attributed deaths (CDC) Percentage of children under 18 with asthma and chronic bronchitis (EPA-C; D1)
FOOD	Calories avail per capita PAHO-B1 % of fruits, vegetables, grains, dairy and processed food with detectable levels of pesticide residues EPA-C 81	Outbreak rate of foodborne illness (Briggs) 86 Incidence of diarrhoea morbidity in children < 5 from foodborne sources (modified from Briggs) 87
WASTE	Number of chemical spills (transportation and fixed facility) EPA 90 % urban pop with regular collection of solid waste PAHO E9	Incidence of chemical spill related injuries and poisonings EPA 91
MULTIPLE EXPOSURES	Percentage of workers exposed to unsafe, unhealthy or hazardous working conditions (Briggs)	Concentrations of lead in blood for children 5 and under, and % with concentrations over 10 micrograms/dl (EPA-C; B1-2) Concentrations of other heavy metals and POPs in blood for at-risk groups Cancer incidence and mortality for children under 20 by type (EPA-C; D5a, D5b) Estimated death rates due to tumors (selected sites according to high priority chemicals) (PAHO C20) Pesticide-related poisoning and illness (CDC) Incidence of occupational mortality (Briggs) Number of reported poisonings per year in children under 5 (Briggs) Mortality rate due to poisonings (Briggs)

	OBJECTIVE 1. ASSESS EXPOSURES AND RISK LEVELS (INCL. PERCEPTIONS AND BEHAVIOURS)	OBJECTIVE 2. ASSESS BIOLOGICAL EXPOSURES AND LEVELS OF RELATED DISEASES (MORTALITY, MORBIDITY, PERCEPTIONS)	OBJECTIVE 3A. IDENTIFY PRIORITY GROUPS FOR INTERVENTION (VULNERABLE)	OBJECTIVE 3B. IDENTIFY PRIORITY GROUPS FOR INTERVENTION (HIGH EXPOSURE)
WATER	Percentage of urban population with potable water through house connections (PAHO E2) Access to basic sanitation (Briggs	Diarrhea mortality in children under 5 (Briggs) Diarrhea morbidity in children under 5 (Briggs)	Population access to health services (PAHO E1) Mortality rate under 5 (PAHO C6) %of population living in extreme poverty (PAHO B8) Birthweight	Degree to which drinking water systems comply to guidelines (CDC) % of children living in areas served by public water systems that exceeded a drinking water standard or violated treatment requirements (EPA-C; E5)
AIR	Number of exceedances days for each ambient air standard (Border) Proportion of youth 15-19 of age who smoke (PAHO D 30) Ambient air concentrations for criteria pollutants in each sister city (Border) Percentage of households using coal, wood or kerosene as main source of heating/cooking fuel (Briggs)	Incidence of morbidity due to acute respiratory infections in children under 5 (Briggs) Estimated death rates due to acute respiratory infections in children under 5 (PAHO C11)		Percentage of children living in counties in which air quality standards were exceeded (EPA-C; E1) Percentage of homes with children under 7 where someone smokes regularly (EPA-C; E4)
FOOD	Level of consumption for raw milk Level of consumption of traditionally preserved food	# of outbreaks of foodborne illness (Briggs) 86		Proportion of children consuming diets with foods with high level of contaminants
WASTE	Number of chemical spills (transportation and fixed facility) EPA 90 Quantities of hazardous waste exported to Mexico for recycling EPA-Env 97	Incidence of chemical spill related injuries and poisonings EPA 91 Blood/urine concentration levels (95th percentile) for heavy metals in the vicinity of recycling and / or hazardous waste facilities modified from EPA 92		% of women of child bearing age and children living in the vicinity of hazardous waste and recycling facilities % of population living in noxious fauna and pest infested dwellings
MULTIPLE EXPOSURES	Adequacy of storage for chemicals in households	Number of reported poisonings per year in children under 5 (Briggs) Estimated death rates due to tumors (selected sites) (PAHO C20) Incidence of birth defects		Total 3 of children living in households with inadequate storage of chemicals

