

Tijuana River Valley
Existing Conditions Report



Prepared by the Tijuana River National Estuarine Research Reserve
for the CURRV project's Stakeholder Working Group
Updated April 14, 2014

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Table of Contents

Acronyms

AMSD	Area Specific Management Directives
CAP	Climate Action Plan
cfs	cubic feet per second
CMP	Comprehensive Management Plan
CSP	California State Parks
CURRV	Climate Understanding & Resilience in the River Valley
CZMA	Coastal Zone Management Act
GHG	Greenhouse Gases
IBWC	International Boundary & Water Commission
ITRFCP	International Tijuana River Flood Control Project
lps	liters per second
mgd	million gallons per day
MHPA	Multi-Habitat Planning Area
MSCP	Multiple Species Conservation Program
NERR	National Estuarine Research Reserve
NERRS	National Estuarine Research Reserve System
NGO	Non-Governmental Organization
NOAA	National Oceanic & Atmospheric Association
NOLF	Naval Outlying Landing Field
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
SBIWTP	South Bay International Wastewater Treatment Plant
SLR	Sea Level Rise
TRNERR	Tijuana River National Estuarine Research Reserve
TRV	Tijuana River Valley
TRVRP	Tijuana River Valley Regional Park
TRVRT	Tijuana River Valley Recovery Team
TRW	Tijuana River Watershed
USFWS	U.S. Fish & Wildlife Service
USN	U.S. Navy
WTP	Wastewater Treatment Plant

Figures

Introduction

Through the Climate Understanding & Resilience in the River Valley (CURRV) project, the Tijuana River National Estuarine Research Reserve (TRNERR) is leading a collaborative process to assess the vulnerability of the Tijuana River Valley to climate change, specifically sea level rise (SLR) and riverine flooding. The CURRV project will result in the development of adaptation strategies to help local communities adapt to climate change, and increase resiliency by providing jointly-developed recommendations to coastal decision-makers on how to consider climate change in managing our natural resources and built infrastructure. (Figure 1)

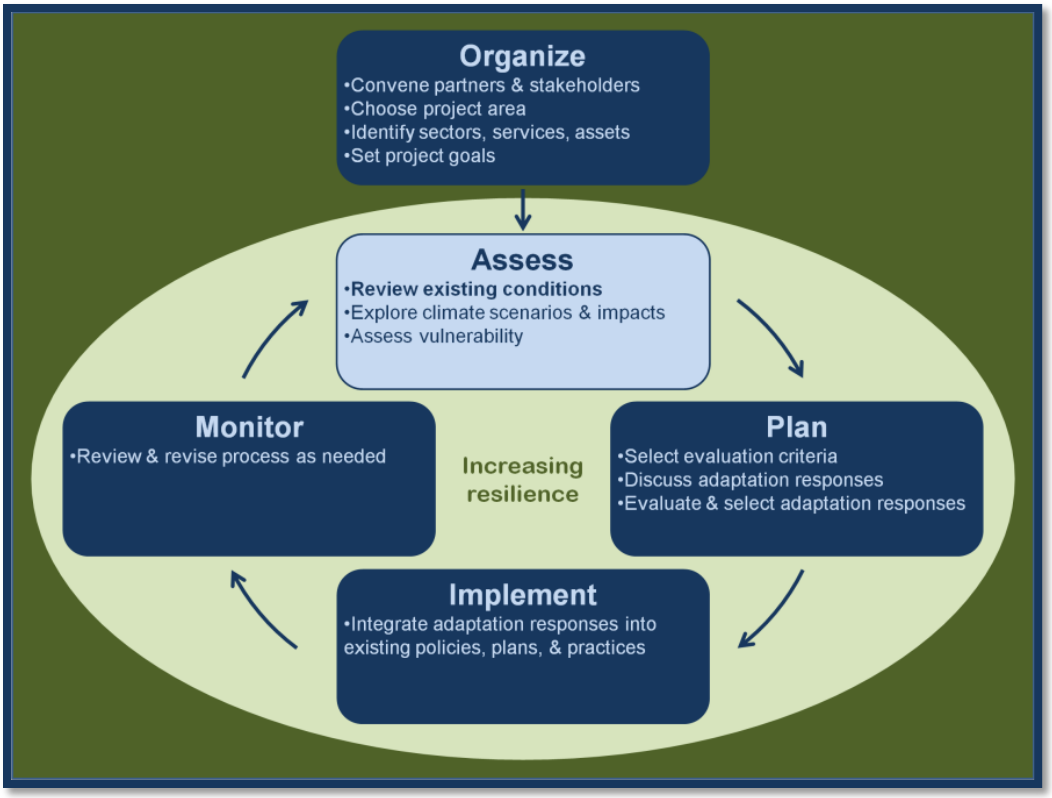


Figure 1: CURRV Planning Process
Reviewing existing conditions is part of the second phase, "assess". [30, 29]

Role of Existing Conditions Report

This report compiles information about the Tijuana River Valley to ensure that all stakeholders involved in the planning process have a baseline understanding of what resources are present within the valley, how the area is managed, and what threatens the long-term sustainability of the natural habitats and built infrastructure. Information in this document has been compiled with input from the CURRV Stakeholder Working Group, providing the foundation for the vulnerability assessment and the development of climate adaptation strategies. Keep in mind that the report serves only as an overview of the existing conditions in the river valley, and may not present a comprehensive review of all that will need to be considered throughout the planning process.

Resources and Geography

Figure 2: *The Tijuana River Valley's location in the larger Tijuana River Watershed, in relation to the Cities of San Diego and Tijuana. [1]*

The Tijuana River Watershed (TRW) straddles the U.S.-Mexico border, with nearly three quarters of the 1750-square-mile drainage area located in Mexico [1]. This unique binational area encompasses many diverse ecosystems, ranging from 6000-foot pine forest-covered mountains to the tidal saltwater estuary at the mouth of the river in the United States [1]. A wide variety of land uses are present in the watershed, with largely undeveloped open space in the upper watershed to highly-urbanized, residential, commercial, military, industrial, and agricultural areas in the lower watershed [1]. The Tijuana River originates at the confluence of Arroyo del Alamar and Río de las Palmas in Mexico, draining to the Pacific Ocean through an approximately 8-square-mile area called the Tijuana River Valley (TRV) that is located in the U.S. adjacent to the border [2, 1] (Figure 2). Despite intense pressure from development associated with being situated on an international border between two major metropolitan areas- San Diego (California, United States) and Tijuana (Baja California, Mexico), the TRV contains the largest intact coastal wetland system in Southern California providing habitat to threatened and endangered species, and contains a number of federally listed historical and archaeological sites.

Climate

The Tijuana River Valley has a Mediterranean climate with cool, wet winters and warm, dry summers [3]. More than 90% of the mean annual precipitation occurs during a six-month period between November and April [3], with an average annual rainfall of nine to ten inches [2]. "It is a climate of extremes, with years or decades of persistent drought sometimes followed by years with torrential floods [3]." Research has shown that the amounts and times of rainfall and stream flow are more important for estuarine dynamics than total precipitation [2].

Topography & Floodplain

The Tijuana River Valley consists of a broad floodplain containing contiguous beach, dune, salt marsh, riparian, and upland ecosystems. The floodplain is bound on three sides by urban development and on the fourth by the Pacific Ocean, with high natural mesas to the south [4]. The floodplain is a mixture of natural habitats intermixed with agricultural fields, equestrian facilities, rural housing, areas disturbed by dumping, off-road activities, grading and recontouring (berming), and the effects of flooding [4].

Hydrology

Annual streamflows of the Tijuana River can vary dramatically, but despite the low rainfall flows that occur frequently during the summer, the Tijuana River mouth typically remains open throughout the year [1] [2]. The main and secondary (e.g., Oneonta Slough) river channels are subject to diurnal tidal regimes [2]. Heavy ocean storm surges may redistribute sand along the littoral transport cell at the beachfront [2]. This littoral transport has the potential to constrict tidal flushing so that a temporal phase delay may be observed between spring and neap tides at the ocean versus within the estuary. This phased condition also may create a "perched" tidal system wherein not all water that flow into the estuary in a given tide series drains out completely during the same series.

[1] In 1984, the mouth closed and had to be dredged open, causing considerable ecological changes, with some organisms slow to recover [2].

A large majority of the surface water flow in the watershed is controlled by several large dams (i.e., Barrett and Morena in the U.S., and Rodríguez and El Carrizo in Mexico) [1]. These dams provide reservoirs of potable water to support residents and associated infrastructure on both sides of the border [1]. They also serve as traps for the downstream movement of sediment and trash to the lower watershed, meaning that the sediment and trash produced in the 462-square-mile area downstream of the dams are what are responsible for impacts to the valley [1]. (Figure 3)

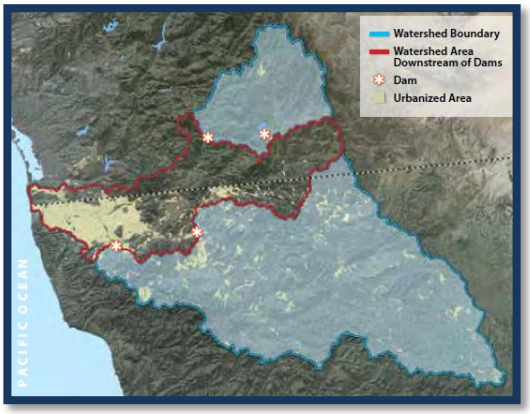


Figure 3: "Storm flows from nearly 75% of the watershed are controlled by four major dams. A significant portion of the area downstream of the dams is urbanized, including Tijuana [1]."

Natural Habitats[2]

Sand Dunes & Beach

"Sand deposits are continually shifted during floods and sea storms, thus creating relatively unstable habitat. In recent years, the dune system has become very unstable, allowing sand to be blown into the tidal channels [2]."

Open Tidal Channels & Mudflats

"Sand, silty clay, and mixed substrates create a variety of subtidal habitats and intertidal mudflats. Loss of this habitat due to elevation increases caused by fill and sedimentation represent a major management concern [2]."

Vegetated Salt Marsh

"Salt marshes have been estimated to comprise approximately 410 acres of… [TRNERR], including low marsh, middle marsh, and high marsh. These classes correspond to the shifts in species composition, community structure, soil salinity and texture, and tidal conditions that occur along the one-meter elevation gradient [2]."

Fresh-brackish Marsh

"Freshwater brackish marshes occur throughout… [TRNERR] and are dominated by bulrushes and cattails [2]."

