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ES12.0 TIJUANA RIVER WMA EXECUTIVE SUMMARY

This section summarizes the results of the 2006-2007 monitoring of the Tijuana River Watershed Management Area (WMA).

Watershed Monitoring

Activities conducted under the 2006-2007 municipal urban runoff monitoring program included:

- Chemical and toxicity testing of storm water runoff.
- Dry weather data analysis.
- Rapid stream bioassessment.

Wet weather monitoring and rapid stream bioassessment sites within the Tijuana River WMA are depicted in Figure ES12-1 (dry weather stations are not shown).

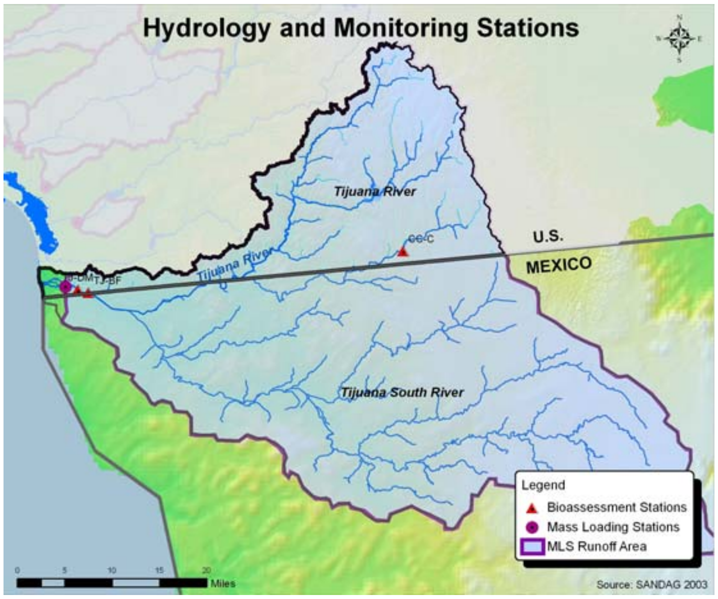


Figure ES12-1. Tijuana River WMA Monitoring Locations.

Storm Water Runoff

The Tijuana River (TJR) mass loading station (MLS) is located under the Hollister Street Bridge in San Diego, downstream from the International Boundary and Water Commission's diversion structure and treatment plant (Figure ES12-2). The contributing runoff area consists of more than 1,091,000 acres, which covers over 99% of the Tijuana River Watershed. The major land uses in the WMA are undeveloped (60%), parks and preserves (25%), and residential (7%) (Figure ES12-3).

Figure ES12-2. Tijuana River MLS Site.

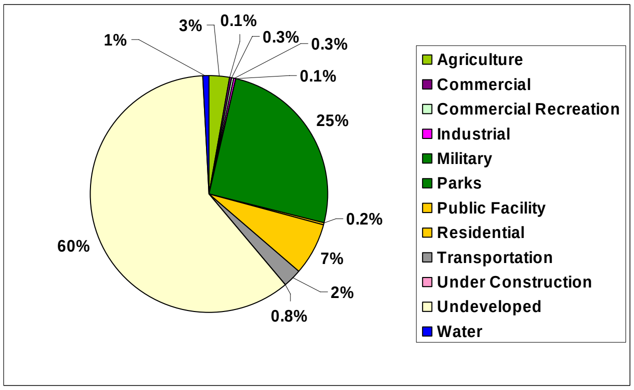


Figure ES12-3. Tijuana River WMA Land Use Statistics

Figure ES12-4 depicts the three storm events that were monitored during the 2006-2007 wet-weather season. The figure depicts the river levels and flow rates observed during the monitoring season.

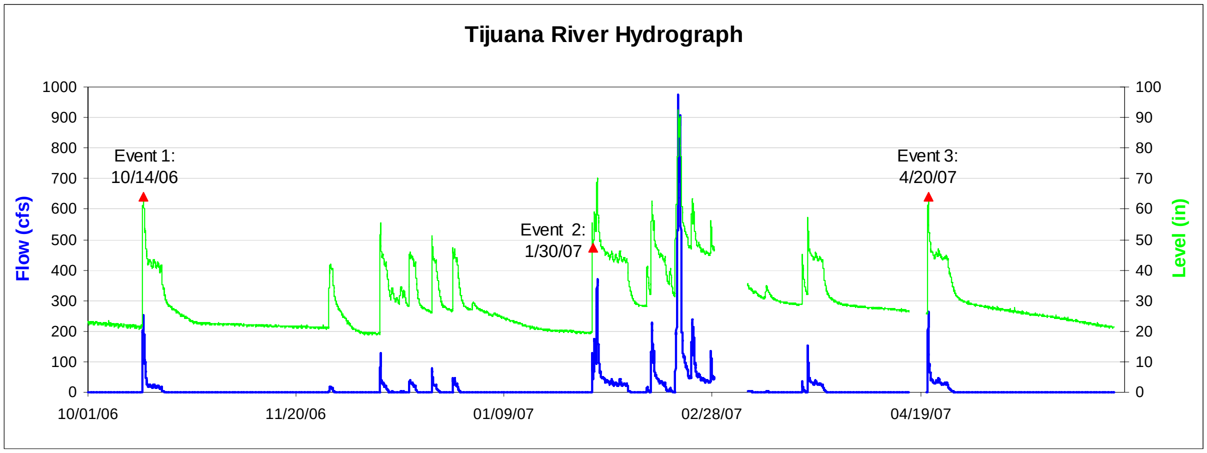


Figure ES12-4. Tijuana River 2006-2007 Wet Weather Monitoring Period Flow Record and Monitored Storm Events.

Table ES12-1 summarizes constituents with concentrations detected at levels above the water quality objective (WQO) benchmarks which are shown in bold. Conventional constituents. Bacteriological, pesticides, total and dissolved metals, and toxicity were all detected at levels above the benchmark WQO.

Table ES12-1. Constituents with Results Above the Benchmark WQO During the 2006-2007 Monitoring Season at the Tijuana River MLS.

ANALYTE	UNITS	Benchmark WQO	SOURCE	2006-2007		
				10/14/06	1/30/07	4/20/07
Oil and Grease	mg/L	15	USEPA Multi-Sector General Permit	**38**	<5	<5
Fecal Coliform	MPN/100 mL	4000	Basin Plan	**16,000,000**	**2,200,000**	**1,700,000**
Un-ionized Ammonia as N	µg/L	25 (a)	Basin Plan	**74.6**	**48.6**	**96.7**
Biochemical Oxygen Demand	mg/L	30	USEPA Multi-Sector General Permit	15.1	**77.7**	**67.6**
Chemical Oxygen Demand	mg/L	120	USEPA Multi-Sector General Permit	**522**	**480**	**379**
Dissolved Phosphorus	mg/L	2	USEPA Multi-Sector General Permit	1.91	1.88	**2.36**
Total Phosphorus	mg/L	2	USEPA Multi-Sector General Permit	**3**	1.94	**3.12**
Total Suspended Solids	mg/L	100	USEPA Multi-Sector General Permit	**1560**	**692**	**1080**
Turbidity	NTU	20	Basin Plan	**646**	**197**	**526**
Diazinon	µg/L	0.08	CA Dept. of Fish & Game	**0.347**	**0.272**	**0.390**
Malathion	µg/L	0.43	CA Dept. of Fish & Game	**1.940**	<0.006	**0.736**
Antimony	mg/L	0.006	Basin Plan	0.004	**0.008**	0.004
Copper	mg/L	(b)	40 CFR 131	**0.07**	**0.104**	**0.045**
Lead	mg/L	(b)	40 CFR 131	**0.102**	**0.078**	**0.047**
Zinc	mg/L	(b)	40 CFR 131	**0.558**	**0.456**	**0.296**
Ceriodaphnia 96-hr	LC50 (%)	100		**16.49**	**16.49**	**17.68**
Ceriodaphnia 7-day survival	NOEC (%)	100		**6.25**	**6.25**	**6.25**
Ceriodaphnia 7-day reproduction	NOEC (%)	100		**6.25**	**6.25**	**6.25**
Hyalella 96-hr	NOEC (%)	100		**25**	**12.5**	**50**

The recent monitoring year and the mean historical ratios of the benchmark WQOs from three monitored storm events per year between October 2001 and April 2007 were plotted and compared to the benchmark WQO (Figure ES12-5). The highest exceedances noted for the Tijuana River WMA were for TSS, turbidity, fecal coliform, Diazinon, total lead, and *Ceriodaphnia* toxicity. The mean results from three storm events per year are also above the benchmark WQO for several constituents which are depicted in gray.

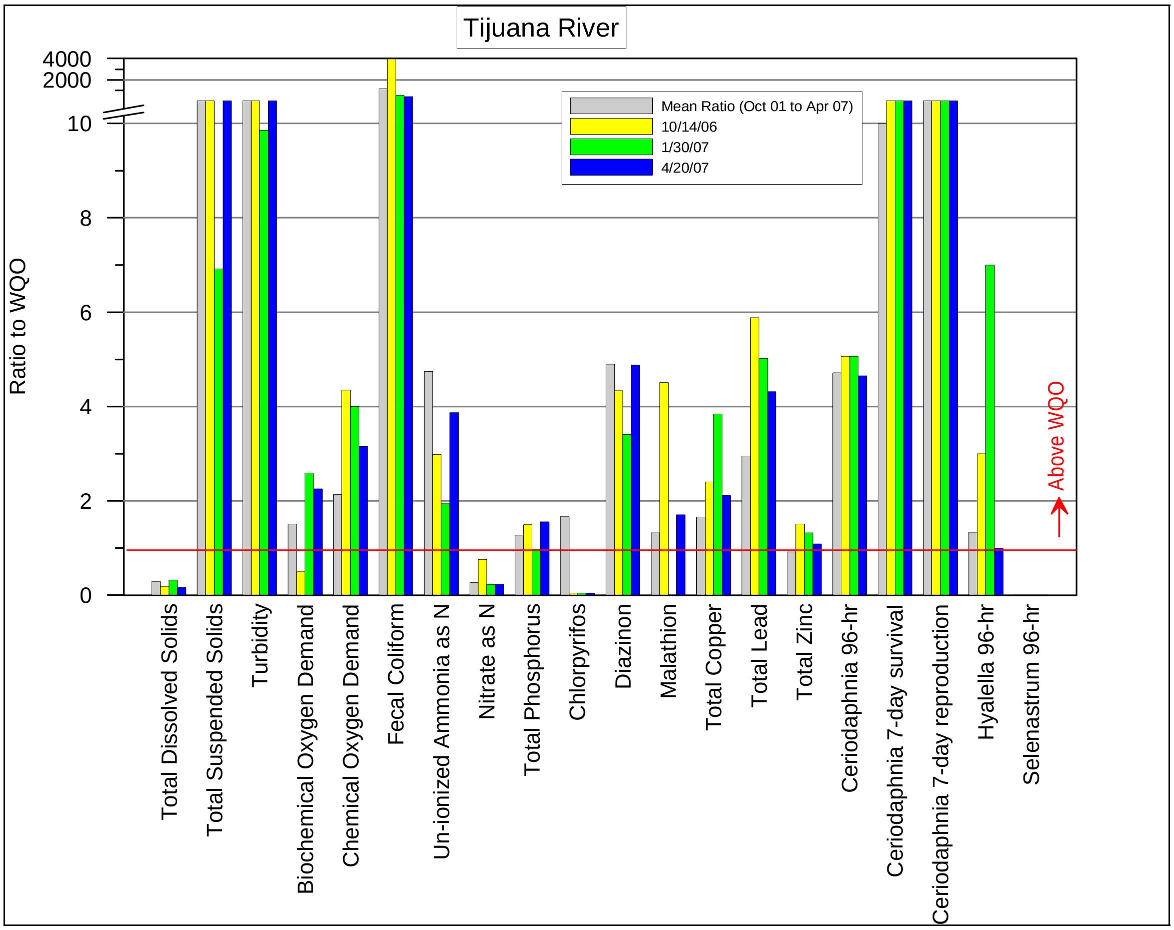


Figure ES12-5. Ratio of Results to Benchmark WQO for the Tijuana River Watershed Management Area.

Mann-Kendall trend analyses were performed to identify any long-term trends observed in the data. Statistically significant long-term increasing trends were observed for the following constituents:

- Nitrate (below, but approaching benchmark WQO)
- TOC (no benchmark WQO)
- TSS (above benchmark WQO)
- Turbidity (above benchmark WQO)
- Fecal coliform (above benchmark WQO)
- Total coliform (no benchmark WQO)
- Total arsenic, lead and zinc (above benchmark WQO for lead and zinc)
- Acute survival endpoint for *Hyalella* (above benchmark WQO)

Statistically significant long-term decreasing trends were observed for the following constituents:

- Conductivity
- TDS
- Diazinon (results still above benchmark WQO, though decreasing)
- Dissolved arsenic and nickel

Constituent Loads

Measured storm event loads were compared to loading values derived from the National Stormwater Quality Database (Pitt et al., 2004). Expected loads based on the national database were used to evaluate the magnitude of loads measured at each MLS site. Measured loads of most of the constituents were greater than expected for a majority of the storm events sampled. Only cadmium and dissolved lead were consistently within the expected range or lower than expected.

Dry Weather Data

A separate dry weather monitoring program is carried out by each jurisdiction. Dry weather monitoring investigations were performed 19 sites in the Tijuana River WMA during the summer of 2006. Eleven of these sites are located upstream of the MLS on the Tijuana River. Constituents found to exceed dry weather action levels are depicted in Table ES12-2.

Table ES12-2. Tijuana River WMA 2006 Dry Weather Exceedances.

Analyte	Number of Action Level Exceedances	Total Samples
Conductivity	3	29
Enterococcus	2	14
Fecal Coliform	1	14
Total Coliform	4	14
Ammonia (NH3-N)	7	25
Orthophosphate (PO4-P)	6	25
MBAS	1	14
Turbidity	10	24
Copper Dissolved	5	14

Stream Bioassessment

Stream bioassessment monitoring in the Tijuana River WMA was conducted at a single site in October 2006, Campo Creek at the Highway 94 overcrossing in the town of Campo (CC-C) (Figure ES12-6). Two sites were sampled in May 2007, including the Campo Creek site (which was moved approximately 1/3 mile downstream to a reach with better habitat) and a site on the Tijuana River near the border fence (TJ-BF) (Figure ES12-7). The Tijuana River site was not sampled in October due to dry conditions and was moved upstream to a point just below the Tijuana flood control channel for the May survey

Two summary indices were used to assess the benthic communities at the monitoring sites: an Index of Biotic Integrity and an O/E ratio. For these indices, higher values indicate better biotic conditions (see Table ES12-3 footnotes for scoring criteria).

Figure ES12-6. Campo Creek Site

Figure ES12-7. Border Fence Site

The Campo Creek site had Index of Biotic Ratings of Very Poor and Fair for the October and May surveys, respectively (Table ES12-3). There were several organisms collected that were otherwise found only at reference sites. The mean O/E ratio for this site indicated moderate impairment, with some survey results showing unimpaired benthic communities. The Tijuana River site near the border fence was rated Poor by the IBI, while the O/E ratio indicated much more severe impairment. Based on analysis of individual taxa present and observations made in the field, the investigators in this study feel that the O/E ratio is a more accurate indication of the benthic community quality in this portion of the Tijuana River.

Table ES12-3. Selected Biological Integrity Ratings and O/E Ratios for the Tijuana River WMA.

Tijuana River Watershed Management Area	Campo Creek in Campo (CC-C)		Tijuana River at the Border Fence (TJ-BF)
Survey	Oct-06	May-07	May-07
Index of Biotic Integrity/ Qualitative Rating*	4 Very Poor	29 Fair	17 Poor
O/E Ratio**	0.37	0.62	0.25

*IBI Score 0-13=Very Poor, 14-26=Poor, 27-40=Fair, 41-55=Good, 56-70=Very Good,
**O/E ratio =observed/expected taxa ratio; value of >0.8 represents unimpacted conditions

Ambient Bay and Lagoon Monitoring

The Ambient Bay and Lagoon Monitoring Program was not conducted during the 2006-2007 monitoring period.

Watershed Management Area Assessment

The Tijuana River WMA was assessed using the interim guidance document "Watershed Data Assessment Framework" (June 2004) to comply with NPDES Order 2001-01. The following triad assessment results for the WMA are presented:

- Persistent exceedance of water quality objectives (high frequency COCs identified),
- Evidence of persistent toxicity, and
- No indications of benthic alteration.

Constituents of concern identified for the Tijuana WMA are summarized in Table ES12-4.

Table ES12-4. Constituent of Concern Rating Table Summary for the Tijuana River WMA.

<table>
<tr><th>Constituents With Any Wet Weather (MLS) Benchmark WQO or Dry Weather Action Level Exceedance</th><th>Frequency of Occurrence Rating</th><th>Criterion Basis</th></tr>
<tr><td>Ammonia</td><td rowspan="7">High</td><td rowspan="7">Mass loading station tests results exceed benchmark WQO in greater or equal to 80% of samples.</td></tr>
<tr><td>Total Suspended Solids</td></tr>
<tr><td>Turbidity</td></tr>
<tr><td>Total Coliform</td></tr>
<tr><td>Fecal Coliform</td></tr>
<tr><td>Enterococcus</td></tr>
<tr><td>Diazinon</td></tr>
<tr><td>BOD</td><td rowspan="5">Medium</td><td rowspan="5">Less than 80% and greater than or equal to 50% of the MLS samples exceed benchmark WQO and no exceedances or data available for DWS in the past year.</td></tr>
<tr><td>COD</td></tr>
<tr><td>Total Phosphorus</td></tr>
<tr><td>Total Copper</td></tr>
<tr><td>Total Lead</td></tr>
<tr><td>MBAS</td><td>Low</td><td rowspan="4">MLS exceedances found in 25% to less than or equal to 50% of the samples and at least one exceedances found in last 2 years at the MLS (with or without DWS exceedances in the past year).</td></tr>
<tr><td>Dissolved Phosphorus</td><td>Low</td></tr>
<tr><td>Malathion</td><td>Low</td></tr>
<tr><td>Total Zinc</td><td>Low</td></tr>
<tr><td>Dissolved Copper</td><td>Low</td><td>DWS exceedances in 10 to 50% of the samples in the past year.</td></tr>
</table>

Recommendations

The recommendations for this watershed are to continue monitoring at the MLS to determine long-term trends, continue monitoring for toxic and benthic impacts and to identify upstream sources of constituents of concern. The implementation of the new monitoring permit cycle will allow for assessing the watershed during both dry weather and wet weather conditions. Additionally, The City of Imperial Beach is in the process of obtaining Clean Beaches Initiative (CBI) funding for a microbial source tracking study within the U.S. jurisdiction of the Tijuana River Watershed. The data collected from this study will identify potential sources of bacteriological contaminants and their loads. These and other monitoring efforts will provide additional valuable management information for future years in the Tijuana River WMA.