	OBJECTIVE 4. REDUCE EXPOSURE/DISEASE THROUGH: -adaptive information support -protective and control measures -preventative, corrective measures (at inds, community, state levels) -promote adaptive behaviours and institutional responses
WATER	% of at-risk population being reached by a public health program promoting basic hygiene measures % of population knowing the quality levels of their drinking water
AIR	Implementation of programs that address motor vehicle emissions (CDC) Schools with indoor air policies that address environmental hazards (incl. smoke and tobacco-free policies) (CDC) Jurisdictions with laws pertaining to smoke-free indoor air (CDC)
FOOD	Training of personnel for food supply management and prevention in the chain of risks Food contamination advisories
WASTE	% pop with regular waste collection, recycling and disposal (Briggs) 101 % of people living in at-risk areas for hazardous waste that are aware of associated risks and available preventative protective measures Total mass of solid waste disposed by regular waste services (per yr) (Briggs) 102
MULTIPLE EXPOSURES	Number of sister cities with contingency plans (Border) Participation of public health officers to environmental impact assessment processes
OCCUPATIONAL	Public health intervention in occupational health to be determined # of industries and agricultural plants with emergency health services # of industries and agricultural plants with occupational accident/injury registry systems

Table 4
Environmental Health Indicators for the U.S.-Mexican border communities proposed by Border XXI.
Source: (Gosselin 2001).

Security

Table 5 shows areas of cross-border cooperation on safety and crime. However, generally border cooperation has occurred on a temporary basis by individual actors and through personal relationships (San Diego Dialogue, 2000 from Ramos 2003). Formal security alliances include the U.S.-Mexico Binational Antidrug Strategy (January 1998), and the Mexican Coordinación para la Seguridad Fronteriza y Nacional (October 3, 2001), established in Tijuana after September 11, 2001. There is also a “Joint Statement between the United States of America and the United States of Mexico” (September 6, 2001), signed in Washington, D.C. that calls for “secure infrastructure,” “secure flows of goods,” and “secure flows of people” (Ramos 2003).

Cross border Cooperation Issues		
Federal	**State**	**Local**
Narcotrafficking	Car theft	Prevent Crime (vigilant, patrol and administrative)
Weapons smuggling	Kidnappings	
Organized crime	Trafficking in minors	Border policy
Border policy	Criminal investigations	Transborder communication

Table 5
Cross border cooperation on crime issues.
Source: (Ramos 2003).

The United States and Mexico have different priorities for border security (Table 6) (Ramos 2003).

Priorities between Mexico y United States on border security issues	
MÉXICO	**UNITED STATES**
Efficiency on border crossings	Improve security
An immigration accord and improve border security (short term)	Balancing border security and trade and border crossings
Improve border security	Improving security and expanding technology to enhance border security
Lack intergovernmental relationship in border security issues	Improve an integrated strategic border management
Promote a border development policy	Promote an immigration accord (long term)
Improving security and expanding technology	Border security and border development

Table 6
Priorities from Mexico and the United States on border security.
Source: (Ramos 2003).

After September 11, 2001, border security efforts changed, and the U.S. consolidated its efforts into a single Bureau of Customs and Border Protection. This centralization runs contrary to Mexican decentralization strategies. Since September 11, U.S. border security operations have delayed border crossing wait times (people and goods) resulting in negative economic and social effects. Changes in security policies have been particularly disruptive to the San Diego-Tijuana economy. Local and state governments along the U.S. border have the prime responsibility for preventing and responding to terrorist attacks, therefore, it makes sense that they play an important role in improving the border cooperation (Ramos 2003).

On April 20, 2001, the former Tijuana Mayor Francisco Vega and former San Diego Mayor Dick Murphy signed a continual Agreement for Binational cooperation. The resulting Binational Work Group developed the Binational Public Safety 1999-2000 Work Plan that includes the following activities:

- Hold a binational conference on emergency management issues.
- Expand awareness of binational public safety issues, which could have an impact on the quality of life within the region: traffic stops, juvenile curfew, 911 system, undocumented migrant policy, domestic violence, and right of way to emergency vehicles.

- Continue San Diego public safety programs that train Mexican personnel in accordance with San Diego police academy philosophy.