Riparian Habitats

"These encompass the entire span of habitats upstream from mean high tide, including freshwater marshes and upland areas [2]."

Coastal Sage Scrub

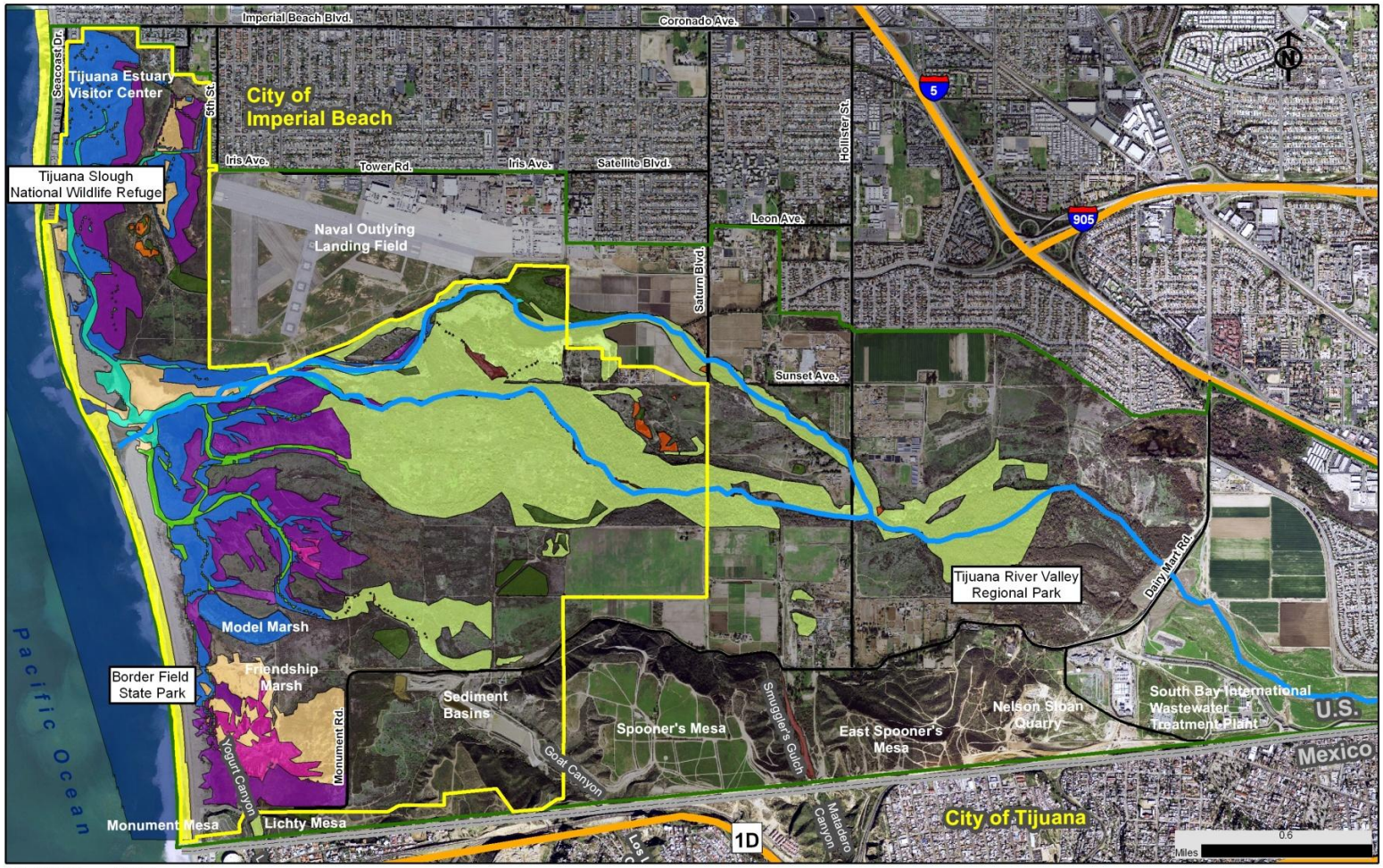
"The bluffs adjacent to the international border along the southern boundary of the… [valley] are classified as coastal sage scrub, [including Maritime Succulent Scrub, Salt Panne, Ruderal meadow, and Chapparal]. This community is considered sensitive habitat throughout San Diego County and Southern California [2]."

Vernal Pools

"A few small vernal pools can be found in… [TRNERR]. These shallow pools, which hold a few inches of water during the wet months, host the San Diego fairy shrimp, a federally endangered species [2]." (Figure 4

[2] Keep in mind that multi-agency land use designations vary. For example, in the City of San Diego's Multiple Species Conservation Program habitat communities in the valley are defined as (1) coastal sage scrub, (2) grassland, (3) riparian/ wetlands, (4) disturbed habitat, (5) developed, and (6) agriculture. [4]

Figure 4: Habitat Map



SLAMM Land Categories

The Sea Level Affecting Marshes Model (SLAMM) uses 2002 as the base year/ initial condition, based on the source image date provided by U.S. Fish and Wildlife Service's National Wetland Inventory (NWI) maps. (Note that SLAMM does not include IBWC land)

- Brackish Marsh
- Dry Land
- Estuarine Beach
- Estuarine Open Water
- Inland Fresh Marsh
- Inland Open Water
- Inland Shore
- Ocean Beach
- Open Ocean
- Riverine Tidal Open Water
- Salt Marsh
- Scrub Shrub
- Swamp
- Tidal Creek
- Tidal Flat
- Project Area
- Tijuana River NERR
- Tijuana River

trnerr.org

Data Source: Richard Gersberg - SDSU, TRNERR, SANDAG and SanGIS.

Habitat map for the valley used for the Sea Level Affecting Marshes Model (SLAMM) run for San Diego County by Dr. Richard Gersberg at San Diego State University. Please note that this map should only be used to give readers an idea of the types of habitats in the TRV and their approximate location, and that this map is only one example of how habitats in the valley are classified. [5]

Endangered and Threatened Species[3]

Bird populations have been an important motivation for the special protective status attributed to the Tijuana Estuary, with over 370 bird species being reported in the area, including several endangered and threatened species [2]. (Tables 1 & 2)

Table 1: Endangered and Threatened Vegetation

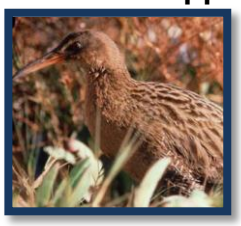
Species	Habitat	State Status	Federal Status
Salt marsh bird's beak  *(Cordylanthus maritimus)* Photo Credit: **[6]**	Typically occurs in upper salt marsh in partially shaded areas that have reduced salinity in spring and do not impound water for more than 24 hours [3]. At the Tijuana River Estuary, salt marsh bird's beak occurs near areas with slightly disturbed soil surfaces, such as along the edges of paths and roads, sparsely vegetated openings, and depressions [2].	Endangered [7]	Endangered [8]

Table 2: Endangered and Threatened Wildlife

Species	Habitat	State Status	Federal Status
Belding's savannah sparrow  *(Passerculus sandwichensis beldingi)* Photo credit: **[9]**	A year-round resident of southern California, the Belding's savannah sparrow nests and forages almost exclusively in the coastal salt marsh environment dominated by pickleweed (*Salicornia virginica*) [3]. Nests are usually built close to the ground surface at the higher levels of the marsh, above the reach of the highest spring tides, concealed by overhanging vegetation [3, 10].	Endangered [7]	None
California least tern  *(Sternula antillarum browni)*	Resides in the Californias only during the breeding season, which begins in mid-April and ends in mid-September [3]. Habitat includes seacoasts, beaches, bays, estuaries, lagoons, lakes, and rivers [10]. Nests usually on open, flat beaches along estuary margins [3, 10]. The least tern is a colonial bird and nests on the ground by creating a small depression [3]. Usually nests in same area in successive years; tends to return to natal site to nest [10].	Endangered [7]	Endangered [8]

[3] In addition to endangered and threatened species there are a number of species that are of concern because they are either sensitive or declining (e.g., elegant tern [27], orange-throated whiptail [28], Coronado skink [28], silvery legless lizard [28], Dehesa kangaroo rat, Short-tailed weasel), or are critical to the survival of a specific habitat (e.g., Cordgrass in salt marshes).

…cont. Table 2: Endangered and Threatened Wildlife

Species	Habitat	State Status	Federal Status
Coastal California gnatcatcher  *(Polioptila californica californica)* Photo Credit: **[11]**	Lives only in coastal southern California's sage scrub, preferring patches dominated by California sagebrush and flat-top buckwheat on coastal slopes, washes, and mesas [12, 10]. Avoids crossing even small areas of unsuitable habitat, including those dominated by sage, laurel sumac, and lemonadeberry [12, 10].	None	Threatened [8]
Least bell's vireo  *(Vireo belli pusillus)* *Photo Credit:* **[13]**	Nests in dense willow scrub in critical habitat in the river valley, associated with freshwater influence of the Tijuana River [3]. Nests usually average about 1m above ground in horizontal or downsloping twig fork, typically found near edge of thicket [10]. Tends to return to same nesting territory in successive years [10].	Endangered [7]	Endangered [8]
Light-footed clapper rail  *(Rallus longirostris levipes)*	Nests in Cordgrass *(Spartina foliosa)* - dominated low marsh habitat under clumps of pickleweed, on ground, or in cordgrass slightly above ground level [10]. Forages at the edge of the salt marsh, mudflats, and tides [3].	Endangered [7]	Endangered [8]
Southwestern willow flycatcher  *(Empidonax traillii extimus)* *Photo Credit:* **[14]**	Riparian woodland, specifically riparian and wetland thickets, generally of willow, tamarisk, or both [12, 10]. Nests are typically placed in trees in areas where plant growth is most dense, where trees and shrubs have vegetation near ground level, and where there is a low-density canopy [10].	Endangered [7]	Endangered [8]
Western snowy plover  *(Charadrius alexandrinus nivosus)*	A year round resident with different individuals present during different times of the year. The breeding season is typically between mid-March and may extend through September, with documented nesting attempts beginning as early as mid-February [3]. The nests are built in sandy dunes or mud flats by scraping a small depression in the ground and lining it with dry grass, twigs, and debris [3].	Species of special concern [3]	Threatened [8]

