Santa Clara Valley
*Urban Runoff*
Pollution Prevention Program

# Watershed Monitoring and Assessment Program

## Monitoring and Assessment Summary Report

*Coyote Creek and Lower Penitencia Creek*

September 15, 2008

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# EXECUTIVE SUMMARY

In Fiscal Year (FY) 2006-2007, SCVURPPP pilot tested a sediment quality triad (SQT) approach that entails a weight of evidence (WOE) approach using bedded sediment chemistry, sediment toxicity, benthic macroinvertebrate (BMI) community and physical habitat data. The SQT approach was implemented to better evaluate relationships between BMIs and stressor variables, and to identify potential causes of aquatic life use impacts in creeks within the Santa Clara Valley. In FY 07-08, SCVURPPP conducted a second year of sampling in the Coyote Creek mainstem and first year of sampling within two major tributaries of the Coyote Creek and Lower Penitencia Creek watersheds, and the SQT approach was again utilized.

BMI bioassessments and physical habitat assessments were conducted at 28 locations in Coyote and Lower Penitencia Creek watersheds in April or May 2008. Sediment samples were collected at a subset of sites (n=10) where bioassessment and PHAB surveys were conducted and analyzed for organic (pyrethroid pesticides) and inorganic (metals) chemicals. Toxicity was also evaluated at sites where chemical analyses were conducted by exposing the amphipod, *Hyallela azteca*, to collected sediments in a standard ten-day survival test.

To estimate the magnitude of contamination in each sediment sample, a Sediment Quality Guideline Quotient (SQGQ) was calculated for each contaminant at each site by dividing the measured sediment contaminant concentration by the Probable Effect Concentration (metals) or the LC50 (pyrethroids). The SQGQs for all contaminants measured were then averaged to determine a mean SQGQ for each site/sampling event. BMIs were assessed using the preliminary Benthic Index for Biological Integrity (B-IBI) previously developed by SCVURPPP.

Each line of evidence used in the SQT was ranked into five condition categories (optimal, good, fair, marginal and poor). In general, multiple lines of evidence generally did not agree at most of the sites. Similar rankings (i.e., “poor” or “marginal”) for toxicity, B-IBI scores and physical habitat scores occurred at the two lowest elevation sites in Coyote Creek mainstem and the Thompson Creek site.

With the exception of nickel (which is a naturally occurring metal at relatively high concentrations in Bay Area watersheds), metals measured in bedded sediments collected at sites in Coyote Creek and Lower Penitencia Creek watersheds appear to be consistently below concentrations that one would expect to observe some degree of toxic response (i.e., PECs). These results suggest that metals are not a primary driver of the condition of aquatic life in Coyote and Lower Penitencia Creek watersheds, although potential for impacts due to the synergism between metals can not be discounted. At least one pyrethroid pesticide was detected at a majority of the sites sampled in Coyote and Lower Penitencia Creek watersheds. In particular, either Bifenthrin or Cypermethrin concentrations in samples collected in Spring 2008 were above levels that one would expect to observe a significant toxic response (i.e., LC50s).

Significant toxicity was observed in sediments collected at 6 of 10 sites during Fall 2007 and/or the Spring 2008, including the two lowest elevation sites on Coyote Creek mainstem (COY080 and COY240) during both sampling events. The co-occurrence of pyrethroid concentrations above LC50s and sediment toxicity suggests that pyrethroids may be causing (at least partially) the toxicity at observed at 4 of the 6 sites.

Total B-IBI scores for sites in Coyote Creek mainstem ranged from 2 – 20 (0-50 possible), sites in Coyote Creek tributaries (i.e., Upper Penitencia and Lower Silver-Thompson Creek) ranged from 6 – 44, and sites in Lower Penitencia Creek watershed ranged from 6-24. PHAB scores for sites in Coyote Creek watershed ranged from 9-54 (0-60 possible), with scores generally increasing in an upstream direction. B-IBI scores for were significantly correlated to average substrate size and reach-scale physical habitat scores.

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# 1.0 INTRODUCTION

The Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)[1] developed a Multi-Year Receiving Waters Monitoring Plan (Multi-Year Plan) in 2001 in compliance with requirements specified in its National Pollutant Discharge Elimination System (NPDES) permit (Permit) issued by the San Francisco Bay Regional Water Quality Control Board (Water Board). The Multi-Year Plan defines monitoring and assessment activities scheduled for completion in 2002-2010. Monitoring conducted under the Multi-Year Plan is designed to assess the condition of beneficial uses (i.e., aquatic life and recreational) in creeks within the Santa Clara Basin.