12.0 TIJUANA RIVER WATERSHED MANAGEMENT AREA

This section presents the Tijuana River Watershed Management Area (WMA) monitoring data for the 2006-2007 monitoring season. The information within the following subsections is presented as follows:

- Overview of the WMA, regulatory water quality challenges, and the monitoring site descriptions used to assess the WMA.
- Watershed water quality monitoring results and data analysis, wet weather pollutant loadings, dry weather data summary, and third party data.
- Stream bioassessment results and data analysis.
- Watershed management area assessments, triad assessment, and LTEA priority ratings.
- Summary and Recommendations.

Changes from last years monitoring program include the following:

- The Ambient Bay and Lagoon Monitoring Program was completed in 2005-2006 and was not performed as part of the 2006-2007 monitoring program activities.
- LTEA water quality priority ratings remain unchanged from the previous Annual Monitoring Report as this was a five year assessment based on data collected from 2001-2006.
- Metals results over the previous two monitoring seasons were only compared to the criterion maximum concentration (CMC) or acute benchmark water quality objective (WQO) since it is believed to be representative of short term conditions. However, the metals results are now compared to both the CMC (acute) and criterion continuous concentration (CCC) or chronic benchmark WQO benchmark for comparison purposes. This change has resulted in some metals (particularly lead) being identified as a constituent of concern in some watersheds where in prior years it was not identified as a constituent of concern.

12.1 Tijuana River Watershed Management Area Description

The Tijuana River Watershed Management Area (WMA) (HU 911.00) is the largest of the San Diego watersheds covering over 1.1 million acres (Figure 12-1). The Tijuana River is formed by two drainage networks that merge in the City of Tijuana, then flow across the U.S. border into the Tijuana River Estuary, and finally to the Pacific Ocean. The watershed is divided by the U.S. / Mexico border with just over 27% lying within the San Diego Region. The watershed is comprised of the following hydrologic areas: Tijuana Valley, Potrero, Barrett Lake, Monument, Morena, Cottonwood, Cameron, and Campo. Major water bodies include the Tijuana River, Cottonwood Creek, and the Tijuana River Estuary. Annual precipitation varies from less than 10.5 inches near the coast to more than 22.5 inches in the inland areas. Locations of wet weather and bioassessment monitoring stations are depicted in Figure 12-1 (dry weather stations are not shown).

The distribution of population within the U.S. area of the watershed is sparse with the major population centers being located at Campo and San Ysidro. The cities of Tecate and Tijuana are the major population centers on the Mexican side of the watershed. The population for the entire watershed is approximately one million (San Diego County, 2002). The population in the U.S. portion watershed is estimated at 82,123 persons or 176 persons per square mile. The population is projected to increase by 45% to reach over 118,838 people by the year 2020 (SANDAG, 2005).

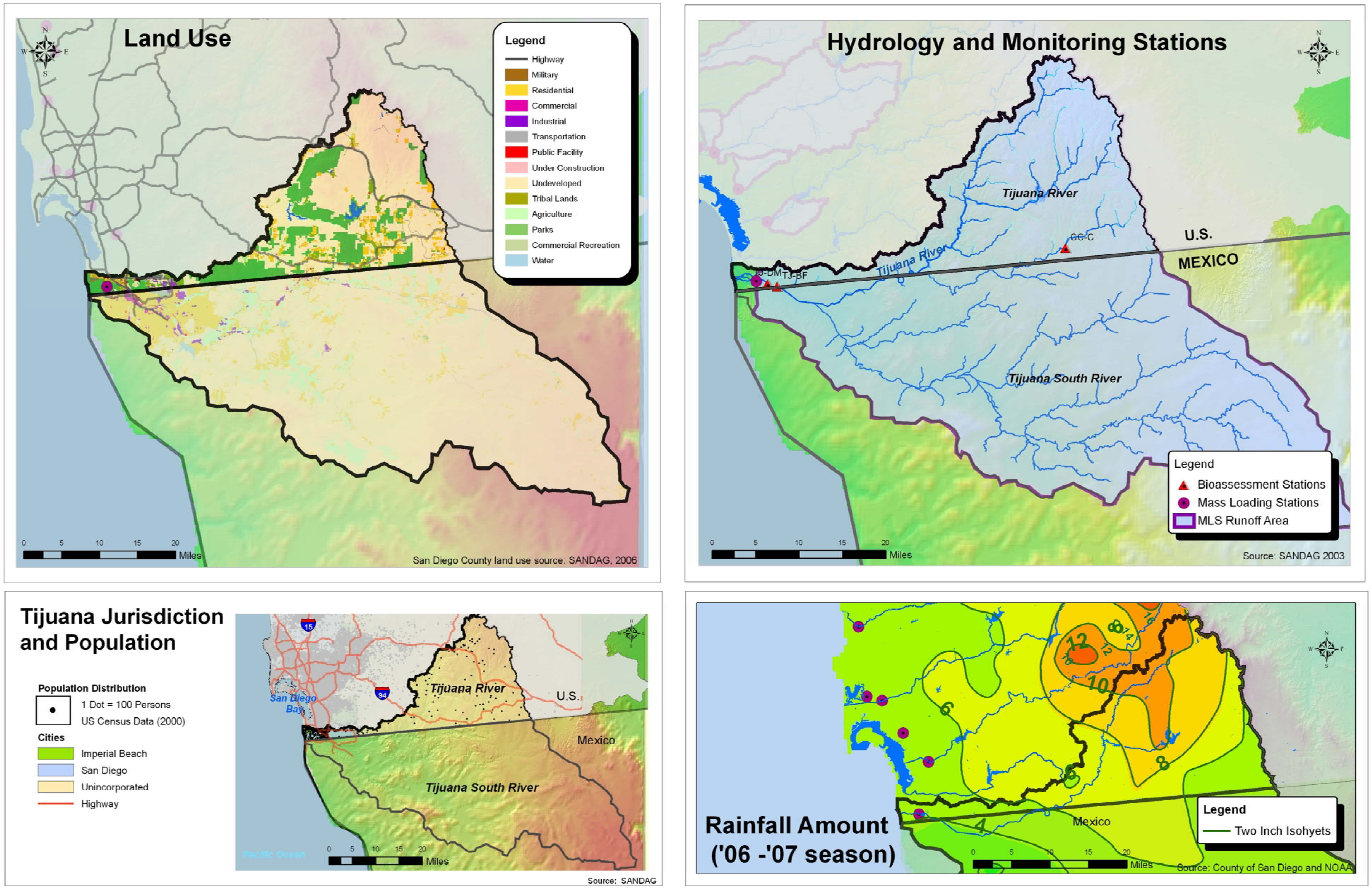


Figure 12-1. Tijuana River Watershed Management Area.

12.1.1 Land Use

Mexico governs 73% of the Tijuana River Watershed. The remaining areas fall within the border of the United States. Dominant land uses in the U.S. portion of the watershed are undeveloped/vacant areas (60.3%) and parks (25.3%). Other land uses include residential (7.3%), agriculture (2.9%) and transportation (2.4%). The combination of commercial, commercial recreation, industrial, military, public facility, construction and water land uses equal less than 2% of the land area in the U.S. portion of the watershed (Figure 12-2) (SANDAG, 2006). Mexico's lands are predominately undeveloped/vacant land use (81.8%). It should be noted that much of Mexico's lands classified as undeveloped are used for low intensity cattle and goat grazing.

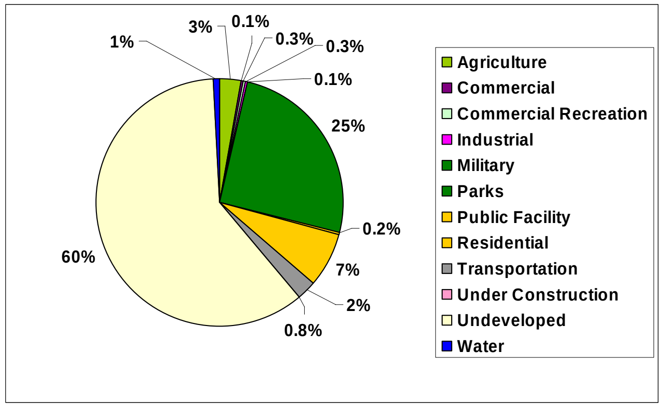


Figure 12-2. Percent Land Use for Tijuana River WMA

12.1.2 Beneficial Uses

The Tijuana River Watershed provides a variety of beneficial uses and sensitive habitats, including the Tijuana River Estuary, which is a National Estuarine Sanctuary (Table 12-1). The major aquifer in the watershed is the Lower Tijuana River Valley Basin.

Table 12-1. Beneficial Uses Within the Tijuana River Watershed.

Beneficial Uses	Inland Surface Waters	Coastal Waters (excluding Pacific Ocean)[(a)]	Pacific Ocean	Reservoirs and Lakes	Ground Waters
Municipal and Domestic Supply	●			●	●
Agricultural Supply	●			●	●
Industrial Service Supply	●		●	●	●
Industrial Process Supply	●			●	
Ground Water Recharge					
Freshwater Replenishment	●			●	
Hydropower Generation					
Navigation			●		
Contact Water Recreation	●	●	●	●	
Non-Contact Water Recreation	●	●	●	●	
Commercial and Sport Fishing		●	●		
Warm Freshwater Habitat	●			●	
Cold Freshwater Habitat	●			●	
Estuarine Habitat		●	●		
Wildlife Habitat	●	●		●	
Biological Habitats of Special Significance	●	●	●		
Rare, Threatened, or Endangered Species	●	●	●	●	
Marine Habitat		●	●		
Migration of Aquatic Organisms		●	●		
Aquaculture			●		
Shellfish Harvesting		●	●		
Spawning, Reproduction and/or Early Development	●	●	●		

(a) = Tijuana River Estuary
● = Existing
Note: Beneficial uses vary by hydrologic unit basin number. Please refer to the basin plan for individual hydrologic units.
Source: Basin Plan September 8, 1994 (Tables 2-2, 2-3, 2-4, 2-5), amendments adopted through 2/8/2006.

12.1.3 Regulatory Water Quality Challenges

The Tijuana River Watershed has a variety of water quality issues. Major impacts to the watershed include surface water quality degradation, trash, sedimentation, eutrophication, habitat degradation and loss, flooding, erosion, and invasive species (San Diego County, 2006). Constituents that have been placed on the SWRCB 2006 303(d) list for water bodies throughout the watershed include bacterial indicators, color, eutrophic conditions, lead, low dissolved oxygen, manganese, nickel, pesticides, pH, phosphorus, solids, synthetic organics, thallium, trace elements, and trash (Table 12-2). The sources of the pollutants are varied and include urban runoff, sewage spills, industrial discharges, agricultural/orchards, livestock/domestic animals, natural sources, and septic systems (San Diego County, 2006).

Table 12-2. Water Bodies on the SWRCB 303(d) List in the Tijuana River Watershed.

Water Body Name	Hydrologic Sub Area (HSA)	HSA #	Pollutant/Stressor
Tijuana River	San Ysidro	911.11	Bacteria Indicators, Eutrophic conditions, Low Dissolved Oxygen, Pesticides, Solids, Synthetic Organics, Trace Elements, Trash
Tijuana River Estuary	San Ysidro	911.11	Bacteria Indicators, Eutrophic conditions, Lead, Low Dissolved Oxygen, Nickel, Pesticides, Thallium, Trash, Turbidity
Pacific Ocean Shoreline, Tijuana HU	San Ysidro	911.11	Bacteria Indicators
Barrett Lake	Barrett Lake	911.30	Color, Manganese, pH
Pine Valley Creek (Upper)	Pine	911.41	Enterococcus, Phosphorus, Turbidity
Morena Reservoir	Morena	911.50	Color, Manganese, pH

Source: SWRCB, 2007

12.1.4 Mass Loading Station Site Description

The Tijuana River (TJR) mass loading station is located under the Hollister Street Bridge in San Diego, downstream from the International Boundary and Water Commission's diversion structure and treatment plant (Latitude: 32° 33.078' Longitude: 117° 5.043'). During periods of low-flow the river is diverted through the treatment plant. The contributing runoff area consists of more than 1,091,000 acres, which covers over 99% of the Tijuana River Watershed. The River flows freely once the water level rises over the diversion structure. The Tijuana River at the MLS sampling site is an unimproved channel. The River flows through Tijuana, Mexico and runoff contributions come from both Mexico and the United States.

Flow was calculated at this monitoring location during the 2006-2007 wet weather monitoring season utilizing a geometric equation that produced an estimated flow by gauging the height of the stream, velocity of the stream, and known dimensions of the channel. This method is similar to previous years monitoring efforts.

12.1.5 Stream Bioassessment Site Description

Stream bioassessment monitoring in the Tijuana River WMA was conducted at a single site in October 2006 in Campo Creek at the Highway 94 overcrossing in the town of Campo (CC-C). Two sites were sampled in May 2007, including the Campo Creek site and a site on the Tijuana River near the border fence (TJ-BF). In May, the Campo Creek site was moved approximately 1/3 mile downstream to a reach with better riffle habitat. This stream reach was not flowing in October. The Tijuana River site was not sampled in October due to dry conditions and was moved upstream to a point just below the Tijuana flood control channel for the May survey. Future surveys will likely sample this same reach to ensure the presence of flowing water.

12.2 Watershed Water Quality Monitoring

The following sub-sections include the results and analysis of chemistry, bacteria, and toxicity data collected during three storm water events and historical data at the MLS, dry weather data collected during the 2006 dry weather monitoring program, toxicity identification evaluations (TIE) performed previously in the watershed, and available and relevant third party data.

The triad approach is used to evaluate chemistry, toxicity, and the benthic community to perform watershed management area assessments. Analysis of watershed water quality monitoring data is one leg of the triad approach. The chemistry data provides an indication of the pollutant load and toxicity data provides an indication of the potential impacts to aquatic organisms during storm events. Dry weather chemistry data provides an indication of urban runoff pollutants. The benthic community data collected during stream bioassessment provides a more direct indication of the ecological health of the watershed in terms of the insect/benthic community abundance and diversity.

12.2.1 2006-2007 Storm Water Monitoring and Results

Annual storm water monitoring has occurred at the Tijuana River MLS since the 2001-2002 wet weather monitoring season. Three storm events were monitored at the MLS on the Tijuana River during the 2006-2007 wet weather season. Storm event monitoring occurred on October 14, 2006, January 30, 2007 and April 20, 2007. Rainfall data obtained from the County of San Diego Alert Network are summarized in Table 12-3. Figure 12-3 shows the stream flow and water levels measured during the 2006-2007 wet weather period and monitoring events occurred. Hydrographs from each individual storm event are presented in Appendix A.

Table 12-3. 2006-2007 Rainfall Statistics for Monitored Storm Events for the Tijuana River Mass Loading Station.

Date Start	Total Rain (in)	Duration (hr)	Intensity (in/hr)	Antecedent Dry Days
10/14/2006	0.12	12	0.01	81
1/30/2007	0.08	15	0.01	26
4/20/2007	0.32	10	0.03	30

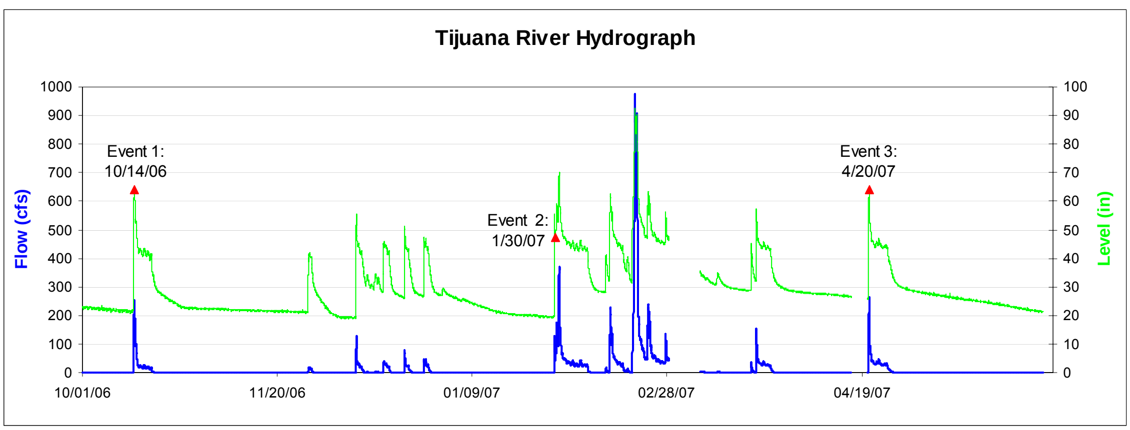


Figure 12-3. Tijuana River 2006-2007 Wet Weather Monitoring Period Flow Record and Monitored Storm Events.

The first storm of the 2006-2007 wet weather monitoring season occurred on October 14, 2006. The storm was preceded by approximately 81 antecedent dry days. The storm produced a total of 0.12" of rainfall. A total of 58 one-liter composite sample aliquots were collected at a pace of one sample for every 50,000 cubic feet of water that passed by the monitoring station. Grab samples for those constituents not conducive to composite sampling were collected. Sampling was conducted over a 6-hour period which captured the rise and peak of the runoff produced by the storm.

The second storm monitored at the Tijuana MLS during the 2006-2007 wet weather monitoring season occurred on January 30, 2007. The storm produced a total of 0.08" of rainfall (Table 12-3). A total of 28 one-liter composite sample aliquots were collected at a pace of one sample for every 150,000 cubic feet of water that passed by the monitoring station. Grab samples were collected for those constituents not conducive to composite sampling. Sampling was conducted over an 8-hour period which captured the rise, peak and declining portion of the runoff produced by the storm.

A large storm event that occurred on February 28, 2007 was monitored and field samples were collected at the Tijuana River MLS. However during the sample compositing process one of the 19 liter storm water sample bottles was inadvertently broken. Because the samples are flow weighted composites and require the full sample portion, the sample was not submitted for analysis.