Cultural & Historical Resources

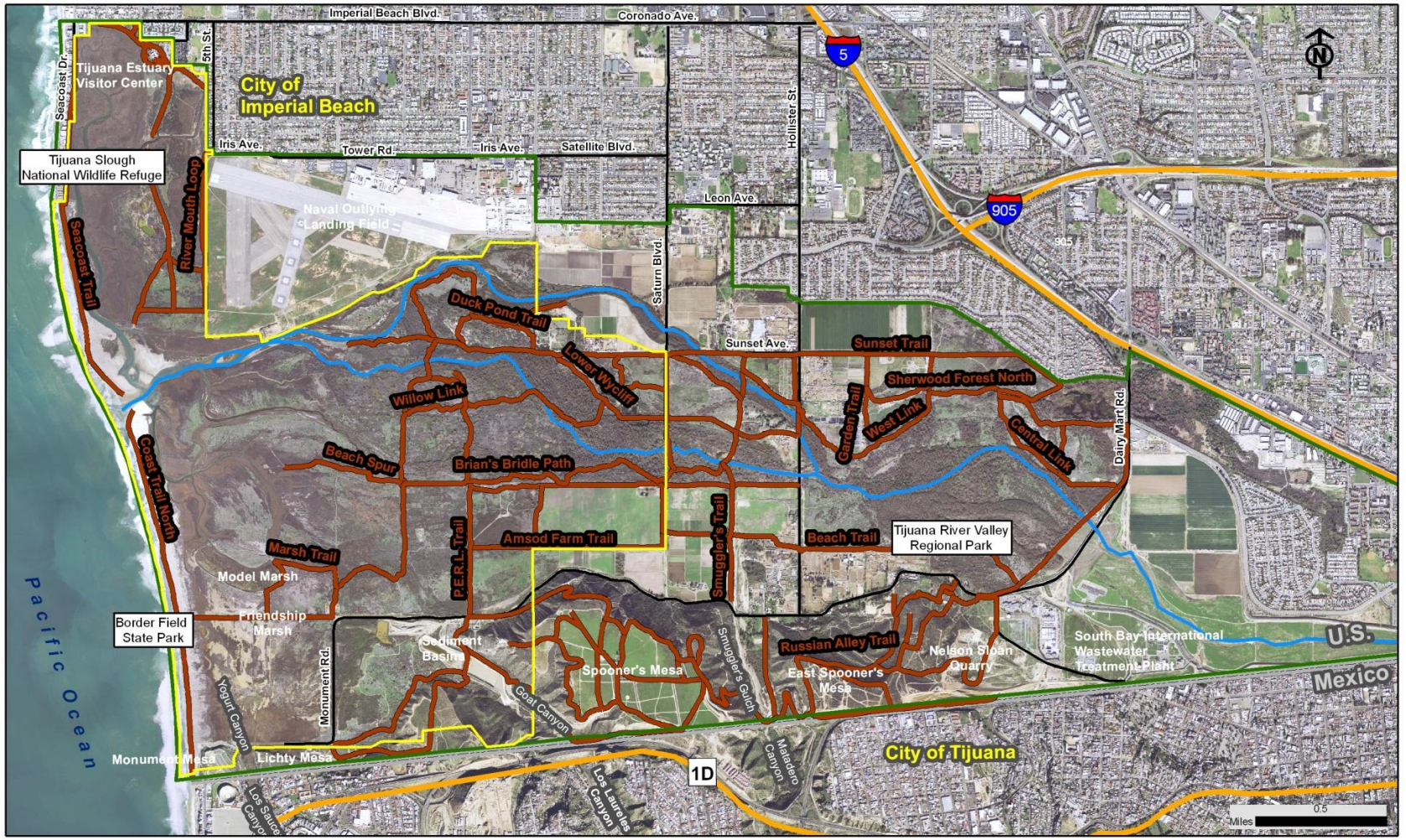
Archeological research has been conducted in the Tijuana Estuary for over seventy years, with surveys beginning in the 1920s [3]. Scientists have documented 61 prehistoric sites in the area, and 18 isolated prehistoric artifacts, with sites dating in the Paleoindian, Early Archaic, and Late Prehistoric periods. A variety of archeological types are present in the area ranging from shell scatters to habitation sites [3]. The recurring theme among the sites is shellfish and lithics, with habitation sites being uncommon but including the enthographically documented Kumeyaay village of Millejo (occupied from the Early Archaic period through at least 1850) [3]. Frequent flooding in the area has affected many of the resources, indicating the potential for buried sites in this region being high. [3]

In addition, the TRV contains several recorded paleontological resources associated with two fossil-containing formations: the San Diego formation and unnamed Pleistocene terrace deposits [2]. These sites are significant because they contain highly preserved fossils, especially fossils from the San Diego Formation, which are preserved as original shell material, with some forms even retaining color [2]. The San Diego Formation also has a high potential for yielding important remains of fossil marine vertebrates, especially marine mammals [2]. Since marine mammal fossils are rare, any sites containing such remains should be considered potentially significant and thus protected [2].

Parks, Recreation, & Public Access

Public access to the shoreline and the surrounding natural habitats is central to both the Coastal Act and the “common use” intentions of the public trust doctrine [15], within the context of broader environmental and wildlife conservation. The Tijuana River Valley has an extensive network of hiking trails that are popular among avid bird watchers; a public beach north and south of the Tijuana River Mouth; and equestrian trails, remaining one of the last places where horseback riding is allowed on a beach in Southern California (Refer to Figure 4: USFWS Trails Map). The protected areas preserved for public access include TRNERR, which includes Tijuana Slough National Wildlife Refuge (USFWS), Border Field State Park (CSP), the Tijuana River Valley Regional Park (County of SD), and Friendship Park (U.S. Border Patrol). In addition, there are numerous recreational facilities throughout the valley important to local communities, including a community garden, a bird and butterfly garden, the Tijuana River Valley Sports Complex, and the Chula Vista Model Radio Control Club.

Figure 5: Trails Map (draft)



Agricultural & Equestrian Resources

Agriculture is one of the primary economic activities that take place in the river valley, containing numerous equestrian and ranch facilities, including the U.S. Border Patrol's horse patrol facility. In addition, organic farming occurs in the valley at Suzie's Farm and Sun Grown Organic Distributors leased by the County of San Diego on Hollister Street, and the International Boundary and Water Commission (IBWC) leases land to the AM Sod Farm on Dairy Mart Road.

Horseback riding along the shoreline near the Tijuana River Mouth, one of the last places horses can be enjoyed on the beaches of Southern California.

Security & Defense

In the TRV, the US Navy owns and maintains the Naval Outlying Landing Field (NOLF), one of the largest helicopter training facilities on the West coast of the United States. In addition the U.S. Border Patrol is active throughout the valley with important security facilities including, the border fence (e.g., secondary fence, tertiary fence), border lighting, camera towers, and border fence gates.

Critical Facilities & Utilities

The San Diego Multi-Jurisdictional Hazard Mitigation Plan defines a critical facility as, "a facility in either the public or private sector that provides essential products and services to the general public, is otherwise necessary to preserve the welfare and quality of life in the County, or fulfills important public safety, emergency response, and/or disaster recovery functions [15, 16]." The primary categories of critical infrastructure in the TRV include stormwater management, wastewater management, and transportation. Below is a list of some of the critical facilities located in the TRV (note: this list is not comprehensive): (Figure 6)

Stormwater Management

There are several miles of storm drain pipes and channels, and numerous storm drain inlets, cleanouts, catch basins, and headwalls throughout the TRV. Below are a few examples of important stormwater management structures:

- Goat Canyon sediment basin (CA State Parks)
- North and South Levees, Tijuana River Flood Control Project (IBWC)
- Goat Canyon Border Culvert, Smuggler's Gulch Border Culvert, W-8 Culvert, and Stewart's Culvert (U.S. Border Patrol)
- Pilot Channel (City of San Diego)

Wastewater Management

There are several pump stations, miles of sewer mains, diversion facilities and pipelines, and land and ocean outfalls located throughout the TRV, including the:

- South Bay International Wastewater Treatment Plant (IBWC)
- South Bay Water Reclamation Plant (City of San Diego)
- South Bay Land and Ocean Outfalls (IBWC, City of San Diego)

Transportation

The primary roads that are important to maintain for emergency vehicles, community evacuations, border security, and public access are listed below:

- Dairy Mart Road
- Hollister Street
- Monument Road

- Seacoast Drive
- Roads on North and South Levees, Tijuana River Flood Control Project (IBWC)
- Access to Imperial Beach Border Patrol Station from Saturn Blvd (U.S. Border Patrol)
- Border Road running from the Ocean to the Levy (U.S. Border Patrol)
- Smuggler's Gulch access road
- Dirt roads throughout TRNERR