The SCVURPPP conducted screening-level monitoring in 11 major watersheds of the Santa Clara Basin during the first five years (FY 02-03 to FY 06-07) of the Multi-Year Plan. SCVURPPP (2007a) provides a summary of the monitoring results as well as an assessment of the condition of aquatic life and recreational uses in creeks monitored over that time. In addition, the report provides preliminary conclusions and lessons learned intended to inform future monitoring efforts conducted by the SCVURPPP.

One of the recommendations identified in the report was to pilot test a sediment quality triad (SQT) that entails a weight of evidence (WOE) approach using bedded sediment chemistry, sediment toxicity, benthic macroinvertebrate community and physical habitat data. The SQT approach is intended to better evaluate relationships between BMIs and stressor variables and identify potential causes of aquatic life use impacts in creeks within the Santa Clara Valley. The SCVURPPP implemented the SQT approach in the Coyote Creek mainstem during FY 06-07. Overall evaluation of the SQT monitoring approach and results from Coyote Creek are provided in SCVURPPP (2007b).

This report provides a summary of data collected during FY 07-08 using the SQT approach for a second year of sampling in the Coyote Creek mainstem and first year of sampling within two major tributaries of Coyote Creek and Lower Penitencia Creek watershed. In addition, SCVURPPP initiated a special study in Steven Creek Watershed to evaluate temporal and spatial variability of sediment chemistry and sediment and water toxicity. Results from the special study are provided in a separate report (SCVURPPP 2008).

## 1.1 Study Area

### 1.1.1 Coyote Creek Watershed

The Coyote Creek watershed covers approximately 320 square miles and drains most of the west-facing slope of the Diablo Range (SCVURPPP 2003). The watershed extends 45 miles from the creek's headwaters in the Mt. Diablo range (approximately 3000 foot elevation) to the tidal sloughs entering San Francisco Bay. The creek originates in the mountains of the Diablo Range northeast of Morgan Hill and flows northwest approximately 42 miles before entering the Lower South San Francisco Bay. Climate in the Santa Clara Valley is typical of Mediterranean areas, with majority of the precipitation (annual rainfall ranges 15 – 40 inches) occurring between November and March.

Coyote Creek has two reservoirs in the middle reaches, Coyote and Anderson Reservoir. The creek flows for approximately 22 miles between Anderson Reservoir and confluence with San Francisco South Bay at Alviso Slough. The lower reaches flow through the City of San Jose, Milpitas and Santa Clara County jurisdictions. Upper Penitencia Creek and Lower Silver - Thompson Creek are the two largest tributaries that empty into the lower reaches of Coyote Creek below Anderson Dam.

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[1] The Santa Clara Valley Urban Runoff Pollution Prevention SCVURPPP is comprised of Santa Clara County, thirteen municipalities and the Santa Clara Valley Water District (i.e., Co-permittees).

### *Upper Penitencia Creek*

Upper Penitencia Creek subwatershed drains approximately 24 square miles. Most of the drainage area (21 square miles) occurs in the Fremont-Livermore Hills and Valleys Ecoregion Subsection (USDA), which can be characterized as steep slopes and deep and narrow canyons (SCVURPPP 2003). The elevation of the upper subwatershed area ranges from 3,000 feet at its headwaters to 50 feet at its confluence with Coyote Creek. A small reservoir (500 acre-feet), Cherry Flat Reservoir, impounds Upper Penitencia Creek about one mile upstream of the confluence of Arroyo Aguague, largest tributary in the subwatershed. Alum Rock Park, managed by the City of San Jose, occurs along a 1-mile reach of Upper Penitencia Creek starting at the base of the foothill region. The watershed area above the park is primarily undeveloped open space land that is combination of privately owned and areas within Santa Clara County Open Space Authority and County Park jurisdictional boundaries.

The lower subwatershed area occurs within the Santa Clara Valley alluvial plain. Approximately 0.5 miles downstream of Alum Rock Park, streamflow is diverted to a series of off-channel percolation ponds adjacent to Upper Penitencia Creek (SCVURPPP 2003). In addition to creek diversion, the percolation ponds receive water from the South Bay Aqueduct. Water is reintroduced from the ponds to the main channel for instream percolation, and then diverted at Mabury Avenue to another percolation pond on the south side of the Creek. Both of these diversion dams are typically operated between April – October and are constructed with concrete weirs with V-notches and pools between the drops. Such augmented streamflow helps to maintain Upper Penitencia Creek as a perennial stream throughout the dry season, although the creek often desiccates in late dry season/early fall in the section between King Road and confluence to Coyote Creek.