Historical and cultural resources

The Tijuana River Valley contains cultural sites of value including prehistoric Native American sites, historic sites, and features associated with World War II preparations. Some of these are potential sites for the National Register of Historic Places (U.S. Army Corps of Engineers 1999).

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In Baja California, there is generally a lack of inventory of historical and cultural monuments, however, work at SDSU together with CUNA is documenting indigenous cultural resources in a GIS database[10] (see also Appendix 5 of the main Vision document for a list of culturally and historically important places).

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Semi-nomadic tribes, including Kumiai, Pai Pai, Kilwa, and Cucapá, hunted and gathered food and performed ceremonies the Tecate area. Camps, paintings (*pinturas rupestres*), *tepalcates, aguajes, lascas de descortezamiento,* stone houses, old churches, tombs, ranches, animal corals, trails, and grinding stones are found throughout the region (Serrano González 2002; Valdez Flores 2001). There are several important cultural and historical sites in around the TRW that are registered with INAH (Serrano González 2002).

- Juntas de Nejí
- San José Tecate
- La Casa de Piedra
- Rancho el Desierto
- San Francisco Tanamá
- Cerro los Monos
- San Ignacio Tanamá
- Rancho Víctor Manuel
- Las Peñas
- Rancho Viejo
- Entrada Rancho Viejo

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[10] Partially funded by SCERP.

- Cerro Bola
- Peña Blanca
- Las Juntas
- Manatial las Juntas

All of these sites have been, or are in danger of being, defaced or destroyed from ranching and development. There is only one site in the municipality that is protected with infrastructure including visitor information and services. This site is El Vallecito, which is outside the TRW. Recommendations for preserving or demarcating specific sites and promoting cultural and ecotourism can be found in Valdez Flores (2001). For example, Peña Blanca has opportunities for camping, hiking, and rock climbing. Nejí would be a good site for walking and horse tours and the community is building a public pool.

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The San Antonio Necua, a Kumiai community, which is just outside the TRW, opened the Siñao Kuatay Community Recreational Center[11] in 2005. It offers camping areas with barbeques, playground equipment, horseback rides, guided hikes, traditional and regional foods, basketry and other handcrafts, medicinal plants, traditional Kumiai music, and campfires. The Center is the first phase of a larger project which will include a restaurant, stores, community museum, information center, traditional village reconstruction and botanical gardens. This type of center could be replicated in indigenous communities in the TRW.

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Formed in 1994, the Native American Environmental Protection Coalition (NAEPC) provides technical assistance, environmental education, professional training, information networking and inter-tribal coordination as need by the tribes. As of 2003 the Chemehuevi, Jamul, Los Coyotes, La Jolla, Pala, Pechanga, Ramona, Rincon, San Pasqual and Soboba tribes participate from the San Diego region (NAEPC 2005).

Socioeconomic recommendations

For urban planning in the TRW, consider the following recommendations derived from the UN Department of Economic and Social Affairs (2005):

[11] For more information contact centroecoturisticonecua@hotmail.com.

- Mix residential and commercial areas to decrease automobile use.
- Model municipal budgeting after Brazil's "participatory budgeting," with public debates on municipal programs and priorities, to help ensure that urban planning and financing meet the needs of all.
- Provide tax-free compensation for use of public transport.
- Dedicate bus lanes along radial routes from the city center. To speed loading, passengers could pay their fares in advance in shelters at the stops.
- Use the "finger plan" approach to urban development to help promote public transit and reduce the need for cars. High-density housing combined with retail stores would be concentrated on a few axes (fingers) extending out from the center of the city. The axes would have rapid transit systems such as subways, light rail or dedicated bus lanes. The land in between the fingers can be used for parks or other low-density uses. Land along rivers in cities can be used as parks with foot and bicycle paths, providing flood protection as well. This approach has been very successful in reducing vehicle traffic and improving the quality of urban life in such cities as Copenhagen, Denmark, and Curitiba, Brazil.
- Ban cars from some streets at certain times—a popular approach in Bogotá, Colombia, and Portland, Oregon. Following London's example, a "congestion charge" can be used to discourage the use of private cars in congested urban areas during peak hours.
- License and regulate the informal sector of *colectivos*, mopeds, and taxis, setting vehicle standards and insurance requirements. Exclude pedicabs, horse, or other small, slow vehicles from major streets. Establish waiting and loading points off the busiest streets. Restrict imports of used cars beyond a certain age.
- Governments, local authorities, and large institutions should purchase hybrid or electric cars to set a good example and stimulate the interest of suppliers.
- Responsible parties should nominate all or some of the cultural and historical sites mentioned in the Vision for UNESCO World Heritage site designation (UNESCO 2004). "Cultural heritage" status includes a monument, group of buildings, or the site of historical, aesthetic, archaeological, scientific, ethnological, or anthropological value. Such status could draw international attention, protection, and/or funds to the TRW.
- Protect cultural and historical sites (Valdez Flores 2001).
- Establish a binational environmental accounting method using GIS in the framework (Jerrett et al. 2003).