Social Landscape

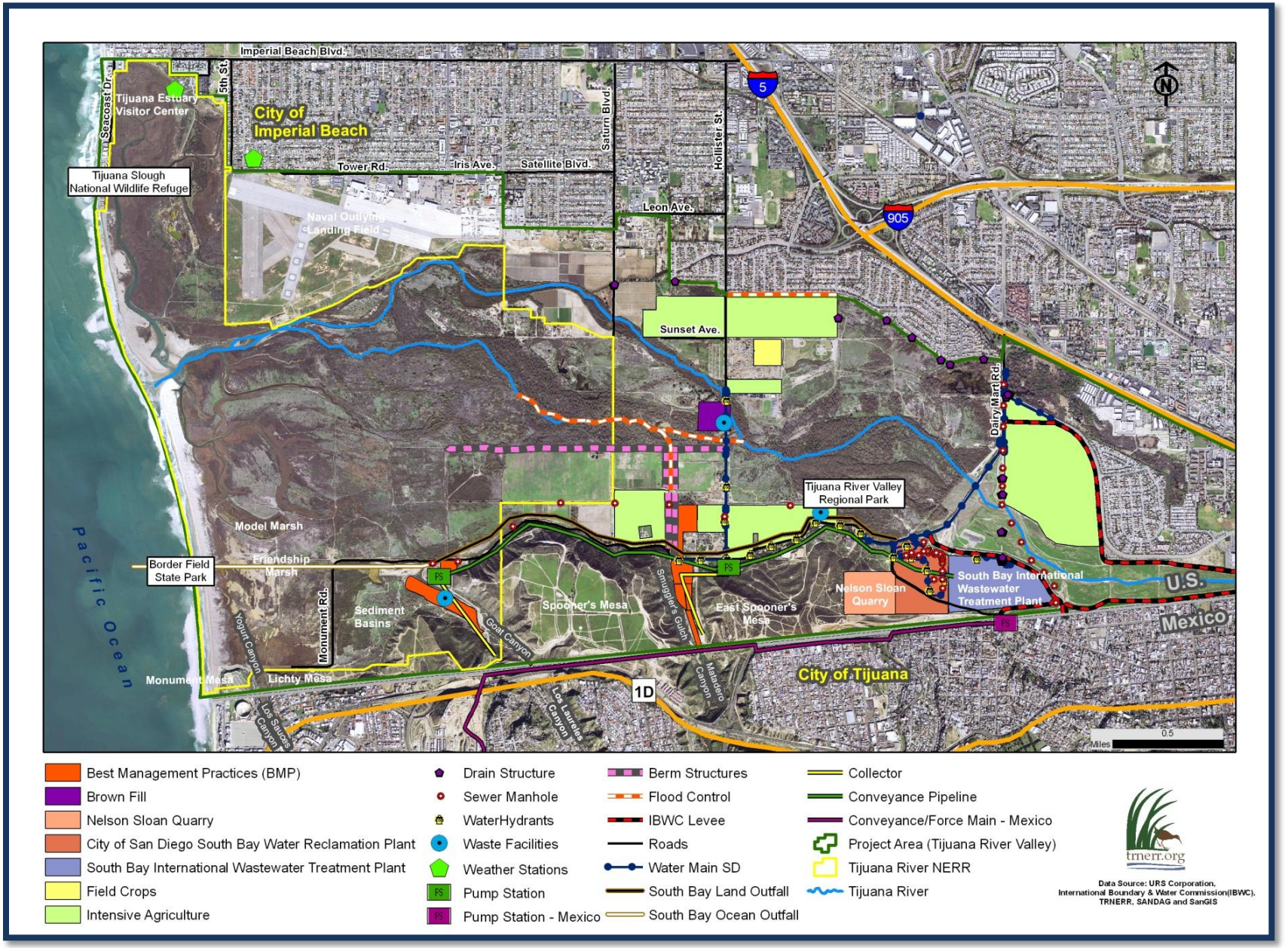
According to SANDAG's community profile, based on data from the 2000 Census, the Tijuana River Valley Community Planning Area[4] has a population of 75 people in 23 households [17]. As mentioned above a majority of private residences in the river valley are agricultural, including farming and equestrian ranches. Many of these private residences and businesses are currently vulnerable to flooding during the wet season.

"Social vulnerability to climate change is the degree to which a community is susceptible to, and unable to cope with, the adverse effects of climate change [18]." In a recent study[5] conducted by the National Oceanic and Atmospheric Administration's (NOAA) Climate Program Office, the Tijuana River NERR was found to have a high social vulnerability to climate change due to the fact that within the surrounding communities, there was a high percentage of the population receiving public assistance; low per capita income; high unemployment; high percentage of the population less than high school educated; high percentage of households run by a single parent; high number of persons per occupied household; and high percentage of rental units [18]. However, the results from NOAA's study do not solely reflect the sensitivity of communities directly located in the river valley, as communities in Mexico were considered in this analysis, with results showing a higher level of social sensitivity in Mexico versus the communities bordering TRNERR on the U.S. side.

[4] Tijuana River Valley Community Planning Area for the City of San Diego is not fully representative of the CURRV project planning area due to differences in project boundaries. The boundaries for the CURRV project encompass a larger area than the City's planning area. Click here for the City's full community profile.

[5] To conduct this social sensitivity study, each reserve was asked to define the appropriate geographic unit(s) that provides the most socially relevant context for the reserve, identifying geographic areas that best capture the social factors and communities most relevant to the reserve's programming and mission [18]. "…The Tijuana River Reserve defined a study unit that included only modest land area in the United States with the remainder in Mexico. As delineated by reserve staff, 90% of the study unit land area is in Mexico. The portion in Mexico has almost all of its population concentrated in two cities, Tijuana and Tecate, and the remaining land area is very sparsely settled… A modified approach was developed to analyze social sensitivity for the Tijuana River Reserve Mexican portion of the study unit due to differences in available data for Mexico. Because of the disparity in data, the social sensitivity of the Mexican portion of the Tijuana River NERR was evaluated as a unique case in this research [18]."

Figure 6: Infrastructure Map



Please note that this is not a comprehensive list of all infrastructure in the river valley, and only provides approximate locations of each asset.

Management

The Tijuana River Valley is owned and managed by eight primary public agencies, in addition to collaborative management of the Tijuana River National Estuarine Research Reserve (TRNERR). Together the City of San Diego and the City of Imperial Beach have overall jurisdictional authority over most of the lower valley. (Figure 7)

Tijuana River National Estuarine Research Reserve

The Coastal Zone Management Act (CZMA) of 1972, created a nationwide network known as the National Estuarine Research Reserve System (NERRS), which includes the Tijuana River NERR [2]. NERRS are estuarine and coastal habitats protected and managed through a federal-state cooperative effort for long-term research, education, and interpretation [2]. At TRNERR, the California State Park system (CSP) is NOAA's partner in this federal-state cooperative effort, encompassing approximately 2,293 acres of tidally flushed wetland, riparian, and upland habitats lying immediately north of the U.S. - Mexico border [2]. "These lands are owned and managed cooperatively by California State Parks, U.S. Fish and Wildlife Service (USFWS), the City of San Diego, the County of San Diego, and the U.S. Navy (USN). TRNERR is linked to two federal land preservation networks: the NERRS, administered by the National Oceanic and Atmospheric Administration (NOAA), and the National Wildlife Refuge System (NWRS), administered by the USFWS [2]"

City of Tijuana adjacent to Border Field State Park along the U.S. - Mexico Border.

California State Parks

CSP owns approximately a 750-acre parcel--Border Field State Park--at the southern end of TRNERR [2].

U.S. Fish & Wildlife Service

The Tijuana Slough National Wildlife Refuge (NWR), which comprises the northern portion of TRNERR, is made up of USFWS fee title lands, USN lands which are administered as an "overlay" National Wildlife Refuge by USFWS, and tidelands leased from the California State Lands Commission [2]. USFWS owns an approximately 500-acre parcel, and the USN controls approximately 600 acres [2].

U.S. Navy

USN's Naval Base Coronado Naval Outlying Landing Field (NOLF) is in the Tijuana River Valley. Approximately 600 acres of the Base are managed by the USFWS for NWR purposes, as part of the Tijuana Slough National Wildlife Refuge and TRNERR [2]. "USFWS assumes lead responsibility for the protection of resources, while the USN assists in the preservation and management of resources and retains ownership rights [2]."

County of San Diego

The County manages approximately 1,897 acres in the Tijuana River Valley, including the Tijuana River Valley Regional Park (TRVRP) [19]. The TRVRP is located in the City of San Diego's southwestern portion west of Interstate 5, featuring a mixture of recreational opportunities, sustainable agriculture, and native habitats [4]. "The TRVRP is bounded on the east by [Dairy Mart ponds,] Dairy Mart Road, and the residential community of San Ysidro,… on the west by Border Field State Park and the Tijuana Estuary, on the south by the U.S.-Mexico International Border, and on the north by Sunset Avenue… and the residential community of Otay-Nestor [19]. The TRVRP is bisected by the east/west flowing Tijuana River, which flows from Mexico through the Park to drain to the Pacific Ocean at the Tijuana Estuary [19].

City of San Diego

The City manages just over 200 acres in the Tijuana River Valley portion of San Diego, containing the TRVRP (described above). The valley is bounded by two City communities: the Otay Mesa-Nestor community to the north and the San Ysidro community to the east.

City of Imperial Beach

Imperial Beach borders the northern portion of the valley. An area of primary focus for this project is a section of Seacoast Drive spanning from Imperial Beach Boulevard south till it dead-ends along the Reserve boundary, approximately .7 miles long. This section of land contains private residences that are sandwiched between the Pacific Ocean and Oneonta Slough, part of the Tijuana Slough NWR.

Oneonta Slough, a section of the Tijuana Slough National Wildlife Refuge, neighboring Seacoast Drive in the City of Imperial Beach.

International Boundary & Water Commission

The International Boundary & Water Commission (IBWC) manages approximately 400 acres of land in the eastern portion of the TRV, including the San Diego Field Office of the IBWC, the South Bay International Wastewater Treatment Plant (SBIWTP)[6], and the International Tijuana River Flood Control Project (ITRFCP)[7]. The IBWC also leases land to the AM Sod Farm on Dairy Mart Road.