### *Lower Silver-Thompson Creek*

The Lower Silver – Thompson Creek subwatershed is the largest tributary (approximately 42 square miles) within the Coyote Creek watershed area below Anderson Dam. Thompson Creek originates in the Diablo Range foothills at an elevation of about 2,300 feet and flows northerly to its confluence with Lower Silver Creek at the eastern edge of the Santa Clara Valley (SCVURPPP 2003). The Thompson Creek Watershed encompasses about 17.5 square miles. Lower Silver Creek flows into Lake Cunningham and continues in the northwesterly direction to its confluence with Coyote Creek.

Historically, with its gentle slopes and poorly drained soils, Lower Silver Creek flowed in an ill-defined channel; most of the flatter areas were often swampy and prone to ponding and frequent floods. In the early 1950s, prior to urbanization, Lower Silver Creek was placed in a defined man-made channel and diverted to its present alignment between Lake Cunningham and what is now North Babb Creek (SCVURPPP 2003). Existing land uses in the Lower Silver - Thompson Creek subwatershed are predominantly urban. The upland areas are devoted to uses ranging from rangelands to wildlife habitat, and are largely located outside of the City of San Jose's Urban Service Area boundary and in unincorporated areas of Santa Clara County. Two drop structures are present upstream and downstream of Quimby Road along Thompson Creek. Further upstream, the channel features levees, rock slope protection, box culverts, and outfalls. Stream flow is typically perennial in Lower Silver below Lake Cunningham and intermittent throughout Thompson Creek.

## 1.1.2 <u>Lower Penitencia Creek Watershed</u>

The Lower Penitencia Creek watershed contains approximately 30 square miles, with about 16 square miles lying on the Santa Clara Valley floor and the remainder in the hills of the Diablo Range. The watershed occurs in unincorporated area of Santa Clara County and in the cities of Milpitas and San Jose. The two major creeks in the watershed are Lower Penitencia Creek and Berryessa Creek.

Lower Penitencia Creek drainage area is approximately 8 square miles and occurs exclusively within the Santa Clara Valley floor, flowing in a northerly direction from Montague Expressway to its confluence with Coyote Creek near I-880 and Dixon Landing Road (SCVURPPP 2003). Lower Penitencia Creek is typically a perennial stream and the lower section has tidal influence. Lower Penitencia Creek drainage area is a small remnant of the historical watershed that once included Upper Penitencia Creek drainage area. The creek was diverted and channelized for agricultural uses resulting in two separate drainage areas (SCBWMI 2001). The existing channel of Lower Penitencia Creek was constructed by the SCVWD between 1955 and 1965 using a combination of earth and concrete bed and bank materials. The drainage area contains a mixture of residential, commercial and industrial land uses.

Berryessa Creek drainage basin is approximately 22 square miles draining the western slope of the Diablo Range and empties into the lower section of Lower Berryessa Creek (SCBWMI 2001). Berryessa Creek is typically perennial below Interstate 680 and intermittent above the highway. The lowest section of creek is tidally influenced. The reach of Berryessa Creek below Interstate 680 is predominately constructed earthen channel flowing through industrial land uses. Upstream of the highway, the channel is mostly a modified natural channel up to the base of the foothills and contains primarily residential land use. The upper reaches are relatively unmodified.

Table 2. SCVURPPP monitoring indicators and parameters, with associated beneficial uses.

| Indicator | Parameter |
|---|---|
| *Aquatic Life* | |
| Physio-chemical | Water temperature, DO, pH, conductivity, stream velocity |
| Sediment Chemistry | Total recoverable metals |
| | Total Organic Carbon and Percent Solids |
| | Bedded Sediment Grain Size |
| | Pyrethroid Pesticide Suite |
| Sediment Toxicity | Sediment bioassay Using *Hyalella azteca* |
| Rapid Bioassessments | Benthic macroinvertebrate community assemblage |
| Physical Habitat | Physical habitat assessment |
| *Recreational Use* | |
| Microorganisms | Total and fecal coliform, *Enterococcus, E coli* |

## 1.2 Beneficial Uses

Beneficial Uses in Santa Clara Valley creeks are designated by the Water Board and are defined as water resources that are protected by State law. Uses include aquatic life, recreation, human consumption, and habitat. Table 1 lists Beneficial Uses designated by the San Francisco Bay Regional Water Board (1995) for water bodies monitored by the SCVURPPP during FY 07-08.