The third storm monitored at the Tijuana MLS during the 2006-2007 wet weather monitoring season occurred on April 20, 2007. The storm produced a total of 0.32" of rainfall (Table 12-3). A total of 33 one-liter composite sample aliquots were collected at a pace of one sample for every 250,000 cubic feet of water that passed by the monitoring station. Grab samples for those constituents not conducive to composite sampling were collected. Sampling was conducted over a 5-hour period which captured the rise, peak and declining portion of the runoff produced by the storm. Field crews did note that a fallen tree blocked the flow sensor at this site during the monitoring event.

Analytical results from the 2006-2007 wet weather monitoring period at the Tijuana River MLS are presented with the historical results in Table 12-4. Sample results are compared to the benchmark water quality objectives (WQO) that are provided in the table. These benchmark WQO were selected by the Copermittee Monitoring Workgroup from the sources provided in the results table. A detailed description of the benchmark WQO sources and the technical reasoning of how the results are compared to the benchmark WQO are provided in Section 3.4. Discussion of sample results occur in groups; conventional parameters, bacteriological, pesticides, metals, and toxicity. A comparison of these results to previous monitoring data is presented in Section 12.2.2.

Table 12-4. Analytes Measured at the Tijuana River Mass Loading Station.

ANALYTE	UNITS	WQO[1]	SOURCE	2001-2002			2002-2003			2003-2004			2004-2005			2005-2006			2006-2007			Frequency Above WQO	Mean Ratio to WQO
				01/29/02	02/17/02	03/17/02	11/08/02	02/11/03	02/25/03	11/12/03	01/25/04	02/03/04	10/27/04	02/11/05	02/18/05	10/18/05	02/19/06	02/28/06	10/14/06	1/30/07	4/20/07		
General / Physical / Organic																							
Electrical Conductivity	umhos/cm			1610	2300	2490	1664	1830	2890	1174	1471	25000	430	1449	1075	1715	1806	752	702	1460	991		
Oil and Grease	mg/L	15	USEPA Multi-Sector General Permit	4	2	1	3.93	1.23	8.56	9.1	2.38	6.44	2	4.69	5.28	2.5	1.32	2.9	38	<5	<5	6%	0.37
pH	pH Units	6.5-8.5	Basin Plan	7.4	8.1	7.6	7.30	8.51	7.32	7.43	7.76	7.96	7.75	7.65	7.43	7.56	7.82	7.87	7.56	7.47	7.53	6%	0.06
Bacteriological																							
Enterococci	MPN/100 mL			170,000	500,000	17,000	2,400,000	50,000	30,000	500,000	5,000,000	2,400,000	800,000	3,000,000	1,700,000	5,000,000	800,000	500,000	1,700,000	800,000	1,700,000		
Fecal Coliform	MPN/100 mL	4000	Basin Plan	800,000c	300,000c	300,000c	5,000,000	500,000	16,000,000	1,700,000	800,000	800,000	5,000,000	2,400,000	2,200,000	>16,000,000	9,000,000	500,000	16,000,000	2,200,000	1,700,000	100%	1127.78
Total Coliform	MPN/100 mL			1,700,000	800,000	1,100,000	>16,000,000	1,300,000	16,000,000	3,000,000	2,800,000	1,300,000	5,000,000	5,000,000	9,000,000	>16,000,000	16,000,000	2,200,000	16,000,000	5,000,000	5,000,000		
Wet Chemistry																							
Ammonia As N	mg/L			8	7.2	6.4	5.22	8.00	10.40	1.9	8.05	6.4	4.5	8.14	3.28	16	4.38	7.21	6.81	7.83	10.4		
Un-ionized Ammonia as N	µg/L	25 (a)	Basin Plan				39.2	636	63.0	16.7	127	124	24.1	86.1	42.7	186.0	68.5	145.0	74.6	48.6	96.7	87%	4.74
Biochemical Oxygen Demand	mg/L	30	USEPA Multi-Sector General Permit	27.3	46.2	33.3	3.56	86.4	23.2	70.9	72.5	98.6	23.9	67	26.6	23.1	28	25	15.1	77.7	67.6	50%	1.51
Chemical Oxygen Demand	mg/L	120	USEPA Multi-Sector General Permit	95	263	122	152	257	113	319	217	903	76	197	50	170	140	141	522	480	379	78%	2.13
Dissolved Organic Carbon	mg/L						30.6	35.7	23.4	45.8	29.3	14.4	39.2	20.3	8.65	30.2	37.9	82.4	65	47.6	42.5		
Dissolved Phosphorus	mg/L	2	USEPA Multi-Sector General Permit	2.2	2.9	2.28	1.75	1.90	0.93	1.56	3.41	1.99	1.69	1.73	1.26	1.23	1.76	1.72	1.91	1.88	2.36	28%	0.96
Nitrate As N	mg/L	10	Basin Plan	1.6	0.8	1.1	3.12	0.72	0.44	8.75	1.72	1.5	4.08	1.97	2.12	3.54	2.65	1.45	7.62	2.34	2.36	0%	0.27
Nitrite As N	mg/L	1	Basin Plan	0.34	1.44	0.6	0.98	0.37	0.13	0.42	0.59	0.34	0.11	0.37	<0.05	0.81	0.66	0.29	0.43	0.66	0.33	6%	0.49
Surfactants (MBAS)	mg/L	0.5	Basin Plan	<0.5	3.3	0.7	0.3	2.0	<0.1	<0.5	1.7	<0.5	<0.5	0.7	0.5	0.5	0.6	<0.5	<0.5	<0.5	<0.5	33%	1.37
Total Dissolved Solids	mg/L	2500	Basin Plan	737	1080	965	885	883	794	650	476	491	400	938	664	1290	532	720	460	796	424	0%	0.29
Total Kjeldahl Nitrogen	mg/L			10.3	12	16.8	9.5	13.6	22.0	16.4	19.8	19.5	19.4	18.2	10.4	16.3	14.7	7.5	9.7	21.6	11.4		
Total Organic Carbon	mg/L						47.5	51.0	18.6	41.8	69.1	72.9	55.5	25.7	23.5	69.7	51.7	136	130	60.4	76.8		
Total Phosphorus	mg/L	2	USEPA Multi-Sector General Permit	3.2	4.7	2.52	2.37	2.04	2.38	1.8	3.41	2.97	1.73	2.7	1.74	2.45	1.98	1.83	3	1.94	3.12	67%	1.27
Total Suspended Solids	mg/L	100	USEPA Multi-Sector General Permit	240	48	176	160	97	1070	590	120	128	7440	890	2900	764	8140	7780	1560	692	1080	89%	18.82
Turbidity	NTU	20	Basin Plan	48.4	19.9	54.7	141	72.8	1000	383	90.6	3270	4540	60.2	537	129	192	147	646	197	526	94%	33.49
Pesticides																							
Chlorpyrifos	µg/L	0.02	CA Dept. of Fish & Game	0.06	0.08	0.09	0.168	<0.03*	<0.03*	<0.01	0.085	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.002	<0.002	<0.002	31%	1.67
Diazinon	µg/L	0.08	CA Dept. of Fish & Game	0.74	0.53	0.57	0.372	0.506	0.339	0.584	0.276	0.907	<0.01	0.394	0.169	0.241	0.278	0.128	0.347	0.272	0.390	94%	4.90
Malathion	µg/L	0.43	CA Dept. of Fish & Game				1.00	0.88	0.27	1.46	0.788	0.284	<0.01	0.498	<0.01	0.641	<0.02	<0.02	1.940	<0.006	0.736	53%	1.32
Hardness																							
Total Hardness	mg CaCO3/L			970	352	286	279	334	395	328	308	417	702	376	350	544	706	496	379	348	263		
Total Metals																							
Antimony	mg/L	0.006	Basin Plan	0.003	0.003	0.003	<0.002	0.002	0.003	<0.005	<0.006	<0.005	<0.005	<0.005	<0.005	<0.005	0.005	<0.005	0.004	0.008	0.004	6%	0.52
Arsenic	mg/L	0.34/0.05	40 CFR 131/ Basin Plan	0.007	0.008	0.006	0.005	0.008	0.018	0.011	0.009	0.055	0.013	0.01	0.003	0.014	0.019	0.012	0.025	0.009	0.009	6%	0.27
Cadmium	mg/L	(b)	40 CFR 131	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.005	0.001	<0.001	<0.001	<0.001	0.006	0.001	0.006	<0.001	<0.001	0%	0.21
Chromium	mg/L	(b)	CTR (Cr VI)	0.02	0.013	0.006	<0.005	0.006	0.049	0.026	<0.005	0.189	<0.005	0.014	0.006	<0.005	0.006	0.006	0.05	0.031	0.024	0%	0.04
Copper	mg/L	(b)	40 CFR 131	0.028	0.013	0.016	0.008	0.021	0.053	0.058	0.02	0.197	0.017	0.038	0.043	0.013	0.082	0.011	0.07	0.104	0.045	50%	1.66
Lead	mg/L	(b)	40 CFR 131	0.025	0.005	0.009	0.004	0.011	0.045	0.048	0.007	0.278	0.009	0.057	0.056	0.009	0.089	0.008	0.102	0.078	0.047	56%	2.95
Nickel	mg/L	(b)/0.1	40 CFR 131/ Basin Plan	0.044	0.033	0.028	0.003	0.021	0.040	0.029	0.013	0.101	0.051	0.015	0.019	0.025	0.050	0.017	0.037	0.032	0.023	6%	0.32
Selenium	mg/L	0.02	40 CFR 131	<0.002	0.008	<0.002	<0.004	<0.004	<0.004	<0.005	<0.005	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	<0.004	0%	0.13
Zinc	mg/L	(b)	40 CFR 131	0.120	0.041	0.062	<0.020	0.077	0.269	0.288	0.056	1.53	0.165	0.392	0.337	0.109	1.100	0.176	0.558	0.456	0.296	33%	0.92
Dissolved Metals																							
Antimony	mg/L	(e)	40 CFR 131	<0.002	<0.002	0.002	0.004	0.003	0.004	<0.005	<0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.003	0.005	0.003		
Arsenic	mg/L	0.34 (c)	40 CFR 131	0.005	0.004	0.005	0.010	0.008	0.005	0.003	0.006	0.006	<0.002	<0.002	<0.002	0.007	0.003	<0.001	0.004	<0.001	<0.001	0%	0.01
Cadmium	mg/L	(b)	40 CFR 131	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0%	0.10
Chromium	mg/L	(b)	40 CFR 131	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0%	0.01
Copper	mg/L	(b)	40 CFR 131	0.008	<0.005	<0.005	0.011	0.060	0.013	0.005	0.01	0.005	0.005	<0.005	<0.005	0.008	0.012	0.009	0.01	0.01	0.008	6%	0.40
Lead	mg/L	(b)	40 CFR 131	<0.002	0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	<0.002	<0.002	<0.002	<0.002	<0.001	<0.001	<0.001	0%	0.13
Nickel	mg/L	(b)	40 CFR 131	0.033	0.028	0.024	0.018	0.017	0.013	0.003	0.011	0.007	0.006	0.009	0.006	0.014	0.013	0.008	0.007	0.011	0.007	0%	0.09
Selenium	mg/L	0.02 (d)	40 CFR 131	<0.002	<0.002	<0.002	<0.004	<0.004	<0.004	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.004	<0.004	<0.004	0%	0.01
Zinc	mg/L	(b)	40 CFR 131	<0.020	0.026	0.057	0.062	0.130	0.046	<0.02	<0.02	<0.02	<0.02	0.023	<0.020	0.033	0.031	<0.020	0.021	0.02	<0.02	0%	0.09
Toxicity																							
Ceriodaphnia 96-hr	LC50 (%)	100		36.11	17.36	32.99	19.5	10.15	32.98	14.36	18.95	17.68	50	25	25	25	35.36	35.36	16.49	16.49	17.68	100%	4.72
Ceriodaphnia 7-day survival	NOEC (%)	100		12.5	12.5	12.5	12.5	6.25	12.5	6.25	12.5	6.25	25	25	25	12.5	12.5	12.5	6.25	6.25	6.25	100%	10.00
Ceriodaphnia 7-day reproduction	NOEC (%)	100		6.25	12.5	6.25	12.5	6.25	12.5	6.25	12.5	12.5	50	25	25	12.5	12.5	12.5	6.25	6.25	6.25	100%	10.33
Hyalella 96-hr	NOEC (%)	100		100	100	100	100	100	50	50	100	50	100	100	100	50	50	100	25	12.5	50	44%	1.33
Selenastrum 96-hr	NOEC (%)	100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0%	0.00

See last page for footnotes and source references.

Table 12-4. Analytes Measured at the Tijuana River Mass Loading Station.

Blank spaces have been verified and no data is available due to changes in the monitoring program.

[1] The Water Quality Objectives (WQO) are benchmarks for comparison of storm water results and were selected by the Copermittee Monitoring Workgroup for this program.

(a) Un-ionized Ammonia is a calculated value, non-detectable values calculated at the detection limit. Basin Plan WQO is 0.025 mg/L; values shown here have been converted to μg/L.
(b) Water Quality Objective for dissolved metal fractions are based on total hardness and are calculated as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000.
(c) Water Quality Objectives for dissolved metal fractions are based on water effects ratios (WER) and are calculated as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000.
(d) Water Quality Objective is based on the total recoverable form as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000.
(e) USEPA has not published an aquatic life criterion value.

Shaded text – bold values are above the **CCC** water quality objective and bold/underlined results are above the **CMC** water quality objective.

* Indicates detection limit above water quality objective, and not included in frequency above water quality objective calculation.

Sources
USEPA National Pollutant Discharge Elimination System (NPDES) Storm Water Multi-Sector General Permit for Industrial Activities, 65 Federal Register (FR) 64746, Final Reissuance, October 30, 2000. Table 3 - Parameter benchmark values.
Siepmann and Finlayson 2000.
Basin Plan, September 8, 1994.
Assembly Bill 411 - Title 17 of the California Code of Regulations, Section 7958.
USEPA Federal Register Document 40 CFR Part 131, May 18, 2000.

Conventional constituents with results above their respective benchmark WQO during the 2006-2007 wet weather season include oil and grease, un-ionized ammonia, biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved phosphorus, total phosphorus, total suspended solids (TSS), and turbidity. The result for un-ionized ammonia was above the benchmark WQO of 25 µg/L during all three monitoring events (74.6 µg/L during the October 14, 2006 event, 48.6 µg/L during the January 30, 2007 event, and 96.7 µg/L during the April 20, 2007 monitoring event). The result for COD was above the benchmark WQO of 120 mg/L during all three monitoring events (522 mg/L during the October 14, 2006 event, 480 mg/L during the January 30, 2007 event, and 379 mg/L during the April 20, 2007 monitoring event). The result for TSS was above the benchmark WQO of 100 mg/L during all three monitoring events (1,560 mg/L during the October 14, 2006 event, 692 mg/L during the January 30, 2007 event, and 1,080 mg/L during the April 20, 2007 monitoring event). The result for turbidity was above the benchmark WQO of 20 NTU during all three monitoring events (646 NTU during the October 14, 2006 event, 197 NTU during the January 30, 2007 event, and 526 NTU during the April 20, 2007 monitoring event). BOD was above the benchmark WQO of 30 mg/L during the January 30 and April 20, 2007 monitoring events (77.7 and 67.6 mg/L respectively). Dissolved phosphorus was above the benchmark WQO of 2 mg/L during only the April 20, 2007 monitoring event (2.36 mg/L). Total phosphorus was above the benchmark WQO of 2 mg/L during the October 14, 2006 and April 20, 2007 monitoring events (3 mg/L and 3.12 mg/L respectively).

All three of the bacterial indicators, total and fecal coliform, and enterococcus, had very high densities observed during all three storm events. Fecal coliform is the only bacterial indicator with a benchmark WQO for wet weather monitoring. Fecal coliform results were above the REC-1 benchmark WQO of 4000 MPN/100 mL during all three monitoring events. Fecal coliform results were 16,000,000 MPN/100mL during the October 14, 2006 event, 2,200,000 MPN/100mL during the January 30, 2007 event, and 1,700,000 MPN/100mL during the April 20, 2007 monitoring event.

The pesticide Diazinon was above the benchmark WQO of 0.08 µg/L during all three monitoring events during the 2006-2007 wet weather season (0.347 µg/L during the October 14, 2006 event, 0.272 µg/L during the January 30, 2007 event, and 0.390 µg/L during the April 20, 2007 monitoring event). Malathion was detected above the benchmark WQO of 0.43 µg/L during both the October 14, 2006 and April 20, 2007 monitoring events (1.940 and 0.736 µg/L, respectively) but was not detected during the January 30, 2007 monitoring event.

Total metals antimony, copper, lead, and zinc were above their respective benchmark WQOs during the 2006-2007 season. Antimony was above the Basin Plan benchmark WQO during the January 30, 2007 event (0.008 mg/L). Total copper was above both the hardness-based acute and chronic benchmark WQOs during all three monitoring events (0.07 mg/L, 0.104 mg/L, and 0.045 mg/L, respectively). Total lead was above the hardness-based chronic benchmark WQO during all three monitoring events (0.102 mg/L, 0.078 mg/L, and 0.047 mg/L, respectively) but below the acute benchmark WQO. Total zinc was above the acute and chronic hardness-based benchmark WQO during all monitored events (0.558 mg/L, 0.456 mg/L, and 0.296 mg/L, respectively).

The dissolved metals antimony, arsenic, copper, nickel, and zinc were all detected during the 2006-2007 monitoring season. However no dissolved metals were above their respective benchmark WQO.

Toxicity was observed for the acute, chronic, and reproductive endpoints for *Ceriodaphnia dubia* during all three sample events of the 2006-2007 wet weather monitoring season. The no observed effect concentration (NOEC) is the concentration of test sample where there was no observed toxicity effect to the test organisms. For example, if the NOEC value for a particular toxicity test is 25% then the sample with a dilution concentration of 50% storm water would have shown a toxic effect to the test organisms while the 25% storm water would not show a toxic effect. The NOEC for the 96-hour survival for *C. dubia* was 16.49%, 16.49%, and 17.68% of the test sample for the three storm events respectively; the NOEC for the 7-day survival and the 7-day reproduction for *C. dubia* was 6.25% of the test sample for each of the three monitoring events. Toxicity was observed for the acute endpoint for *Hyalella azteca* during all three monitoring events. The NOEC for the 96-hour survival for *H. azteca* was 25%, during the October 14, 2006 event, 12.5% during the January 30, 2007 event, and 50% during the April 20, 2007 monitoring event. Toxicity was not observed to the freshwater algae *Selenastrum capricornutum* at the Tijuana River MLS during the three sample events of the 2006-2007 wet weather monitoring season.