Implementation timeline

A conference on watershed management (Water Environment Federation 1998) discussed the top 10 lessons learned in watershed management planning and ways to avoid "collecting dust" on watershed management plans. The top reason for failure of plans in the study was the lack of a clear implementer. It was mentioned that the watershed coordinator should be based in the watershed. In addition, many plans were written at too large a scale. Successful plans have involved local governments, which have access to funding and decision-making authority over land use planning. Some other successful plans have been citizen-driven, focusing on small projects. One example cited a stream clean up program started by a West Virginia coal miner, which gained popularity and grew to 25 people.

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The U.N. handbook suggests some implementation strategies that might be relevant to the TRW (IUCN 2005b):

- Adopt integrated water resources management (IWRM) and water efficiency strategies.
- Give due attention to capacity building and institutional strengthening; ensure that organizations are able to take on the new responsibilities and challenges.
- Ensure broad-based support grounded in different levels of government and the community so that the Vision is not vulnerable to changes in political regimes or the departure of key personnel.
- Task the same body responsible for leading the strategy development (BWAC) with overseeing implementation, and making them accountable to a higher authority. The BWAC may find it useful to report to an institution of higher level, such as an international group.

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The 14 action plans in the main Vision document need financial estimates[12] to make it easier to promote them to funding agencies, donors, and government officials. In 1995 CalEPA compiled a U.S.-Mexico border needs assessment with one-page plans that include a description of the environmental need, the suggested project, estimated cost, and current status along with

[12] Funding may be possible through CalEPA.

contact information (Tomlinson et al. 1995). This same format may prove useful for the 14 Vision action items.

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?

The United States, Mexico, and tribal governments are taking steps to collaborate on infrastructure planning through SANDAG. Examples of these efforts are the Borders Committee, created to provide oversight for planning activities with Mexico and other bordering jurisdictions. The Committee on Binational Regional Opportunities (COBRO) provides policy guidance to the SANDAG Board of Directors, and advises the Borders Committee. In 2002, a tribal liaison began to work with the tribal governments to promote better government-to-government communications and coordination. Like SANDAG, the Comisión de Conurbación Tijuana Tecate, Playas de Rosarito collaboratively plans for regional growth (SANDAG 2005).

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Many countries in Europe have water data networks and binational agreements based on watershed design for surface and groundwater quality issues. Mexico and the United States need this type of formal watershed mechanism. Small steps to this end have been taken. In 1996 both countries agreed to create a seamless transboundary map of the entire border 209 km (130 mi) at 1:40,000. Mexico's INEGI was still working on this project as of 2002. In addition, around 1999, DOI submitted a draft proposal to the IBWC for better data sharing and collaboration on shared resources with Mexico. A binational water quality sampling field methods manual was created and distributed, an important step in the direction of water quality monitoring (Klein et al. 2002).

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Previous research proposals (JPL/SCERP-SDSU 1994) sketched a framework for creating a binational management mechanism for overall environmental assessment and monitoring. The goal of the proposal was to establish a baseline against which to measure changes in future environmental conditions, and to provide border policy with a scientific and technical basis. The first phase would implement a user needs analysis and data gap analysis. The proposal includes an information flow diagram showing the multi-format collection of data, data fusion, data normalization, data filtering, and data distribution processes. The project was projected to cost from US$750,000—$1,000,000 (MN$7.5—10 million) and take about one year to complete.