Table 1. Beneficial uses designated in the *Water Quality Control Plan for the San Francisco Bay Basin* for Santa Clara Valley creeks monitored by SCVURPPP during FY 07-08.

| WATER BODY | AGR | COLD | FRSH | GWR | MIGR | NAV | RARE | REC-1 | REC-2 | SPWN | WARM | WILD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coyote Cr | | E | | | E | | E | P | E | E | E | E |

## 1.3 Monitoring Design and Sampling Locations

### 1.3.1 Monitoring Design

The types of aquatic life and recreational use indicators and associated parameters measured by SCVURPPP during FY 07-08 are shown in Table 2. Specific methods for each parameter are described in Appendix A. Bedded sediment samples were collected during two seasonal/hydrological time periods: 1) dry season (June-October) and spring/decreasing hydrograph season (April – May). Sediment samples were primarily collected during the spring season sampling event, with the exception of Coyote Creek mainstem sites, which were sampled in fall and spring.  These two sampling periods were initially selected for monitoring in Coyote Creek mainstem during FY 06-07 to bracket the rainy season and assist in the evaluation of pre- and post-wet season conditions.  The spring season was selected as the index period for sediment sampling for sites monitored during FY 07-08, with the exception of the four Coyote Creek mainstem sites.  During FY 07-08, the temporal variability of sediment chemistry and toxicity is being investigated in the Stevens Creek watershed and results of that study are included in a separate report.  Based on this evaluation, a single index period will likely be selected.

Sediment samples were analyzed for metals and pyrethroid pesticides.  Sediment bioassays were conducted at all sites using a ten-day survival and growth test for *Hyalella azteca*. Conventional water quality parameters of temperature, pH, conductivity and dissolved oxygen were measured during all sample events, except at locations sampled for bacterial indicators. Kinnetic Laboratories, Inc. (KLI) collected all water and sediment samples.   Toxicity was performed by ToxScan Inc. and chemical analyses were conducted by CRG Marine Laboratory and Soil Control Laboratory.

Benthic macroinvertebrate (BMI) bioassessments and physical habitat assessments (PHAB) were conducted during the spring season (April – May).  Conventional water quality parameters of temperature, pH, conductivity and dissolved oxygen were measured during all bioassessment sample events.  EOA, Inc. conducted all bioassessments and physical habitat assessments.

### 1.3.2 Site Locations

BMI bioassessments and physical habitat assessments were conducted at 28 locations and sediment chemistry and toxicity testing was conducted at a subset of those locations (n=10). Sampling locations within Coyote Creek and Lower Penitencia Creek watersheds are shown in Figure 1.  Information on site location, data of sampling and parameter measured is shown in Table 3.