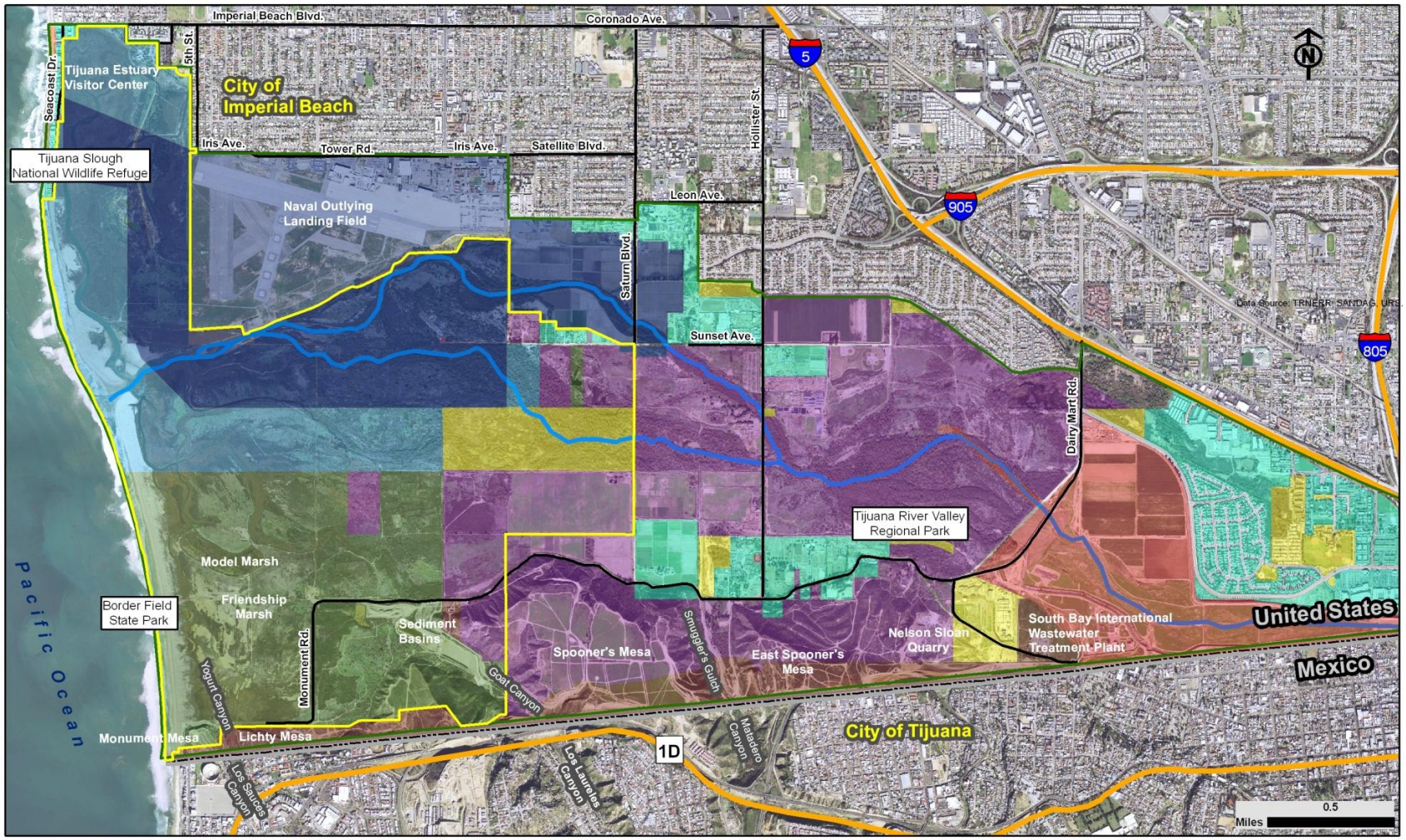
U.S. Border Patrol

The Border Patrol manages approximately 250 acres along the U.S.-Mexico Border, containing the border fence, including the secondary and tertiary fences, border lighting, camera towers, and border fence gates. In addition, the Imperial Beach Station and horse patrol facilities are located in the TRV.

[6] "The SBIWTP is located on a 75-acre site near the international border and provides for advanced primary treatment of 25 mgd of Tijuana sewage [26]."

[7] "The Tijuana Flood Control Channel… is used to contain and convey Tijuana River flood flows up to 135,000 cubic feet per second (cfs) in both the U.S. and Mexico. In the United States, the channel consists of a partial trapezoidal concrete lined channel, which expands to grouted stone, and then natural soil flood way [26]."

Figure 7: Landownership Map



Key Planning Documents

Listed below are important local and regional planning documents that are central to the management of the Tijuana River Valley. For those documents that address climate change and/or sea level rise directly a brief description of how the topic is addressed is included. As adaptation strategies are developed it is important to keep these documents in mind as they determine how the resources of the TRV are managed and/or address relevant hazards, including coastal storms, erosion, and flooding, among others. Understanding these documents will ensure that climate adaptation planning is successfully integrated into existing management strategies. (To access each individual document online, click on the underlined title of the document)

A Binational Vision for the Tijuana River Watershed

Binational Watershed Advisory Council for the Tijuana River Watershed, 2005

This document is a result of the Binational Watershed Advisory Council (BWAC), a binational team of researchers and practitioners, collaboratively outlining future desired conditions of the TRW, and devising strategies and options for achieving that vision [20]. Baseline data and trends for each of the major areas of concern identified by stakeholders were documented as part of the Vision, including water, air, ecosystems and natural resources, waste, and socioeconomic issues [20].

Climate change reference:

- Global warming and climate change are briefly mentioned in this document as a challenge that may exacerbate air quality problems (p. 124) [20].

Border 2020: U.S. - Mexico Environmental Program

Environmental Protection Agency, SEMARNAT, 2011

The Border 2020 program is a binational effort that aims, "to protect the environment and public health in the U.S. - Mexico Border region, consistent with the principles of sustainable development [21]." The five strategic goals of this program include: (1) Reduce air pollution; (2) Improve access to clean and safe water; (3) Promote materials management and waste management, and clean sites; (4) Enhance joint preparedness for environmental response; and (5) Enhance compliance assurance and environmental stewardship [21]." In addition, six fundamental strategies are outlined, "…set[ting] the expectation for how program partners will approach and consider complex and critical environmental challenges faced by communities along the U.S. - Mexico Border [21]."

Climate change reference:

- One of the objectives, as part of the long-term strategic goal to *Reduce air pollution,* is to, "… support completion of climate action plans in each of the six northern Mexican Border States…and build the necessary capacity to guarantee sustained implementation (p. 19) [21]."
- Under the second strategic goal to *Improve access to clean and safe water* the Border 2020 program partners will work together to address the, "…impacts of climate change that affect precipitation patterns and duration of droughts, making water availability even more challenging in the arid border region, and making wastewater infrastructure more vulnerable to damage from floods (p.20) [21]." In order to achieve this goal one objective is to, "… help drinking water and wastewater service providers in the border region to implement sustainable infrastructure practices to reduce operating costs, improve energy efficiency, use water efficiently and adapt to climate change (p. 21) [21]."
- One of the six fundamental strategies set forth to help achieve the five strategic goals is *Building capacity towards climate change resiliency*, in which, "…efforts will focus on reducing greenhouse gas (GHG) emissions and on actions to help border communities become more resilient to the effects of climate change", including increasing cross-border sharing on energy efficiency technologies (p. 3-4) [21]."

Imperial Beach General Plan & Local Coastal Plan

City of Imperial Beach, 2010

The General Plan/Local Coastal Plan is the City's constitution for physical development, regulating land use throughout the City [22]. The Plan addresses nine elements: (1) Circulation; (2) Conservation; (3) Housing; (4) Land Use; (5) Noise; (6) Open Space; (7) Safety; (8) Design, Facilities and Services; and (9) Parks, Recreation, and Access [22].

Multiple Species Conservation Program (MSCP) Subarea Plan

City of San Diego, 1997

The Tijuana River Valley's Multi-Habitat Planning Area (MHPA) delineates core biological resource areas and corridors targeted for conservation[8], incorporating the 25-year floodplain within the City's jurisdiction and much of the 100-year floodplain in the valley [4]. The optimum future condition of the TRV is defined as follows in the MSCP: "… a broad natural floodplain containing riparian and wetland habitats, and bounded by high mesas and deep canyons with chaparral, sage scrub, and grasslands. The natural habitat would be intermixed with compatible agricultural, recreational, and water quality improvement activities, all functioning in concert to maintain and enhance natural ecosystems and processes, water quality, and the full range of native species, and to generally improve the local quality of life and the environment [4]."

Recovery Strategy

Tijuana River Valley Recovery Team, 2012

The vision of the Recovery Team (TRVRT), "…is a Tijuana River Valley free of historical trash and sediment, protected from future deposits of trash and sediment, restored to a sustained physical, chemical and biological integrity, and performing its hydrologic functions, while respecting the interests of current and future landowners and users [1]." The Strategy identifies a collaborative path forward, "…to cost-effectively address sediment and trash issues while respecting natural and cultural resources, the roles and responsibilities of agency managers, and the needs of landowners, residents, recreational users, and visitors [1]."

Climate change reference:

- One of the goals set forth by the Recovery Strategy is the "Creation of a sustainable, interconnected complex of natural habitats that supports native species, provides valuable ecosystem services, and offers opportunities for education and research [1]." In the discussion of this goal the Recovery Strategy recognizes that currently habitats are threatened by numerous anthropogenic sources of pollution and degradation, including the influx of sediment and trash, altered hydrology, continued pollution during wet weather, and invasive species [1]. Additionally, the document states that such threats must be addressed in order to make habitats less vulnerable to the future adverse impacts associated with sea level rise caused by climate change [1]. The ecological vision for the valley is "…a largely natural, interconnected complex of habitats that support native plants and animals, as well as passive recreation opportunities for people [1]." Recognizing the interconnectedness of climate change to resiliency, "the vision was designed to maximize natural processes and respect existing stakeholders and landowners, while allowing for the need to adapt to changing environmental conditions, such as those caused by climate change [1]." The key benefits of restoring valley ecosystems will make the system more resilient to SLR and changing watershed inputs (p.14). (Figure 8)
- In order to achieve the Strategy's Vision, 8 Priority Action Areas were outlined helping to guide the implementation of the Strategy, with *Climate Change Analysis and Planning* listed as one step involved in completing the Priority Action Area- *Protect and Enhance Natural Resources* (p.21) [1]. In completing the C*limate Change Analysis* step, the potential impacts of sea level rise and changing watershed

[8] Covered species in the valley include the following plants: Orcutt's bird's-beak, San Diego barrel cactus, Shaw's agave, and Wart-stemmed ceanothus; and the following wildlife: California gnatcatcher, Cooper's hawk, Least Bell's vereo, and Northern harrier [4].

inputs will be analyzed to develop long-term planning needs [1]. The expected results[9] of this analysis include: "prediction of habitat migration; identification of potential impacts to infrastructure and property; development of climate change adaptation plans (p.28) [1]."

- Finally, climate change is mentioned again under the Priority Action Area- *Protect and Enhance Natural Resources*, within which one of the steps listed is *Integrated Floodplain Management Alternatives Analysis*. Within this step, an analysis will be conducted in order, "…to determine the technical viability of integrated flood control, vegetation maintenance, and invasive species management alternatives in the valley [1]." One of the expected outcomes of this analysis is to, "…reduce the presence of invasive plant species and plan for river and estuary resiliency to climate change (p. 28) [1]."

TRNERR Comprehensive Management Plan

CSP, NOAA, USFWS, 2010

Guides TRNERR in its mission of estuarine resource protection through the following vision: "The Reserve and its partner organizations will inspire among diverse audiences more effective estuarine and marine management, compatible use, and proper resource protection using innovative and coordinated research, education and conservation approaches, throughout the biogeographic region between Point Conception and San Quintín [2]." The vision statement is supported by the following four over-arching Management Plan Goals: (1) "To protect, restore and enhance the viability of key coastal habitats and species and preserve the region's cultural heritage while encouraging compatible public use, education and research"; (2) "To fully integrate the Reserve's research, stewardship and education programs and provide a model of excellence in all three areas."; (3) "To engage coastal decision-makers and the general public in the Reserve's stewardship mission by promoting awareness, a sense of pride in the resource and an enhanced capacity to improve Tijuana River coastal and watershed ecosystems in general"; and (4) "To assume a regional leadership role for science-based natural resource enhancement and urban ecosystem management [2]."

Climate change reference:

- This planning document recognizes the fact that in the future TRNERR's boundaries may need to be altered as new land parcels "…become important for adaptation to climate change and effective management of a migrating estuary (p.86) [2]."
- In addition, all future restoration plans will directly consider SLR in the design and implementation of the plan in maintaining a functional tidal system (p. 105) [2].
- The document also recognizes the need for GIS-related products that provide, "…projections of climate change impacts, including sea-level rise and changes in watershed inputs (p.122) [2]."