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Many agencies recognize the importance of working at the watershed scale versus within jurisdictional boundaries. The Army Corps of Engineers Regulatory Branch and Planning Division study of the Tijuana River Valley (1999) considered a watershed approach to issues such as sedimentation and flooding. They proposed a watershed analysis of several management alternatives including flood control, ecosystem and environmental restoration, storm water retention, water conservation and supply, and recreational needs from a basin-wide perspective.

Recommended future steps to implement this action:

- Find funding for the environmental assessment and monitoring data framework proposal.
- The Army Corps watershed analysis should be performed in the TRW, including the Mexican portion.
- The Regulatory Branch of the Army Corps should consider collaborating with CNA and creating binational permitting standards for activities under Army Corps authority such as creating or altering national waters, dams, and dikes.
- The SWRCB is also interested in creating binational standards for TMDLs, a process that could be negotiated through the border liaison mechanism under through the TRW Technical Subcommittee.

Regulatory Framework

U.S. Regulatory Framework

The U.S. Army Corps of Engineers has regulatory authority over construction, excavation, or deposition of materials into national water, dams and dikes, refuse disposal, and the transportation of dredged material to be dumped in the ocean (U.S.ACE 2005).

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Agencies involved in water quantity and quality in the United States are listed in Table 7 (O'Connor 1995; U.S.ACE 2005):

INTERNATIONAL	
Agency	**Responsibilities**
IBWC	Upholds treaties, Tijuana River flood control project, South Bay IWTP
FEDERAL	
Agency	**Responsibilities**
U.S. Army Corps of Engineers	Flood control projects, reservoirs
U.S. Bureau of Reclamation	Surface water supplies
Natural Resources Conservation District	Best management practices
USFS	Manages watersheds
USGS	Provides water quality and quantity data
USE.P.A.	Implements surface, ground, and drinking water quality programs
Campo EPA	Water quality on the reservation
Farm Services Agency	Wetlands, ecological diversity/restoration, erosion/sediment control
Agricultural Research Service	erosion/sediment control, water quality, water supply
National Marine Fisheries Service	Oceans and estuaries, wetlands, navigation, wildlife, fisheries, water quality
NOAA	Oceans and estuaries, fisheries, water quality, flood risk management
Federal Energy Regulatory Commission	Hydropower
Bureau of Indian Affairs	Wetlands, wildlife, fisheries, ecological diversity, restoration, erosion/sediment control, water quality, flood risk management
Federal Emergency Management Agency	Flood risk management
National Park Service	Recreation, preservation, wildlife, fisheries, ecological diversity/restoration
STATE	
Agency	**Responsibilities**
CalEPA	Environmental and human health protection
CA Dept. of Health Services	Controls drinking water quality
DWR	Large water supply needs
CA Public Utilities Commission	Supervises drinking water utilities
CASWRCB	Supervises all water rights and water quality

Table 7
U.S. agencies that are responsible for water quality and quantity.
Source: (O'Connor 1995; U.S.ACE 2005).

Mexican Regulatory Framework

There are several laws in place in Mexico to protect sites of historic, cultural, and scientific value. The Federal Law on Monuments and Archaeological, Artistic, and Historic Zones (INAH), the Baja California State Cultural Heritage Preservation Law, and the General Law of Ecological Equilibrium and Environmental Protection (LGEEPA), under “natural monuments,” all apply. The Baja California State Environmental Protection Law considers state natural monuments (Leyva Aguilera et al., n.d.). Poor enforcement of these laws is related to lack of government coordination and funding. Some of the legal instruments that can be used to protect cultural sites are also good for protecting ecologically important sites.

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Groundwater well quality is regulated by NOM –127-SSAI-1994.

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Under Article 159 of LEGEPA, SEMARNAT organizes *consejos consultivos para el desarrollo sustentable* (advisory councils for sustainable development).