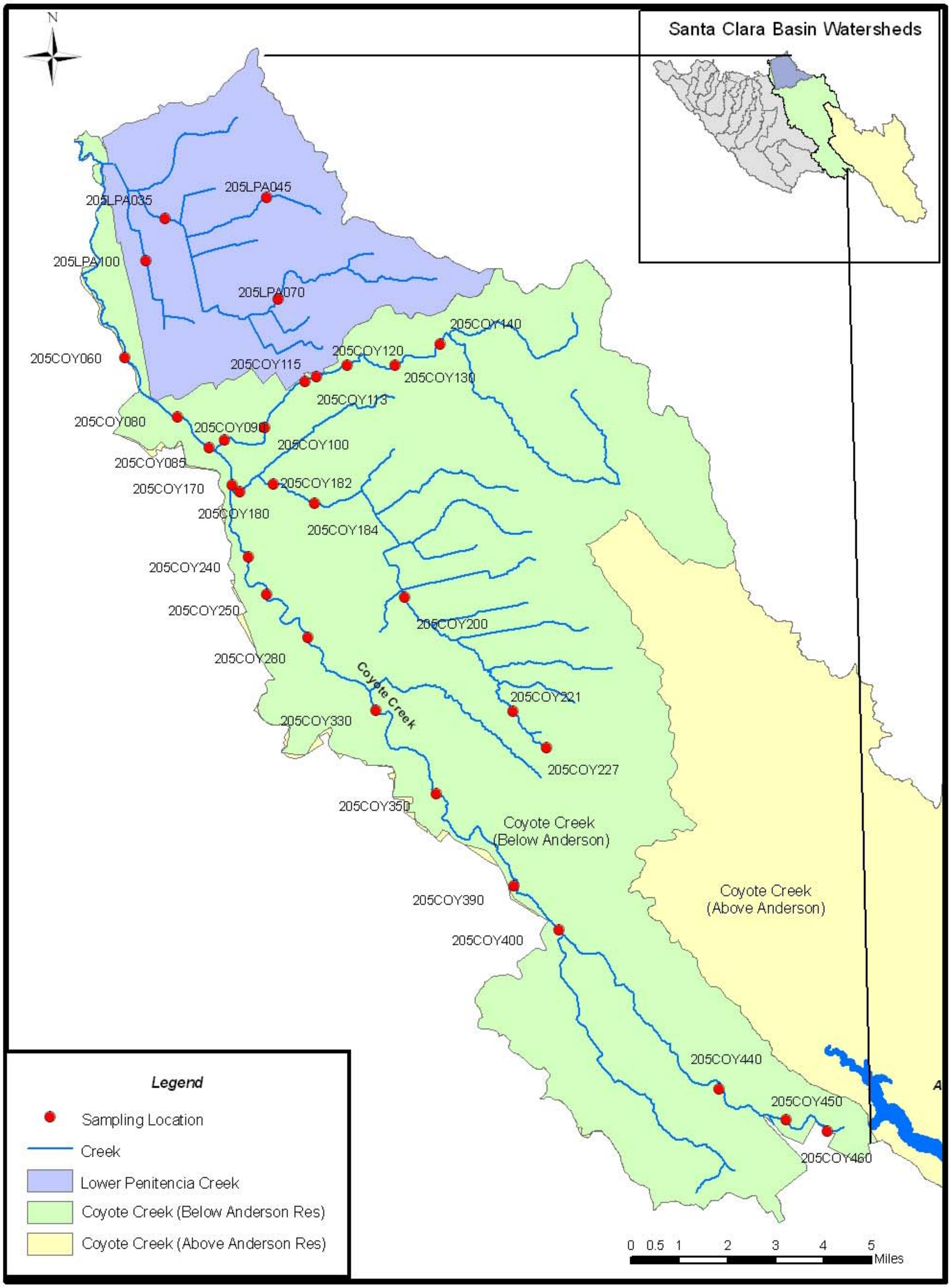

Figure 1. Sampling stations in Coyote Creek and Lower Penitencia Creek watersheds monitored by SCVURPPP during FY 07-08.

Table 3. Sampling site locations and monitoring parameters for 31 sites in Coyote and Lower Penitencia Creek watersheds monitored by SCVURPPP during FY 07-08.

| Waterbody | SWAMP ID | Description | Latitude | Longitude | Sediment Chemistry | Toxicity | BMI/ PHAB |
|---|---|---|---|---|---|---|---|
| Coyote Creek Watershed | | | | | | | |
| Coyote Creek | 205COY060 | Coyote Cr at Montague | 37.39540 | 121.91485 | | | X |
| Coyote Creek | 205COY080 | Coyote Cr at Oakland Ave | 37.37778 | 121.89455 | X | X | X |
| Coyote Creek | 205COY085 | Coyote Cr at Berryessa Rd | 37.36856 | 121.88235 | | | X |
| Coyote Creek | 205COY170 | Coyote Cr at Watson Park | 37.35719 | 121.87377 | | | X |
| Coyote Creek | 205COY240 | Coyote Cr at William St Park | 37.33575 | 121.86707 | X | X | X |
| Coyote Creek | 205COY250 | Coyote Cr at Kelley Park | 37.32444 | 121.85983 | | | X |
| Coyote Creek | 205COY280 | Coyote Cr at Tully Rd | 37.31157 | 121.84405 | | | X |
| Coyote Creek | 205COY330 | Coyote Cr at Yerba Buena Rd | 37.29000 | 121.81801 | X | X | X |
| Coyote Creek | 205COY350 | Coyote Cr at Shady Oaks Park | 37.26498 | 121.79468 | | | X |
| Coyote Creek | 205COY390 | Coyote Cr at Forsum Rd (Metcalf Ponds) | 37.23747 | 121.76483 | | | |
| Coyote Creek | 205COY400 | Coyote Cr at Metcalf Rd | 37.22429 | 121.74741 | X | X | X |
| Coyote Creek | 205COY440 | Coyote Cr above Osier Ponds | 37.17674 | 121.68610 | | | X |
| Coyote Creek | 205COY450 | Coyote Cr at Burnette Rd | 37.16773 | 121.66072 | | | X |
| Coyote Creek | 205COY460 | Coyote Cr at Cochrane | 37.16457 | 121.64510 | | | X |
| Upper Penitencia Creek | 205COY090 | Upper Penitencia Cr at Flea Market | 37.37080 | 121.87660 | X | X | X |
| Upper Penitencia Creek | 205COY100 | Upper Penitencia Cr at Jackson Road | 37.37500 | 121.86140 | | | X |
| Upper Penitencia Creek | 205COY113 | Upper Penitencia Cr at Kyle St (Park) | 37.38908 | 121.84642 | | | |
| Upper Penitencia Creek | 205COY115 | Upper Penitencia Cr at White Road | 37.39053 | 121.84213 | | | X |
| Upper Penitencia Creek | 205COY120 | Upper Penitencia Cr at Talent Ave | 37.39400 | 121.83070 | | | X |
| Upper Penitencia Creek | 205COY130 | Upper Penitencia Cr at Quail Hollow | 37.39420 | 121.81250 | X | X | X |
| Upper Penitencia Creek | 205COY140 | Upper Penitencia Cr at Live Oak Br | 37.40090 | 121.79550 | | | X |
| Lower Silver Creek | 205COY180 | Lower Silver Cr at Wooster Ave. | 37.35548 | 121.87052 | X | X | X |
| Lower Silver Creek | 205COY182 | Lower Silver Cr at King Rd | 37.35775 | 121.85786 | | | |
| Lower Silver Creek | 205COY184 | Lower Silver Cr at Kammerer | 37.35222 | 121.84227 | | | X |
| Thompson Creek | 205COY200 | Thompson Cr at Quimby Road | 37.32423 | 121.80757 | X | X | X |
| Thompson Creek | 205COY221 | Tompson Cr at Jasper Hills Rd | 37.29020 | 121.76610 | | | X |
| Thompson Creek | 205COY227 | Thompson Cr at Flowering Meadow | 37.27940 | 121.75320 | | | X |
| Lower Penitencia Creek Watershed | | | | | | | |
| Berryessa Creek | 205LPA035 | Berryessa Cr at Milpitas Blvd. | 37.43745 | 121.90048 | X | X | X |
| Los Coches Creek | 205LPA045 | Los Coches Cr below Ed Levin Co. Park | 37.44439 | 121.86195 | | | X |
| Berryessa Creek | 205LPA070 | Berryessa Cr below Piedmont Av | 37.41382 | 121.85724 | | | X |
| Lower Penitencia Creek | 205LPA100 | Lower Penitencia Cr at Corning Ave. | 37.42475 | 121.90745 | X | X | X |