Tijuana River Valley: Local Coastal Program Land Use Plan

City of San Diego, 1999

This Plan shifted, "…the primary land use emphasis to preservation, enhancement, and restoration of the natural features of the area, while still allowing for limited recreational and agricultural use"; whereas previous local plans[10] which provided for "…a wider mix of uses, including commercial recreation, such as camping, hotels and retail establishments, and placed greater emphasis on housing and agriculture [23]." Overall, goals include: (1) "To provide flood protection commensurate with economic cost benefits for urbanized portions of south San Diego and Tijuana, Mexico, and to provide benefits to satisfy the International Treaty with Mexico"; (2) "To fulfill the international obligations between the United States and Mexico to complete the flood channel to the boundary and prevent backwater flooding from the United States into Mexico"; (3) "To protect, preserve and restore natural coastal resources"; (4) "To conserve and enhance agricultural productivity where appropriate, consistent with the priority for long-term restoration,

[9] The results from the CURRV project will help TRVRT implement the Recovery Strategy by contributing to completing the *Climate Change Analysis and Planning* step in working towards the priority action area, *Protect and Enhance Natural Resources*.

[10] Referring to the previous Tijuana River Valley Plan and Local Coastal Program Addendum which was adopted in March 1977, and the 1982 Border Highlands Local Coastal Program Land Use Plan [23].

enhancement and preservation of the natural ecosystem of the Tijuana River Valley"; (5) "To provide visual and passive relief from continuous urbanization for the residents in the vicinity of the Tijuana River Valley"; and (6) "To provide necessary public health and safety facilities and services, including Border Patrol operations, within the public lands portion of the planning area in keeping with the passive use of the natural environment [23]."

Tijuana River Valley Regional Park- Area Specific Management Directives

County of San Diego, 2007

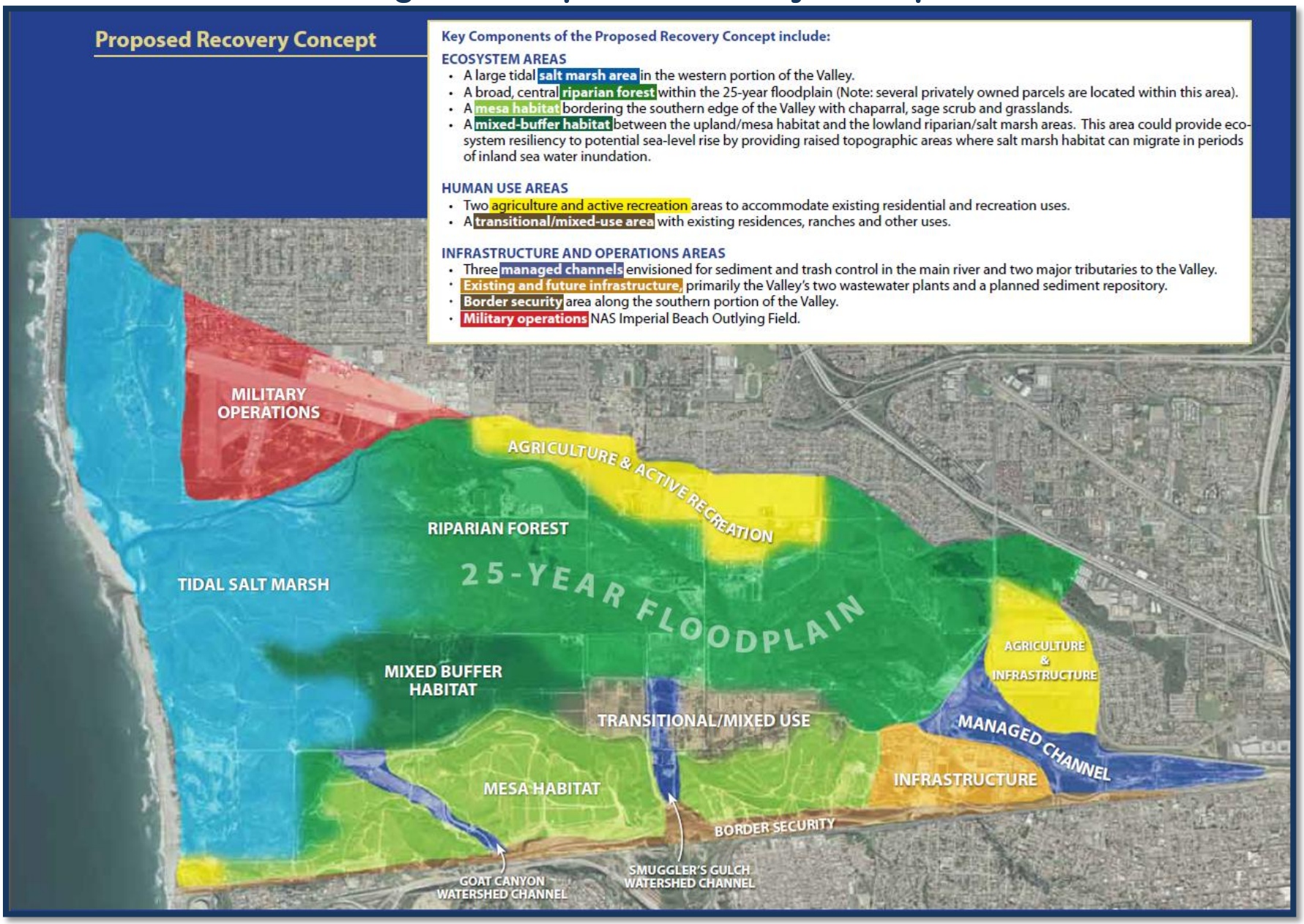
"…A guidance document to preserve and manage the biological and cultural resources within TRVRP while balancing the need to provide appropriate passive recreational opportunities", addressing four elements (1) biological, (2) cultural resources, (3) paleontological, and (4) public use/ facility maintenance [19]. For each of the elements specific goals and objectives are outlined [19].

Water Quality Control Plan for the San Diego Basin (9)

California Regional Water Quality Control Board San Diego Region, 1994

This Plan "…is designed to preserve and enhance water quality and protect the beneficial uses of all regional waters [24]." Specifically, the document: "(1) designates beneficial uses for surface and ground waters; (2) sets narrative and numerical objectives that must be attained or maintained to protect the designated beneficial uses and conform to the state's antidegradation policy; (3) describes implementation programs to protect the beneficial uses of all waters in the Region; and (4) describes surveillance and monitoring activities to evaluate the effectiveness of the Basin Plan [24]."

Figure 8: Proposed Recovery Concept



As part of the TRVRT Recovery Strategy, a proposed Recovery Concept was developed, integrating the basic principles for flood control, recreation, and protection of cultural and natural resources. [1]

Regional Climate Adaptation Planning

In addition, there are several examples of documents that directly address climate mitigation and adaptation on the state and local level. These documents are worth referencing to gain a better understanding of the methodology and goals of climate adaptation within a broader context.

California Climate Adaptation Strategy

California Natural Resources Agency, 2009

County of San Diego Climate Action Plan [11]

County of San Diego, 2012

City of San Diego Climate Action Plan

City of San Diego, Draft 2014

City of Chula Vista Climate Adaptation Strategies- Implementation Plans

City of Chula Vista, 2011

Sea Level Rise Adaptation Strategy for San Diego Bay

ICLEI- Local Governments for Sustainability, The San Diego Foundation, 2012

[11] Climate Action Plans (CAPs) are primarily in place to identify strategies to meet GHG reduction targets. Even though CAPs primary concern is climate mitigation, often adaptation measures are integrated into these documents.

Conservation Focal Areas

There are four primary areas of management concern in the river valley: (1) Extreme Events & Flood Control, (2) Sediment & Trash, (3) Water Quality, and (4) Invasive Species. These current management focal areas need to be understood in order to effectively increase the resiliency of the TRV to climate change because current stressors on the ecosystems and infrastructure will lessen the overall systems ability to absorb new or exacerbated stressors, such as sea level rise or changes in watershed inputs. In addition, many adaptation strategies will be mainstreamed into current best management practices which address many of these focal areas.

Extreme Events & Flood Control

"Development related to agriculture, ranching, and residential activities in the watershed and valley over the past 100 years has significantly changed the hydrology of the river and made flood control a major issue… [1]" (Table 3). As a result of major flood events in the 1980s and '90s, berms were constructed on several properties to protect existing infrastructure, leading to reduced channel capacity and may have lead to an increase in upstream flooding [1]. Since the 1920s, urban expansion in the watershed increased significantly leading to several major changes, including:

Aerial view of a severe flood event in 1993. [1]

- "Four dams, which control upstream flows from approximately 73% of the watershed, were constructed to provide water supply reservoirs to both the U.S. and Mexico [1]."(Figure 2)
- "The Tijuana River Valley Flood Control Project was constructed to contain an approximate 500-year storm event in the main river as it enters the U.S. from Mexico [1]."
- "A one-mile-long earthen 'pilot' channel was constructed to direct flows away from a northern channel that formed during a flooding event in 1993 [1]."
- "Conagua has nearly completed construction of a concrete-lined channel on the Rio Alamar for an upstream distance of approximately 6 miles (10km) [1]."

These changes have led to management challenges for the IBWC, County, and City, as they are responsible for flood control in the valley [1]. "Based on the current conditions, a 5-to 10-year flood[12] …can cause localized flooding along Monument Road and Hollister Street, and on private leased properties in the valley", limiting vehicular access in and out of the valley, impacting residences and other infrastructure, and impeding border protection operation [1] (Figure 9). In order to address localized flooding issues, the City and IBWC perform channel maintenance and clearing activities to remove accumulated sediment and trash at considerable cost [13] [1]. (Figures 10-13)

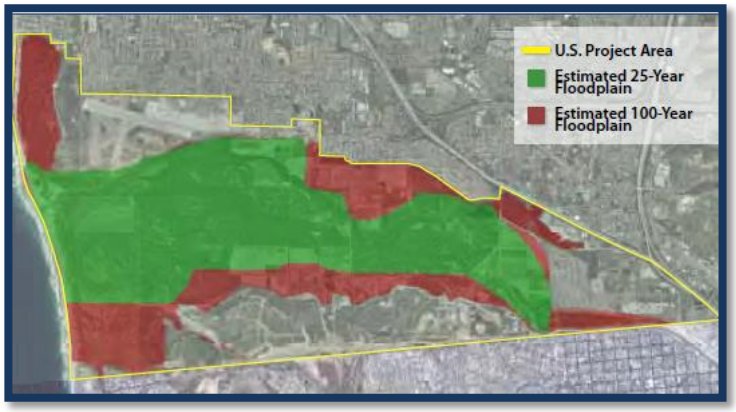


Figure 9: Estimated 25-year and 100-year floodplain in the TRV. [1]

[12] Representing a flow of between 7,000 and 14,000 cubic feet per second (cfs) [1].
[13] Costing approximately $100-$120 per cubic yard to remove.