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The Mexican federal government has designed a program called PRONAGUA to establish water markets and remove barriers to the privatization of water utilizes. Criticism of this program from the public sector includes lack of guarantee on return of investments, and the degree of government commitment to privatization considering a tradition to provide low-income users with free water as in the past (Brown 2003).

***

The following Mexican agencies are responsible for water quality and quantity (Table 8).

INTERNATIONAL	
Agency	**Responsibilities**
CILA	Upholds treaties, Tijuana River flood control project, South Bay IWTP
FEDERAL	
Agency	Responsibilities
CNA	Under SEMARNAT. Manages national waters. Planning, Regulations, builds infrastructure
STATE	
Agency	**Responsibilities**
CEA	Planning and coordinating activities related to water and wastewater quality and distribution
COSAE	Statewide water management, aqueducts, purchases
Consejo de Cuenca de Baja California	Water users manage the watersheds
CEA	Planning and coordinating activities related to water and wastewater quality and distribution
COSAE	Statewide water management, aqueducts, purchases

Table 8
Mexican agencies are responsible for water quality and quantity.
Source: (GNEB 2005).

International agreements

The World Summit on Sustainable Development in 2002 called for all countries to craft integrated water resources management (IWRM) and water efficiency strategies by the end of 2005. The goal for the TRW would be to maximize benefits from infrastructure investments planned for the future (for example, CESPTe and CESPT NADBANK renovations, the Tijuana-Rosarito Master Plan, South Bay and IWTP upgrades, Tecate and Alamar river parks, new connections to *colonias*, etc.). In addition, an integrated approach would allow benefits to be more equitably distributed throughout the watershed, ensure that economic gains are sustainable, and ecosystem health is protected, if not enhanced (IUCN 2005b). This Vision document may help begin the process of IWRM.

International minutes

IBWC-CILA is in charge of dealing with binational water resources and sanitation under the 1944 Treaty and a series of subsequent minutes (Table 9).

Minute	Date	Description
258	May 27, 1977	Approved construction plans for the U.S. portion of the flood control channel design including a levee, drainage channel, fencing, and removal of an old dike and silt deposits.

Table 9
IBWC-CILA minutes affecting the TRW.
Addition to main document Table 28.

Land acquisition tools

Tools in Mexico

Legal conservation tools that allow landowners to voluntarily restrict the type and amount of development to protect natural resources are relatively new in Mexico. Some examples are described in Table 10 below.

Tool	United States	Mexico
Comodato	Lease free of charge	Civil law contract, landowner lends land or rights to resources free of charge.
Rental agreements	Not common. NGOs or other rent property for conservation uses or ecotourism	NGO's or other rent property for conservation uses or ecotourism
Purchase of resource contracts	NGOs purchase mining or timber rights	NGOs purchase mining or timber rights
Community accords		*Ejidos* or communities sign agreements to protect lands or seasonal habitat.

Table 10
Summary and comparison of land conservation tools in the United States and Mexico.
Addition to Table 29 in main document. Source: (Environmental Law Institute 2003).

International tools

Examples of successful programs from around the world can aid Baja California land conservation. Economic incentives in Costa Rica include a government subsidy of US$50/ha/yr (US$20/acre/yr). Exemptions from property tax are found in Brazil and Costa Rica (Environmental Law Institute 2003).

Recommendations for land acquisition

Specific recommendations for conservation of private lands in Mexico include (Environmental Law Institute 2003):

- Exempt donated land or bequests from Mexican income taxes and property transfer taxes.
- Develop Mexican state laws to create private reserves.
- Develop a Mexican federal law that promotes private land conservation through easements and transferable development rights and private reserves.
- Recognize the socioeconomic use of conserved land in Mexican federal law and implement a national registry of sites.
- Remove the legal limit of land that can be owned by NGOs.
- Improve the Mexican laws for enforcement.
- Establish a Mexican federal income tax deduction and a federal mechanism for payments for environmental services such as carbon sequestration.
- Provide tax exemptions for NGOs for holding lands in conservation.

- Implement jurisdictional security reforms for private lands that will help owners feel secure in keeping land undeveloped; there is a fear that unoccupied private lands will be seized by the government and given away.