# 2.0 METHODS

## 2.1 Benthic Macroinvertebrate Bioassessment

Benthic macroinvertebrate (BMI) communities were sampled at 28 sites using the Reach-wide Benthos (RWB) method described in Ode (2007), which was developed for the California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP).

### 2.1.1 BMI Field Sampling and Laboratory Processing

Each bioassessment sampling site consisted of approximately 150-meter reach of the channel that is divided into 11 equidistant transects that are placed perpendicular to the direction of flow. Ten additional transects ('inter-transects") are located between main transects for total of 21 transects within the reach. Inter-transects are used for physical habitat component of the procedure (see below). BMIs are collected using 500-u mesh D-frame net at each of the 10 main transects. The sampling position within each transect is alternated between 25%, 50% and 75% distance of the wetted width of the stream as you move upstream from transect to transect. The benthos from a 1 $ft^2$ area at each transect were disturbed by manually rubbing coarse substrate followed by 'kicking' the upper layers of substrate to dislodge any remaining invertebrates into a D-frame kick net. Material collected from all eleven 1 $ft^2$ areas was then transferred into a 500-ml wide-mouth jar containing approximately 200 ml of 95% ethanol.

Bioassessment Services, Inc. laboratory was contracted for processing all BMI samples collected. Based on CDFG (1999, 2003) each sample was rinsed in a standard no. 35 sieve (0.02 in; 0.5 mm) and transferred to a tray with twenty, 4 $in.^2$ (26 $cm^2$) grids for subsampling. Benthic material in the subsampling tray was transferred from randomly selected grids (or half grids if BMI densities were high) to petri dishes where the BMIs were removed systematically with the aid of a stereomicroscope and placed in vials containing 70% ethanol and 2% glycerol. At least 500 BMIs were subsampled from a minimum of three grids. If there were more BMIs remaining in the last grid after 500 were archived, then the remaining BMIs were tallied and archived in a separate vial. This was done to assure a reasonably accurate estimate of BMI abundance based on the portion of benthos in the tray that was subsampled. These "extra" BMIs were not included in the taxonomic lists and metric calculations.