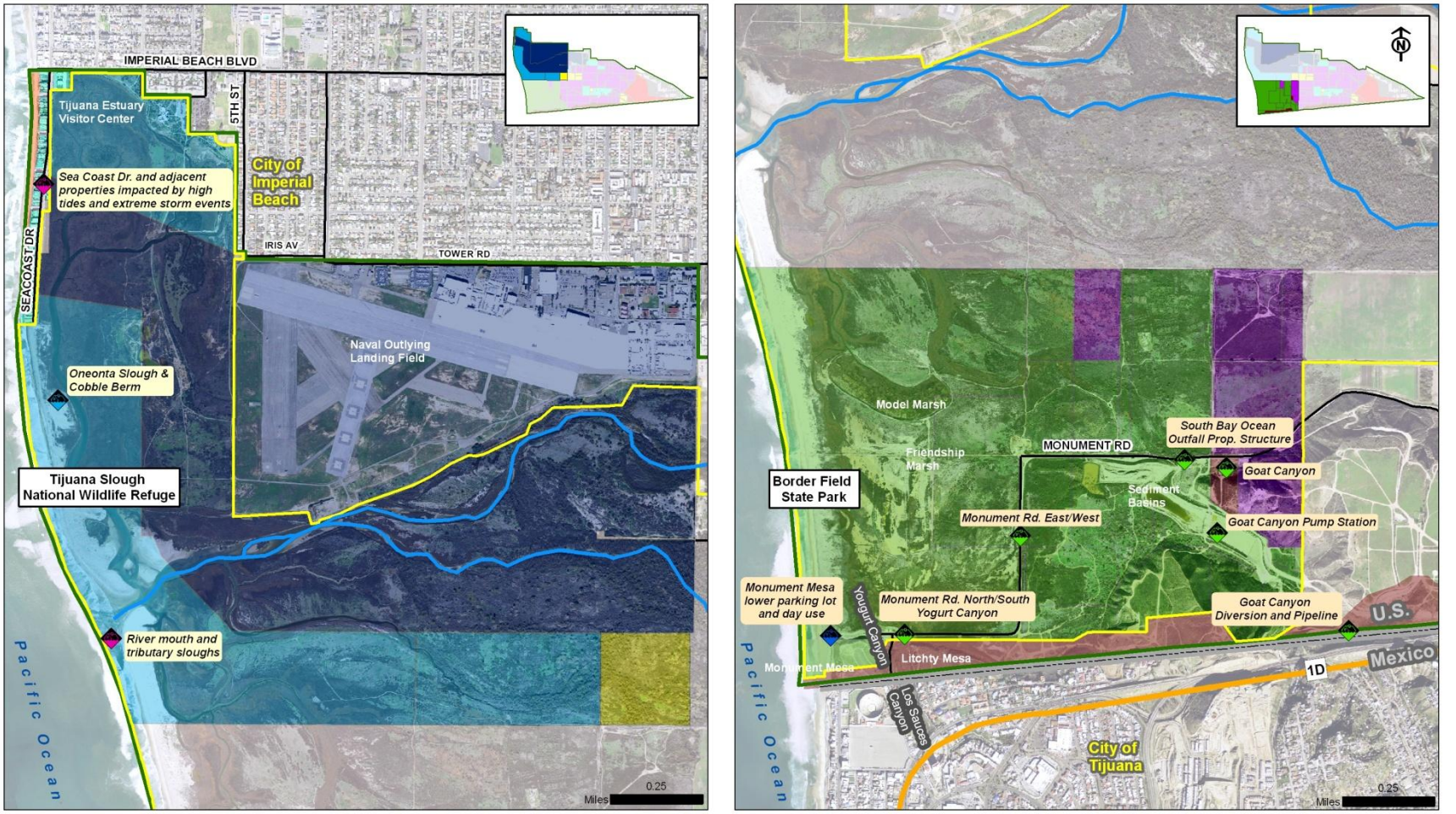
DATE	Discharge (cfs)	Discharge (m^3/s)	RANK[5]
February, 1884	50,000[1]	1400[1]	2
December, 1889	20,000[1]	570[1]	8-9
February, 1991	20,000[1]	570[1]	8-9
January, 1895	38,000[1]	1100[1]	3
January, 1916	75,000[1]	2100[1]	1
February, 1927	25,000[1]	710[1]	6
February 7th, 1937	*17,700*[2]	*500*[2]	11
January 30th, 1980	31,000[1] **19,500**[4]	880[1] **547**[4]	10
February 21st, 1980	33,500[2, 3] **30,000**[4]	950[2, 3] **852**[4]	4
March 3rd, 1983	27,700[3] **24,500**[4]	780[3] **697**[4]	7
January 16th, 1993	33,000[3] **26,000**[4]	934[3] **731**[4]	5
February 20th, 1993	**17,500**[4]	**496**[4]	12
March 12th, 1995	**16,500**[4]	**464**[4]	13

Notes:
(1): Estimations of past floods (made originally in cfs). Published on [2]. Values assumed to be peak flows.
(2): Peak flow measurements from the USGS Nestor Gauge (in cfs) according to [1a]
(3): Measurements according to References [2, 21]
(4): Measurements per published values of the IBWC [1]. Measurements published in m^3/s
(5): Rank and statistical properties obtained with bold values when two values exist.

Table 3: Peak flows of historical extreme flooding events[14]. [25]

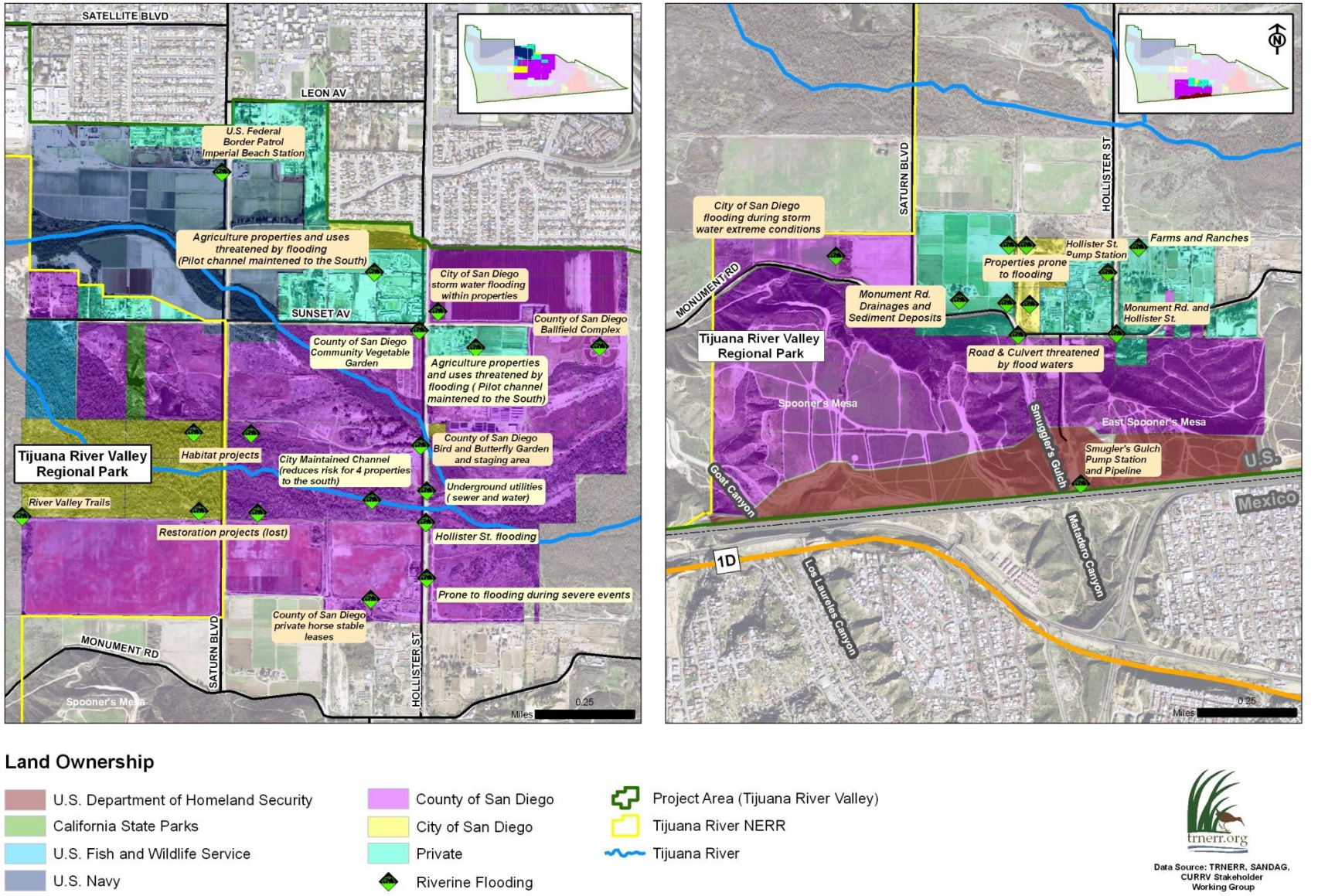
[14] It is important to note that peak flows before 1912 were not controlled by dams, possibly explaining why peak flows exceeding 20,000 cfs were more common before 1920 [25]. The different dams entered in operation as follows: Morena Dam, 1912; Barrett Dam, 1922; Rodriguez Dam, 1937 and El Carrizo Dam, 1974 [25]. "From the previous values, it is evident that Rodriguez Dam and to a lesser extent Barrett Dam have played an important role in the peak flows measured since 1937 [25]."