12.2.2 Monitoring Results Comparison to Benchmarks/Statistical Analyses/Trends

An evaluation of storm water monitoring data collected at the Tijuana River MLS over the past six years was performed. This evaluation compares the frequency of constituents measured above benchmark WQOs, statistical trend analyses, and comparison of the magnitude of exceedance.

12.2.2.1 Comparison to Benchmarks

Conventional constituents that have had concentrations frequently measured above their respective benchmark WQO (≥50%) are presented below with their respective frequency of occurrence above the benchmark WQO:

- Un-ionized ammonia – 87%
- Biochemical Oxygen Demand – 50%
- Chemical oxygen demand (COD) – 78%
- Total phosphorus – 67%
- Total suspended solids – 89%
- Turbidity – 94%

Several other constituents have had results above the benchmark WQO, but less frequently, over the past six monitoring seasons and are presented below:

- Dissolved phosphorus– 28%
- Nitrite as N – 6%
- Surfactants (MBAS) – 33%

At the Tijuana River MLS, all bacterial indicators have shown elevated density levels in all 18 storms monitored during the past 6 years. The Tijuana River bacteria levels are higher than any of the other watersheds in the monitored region.

It should be noted that the presence of elevated BOD, COD, TSS, and turbidity in combination with elevated bacterial densities are indicative of the presence of untreated wastewater.

Pesticides have also been consistently detected at the Tijuana River MLS during the past 6 years. Chlorpyrifos has been above the benchmark WQO in 31% of the monitoring events (n=5/16) although has not been detected in any monitoring events in the past three years. Diazinon results have been above the benchmark WQO during 94% (n=17/18) of the monitored events since 2001. Malathion results have been above the benchmark WQO during 53% (n=8/15) of the monitoring events, including two monitoring events during the 2006-2007 wet weather season.

The total metals copper, lead, and zinc are the most frequent metals detected above their respective hardness-based acute or chronic benchmark WQO. Total copper results have been above either the acute or chronic benchmark WQO during 50% (n=9/18) of the monitoring events. Total lead results have been above the chronic benchmark WQO during 56% (n=10/18) of the monitoring events but have never been above the acute benchmark WQO. Total zinc results were above both the acute and chronic benchmark WQO during 33% (n=6/18) of the monitoring events. Antimony results were above the chronic benchmark WQO during 6% of the monitoring events. Total arsenic results were above the acute and chronic benchmark WQO during 6% of the monitoring events.

Only one dissolved metal was found above the benchmark WQO during the past six monitoring seasons. Dissolved copper, while frequently detected, was above the hardness-based acute and chronic benchmark WQO during only 6% of the monitoring events but has not exceeded the benchmark WQO over the past four monitoring seasons.

The *Ceriodaphnia dubia* toxicity tests have shown toxicity for the acute, chronic, and reproductive endpoints in all 18 monitored events over the past 6 years (100%). Toxicity has been observed for *Hyalella azteca* during 8 of 18 monitoring events (44%) with five of the eight events occurring in the past two monitoring seasons. Toxicity has never been observed for the fresh water algae *Selenastrum capricornutum* at the Tijuana River MLS over the past 6 years of monitoring.

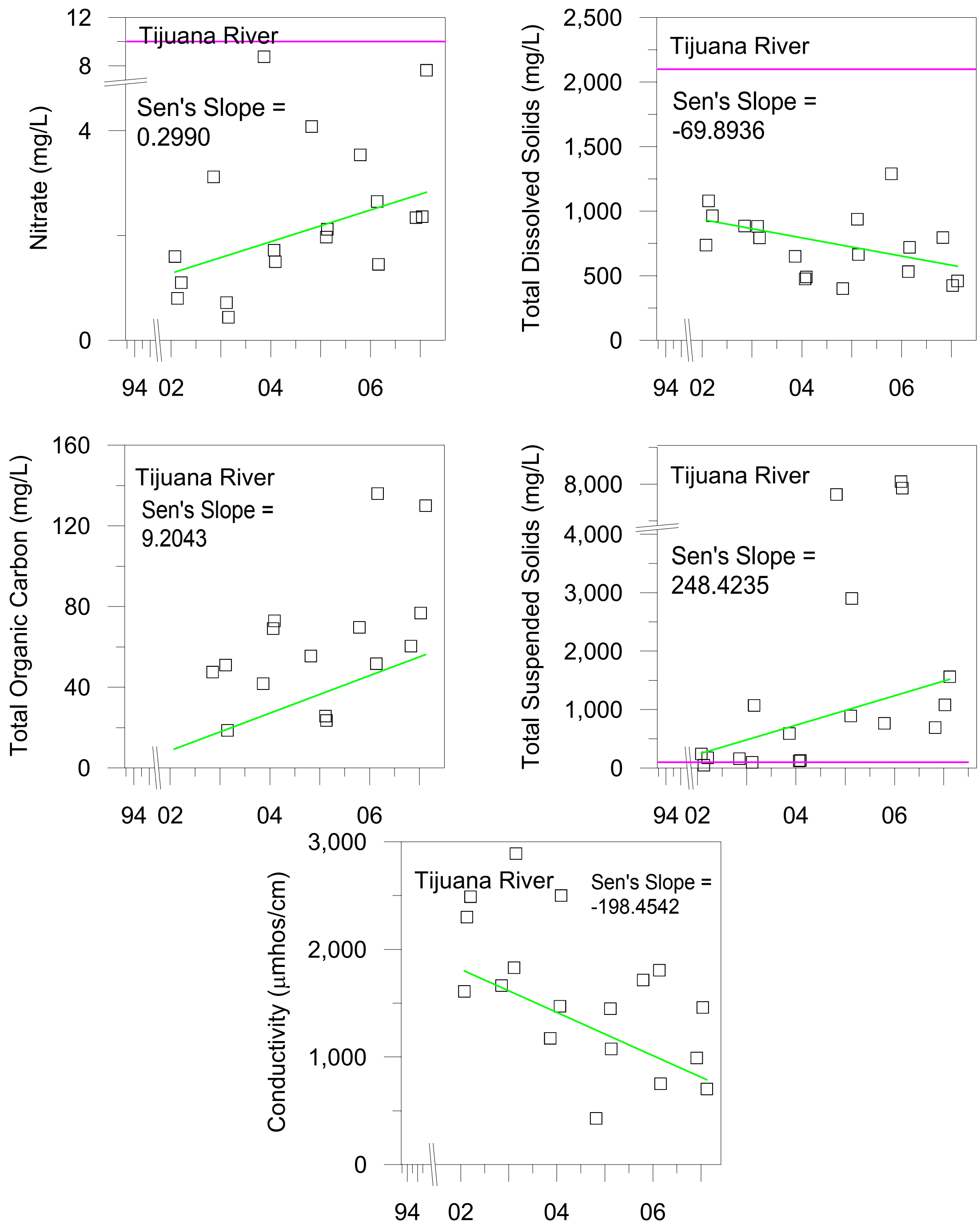
12.2.2.2 Trends

A non-parametric trend analysis was conducted using the Mann-Kendall trend test to evaluate the presence or absence of significant trends using all available monitoring data. This test is often employed for analysis of environmental time series data. The test does not assume any single distribution for the data being tested, which is an advantage when analyzing environmental data. This test does not incorporate magnitude, but instead calculates the number of positive and negative differences between samples. The number of positive and negative differences is summed to calculate the S statistic, which is compared to a table value to determine significance.

Sen's estimate of slope is shown on the graphs to illustrate the median trend of the data per constituent unit per year. This is not a predictive slope, but rather an estimate of the median true slope (change per unit time).

Any change in observed trends from prior years data to 2006-2007 is likely affected by the new use of methodology in trend analysis. The 2006-2007 data set analysis utilized the Mann-Kendall method for trend analysis which is insensitive to outliers (see Methods Section 3.5). Outliers may have influenced the estimate of trend in previous years due to the parametric trend test used. Only the significant trends are shown in this WMA section. All other scatterplots can be found in Appendix C. A table of trend results including the S values and critical S values is also included in Appendix C.

A review of the trend analysis for conventional constituents indicates a statistically significant increasing trend for nitrate, total organic carbon, total suspended solids, and turbidity and a statistically significant decreasing trend for conductivity and total dissolved solids over the monitoring period. The trend for nitrate (S=47) has a magnitude of 0.299 mg/L/yr (Figure 12-4). The trend for total organic carbon (S=41) has a magnitude of 9.20 mg/L/yr (Figure 12-4). The trend for TSS (S=67) has a magnitude of 248 mg/L/yr (Figure 12-4). The trend for turbidity (S=59) has a magnitude of 36.5 mg/L/yr (Figure 12-4). For the decreasing trends, the trend for conductivity (S=-55) has a magnitude of -198 μmhos/cm/yr and the trend for TDS (S=-51) has a magnitude of -69.9 mg/L/yr (Figure 12-4). It should be noted, however, that TSS and turbidity are the only conventional constituents with a significant trend where results are consistently above the benchmark WQO.



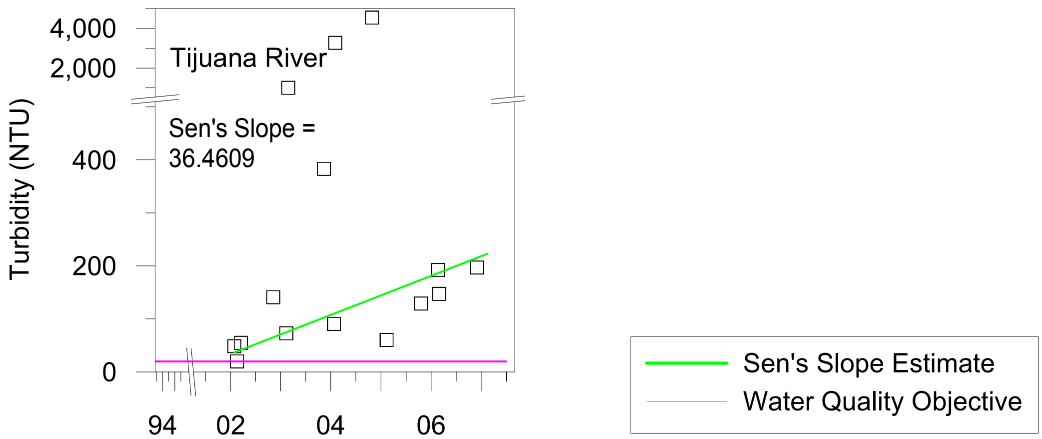


Figure 12-4. Scatterplots of Conventional Constituents with Significant Mann-Kendall Trends and Sen's Estimate of Slope.

A review of the trend analysis for bacteriological constituents indicates statistically significant increasing trends for total coliform (S=54) and fecal coliform (S=44) over the monitoring period. The trends however, only show a slight increase in bacteriological concentration over time, increasing only 0.140 MPN/100mL/yr and 0.148 MPN/100mL/yr, respectively (Figure 12-5). It should also be noted that the results for fecal coliform are consistently above the benchmark WQO.

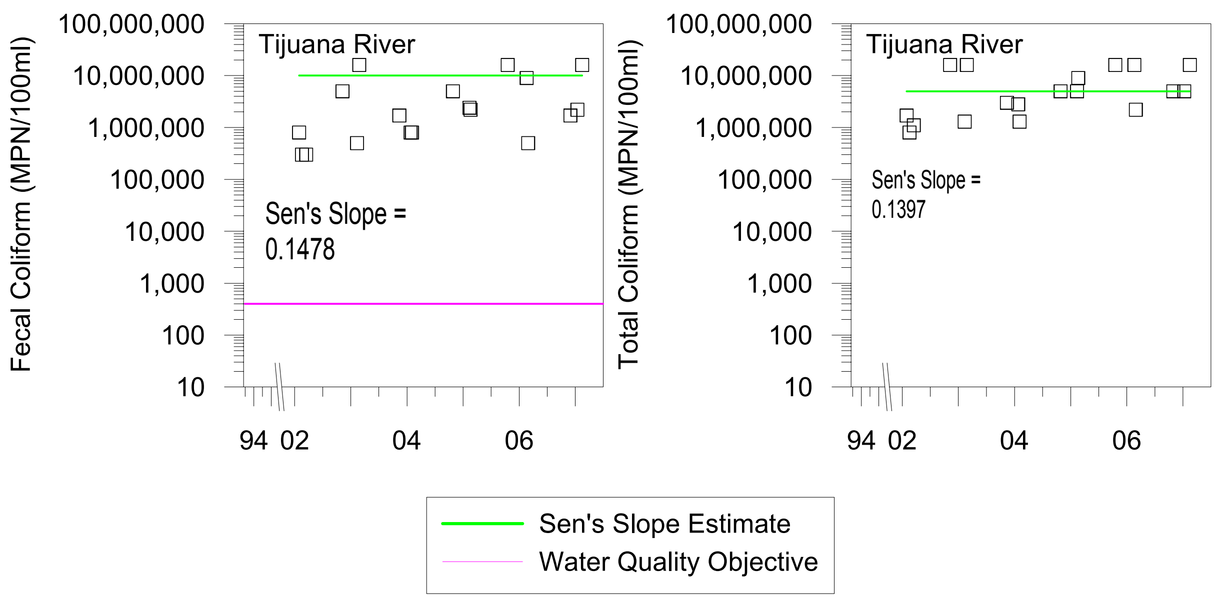


Figure 12-5. Scatterplots of Bacteriological Constituents with Significant Mann-Kendall Trends and Sen's Estimate of Slope.

A review of the trend analysis for pesticide constituents indicates a statistically significant decreasing trend for Diazinon (S=-57) over the monitoring period. The magnitude of the trend is -0.064 μg/L/yr (Figure 12-6). Although the majority of the results are above the benchmark WQO the trend indicates that Diazinon results will likely continue to decrease to levels below the benchmark WQO in future years.

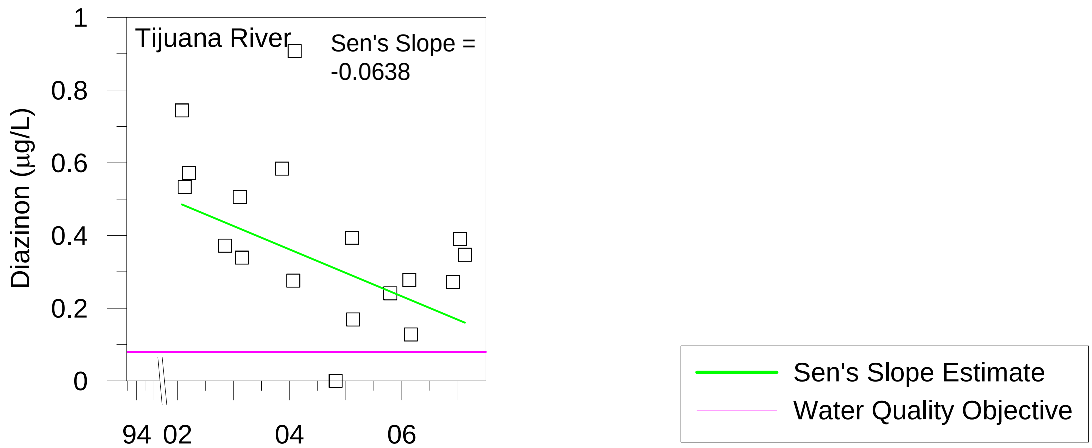


Figure 12-6. Scatterplots of Pesticide Constituents with Significant Mann-Kendall Trends and Sen's Estimate of Slope.

A review of the trend analysis for metals constituents indicates a statistically significant increasing trend for total arsenic, total lead and total zinc and a decreasing trend for dissolved arsenic and dissolved nickel. The trend for total arsenic (S=45) has a magnitude of 0.001 mg/L/yr (Figure 12-7). The trend for total lead (S=52) has a magnitude of 0.009 mg/L/yr and the trend for total zinc (S=69) has a magnitude of 0.063 mg/L/yr (Figure 12-7). It should also be noted that results for total lead and total zinc are also often above the benchmark WQOs (WQO not shown due to hardness calculation). The decreasing trend for dissolved arsenic has an S value of -67 however the Mann-Kendall test does not allow a calculation of the magnitude of the trend for datasets with greater than 15% non-detect values. As a result, the magnitude of the trend is not reported for dissolved arsenic. Dissolved nickel indicates a statistically significant decreasing trend (S=-73) over the monitoring period. The magnitude of the trend is -0.003 mg/L/yr (Figure 12-7).