The subsampled BMIs identified from each sample were archived in labeled vials with a mixture of 70% ethanol and 2% glycerol. Subsampled BMIs were identified using taxonomic keys (Kathman and Brinkhurst 1998, Merritt and Cummins 1996, Stewart and Stark 1993, Thorp and Covich 2001, Wiggins 1996) and unpublished references. A standard level of taxonomic effort was used as specified in the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) master taxa list (http://www.waterboards.ca.gov/ swamp/docs/safit/ste_list.pdf). California tolerance values and functional feeding group designations were obtained from the California Aquatic Macroinvertebrate Laboratory Network (CAMLnet) list of taxonomic effort (27 January, 2003 revision). One exception to the level 1 standard taxonomic effort included identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae). Minor exceptions included lower resolution identification of some immature organisms and pupae.

### 2.1.2 Physical Habitat Assessment

Physical habitat assessments were conducted at each BMI bioassessment sampling event using protocols described in Ode (2007). Physical habitat data were collected following the "Basic" level of effort, with the following exception: pebble counts, habitat types, bank stability and canopy cover were measured and/or assessed at each main transect and inter-transect location. In addition, bankfull width and heights were measured at 2-3 transect locations (where possible) and water velocities were measured at one transect (where possible) using protocols described in Ode (2007). PHAB quality was assessed using three physical habitat sub-categories (epifaunal substrate/cover, sediment deposition, and channel alteration). Combined PHAB scores ranged from 0 to 60 (20 possible points per sub-category), with higher scores reflecting higher quality habitat.

### 2.1.3 BMI Data Quality Assessment

Duplicate samples were collected at 10% of sites sampled each year to evaluate precision of field sampling methods. In addition, 10% of the total number of samples collected was submitted to CDFG's Aquatic Bioassessment Laboratory for independent assessment of taxonomic accuracy, enumeration of organisms and conformance to standard taxonomic level.

### 2.1.4 Data Analysis and Interpretation

The biological condition of each site was assessed by calculating a Benthic Index of Biotic Integrity (B-IBI) score, using a preliminary draft B-IBI scoring system recently developed by SCVURPPP (2007) for the Santa Clara Basin. Five metrics were selected for the B-IBI based on their ability to discriminate between reference and test sites, which include:

1. EPT Richness
2. Diptera Richness
3. Predator Richness
4. Percent Collector Individuals
5. Percent Non-insect Taxa

Metric scoring ranges were defined using techniques described in Hughes *et al*. (1998) and McCormick *et al*. (2001). Table 4 presents the scoring ranges for the five metrics included in the preliminary Santa Clara County B-IBI.

Table 4. Scoring Ranges for the Five Metrics Included in the Preliminary Draft Santa Clara County B-IBI (SCVURPPP 2007a)

| IBI Score | # EPT Taxa | % Non-Insecta Taxa | # Diptera Taxa | # Predator Taxa | % Collectors |
|---|---|---|---|---|---|
| 10 | ≥21 | 0 - 11 | >10 | ≥12 | 0 - 48 |
| 9 | 19-20 | 12 - 19 | 10 | 11 | 49 - 54 |
| 8 | 17-18 | 20 - 26 | 9 | 10 | 55 - 60 |
| 7 | 15-16 | 27 - 32 | 8 | 9 | 61 - 66 |
| 6 | 13-14 | 33 - 39 | 7 | 8 | 67 - 72 |
| 5 | 11-12 | 40 - 46 | 6 | 7 | 73 - 78 |
| 4 | 9-10 | 47 - 53 | 5 | 6 | 79 - 84 |
| 3 | 7-8 | 54 - 60 | 4 | 5 | 85 - 90 |
| 2 | 5-6 | 61 - 67 | 3 | 4 | 91 - 96 |
| 1 | 3-4 | 68 - 74 | 2 | 3 | 97 - 99 |
| 0 | ≤2 | 75 -100 | <2 | ≤2 | 100 |

## 2.2 Sediment and Water Field Sampling and Laboratory Analysis

### 2.2.1 Physio-chemical Measurements

Conventional water quality parameters of temperature, pH, conductivity, and dissolved oxygen (D.O.) were measured with portable field instruments. During water quality sampling events, temperature, pH, and, conductivity were measured with an YSI Model 63 handheld instrument, and D.O. was measured with an YSI Model 58 portable D.O. meter. In addition, water velocity was measured in feet/second with a Global Water FP101 flow meter.

Water quality was measured during the BMI bioassessments using a multi-parameter probe YSI model 556MPS. Stream velocity was measured at each sample riffle using a Global Water FP201 flow meter.