Figure 10: Existing Flooding Conditions (Western TRV)



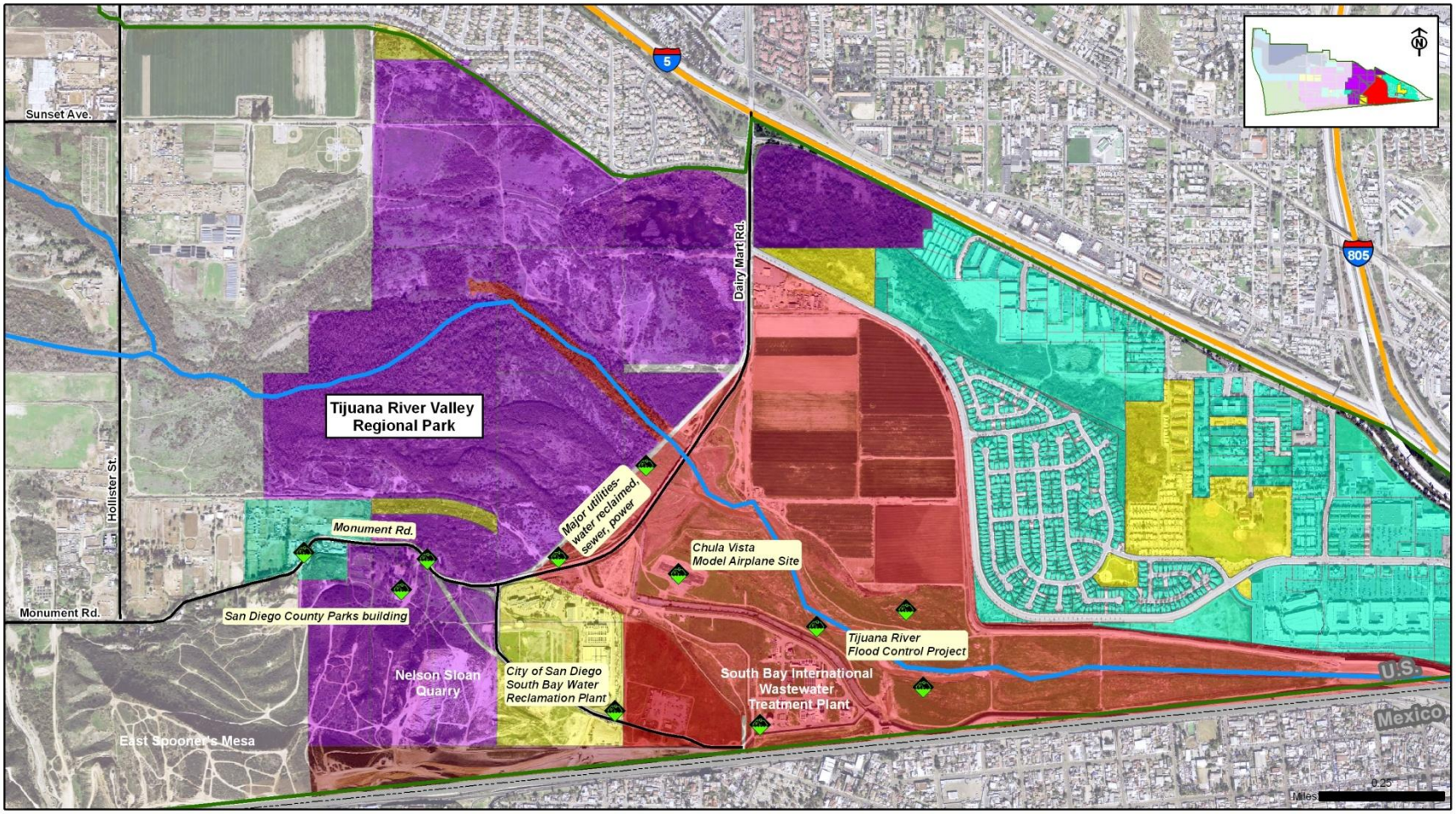
*Areas identified by the CURRV Stakeholder Working Group in March and April 2013 that currently experience flooding within the **western** portion of the TRV. Note that this is not a comprehensive assessment of current flooding conditions and only provides approximate locations.*

Figure 11: Existing Flooding Conditions (Central TRV)



*Areas identified by the CURRV Stakeholder Working Group in March and April 2013 that currently experience flooding within the **central** portion of the TRV. Note that this is not a comprehensive assessment of current flooding conditions and only provides approximate locations.*

Figure 12: Existing Flooding Conditions (Eastern TRV)



Land Ownership

- U.S. Department of Homeland Security
- International Boundary & Water Commission (IBWC)
- County of San Diego
- City of San Diego
- Private
- Riverine Flooding
- Project Area (Tijuana River Valley)
- Tijuana River NERR
- Tijuana River

trnerr.org

Data Source: TRNERR, SANDAG, CURRV Stakeholder Working Group

*Areas identified by the CURRV Stakeholder Working Group in March and April 2013 that currently experience flooding within the **eastern** portion of the TRV. Note that this is not a comprehensive assessment of current flooding conditions and only provides approximate locations.*

Sediment & Trash

The population of the City of Tijuana continues to grow rapidly with infrastructure improvements, such as paved roadways and waste management services, unable to keep pace with growth [1]. This situation can lead to problems, including accelerated erosion, and illicit disposal of trash and other waste materials in and around the City [1]. “In addition, basic development practices in many areas of the watershed have resulted in disturbance of natural drainage patterns and vegetation removal from slopes, making them unstable and prone to erosion. Storm flows mobilize and then transport sediment and trash downstream, threatening the health of riparian and estuarine habitats in both the U.S. and Mexico and reducing the flow capacity of the river and tributary channels [1].” Sediment and trash are linked, as they both are transported by storm flows, but each pollutant is managed differently because they behave differently in the water column [1].

Sediment

Sedimentation is rapidly changing the topography of the valley, negatively impacting the ecology of the border region and threatening infrastructure by exacerbating flooding. The approach to sediment management varies by drainage into the valley and estuary [1], a brief outline of ongoing efforts to manage sediment loads is below:

- Salt marsh habitat in the valley has been steadily degrading due to direct impacts from sediment discharged from Goat Canyon [1]. California State Parks constructed two sediment basins downstream of the international border to control degradation, currently intercepting the majority of the sediment during the wet season [1]. “In very wet seasons, as in 2005, the basins filled and 18 acres of salt marsh was smothered by up to 4 feet of sediment in a single storm event [1].”
- In Smuggler’s Gulch, excessive sediment loads reduce the capacity of natural channels to carry storm flows, exacerbating flooding [1]. To maintain the Gulch’s capacity to carry storm flows, subsequently minimizing the effects of flooding, the City of San Diego and the County clear sediment, when resources are available [1]. Additionally,”… in the early 1990s, the City excavated an earthen channel (i.e., the Pilot Channel) to direct larger storm flows away from the northern portion of the valley where flooding has resulted in significant damage to public and private property [1].” The Pilot Channel also requires the City to actively clear sediment to reduce flood risk [1].
- The majority of stormwater, sediment, and trash enter the U.S through the main Tijuana River channel [1]. “Over time, the downstream areas have served as a sink for accumulated sediment, resulting in an increase in vegetation. This causes storm flows to flood and deposit additional sediment and trash [1].”

Figure 13: The three major tributaries that contribute sediment and trash to the valley. [1]

Over the years, sediment management operations have increased in frequency and cost, exceeding local, state, and federal operating budgets [1]. “Operations entail excavating material from the basins or managed channels, sorting trash and tires from sediment, and disposing of all material properly…In an effort to stabilize and reduce costs, City, County, State Parks, and U.S. IBWC have began investigating a suite of alternative local reuse options, including using the sediment to replenish beach sand and restore upland areas [1].”

Trash

"Heavier trash, such as tires, are imbedded in the sediment excavated from basins and channels. Floatable trash behaves differently, as it is more easily transported in low flows and can be transported by wind [1]." The Goat Canyon sediment basin contains nets to trap surficial trash and debris, effectively trapping trash in areas where flow velocities are relatively low [1]. Unfortunately, maintaining the nets can be difficult and labor intensive, especially during extremely wet years [1]. In addition, several non-governmental organizations (NGOs) conduct cleanups of trash and waste tires in the valley [1]. "However, the timing and frequency of these activities are limited due to permit restrictions related to threatened and endangered species' breeding season(s), access constraints during the wet weather season, and health and safety concerns to volunteers [1]."

Water Quality

Deteriorated water quality represents a significant problem for the Tijuana River Valley, particularly in the river channel and along the ocean beach, leading to periodic closures of public space for public health and safety purposes [2]. "The main source of pollution is sewage flow in the Tijuana River…Since 1999, however, conditions have improved with the construction of the South Bay International Wastewater Treatment Plant (SBIWTP) [2]." The SBIWTP treats 25 million gallons per day (mgd) of municipal wastewater from Tijuana to secondary standards, and discharges it to the Pacific Ocean via the South Bay Ocean Outfall. During the dry season, Mexico diverts and pumps water from the Tijuana River into the Tijuana sewer system[15], with the SBIWTP receiving wastewater directly from the City's sewer system. During the dry season, the River consists mainly of treated wastewater effluent from secondary wastewater treatment plants in Tijuana and Tecate. During the wet season, Mexico's river diversion and pumping system is shut down when flows in the river exceed 1000 liters per second (lps). This means river flows during the winter often consist of urban runoff, sewage, trash and sediment, leading to poor water quality. During these periods of poor river water quality, as the river reaches the ocean south of Imperial Beach in the U.S., beaches are often closed by the San Diego County Health Department.

Invasive Species

"The composition of vegetation communities in the Tijuana River Valley has been influenced by numerous factors, including freshwater input, sedimentation, and disturbance from border patrol, military and agricultural uses. Historically, the … [Tijuana Estuary] was tidally influenced and received freshwater primarily during the rainy season in late winter and spring. Recently, however, wastewater inflows from the City of Tijuana…have resulted in increased freshwater influence over a greater proportion of the area [3]." The increase in freshwater flows combined with sedimentation, raising the elevation of the marsh plain, has, "…facilitated the colonization by exotic plant species in many areas that once supported only salt marsh plant species [3]." Several severe invasions by exotic plant species threaten the viability of native habitats, and their ability to support species of special concern, including: [2]

- "Invasion of the coastal back dunes and upper marsh areas, especially at Border Field State Park, by the exotic succulent sea fig *(Carpobrotus edulis);*
- Invasion of the riparian corridor in the Tijuana River Valley by several species of tamarisk *(Tamarix* sp.), and giant cane *(Arundo donax);* and
- Invasion of the disturbed upland areas by a host of exotic grasses and annuals [2]."

[15] In the near future, these flows will be diverted and pumped via a separate conveyance system and discharged to the ocean near San Antonio de los Buenos WTP in Mexico, near Punta Bandera.

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