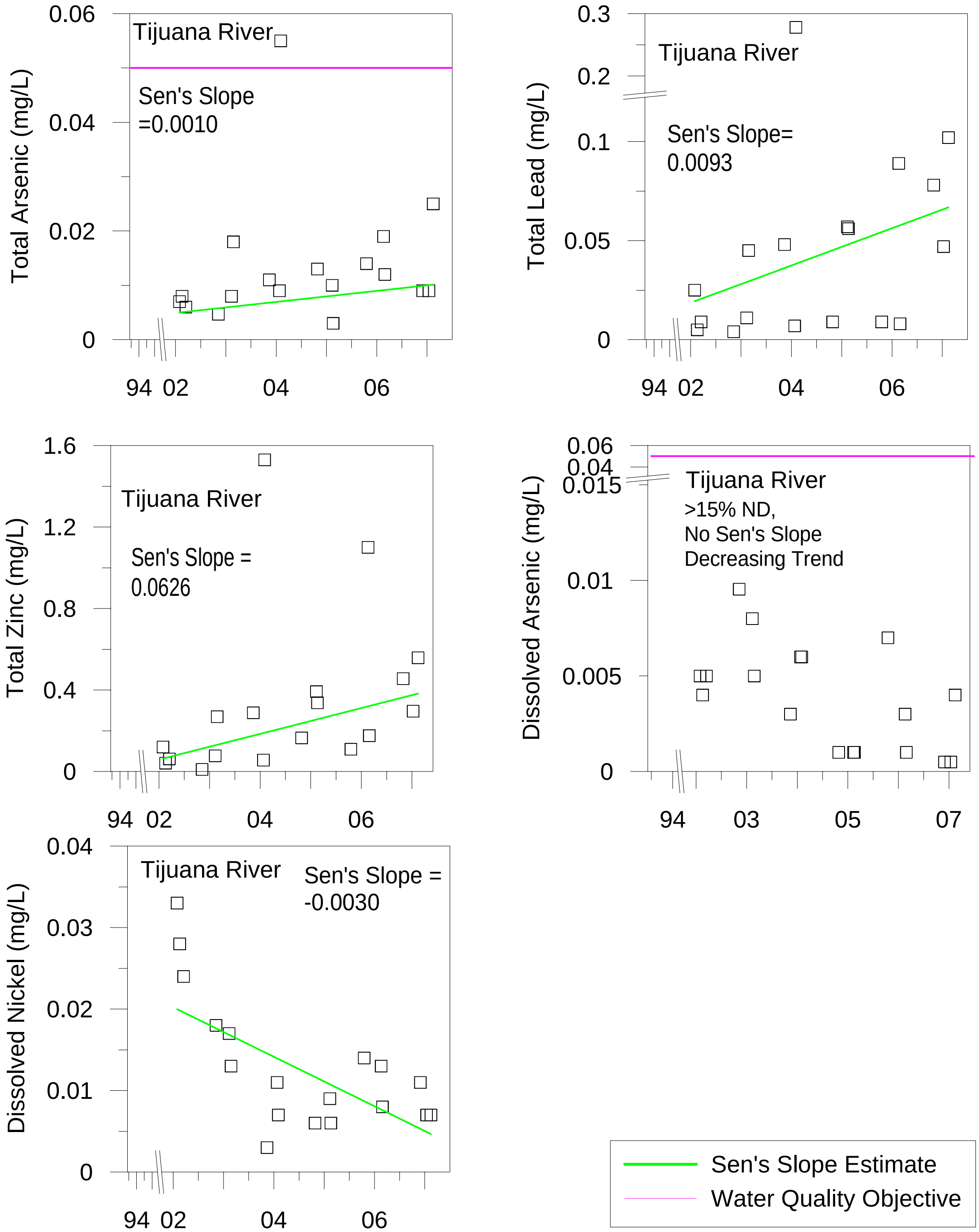


Figure 12-7. Scatterplots of Metals Constituents with Significant Mann-Kendall Trends and Sen's Estimate of Slope.

A review of the trend analysis for toxicity indicates a statistically significant increasing trend for *Hyalella azteca* acute survival (S=57) over the monitoring period. The magnitude of the trend is 0.005 NOEC%/yr (Figure 12-8). It should also be noted that results for *Hyalella* toxicity are frequently above the benchmark WQOs.

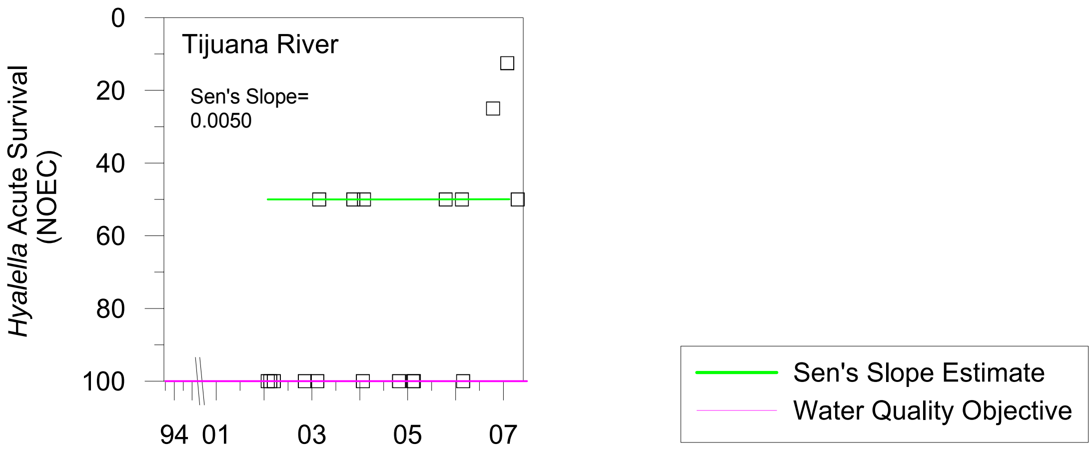


Figure 12-8. Scatterplots of Toxicity Constituents with Significant Mann-Kendall Trends and Sen's Estimate of Slope.

12.2.2.3 Magnitude of Exceedance

In order to illustrate the magnitude of the water quality constituents with results above the benchmark WQO for the 2006-2007 monitoring season, the ratio of water quality results to the benchmark WQOs were plotted for several of the most common constituents. The average ratio of the water quality result to the benchmark WQOs was also determined for each constituent by calculating the ratio of mean water quality results to the benchmark WQOs from all storm events from October 2001 through April 2007. The results are shown in Figure 12-9. The largest single benchmark WQO ratio was for fecal coliform, which was approximately 4,000 times the benchmark WQO during the October 14, 2006 storm event and over 2,000 times the benchmark WQO during the January 30, 2007 event. The mean result for fecal coliform for the past six monitoring seasons is nearly 1,000 times the benchmark WQO. These results are indicative that the Tijuana River receives discharges of raw wastewater. Other constituents with mean results above the benchmark WQO include TSS, turbidity, BOD, COD, ammonia, total phosphorus, Chlorpyrifos, Diazinon, Malathion, total copper, total lead, toxicity to the acute, chronic, and reproductive endpoints for *C. dubia*. Constituent results for the 2006-2007 monitoring season were fairly consistent with the mean ratio exceedances in that results from at least one storm event were above the benchmark WQO with the exception Chlorpyrifos which was below the benchmark WQO during all three monitoring events.

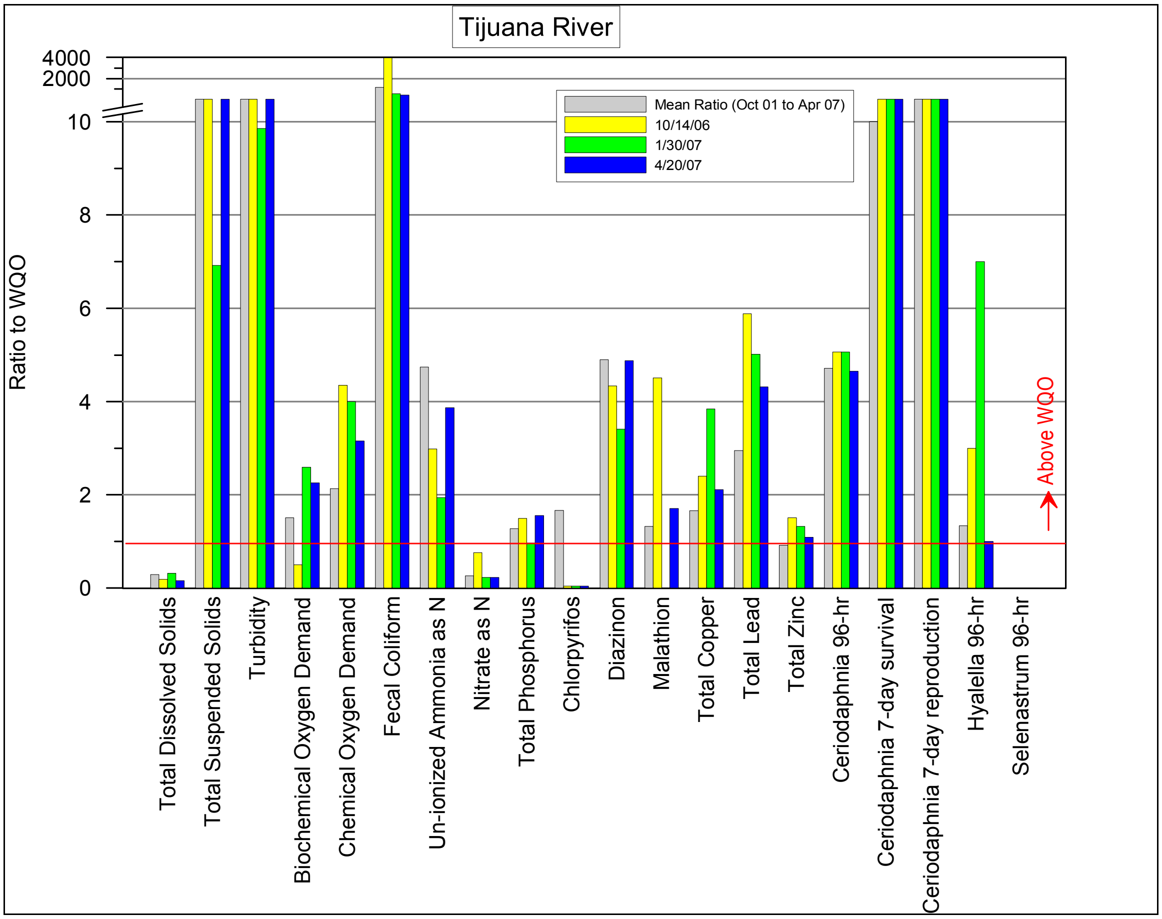


Figure 12-9. Tijuana River Water Quality Ratios.

12.2.3 Wet Weather Constituent Loadings Analysis

As discussed in the methods section, measured storm event loads may not represent the entire duration of the storm event due to monitoring constraints related to safety, autosampler pacings, and the unpredictable nature of rainfall events in general. For example, rain events can be scattered throughout the watershed and flow can stop and start again for any given storm event. Weston makes every attempt and uses best professional judgment to make decisions on cessation of sample collection. The modeled storm event loads represent the entire volume of runoff from the entire rainfall volume of the event. In order to compare the measured loads with the modeled loads, the proportion of the storm volume sampled must be determined. This proportion can be expressed as the ratio of the modeled volume of runoff for the storm event to the volume of water that passes by the MLS during sample compositing. This ratio is then used to estimate what the measured load would be if the entire event runoff were sampled. The estimation of the full storm load allows the comparison to expected loading based on land use and rainfall event modeling.

Measured loading values for each constituent sampled were derived using the event mean concentration (EMC) values obtained from composite samples collected at the TJR MLS site and the recorded volume of water discharged during the sampling period. The entire runoff for each storm event runoff was derived using the "Simple Method" (Schueler, 1987) based on event rainfall amounts and impervious areas in the MLS catchment. Entire storm event loads were estimated from measured loads using the proportion of runoff estimated through modeling to that runoff measured during sample compositing. The Simple Method is limited in that it makes assumptions regarding rainfall across an entire watershed. The Simple Method does not account for storage, evaporative loses, or retardation which more complex models are used for. Additionally, rainfall may vary throughout a watershed in intensity, duration, and volume.

Measured storm event loads were compared to loading values derived from the National Stormwater Quality Database (NSQD) (Pitt et al., 2004). For each land use, the 25^{th} percentile and the 75^{th} percentile EMC from the NSQD were used to derive area weighted EMC values for each MLS catchment. The interquartile range (between the 25^{th} and 75^{th} percentiles) of these area-weighted loads can be used as expected loads based on the national database. One can evaluate the degree of measured loading in terms of the range of expected loads.

Measured loads (estimated for the entire storm event) were compared to the 25^{th} and 75^{th} percentile loads estimated through land use and rainfall modeling (Table 12-5). Measured loading values that were above the range of expected loads are identified in Table 12-5 with a "+" symbol. Measured loading values that were below the range of expected loads are identified with a "-" symbol. Measured loading values within the range of expected loads are shown with a "0" symbol.

The comparison of the sampled runoff to the total runoff shows a difference between events. The amount of runoff ranged between 70 and 256 times more than was sampled. This variation represents differences in the duration of composite sampling times between storm events which ranged from 4.4 hours to 8.7 hours and due to the limitations of the Simple Method.

Measured loads of most of the constituents were greater than expected for a majority of the storm events sampled. Only cadmium and dissolved lead were consistently within the expected range or lower than expected.

Table 12-5. Modeled Loading Values Compared to Measured Loading Values for Tijuana River (TJR) Mass Loading Station.

MLS Station - Event	TJR Event 1	TJR Event 2	TJR Event 3
Event Date	14-Oct-2006	30-Jan-2007	20-Apr-2007
Composite Duration (hours)	6.1	8.7	4.4
Modeled to Composite Runoff Ratio	70	256	97
Conventional Constituents			
Oil & Grease	+	0	0
Total Dissolved Solids	+	+	+
Total Suspended Solids	+	+	+
Biochemical Oxygen Demand, 5-day	+	+	+
Chemical Oxygen Demand	+	+	+
Nutrients			
Ammonia	+	+	+
Nitrate+Nitrite	+	+	+
Total Kjeldahl Nitrogen	+	+	+
Dissolved Phosphorus	+	+	+
Total Phosphorus	+	+	+
Metals			
Cadmium, Total	+	–	–
Cadmium, Dissolved	0	0	0
Chromium, Total	+	+	+
Chromium, Dissolved	+	+	+
Copper, Total	+	+	+
Copper, Dissolved	+	+	+
Lead, Total	+	+	+
Lead, Dissolved	–	–	–
Nickel, Total	+	+	+
Nickel, Dissolved	+	+	+
Zinc, Total	+	+	+
Zinc, Dissolved	+	+	0
Bacterial Indicators			
Fecal Coliform	+	+	+
Total Coliform	+	+	+

+ Loading is greater than expected
- Loading is less than expected
0 Loading is within the expected range

12.2.4 2006 Dry Weather Monitoring Data Evaluation

In addition to the wet weather monitoring discussed above, a separate dry weather monitoring program is carried out by each jurisdiction. Dry weather monitoring reports are provided separately by each jurisdiction in its Jurisdictional Urban Runoff Management Program (JURMP) Annual Report. Dry weather data are also provided in a regional data sharing format which is used for the watershed management area assessments and regional comparisons in this report as described in Section 3. A total of 19 dry weather monitoring sites with field parameter and chemistry results are presented in this section and are shown on Figure 12-10.

Dry weather water quality monitoring was performed at 19 locations in the Tijuana River WMA during the 2006 dry weather monitoring program. The total number of samples collected for each analyte may differ from the number of sample locations due to multiple sample analysis at each location. Of these, 11 sites are located upstream of the mass loading station in the Tijuana River. A summary of the 2006 dry weather monitoring results for the Tijuana River WMA is presented below in Table 12-6.

Table 12-6. Summary of the 2006 Dry Weather Monitoring Results for the Tijuana River WMA.

Analyte	Units	DW Action Level	Number of Samples	RESULTS		
				Minimum	Mean	Maximum
Conductivity*	µS/cm	5,000	29	376	5,420	48,200
Oil & Grease	mg/L	15	14	0.50	2.31	8.90
pH	pH units	6.5-9	26	6.70	7.54	8.69
Enterococcus	MPN/100mL	10,000	14	1	14,184	160,000
Fecal Coliform	MPN/100mL	20,000	14	1	14,095	160,000
Total Coliform	MPN/100mL	50,000	14	1	219,349	1,600,000
Ammonia (NH3-N)	mg/L	1	25	0.01	1.45	10
Orthophosphate (PO4-P)	mg/L	2	25	0.03	1.37	10
Nitrate (NO3-N)	mg/L	10	26	0.04	0.87	3
MBAS	mg/L	1	14	0.03	1.39	16.60
Turbidity**	NTU	20	24	0.01	75.49	1000
Chlorpyrifos	µg/L	0.5	14	0	0.02	0.03
Diazinon	µg/L	0.5	14	0.03	0.03	0.03
Hardness	mg CaCO3/L		15	153	290	445
Cadmium Dissolved	µg/L	(a)	14	1.04	2.18	2.50
Copper Dissolved	µg/L	(a)	14	1.04	21.77	72
Lead Dissolved	µg/L	(a)	14	1.04	2.15	2.50
Zinc Dissolved	µg/L	(a)	14	7.22	39.90	95.50

* Action Levels were adopted by the Dry Weather Working Group (Table 3-8) and are based on best professional judgment (BPJ).

** For Action Level the Basin Plan benchmark WQO was used instead of BPJ when comparing with MLS data.

Mean values are calculated including non-detect results at half the reporting limit. If the mean value was less than the reporting limit, then the mean was not included in the table.

(a) Dry weather action level for dissolved metal fraction based on total hardness and calculated as described by the USEPA Federal Register Doc. 40 CFR Part 131, May 18, 2000. If Total Hardness was greater than 400 mg/L, then 400 mg/L was used to calculate dissolved metals water quality objectives.

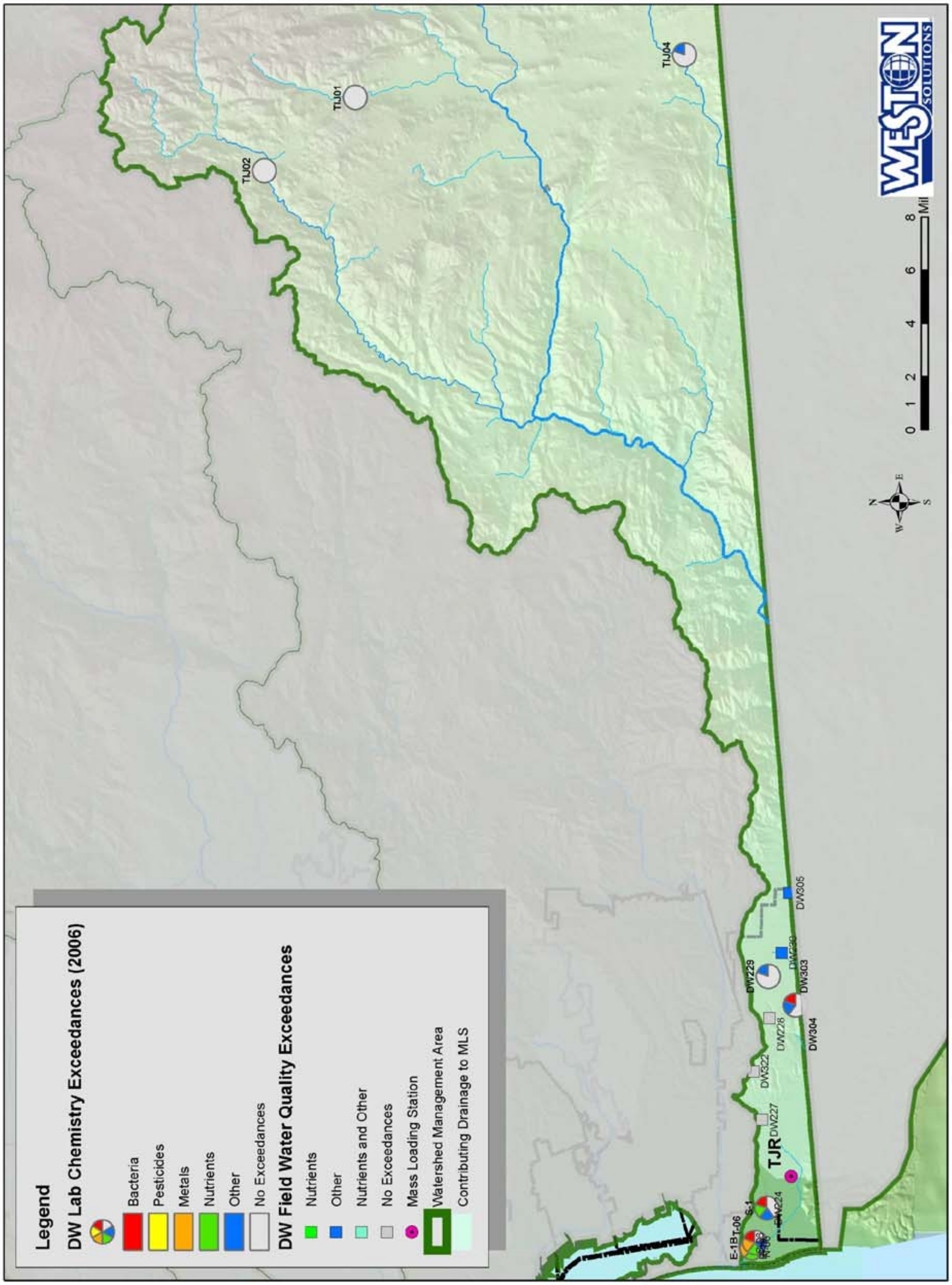


Figure 12-10. Tijuana River WMA Dry Weather Exceedance Map.