Integration with other planning documents

The Vision fits in with and helps meet the goals of the ***CASWQCB's Nonpoint Source Program Strategy and Implementation Plan, 1998-2013,*** which establishes 61 management mechanisms (MMs) to combat non-point source pollution (CASWRCB 2000). Specifically, these two plans line up in their watershed approaches and focus on interagency cooperation and community participation.

The Vision in is line with the ***City of San Diego Otay Mesa Community Plan Update*** which is attempting to convert the industrial character of this area to more mixed use developments in the future (SANDAG 2005).

The ***County of San Diego East Otay Mesa Specific Plan*** promotes the development of an industrial and business district in Otay Mesa with several defined zones: technology, light industrial, heavy industrial and conservation (SANDAG 2005). The Vision also promotes mixed use of already development land with some land converted to conservation and recreational uses.

The ***Plan Parcial Mesa de Otay*** identifies Otay Mesa as a priority area because of the new Mesa de Otay II Port of Entry. Housing and industrial developments, habitat corridors, and transportation will all be affected by the crossing. IMPLAN is currently developing this plan and the Vision supports the call for connectivity of habitat corridors and vehicular corridors across the U.S.-Mexican border (SANDAG 2005).

The Vision uses a similar thematic structure as the ***Integrated Environmental Plan for the Mexican-U.S. Border Area (IBEP)*** (U.S. EPA and SEDUE 1992). The sections cover water, air, hazardous materials and solid waste, pesticides, contingency planning/emergency response, pollution prevention, environmental heath, environmental education, urban development issues, border infrastructure, and other multimedia issues. Like the Vision, the plan also breaks each theme down by geography and offers timeline. A future version of the Vision may seek to include some of the same themes listed above that are critical in other border areas including pesticides, emergency response, etc.

The Vision supports the ***Comprehensive Management Plan for Tijuana River National Estuarine Research Reserve and Tijuana Slough National Wildlife Refuge*** (CONCUR 2000) which specifies actions for coordination within this binational watershed project. The operating agencies hope to strengthen their understanding of how the Reserve is perceived by people living south of the border, to improve the design of future natural resource projects and environmental education initiatives, to explore other areas of importance to the watershed, and to increase applied research in the watershed.

Potential sources of funding to implement the Vision

Throughout the main Vision document, many sources of support for individual projects have been mentioned. Others include EPA's Office of Water which offers a construction grants program, California state revolving funds (seed money for environmental projects), Section 106 water pollution control program grants, water quality cooperative agreements, Clean Water Act Indian set-aside grants, small community outreach and education (SCORE) program, and the rural community assistance program (EPA 1998).

California Prop 50 applications are being submitted by the San Diego County Water authority to the State of California during 2005. The Campo Indian Reservation, San Diego State University, and Southwest Wetlands Interpretive Association (SWIA) teamed up to request funds to remove invasive plant species from riparian areas in the watershed and revegetate with native plants.

SANDAG has requested a planning grant from Caltrans for the "San Diego Region-Baja California border interregional partnership" formed by signatories of the agencies in 1998, to plan the new Otay Mesa II Port of Entry connecting State Route 11 and the Tijuana-Rosarito 2000 (SANDAG 2005).

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.[13]

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

6. Appendix: Simple things residents can do in their homes, schools, and businesses to improve the environmental and social conditions of the TRW

- The City of San Diego Environmental Services Department collects recyclables in blue bins from the street curb. Permitted mixed materials in the blue bins include magazines, newspapers, catalogs, phonebooks, dry food boxes, packaging, paper bags, cardboard, white paper, colored paper, letters, junk mail, steel, tin, aluminum, foil, pie plates, glass, plastic bottles (1 and 2), all California redemption value (CRV) containers, and empty aerosol cans.

- The City of San Diego Environmental Services Department also can recommend companies to recycle construction, demolition, and yard wastes. They offer condominium and apartment recycling programs, and commercial recycling programs. Household hazardous wastes are accepted at the hazardous waste transfer facility which is open Saturdays at the Miramar Landfill entrance on Convoy St. just north of 53-Frwy. For all questions regarding recycling in San Diego call 858-694-7000.