Table 12-7 summarizes the 2006 Dry Weather Program constituent exceedances for the Tijuana River WMA. Constituent results that were above the dry weather action level at the dry weather monitoring sites include conductivity, enterococcus, total and fecal coliform, ammonia, orthophosphate, MBAS, turbidity, and dissolved copper.

Table 12-7. Tijuana River WMA 2006 Dry Weather Exceedance Matrix.

Analyte	Category	Total	Number of Exceedances	Average Ratio of Exceedance*	St. Dev. Ratio of Exceedance
Conductivity	Other	29	3	1.08	2.54
Enterococcus	Bacteria	14	2	1.42	4.27
Fecal Coliform	Bacteria	14	1	0.70	2.12
Total Coliform	Bacteria	14	4	4.39	9.30
Ammonia (NH3-N)	Other	25	7	1.45	2.73
Orthophosphate (PO4-P)	Nutrients	25	6	0.69	1.07
MBAS	Other	14	1	1.39	4.38
Turbidity	Other	24	10	3.77	10.21
Copper Dissolved	Metals	14	5	0.64	0.81
Tijuana River Total		**309**	**39**	**0.99**	**4.00**

* Average ratio of exceedance is equal to the average concentration for all samples collected divided by the dry weather action level.

Constituents with average ratios of exceedance and standard deviations greater than one indicate more frequent and wider ranges of exceedances. Constituents with average ratios of exceedance and standard deviations less than one indicate exceedances that occur on a more random and infrequent basis. In the Tijuana River WMA, conductivity, enterococcus, total coliform, ammonia, MBAS, and turbidity had average ratios of exceedance greater than one.

Figure 12-10 depicts the 2006 dry weather program monitoring sample locations. Locations shown with circles have both field parameters and laboratory sample results. Locations shown as squares have field parameter results only. Pie symbols appear at dry weather stations that have had dry weather action level exceedances. The colored slices of the pie show the different constituent groups that contributed to the exceedances.

12.2.5 TIEs

Toxicity identification evaluation (TIE) testing was not performed on Tijuana River samples during the 2006-2007 monitoring season. A TIE may be useful in determining the specific contaminants causing toxicity in water samples. However, given the presence of Diazinon exceeding the benchmark WQO during each storm event, it is likely that Diazinon was a contributor to the toxicity of the Tijuana River samples to *Ceriodaphnia dubia*. Diazinon has a low solubility and a tendency to bind to organic matter and sediments (Ladaa et al., 1998). In addition, threshold analyses performed during the 2005-2006 data analysis indicate that Diazinon concentrations were above the threshold and would likely induce toxic responses to *Ceriodaphnia* (Weston, 2007).

Non-polar organic compounds were identified in the 2002-2003 and 2003-2004 TIE testing. Diazinon was the suspect contaminant in these testing periods as determined by methanol fractionation procedures.

TIEs are not recommended for future monitoring seasons in the Tijuana River MLS samples unless notable declines in the concentration of diazinon are observed and toxicity remains persistent.

12.2.6 Watershed Water Quality Monitoring Summary

Conventional constituents most prevalent in the Tijuana River that pose the greatest concern are typical of conditions found with untreated wastewater. BOD, COD, TSS, turbidity, and nutrients (un-ionized ammonia-N and total phosphorus) consistently are found above the benchmark WQOs. Additionally, although total coliform and enterococci do not have corresponding benchmark WQOs, results for these bacterial indicators have consistently been observed at highly elevated densities and are also indicative of conditions found with untreated wastewater. Pesticides have also been frequently observed above the benchmark WQO in the Tijuana River MLS samples. Diazinon, in particular, has been above the benchmark WQOs in 17 of the last 18 monitored events and has been identified in previous years as the likely cause of toxicity in the Tijuana River. Malathion has also been observed in concentrations above the benchmark WQO in 8 of the last 15 monitored events, and in 2 of 3 events in the 2006-2007 monitoring season.

12.3 Stream Bioassessment

Stream bioassessment monitoring in the Tijuana River WMA was conducted at a single site in October 2006 in Campo Creek. For the October survey, the only flowing portion of the stream was at the Highway 94 overcrossing in the town of Campo (CC-C). This site has relatively poor habitat quality with fine organic deposits and lacks good riffles. Two sites were sampled in May 2007, including the Campo Creek site (which was moved approximately 1/3 mile downstream to a reach with better habitat) and a site on the Tijuana River near the border fence (TJ-BF). The Tijuana River site was not sampled in October due to dry conditions and was moved upstream from the historical sampling reach near Dairy Mart Road to a point just below the Tijuana flood control channel for the May survey. The two sites are relatively close and have very similar habitat characteristics. Future surveys will likely sample this new reach to ensure the presence of flowing water.

To assess the quality of the benthic macroinvertebrate communities at each site, biological metrics were calculated as well as two summary indices. The summary indices included a multi-metric Index of Biotic Integrity (IBI) and an Observed to Expected ratio (O/E), both of which are specific to Southern California ecological conditions.

The IBI is the cumulative score (0-70) of seven biological metrics, with the final score divided into five quality rating categories ranging from Very Poor to Very Good. An IBI score above 26 is presumed to represent unimpacted conditions.

O/E is the ratio of organisms observed at a site (O) to the organisms expected to occur at a site (E). An O/E ratio of greater than 0.8 indicates unimpacted conditions, and represents a 20 percent loss of expected taxa (i.e. 0.8 is 20 percent below 1.0). These indices are described in greater detail in Methods Section 3.2.7. While the IBI and O/E ratio are very useful at broadly identifying impairment, analysis of individual taxa present (often in low numbers) may provide signals of benthic community quality that are too weak to be represented by summary indices.

An additional analysis was performed to assess macroinvertebrate community quality trends since the beginning of this monitoring program in 2001. The analysis was performed separately for the two summary indices described above, the IBI and O/E ratios.

12.3.1 Results and Discussion

Campo Creek Monitoring Site: CC-C

The Campo Creek monitoring site had a benthic macro-invertebrate community with an Index of Biotic Integrity rating of Very Poor for the October 2006 survey and Fair for the May 2007 survey, with IBI scores of 4 and 29, respectively (Table 12-8). The results of the O/E analysis show that the Campo Creek monitoring site had O/E ratios of 0.37 and 0.62. This implies that the benthic community has lost an estimated 63 to 38 percent of the biodiversity expected to occur at the site. These results indicate that for the May survey the site was unimpaired according to the IBI, but somewhat impaired by the O/E ratio.

The May survey sampled a stream reach that had much better riffle habitat than the October survey (discussed below), and this may account for the significantly higher scores for the May surveys. The higher quality downstream reach that was sampled in May does not flow during dry years and the upper reach sampled in October is the only portion of Campo Creek that has had flow in dry years.

Table 12-8. Selected Biological Metrics and Physical Measures of the Tijuana River WMA.

Tijuana River Watershed Management Area	Campo Creek in Campo (CC-C)		Tijuana River at the Border Fence (TJ-BF)
Survey	**Oct-06**	**May-07**	**May-07**
Index of Biotic Integrity/ Qualitative Rating*	**4 Very Poor**	**29 Fair**	**17 Poor**
O/E Ratio**	**0.37**	**0.62**	**0.25**
Metrics			
Taxa Richness	12	20	10
EPT Taxa (mayflies, stoneflies, and caddisflies)	0	5	0
% Intolerant Taxa	0.0%	0.2%	0.0%
% Tolerant Taxa	61.5%	27.8%	43.0%
Average Tolerance Value	6.9	6.5	7.4
% Collector Filterers + Collector Gatherers	89%	79%	73%
Physical Measures			
Elevation	2550		25
Physical Habitat Score	95	125	37
Riffle Velocity (ft/sec)	0.1	0.1	0.6
Substrate Composition			
Silt	30%	7%	83%
Sand	32%	43%	10%
Gravel	3%	2%	7%
Cobble		7%	
Boulder	10%	5%	
Roots	25%	10%	
Bedrock/Solid		26%	
Water Quality			
Temperature ˚C	13.2	12.4	27.5
pH	7.7	8.2	7.8
Specific Conductance (ms/cm)	1.413	1.315	2.495
Dissolved Oxygen (mg/l)	3.34	8.61	0.73

*IBI Score 0-13=Very Poor, 14-26=Poor, 27-40=Fair, 41-55=Good, 56-70=Very Good
**O/E ratio of >0.8 represents unimpacted conditions

There were 12 and 20 different taxa collected, including 0 and 5 different EPT taxa in October and May, respectively. The percent tolerant taxa comprised 62 and 28 percent of the community per survey and percent intolerant (sensitive) taxa comprised 0.2 percent of the community in the May survey.

In the October survey, the benthic community was dominated by the amphipod, *Hyalella*, Oligochaetes (earthworms), and the clam, *Pisidium* (Table 12-9). In May, the community was dominated by chironomid midges, the non-native snail *Physa*, and Ostracods. The high numbers of *Hyalella* and Oligochaetes in October was likely due to the high levels of fine particulate organic matter in the sampling reach. There were several organisms collected in low numbers in the May survey that are typically only collected at reference sites. These included the mayfly, *Paraleptophlebia*, the caddisfly, *Ochrotrichia*, and an immature chloroperlid stonefly (Appendix B.2-2). The collection of four different Coleoptera taxa (beetles) was also a signal of good benthic community quality. The clam, *Pisidium* is more commonly collected at reference sites, but considering the organism's high tolerance value this is probably more related to water temperature than water quality.

Table 12-9. Macroinvertebrate Community Summary: Five Most Abundant Taxa for the Tijuana River WMA

		Taxon	Common Name	Percent Composition	Tolerance Value	Functional Feeding Group
Campo Creek in Campo (CC-C)	Oct-06	***Hyalella***	**amphipod**	**39%**	**8**	**Collector Gatherer**
		Oligochaeta	earth worm	30%	5	Collector Gatherer
		Pisidium	clam	11%	8	Collector Filterer
		Ostracoda	seed shrimp	6%	8	Collector Gatherer
		Physa	aquatic snail	4%	8	Scraper
	May-07	Chironomidae	non-biting midges	63%	6	Collector Gatherer/Filterer
		Physa	aquatic snail	14%	8	Scraper
		Ostracoda	seed shrimp	10%	8	Collector Gatherer
		Oligochaeta	earth worm	3%	5	Collector Gatherer
		Callibaetis	minnow mayfly	2%	5	Collector Gatherer
Tijuana River at the border fence (TJ-BF)	May-07	***Psychoda***	**bathroom fly**	**41%**	**10**	**Scraper**
		Oligochaeta	earth worm	27%	5	Collector Gatherer
		Muscidae	true fly	13%	6	Predator
		Ephydridae	shore fly	13%	6	various
		Culicoides	biting midges	2%	6	Predator

The physical habitat of the monitoring reach was marginal to sub-optimal. The downstream monitoring reach that was sampled in May had better habitat quality than the October sampling reach, with a much lower percent of silt in the streambed. A moderate amount of cobble, boulder, emergent vegetation, and tree roots provided stable habitat for invertebrate colonization. Specific conductance was relatively low with values of 1.413 and 1.315 mS/cm. Values for pH were 7.7 and 8.2. Water temperatures were lower than the other urban sites in the program, with values of 13.2º and 12.4º C.

The Tijuana River mass loading station was too spatially disconnected from Campo Creek to correlate any of the storm water information with the benthic community.

Summary Indices Results Over Time

The Campo Creek site has been sampled seven times since October of 2004. The mean IBI scores have significant seasonal variation, with mean values of 8.3 for October surveys and 18.0 for May surveys (Figure 12-11). Individual IBI scores have ranged from 4 (May 2005, October 2006) to 29 (May 2007). The May 2007 IBI score indicated an unimpaired benthic community. Whereas most sites in San Diego County have higher IBI scores in the fall, Campo Creek has been on average higher in the spring. This is likely due to the relatively high elevation and cooler water temperatures of the site, as reduced seasonality has often been observed at other higher elevation (>2,500 ft) sites.

The mean O/E ratios for the Campo Creek site were 0.64 for October surveys and 0.74 for May surveys (Figure 12-12). Three of the surveys (May 2004, October 2005, and May 2006) rated the benthic community unimpaired. The O/E results indicated an overall higher benthic community quality than the IBI scores, but both showed similar variability and within year rankings.

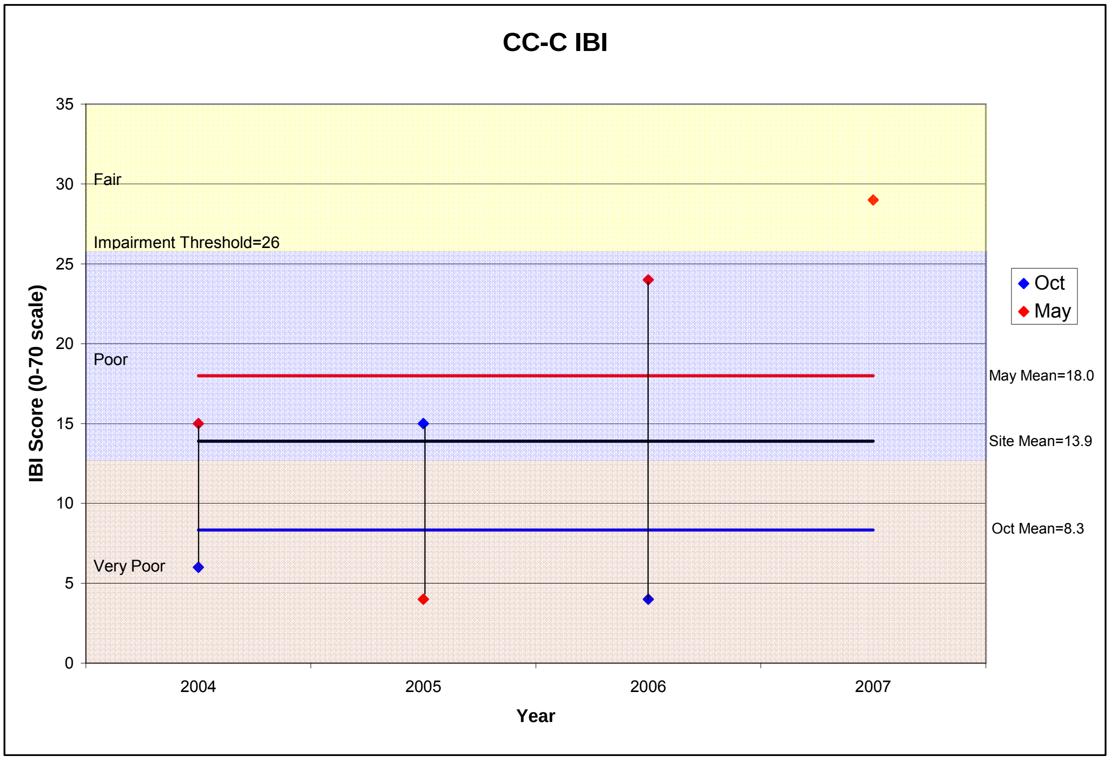


Figure 12-11. Index of Biotic Integrity for Campo Creek in Campo (CC-C).

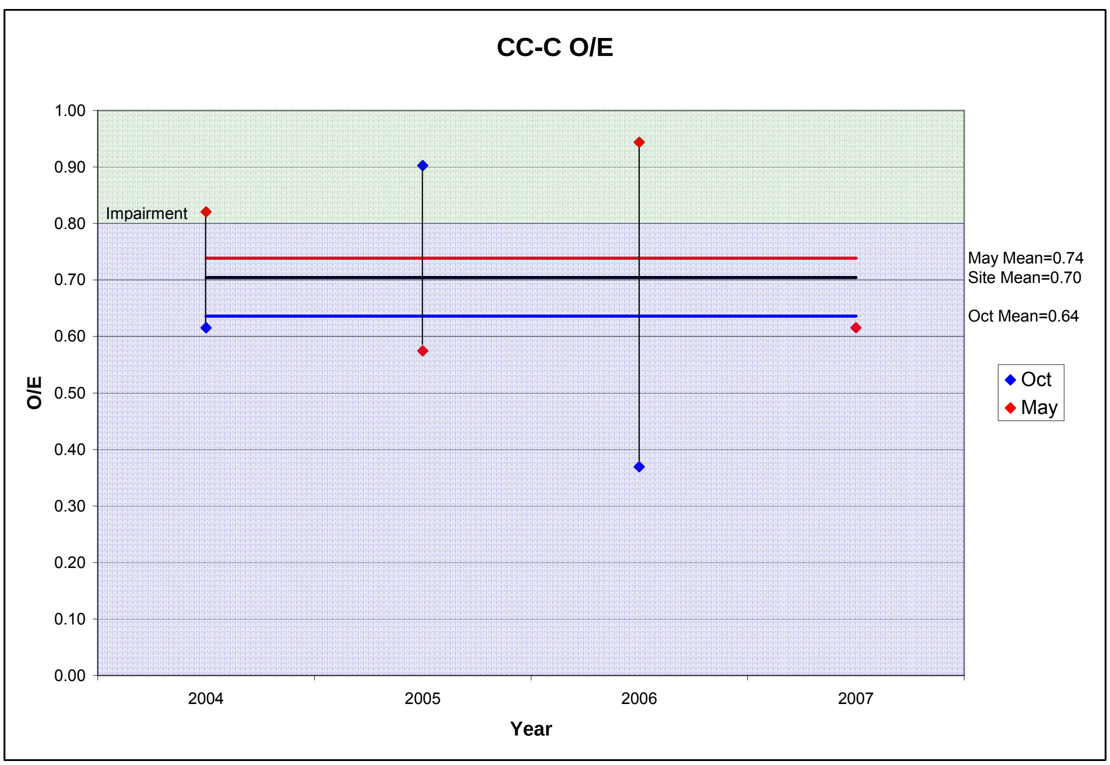


Figure 12-12. O/E Ratio for Campo Creek in Campo (CC-C).

Tijuana River at Border Fence: TJ-BF

The Tijuana River monitoring site had a benthic macroinvertebrate community with an IBI score of 17 and a quality rating of Poor for the May 2007 survey (Table 12-8). The results of the O/E analysis show that the Tijuana River monitoring site had an O/E ratio of 0.25. This implies that the benthic community has lost an estimated 75 percent of the biodiversity expected to occur at the site. The O/E ratio rated the site substantially lower than the IBI.

There were ten different taxa collected, with no EPT taxa. Nine of the ten taxa collected were dipterans (true flies). There were no highly intolerant (sensitive) taxa collected, and highly tolerant taxa accounted for 43 percent of the community. The community was dominated by the fly, *Psychoda* and this organism thrives in the presence of organic pollution. Oligochaetes and dipterans comprised the rest of the community. In contrast to previous sampling events in Tijuana River, the abundance of organisms was relatively high.

The monitoring reach had very poor physical habitat conditions. The substrate was over 80 percent silt with some sand and gravel. There was emergent vegetation at the river margins, but the site lacked canopy cover and is subject to severe erosion during high storm flows. During field sampling, it was noted that the river had an unpleasant odor. The substrates were covered with a blue-gray “biofilm” and there were considerable deposits of fine anoxic silt in the riverbed.

The IBI score for the Tijuana River site, when ranked against other sites in the county, was not representative and the very low O/E ratio that is most certainly a more accurate indicator of the true benthic community quality. Two of the IBI metrics over-scored this site: percent Collector Filterers plus Collector Gatherers and percent Non-insect Taxa. There was a relatively high percent of Predator taxa, but the organisms in this feeding group are very tolerant of polluted water. The dominance of the fly *Psychoda* was also a strong indicator of very poor water quality. A contributing factor to the unrealistic IBI score was the predominance of several dipteran families such as Chironomidae, Ephydridae, and Muscidae that were not identified to lower taxonomic levels. These families have many genera that are highly tolerant to extreme ecological conditions (e.g., some Ephydrids survive in heavy metal contaminated, hyper-saline waters in certain Imperial Valley lakes) and greater taxonomic effort would likely have shown a more degraded benthic community.

Information from the mass loading stations have indicated high levels of pesticides (primarily diazinon) in the river, exceedances for total suspended solids, un-ionized ammonia, nutrients, and some metals, and there has been persistent toxicity to *Ceriodaphnia dubia* (Table 12-4). Additionally, bacteria levels were high, with elevated BOD and COD indicating probable raw wastewater discharges. These indicators of very poor water quality confirm the assertion that the IBI score for the site is higher than the actual benthic community quality suggests.

Summary Indices Results Over Time

The Tijuana River site has been sampled four times since the beginning of the program, all of the surveys occurring in May due to dry conditions in the fall. The mean value of IBI scores has been 13.5 (Figure 12-13). The lowest score was in 2003 (6) and the highest were in 2005 and 2007 (17). The site has consistently rated the site impaired, but as noted above, the scores are somewhat elevated considering the biological community composition.

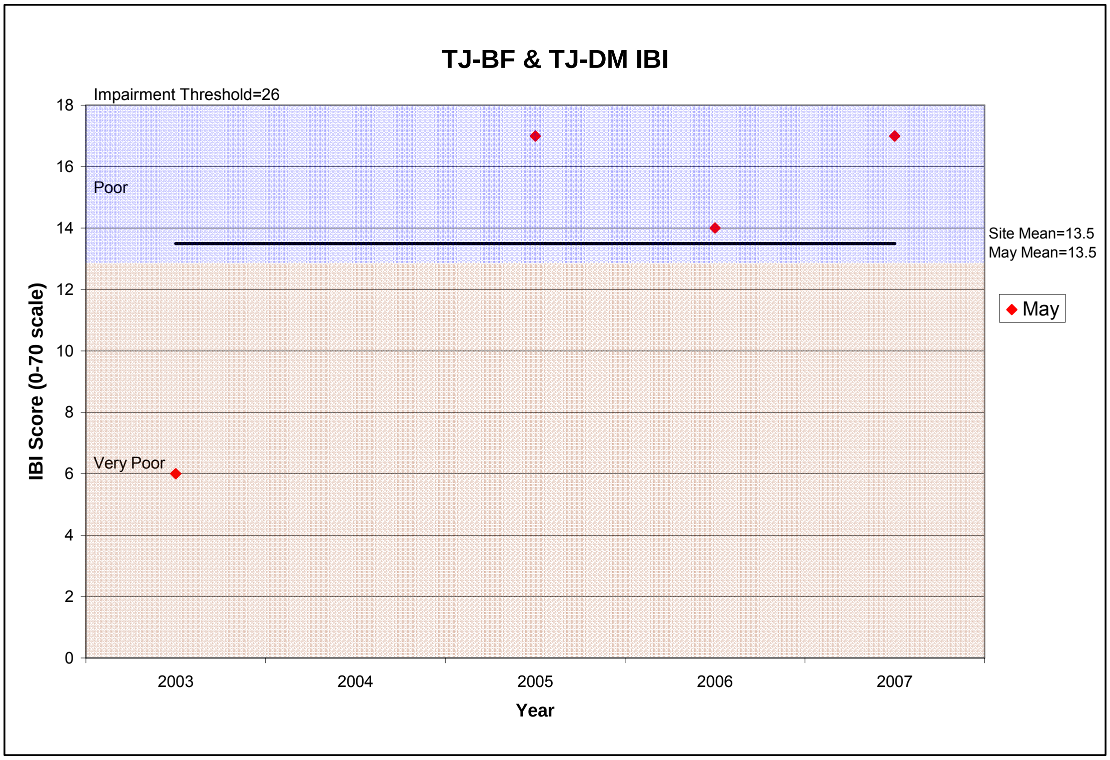


Figure 12-13. Index of Biotic Integrity for Tijuana River at the Border Fence (TJ-BF) and Dairy Mart Road (TJ-DM)

The mean O/E ratio for Tijuana River has been 0.33, indicating a severely degraded biological community (Figure 12-14). The O/E ratios were quite consistent and identify a greater level of impairment than the IBI scores. It is interesting to note that most of the O/E values were in direct contrast to the IBI scores by individual survey i.e. low O/E values had corresponding high IBI scores (although the differences were not statistically significant). This discrepancy between the IBI and O/E indices is frequently encountered at sites with very low diversity and where one or two of the IBI metrics are overscored.

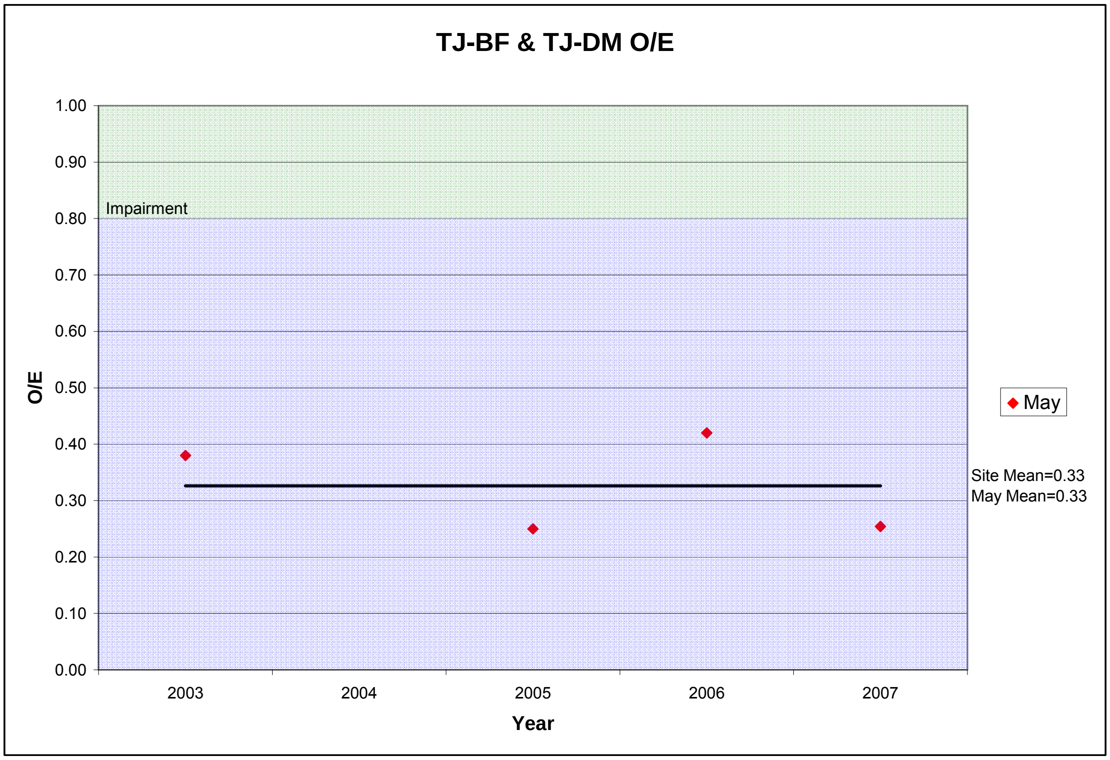


Figure 12-14. O/E Ratio for Tijuana River at the Border Fence (TJ-BF) and Dairy Mart Road (TJ-DM)

12.3.2 Stream Bioassessment Summary

Two stream bioassessment monitoring sites were sampled in the Tijuana River WMA. One site in Campo Creek was sampled in October and May and one site in the Tijuana River near the border fence was sampled in May 2007 only.

The Index of Biotic Integrity rating for the Campo Creek site ranged from Very Poor to Fair, and there were several organisms collected that were otherwise found only at reference sites. The average O/E ratios for this site indicated moderate impairment, with some individual survey results rating the benthic community unimpaired.

The Tijuana River site near the border fence was rated Poor by the IBI, while the O/E ratio indicated much more severe impairment. Based on the analysis of individual taxa present and observations made in the field, the investigators in this study feel that the O/E ratio is a more accurate indication of the benthic community quality in this portion of the Tijuana River.

12.4 Tijuana River WMA Assessment

The Tijuana River Watershed Management Area was assessed utilizing chemistry and toxicity data collected during storm events from a single MLS, chemistry data collected from 11 dry weather monitoring sites upstream of the MLS, and IBI scores generated at two bioassessment sites (Table 12-10). The watershed management area assessment methods presented in Section 3.4 were applied to these data to determine which constituents were of concern and to develop a high, medium, or low frequency of occurrence for these constituents. The results of this assessment are presented in Table 12-11.

Table 12-10. Watershed Assessment Data Set

Program Data Set	Data Collection Period	Constituents Assessed
Mass Loading Stations (MLS) Storm Event Monitoring	January 29, 2002 - April 20, 2007	Toxicity, Chemistry
Rapid Stream Bioassessments	October 2006 and May 2007	Benthic Macroinvertebrates
Dry Weather Monitoring (DWM)	May 2006 – September 30, 2006	Chemistry

12.4.1 Tijuana River WMA Criterion Assessment

Seven constituents were found to have a high frequency of occurrence and are listed below as constituents of concern. All of these constituents received a rating of three diamonds based on Criteria No. 1. Criteria No. 1 occurs when mass loading station tests results exceed the benchmark WQO in greater than or equal to 80% of samples. High frequency constituents of concern based on Criteria No. 1 include:

- Total Coliform
- Fecal Coliform
- Enterococcus
- Total suspended solids
- Turbidity
- Diazinon
- Ammonia

Five constituents were found to have a medium frequency of occurrence and received a two diamond rating based on Criteria No. 5. Criteria No. 5 occurs when less than 80% and greater than or equal to 50% of the MLS samples exceed the benchmark WQO and no exceedances or data available for dry weather sites in the past year. These constituents include:

- BOD
- COD
- Total phosphorus
- Total copper
- Total lead

Table 12-11. Wet Weather Constituent Exceedances in the Tijuana River WMA.

Constituents With Any Wet Weather (MLS) WQO or Dry Weather Action Level Exceedance	MLS (Wet Weather) Results														Dry Weather Results *		Frequency of Occurrence	Criterion No.
	2001/2002		2002/2003		2003/2004		2004/2005		2005/2006		2006/2007		CUMULATIVE		2006			
	#/3	%	#/3	%	#/3	%	#/3	%	#/3	%	#/3	%	#/18	%	#	%		
Conventional Parameters																		
pH	0	0	1	33	0	0	0	0	0	0	0	0	1	6	0	0	-	-
Ammonia[1]	NA		3	100	2	67	2	67	3	100	3	100	13	87	0	0	♦♦♦	1
BOD	2	67	1	33	3	100	1	33	0	0	2	67	9	50	0	0	♦♦	5
COD	2	67	2	67	3	100	1	33	3	100	3	100	14	78	0	0	♦♦	5
Oil and Grease	0	0	0	0	0	0	0	0	0	0	1	33	1	6	0	0	-	-
Surfactants (MBAS)	2	67	1	33	1	33	1	33	1	33	0	0	6	33	1	14	♦	9
Total Suspended Solids	2	67	2	67	3	100	3	100	3	100	3	100	16	89	0	0	♦♦♦	1
Turbidity	2	67	3	100	3	100	3	100	3	100	3	100	17	94	6	50	♦♦♦	1
Nutrients																		
Dissolved Phosphorus	3	100	0	0	1	33	0	0	0	0	1	33	5	28	0	0	♦	9
Total Phosphorus	3	100	3	100	2	67	1	33	1	33	2	67	12	67	0	0	♦♦	5
Bacteriological																		
Total Coliform	3	100	3	100	3	100	3	100	3	100	3	100	18	100	2	29	♦♦♦	1
Fecal Coliform	3	100	3	100	3	100	3	100	3	100	3	100	18	100	0	0	♦♦♦	1
Enterococcus	3	100	3	100	3	100	3	100	3	100	3	100	18	100	0	0	♦♦♦	1
Pesticides																		
Chlorpyrifos	3	100	1	33	1	33	0	0	0	0	0	0	5	31	0	0	-	-
Diazinon	3	100	3	100	3	100	2	67	3	100	3	100	17	94	0	0	♦♦♦	1
Malathion	NA	NA	2	67	2	67	1	33	1	33	2	67	8	44	0	0	♦	9
Total Metals																		
Antimony	0	0	0	0	0	0	0	0	0	0	1	33	1	6	0	0	-	-
Arsenic	0	0	0	0	1	33	0	0	0	0	0	0	1	6	0	0	-	-
Copper	0	0	1	33	2	67	2	67	1	33	3	100	9	50	0	0	♦♦	5
Lead	1	33	1	33	2	67	2	67	1	33	3	100	10	56	0	0	♦♦	5
Nickel	0	0	0	0	1	33	0	0	0	0	0	0	1	6	0	0	-	-
Zinc	0	0	0	0	1	33	1	33	1	33	3	100	6	33	0	0	♦	9
Dissolved Metals																		
Copper	0	0	1	33	0	0	0	0	0	0	0	0	1	6	1	14	♦	8
Toxicity																	**EVIDENCE OF PERSISTENT TOXICITY?**	
Ceriodaphnia 96-hour	3	100	3	100	3	100	3	100	3	100	3	100	18	100			Yes	
Ceriodaphnia 7-day survival	3	100	3	100	3	100	3	100	3	100	3	100	18	100			Yes	
Ceriodaphnia 7-day reproduction	3	100	3	100	3	100	3	100	3	100	3	100	18	100			Yes	
Hyalella 96-hour	0	0	1	33	2	67	0	0	2	67	3	100	8	44			No	
Bioassessment	IBI Rating																**EVIDENCE OF BENTHIC ALTERATION?**	
Campo Creek	NA		NA		Poor		Very Poor		Poor		Poor		Poor		NA		No	
Tijuana River, at Border Fence.	NA		Very Poor		NA		Poor		Poor		Poor		Poor		NA			

* = Total number of observations varied among constituents.
NA = Not assessed.
[1] Wet weather data is compared to the Basin Plan WQO for un-ionized ammonia, dry weather data is compared to the dry weather action levels.
- = Constituent results are below the defined requirements for a Low Frequency of Occurrence rating.
♦ = Low Frequency of Occurrence rating.
♦♦ = Medium Frequency of Occurrence rating.
♦♦♦ = High Frequency of Occurrence rating.

Five constituents were found to have a low frequency of occurrence and were assigned one diamond based on Criteria Nos. 8 and 9. Criteria No. 8 is when dry weather site exceedances are found in 10 to 50% of the samples in the past year and Criteria No. 9 is MLS exceedances found in 25% to less than or equal to 50% of the samples and at least one exceedances found in last 2 years at the MLS (with or without dry weather site exceedances in the past year). Low frequency constituents of concern based on Criteria No. 8 include:

- Dissolved Copper

Low frequency constituents of concern based on Criteria No. 9 include:

- Surfactants (MBAS)
- Dissolved Phosphorus
- Malathion
- Total zinc

BOD and COD are unique among the constituents assessed in the storm water program because they provide an indirect measure of the total oxidizable material available in the water column due to other factors, including anthropogenic contaminants as well as natural processes (as opposed to other methods which only provide results for the specific analyte tested). The presence of BOD or COD above their respective water quality criteria indicates the presence of other contaminants that may have caused the exceedance. Thus, management actions aimed at reducing BOD or COD may be most effective if the source or sources of the elevated levels are addressed directly. In this way, a reduction in BOD or COD levels would be a by-product of actions taken against more easily rectified constituents.

All of the bioassay tests conducted on *Ceriodaphnia dubia* have shown evidence of persistent toxicity in all six years of monitoring. Although there has been toxicity to *Hyalella azteca* during five of the six of the monitored storm events over the past two monitoring seasons the overall incidence of toxicity is 44% of the monitored storm events (8 of 18). As a result, there is no evidence of persistent toxicity to *Hyalella* based on the assessments at this time.

Cumulative IBI scores resulting from bioassessment monitoring on the Tijuana River throughout the monitoring period indicated a rating of poor at both sites, but does not suggest evidence of benthic alteration. It should be noted, though, that the bioassessment monitoring site in Campo is spatially segregated from the water quality monitoring stations located much further downstream. The bioassessment site in Campo is likely not affected by the communities of Tecate or Tijuana, Mexico.

Figure 12-15 illustrates the number of exceedances for each wet weather monitoring season for six categories of constituents, including conventional parameters, nutrients, bacteria, pesticides, metals, and toxicity. The stacked bars were developed the using number of exceedances from values in Table 12-11 for each constituent category. The overall number of benchmark WQO exceedances at the Tijuana River MLS has been consistently high throughout the six years of monitoring and the total number of exceedances during the 2006-2007 monitoring period was the highest during the monitoring period. The relative distribution of exceedances among the six categories of constituents has also remained relatively consistent throughout the monitoring period with exceedances spread relatively uniform across the conventional, bacteriological and toxicity categories. The 2006-2007 monitoring season had an increased number of metals exceedances than in past monitoring seasons.

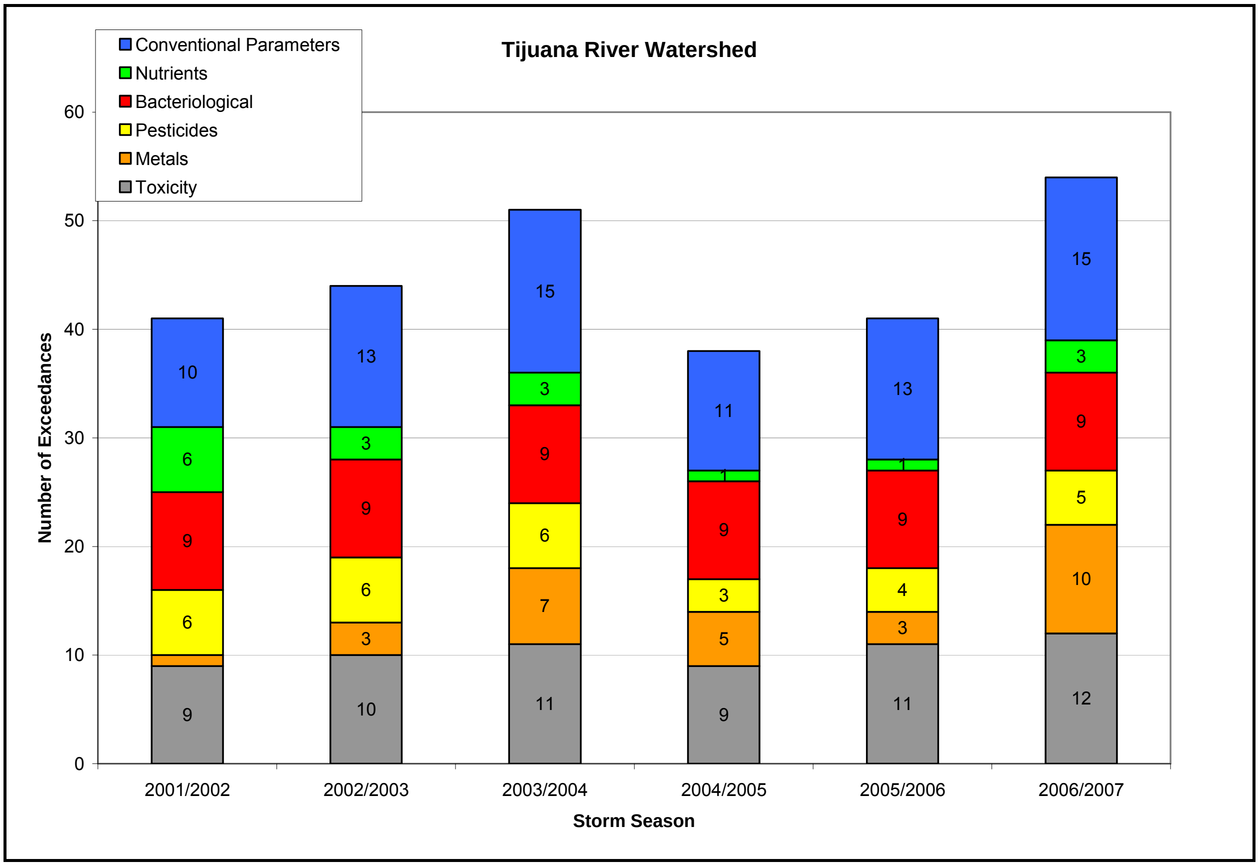


Figure 12-15. Stacked Bar Chart of the Number of Wet Weather Exceedances of Constituent Groups in the Tijuana River.

12.4.2 Triad Decision Matrix

The data from wet and dry weather, toxicity and bioassessment monitoring efforts were evaluated for this watershed using the triad decision matrix. The triad decision matrix incorporates the chemistry data from wet and dry weather events with the toxicity and bioassessment results to provide indications of pollutant loading, potential impacts to organisms and the ecological health of the watershed. The triad assessment presents possible conclusions about the watershed and provides possible actions or decisions for future monitoring and assessment. Table 12-12 summarizes these results and lists possible conclusions and actions.

Based on the triad matrix, there was evidence of persistent benchmark WQO exceedances, evidence of persistent toxicity, and no evidence of benthic alteration. However, the IBI scores appear to over-estimate the actual conditions in the downstream sample locations. The water quality degradation and persistent toxicity observed from monitoring at the MLS in the lower Tijuana River is likely causing benthic alterations downstream of the United States border.

Table 12-12 indicates that a possible action to address the conclusions of the triad matrix would be to perform a TIE to identify contaminants of concern, based on the TIE metric. Although trend analysis indicates Diazinon concentrations are decreasing, concentrations have been persistently observed above the benchmark WQOs. Previously conducted TIEs have indicated Diazinon as the likely source of toxicity in storm water samples. Additional TIEs are not recommended until Diazinon concentrations decrease below the benchmark WQOs and if toxicity remains persistent.

Table 12-12. Triad Decision Matrix Results for the Tijuana River Watershed.

Chemistry	Toxicity	Benthic Alteration	Possible Conclusion(s)	Possible Actions or Decisions
6. Persistent exceedance of benchmark WQOs (high frequency COC identified)	Evidence of persistent toxicity	No indications of alteration	Toxic contaminants are bioavailable, but in situ effects are not demonstrable Benthic analysis not sensitive enough to detect impact Potentially harmful pollutants not yet concentrated enough to change community	1) Determine if chemical and toxicity tests indicate persistent degradation. 2) Recheck benthic analyses; consider additional data analyses. 3) Toxicity tests at higher dilutions to better quantify toxicity: • If recheck indicates benthic alteration, perform TIE to identify contaminants of concern, based on TIE metric. Evaluate/investigate upstream source as a high priority. • If recheck shows no effect, use TIE to identify contaminants of concern, based on TIE metric. Evaluate/investigate upstream source identification as a medium priority.

12.4.3 2001-2006 Baseline Long-Term Effectiveness Assessment (BLTEA) Ratings for the Tijuana River WMA

The baseline water quality priority ratings presented in the 2005-2006 Urban Runoff Monitoring Report are also presented in this report in Table 12-13. These tables are tools that assist managers in prioritizing watershed activities or are used for identifying data gaps. The priority ratings are based on the methodology presented in the BLTEA report (WESTON, MOE, & LWA, 2005) and are presented in the Methods Section 3.4.

The LTEA ratings are used to guide long-term programmatic watershed activities and are performed on a 5-year cycle. The WMA assessments are used to guide annual water quality monitoring activities and to evaluate annual differences or changes through time. The WMA constituents of concern are compared to the LTEA ratings to evaluate if activities are showing improvements or impairments through the 5-year cycle.

Constituent groups and stressor groups are given a ranking from A to D with A being the highest priority rating and D the lowest priority rating. Items ranked with a D indicate that the constituent group or stressor is a low priority or does not have sufficient data to support a higher ranking. The priority ratings were based on the data record from 2001-2006 from the following programs and will be updated on a 5-year cycle:

- Storm water Mass Loading Monitoring (MLS) – Wet Weather Data (2000-2006)
- Copermittee Dry Weather Data Monitoring (2003-2005)
- Available Third Party Data (SWAMP, 2004)
- Ambient Bay, Lagoon, and Coastal Receiving Water Monitoring (2003-2005)
- Urban Stream Bioassessment Monitoring (2000-2006)
- Triad Assessment – Toxicity Testing of Storm water (2000-2006)
- 303(d) Listing (2003)

Table 12-13. Updated Water Quality Priority Ratings for the Tijuana River WMA

Watersheds/Sub-watersheds	Percentage of Total Area	Priority Ratings*										
		Constituent Groups									Stressor Groups	
		Heavy Metals	Dissolved Minerals	Organics	Oil and Grease	Sediments	Pesticides	Nutrients	Gross Pollutants	Bacteria/ Pathogens	Benthic Alterations	Toxicity
Tijuana WMA	**100%**	***B***	***D***	***D***	***D***	***B***	***B***	***C***	***C***	***B***	***B***	***B***
Tijuana Valley HA (911.10)	7%	*A*	*D*	*A*	*D*	*A*	*A*	*A*	*A*	*A*	*A*	*B*
Potrero HA (911.20)	18%	*B*	*D*	*D*	*D*	*B*	*B*	*B*	*B*	*B*	*B*	*B*
Barrett Lake HA (911.30)	20%	*B*	*D*	*D*	*D*	*C*	*B*	*C*	*C*	*B*	*B*	*B*
Monument HA (911.40)	8%	*C*	*D*	*D*	*D*	*A*	*C*	*C*	*C*	*A*	*B*	*B*
Morena HA (911.50)	5%	*B*	*D*	*D*	*D*	*B*	*B*	*B*	*B*	*B*	*B*	*B*
Cottonwood HA (911.60)	10%	*C*	*D*	*D*	*D*	*B*	*C*	*C*	*C*	*C*	*B*	*B*
Cameron HA (911.70)	10%	*B*	*D*	*D*	*D*	*B*	*B*	*B*	*B*	*B*	*B*	*B*
Campo HA (911.80)	23%	*C*	*D*	*D*	*D*	*A*	*C*	*C*	*C*	*C*	*B*	*B*
2006-07 High[1] Frequency of Occurrence Ratings						♦♦♦	♦♦♦		♦♦♦	♦♦♦		
Constituents of Concern						TSS Turbidity	Diazinon		Ammonia	Total Coliform Fecal Coliform Entero-coccus		

1. High frequency of occurrence ratings are derived from the constituent exceedances tables and are provided for comparison purposes.

Notes:

** = Rating Calculated Based on Area Weighted Averages of Score Value from the sub-watershed areas.*

*** = Priority Level (Highest-A to Lowest-D)*

High Priority Level Based on Data

303d listing

The Tijuana River WMA did not have any high priority (A) ratings for the overall WMA. The highest rated constituents were heavy metals, sediments, pesticides, bacteria, benthic alteration, and toxicity which were all assigned a B priority rating. All other categories received either a C or D priority rating. The complete tables used to calculate the ratings are presented in Appendix G.

The Tijuana Valley sub-watershed which accounts for only 7% of the watershed had several high priority (A) rated constituents primarily due to 303(d) listings and wet weather monitoring data which include, heavy metals, organics, sediments, pesticides, nutrients, gross pollutants, bacteria, and benthic alteration. Dissolved minerals and oil and grease were found to have a low priority (D) rating in this sub-watershed. Other high priority (A) ratings include sediment in the Monument and Campo Sub-watersheds and for bacteria in the Monument Sub-watershed due to bacteria being on the 303(d) list in this area. Because the assessment is based on a weighted average, larger sub-watersheds will have a greater influence in the overall watershed rating. The Tijuana River WMA has only limited data from the upper watersheds which results in lower priority ratings. Other challenges include the fact that a large portion of the watershed lies outside of the regulatory controls of this program.

High frequency of occurrence ratings from the WMA criterion assessments were also included in the water quality priority rating summary table above. High frequency of occurrence ratings were determined for ammonia, TSS, turbidity, Diazinon, and all three bacterial indicators for the Tijuana River WMA. In comparison, the water quality priority ratings found B priority ratings for these categories, suggesting that the major water quality concerns are primarily focused in the area downstream of the urban population center of Tijuana, Mexico in the Tijuana Valley Sub-watershed.

A list of potential likely or unknown sources for the nutrients and bacteria category in the Tijuana River Watershed that are based on the threat to water quality inventory ratings tables can be found in the BLTEA report (WESTON, MOE, & LWA, 2005).

12.5 Conclusions and Recommendations

The Tijuana River WMA is the largest of the San Diego watersheds covering over 1.1 million acres. Mexico governs the majority of the Tijuana River Watershed (73%) with the remaining areas belonging to the United States. Undeveloped areas account for 60% of U.S. lands, with another 25% devoted to parks. The Tijuana River flows through Tijuana, Mexico and runoff contributions come from both Mexico and the United States.

For the Tijuana River WMA, ammonia, all three bacterial indicators, TSS, turbidity, and Diazinon were identified as high frequency of occurrence COC. Medium frequency COC were identified as BOD, COD, total phosphorus, total copper and total lead. The constituents MBAS, dissolved phosphorus, Malathion, total zinc, and dissolved copper were identified as low frequency of occurrence COC. The elevated densities of all three bacterial indicators and elevated levels of BOD, COD, un-ionized ammonia, and nutrients (total phosphorus) are indicative of raw wastewater discharges. Pesticides (primarily Diazinon) are also persistently found above benchmark WQOs in the watershed and are likely the major cause of toxicity observed towards the freshwater amphipods *Ceriodaphnia dubia* and *Hyalella azteca*.

A review of the trends shows statistically significant increasing trends for nitrate, TOC, TSS, turbidity, total and fecal coliform, total arsenic, total lead, and total zinc and the acute survival endpoint for *Hyalella azteca*. The increasing trend for *Hyalella azteca* survival indicates a decrease in the toxicity to this species. Statistically significant decreasing trends are evident for TDS, Diazinon, dissolved arsenic, and dissolved nickel.

Measured storm event loads at the Tijuana River MLS site were compared to the loading values derived from the EMC National Stormwater Quality Database (NSQD) (Pitt et al., 2004). Measured loads of most of the constituents were greater than expected for a majority of the storm events sampled. Only cadmium and dissolved lead were consistently within the expected range or lower than expected.

Two stream bioassessment monitoring sites were sampled in the Tijuana River WMA. One site in Campo Creek was sampled in October 2006 and May 2007 and one site in the Tijuana River at the border fence was sampled in May 2007 only. The Index of Biotic Integrity rating for the Campo Creek site was Very Poor for the October 2006 survey and Fair for the May 2007 survey. The results of the O/E analysis show that the Campo Creek monitoring site had observed to expected taxa ratios of 0.37 and 0.62. This implies that the benthic community has lost an estimated 63 to 38 percent of the biodiversity expected to occur at the site. These results indicate that for the May survey, the site was above the impairment threshold according to the IBI, but was below the O/E impairment threshold. The Tijuana River site was rated Poor, but based on an assessment of individual metrics and observations made in the field, the investigators in this study feel that this rating is much higher than indicated by the actual benthic community quality.

The water quality priority ratings agreed with the WMA assessment findings for the Tijuana Valley sub-watershed but since this sub-watershed is only 7% of the entire Tijuana River WMA, it suggests that the high priorities and COCs may be more localized to the area near the MLS. The overall Tijuana River WMA did not have any high priority (A) ratings. The highest rated constituents were heavy metals, sediments, pesticides, bacteria, benthic alteration, and toxicity which were all assigned a B priority rating. All other categories received either a C or D priority rating.

The information provided from the triad matrix results used in conjunction with the water quality priority ratings can assist the jurisdictions in making informed decisions in developing their WURMP programs. The two reports also allow for an evaluation of where data gaps exist and where efforts should be targeted.

One issue to be considered is the contribution of runoff and potential COCs from the portion of the watershed outside the jurisdiction of the United States. To this end, it is recommended that a liaison process with cross-border agencies be implemented to address water quality concerns in the Tijuana River WMA. A second consideration for the Tijuana River WMA is the consistent measurement of Diazinon concentrations above the benchmark WQO and persistent observed toxicity to *Ceriodaphnia* organisms in storm water samples collected over the past six years of monitoring. TIEs performed in previous years have indicated that Diazinon is the causative agent of toxicity in these samples. The triad assessment process (Section 12.4.2) developed as part of the San Diego Regional Storm Water Monitoring Program provides standardized guidelines for recommendations based on wet and dry weather, toxicity and bioassessment monitoring efforts in conducted watersheds covered under the Program. Based on the 2006-2007 monitoring results, the triad matrix recommends the performance of a TIE to identify the source of toxicity. However, the triad assessment process does not at this time provide specific recommendations for addressing consistent toxicity that has been previously linked to specific COCs through previous TIEs, as is the case with the constituent Diazinon in the Tijuana River WMA. In the case of the Tijuana WMA, it is not recommended to perform TIEs for future monitoring seasons in the Tijuana River MLS samples unless notable declines in the concentration of diazinon are observed and toxicity remains persistent.

The recommendations for this watershed are to continue monitoring at the MLS to determine long-term trends, continue monitoring for toxic and benthic impacts and to identify upstream sources of constituents of concern. The implementation of the new monitoring permit cycle will allow for assessing the watershed during both dry weather and wet weather conditions. Additionally, two watershed assessment stations (TWAS) upstream of the current MLS will provide water quality data on the United States side of the international border in upstream locations. Additionally, the City of Imperial Beach is in the process of obtaining Clean Beaches Initiative (CBI) funding for a microbial source tracking study within the U.S. jurisdiction of the Tijuana River Watershed. The data collected from this study will identify potential sources of bacteriological contaminants and their loads. These and other monitoring efforts will provide additional valuable management information for future years in the Tijuana River WMA.