### 2.2.2 Sediment Chemistry

Bedded sediments were collected in the fall of 2007 (October 9) and spring (March 31-April1) from 4 sites along the mainstem of Coyote Creek. During the spring, additional samples were collected from 2 sites in Upper Penitencia Creek, 2 sites in Lower Silver-Thompson Creek, 1 site in Berryessa Creek and 1 site in Lower Penitencia Creek (Table 3, Figure 1). At each sampling site, sediment samples were preferentially collected in areas with fine sediment deposition. Sediment samples were collected with a Tefzel-coated stainless spoon, lifted slowly through overlying water and placed into a Tefzel-coated steel pan. Samples were pooled at each site, homogenized, placed in sample containers and later analyzed for total recoverable metals and suite of pyrethroid pesticides. Total organic carbon and grain size were also measured for each sediment sample. Analytical methods, reporting limited and holding times for each analyte are provided in Appendix A.

### 2.2.3 Sediment Toxicity

The toxicity of sediments from 10 sites in Coyote and Lower Penitencia Creek watersheds (Figure 1) was evaluated by exposing the amphipod, *Hyalella azteca,* to the collected sediments in a standard ten-day survival test (EPA method 600-R-99/064). This test uses eight replicates per site, with ten amphipods per replicate. For tests to meet basic quality control requirements, the lab control had to achieve a mean survival of 80%. Tests for reduced survival compared to a lab control were done using Dunnett’s one-way Analysis of Variance (ANOVA) test ($p = 0.05$).

### 2.2.4 Data Quality Assessment

Quality Assurance/Quality Control (QA/QC) activities associated with the field data collection and laboratory analyses are described in more detail in the SCVURPPP Draft Quality Assurance Project Plan (QAPP). The major goal for these QA/QC procedures is to have representative, comparable, accurate and precise data, to the extent possible under the given limitations. QA/QC activities associated with water quality field sampling and laboratory analysis included the following:

- Employing analytical chemists trained in the procedures to be followed;
- Adherence to documented procedures, USEPA methods and written SOPs;
- Calibration of analytical instruments;
- Use of quality control samples, internal standards, surrogates, and SRMs
- Complete documentation of sample tracking and analysis.

Data validation was performed in accordance with the National Functional Guidelines for Organic Data Review (EPA540/R-99/008) and Inorganic Data Review (EPA540/R-01/008).

### 2.2.5 Data Analysis and Interpretation

#### *Sediment Quality*

To assess sediment quality, contaminant concentrations are often compared to established sediment quality guidelines to help understand the potential negative impacts that the observed concentrations might exert. MacDonald et al. (2000) developed a set of ecotoxicological effects-based thresholds to provide a basis for assessing sediment quality conditions in freshwater ecosystems. Sediment Quality Guidelines are concentrations of sediment contaminants that typically represent some type of threshold, above which a predictable effect on biota has been shown (Ingersoll et al 2000). Independent Sediment Quality Guidelines have been developed by various federal, state, and provincial agencies in North America (Ingersoll et al 2000).

In an effort to generalize the application of these guidelines, MacDonald et al. (2000) developed “consensus-based sediment quality guidelines” by calculating the geometric mean of existing literature values for a range of contaminants of concern. As a result, two types of “consensus-based” guideline values were developed:

1. **Probable Effect Concentrations (PECs),** which represent concentrations above which one would expect to observe some degree of toxic response; and,
2. **Threshold Effect Concentrations (TECs),** which represent concentrations below which one would not expect to observe toxic responses.

These guidelines were then empirically tested for their reliability against additional existing sediment chemistry and toxicity data collected from North American field studies. The criteria for evaluating the reliability of the effects based thresholds were:

- TECs were considered reliable if >75% of the sediment samples were correctly predicted to be *not* toxic; and,
- PECs were considered reliable if >75% of the sediment samples were correctly predicted to be toxic using the PEC threshold (MacDonald et al. 2000).

The results of the study demonstrated that consensus-based sediment quality guideline values could provide a reliable basis for predicting sediment quality conditions in freshwater ecosystems. The resulting PEC and TEC guidelines for a variety of contaminants are presented in Table 5.

Although PEC and TEC guidelines have not been developed for pyrethroid pesticides, LC50s[2] have been published for seven pyrethroids (Maund et al 2002, Amweg et al 2006). Therefore, LC50’s for pyrethroids were used in the absence of PEC/TEC guidelines to assess sediment contamination (Table 5).

To estimate the magnitude of contamination in each sample, a Sediment Quality Guideline Quotient (SQGQ) was calculated for each contaminant at each site by dividing the measured sediment contaminant concentration by the Probable Effect Concentration (metals) or the LC50 (pyrethroids) (Ingersoll et al 2000). The SQGQs for all contaminants measured were then averaged to determine a mean SQGQ for each site/sampling event. Long, Ingersoll, and Macdonald (2006) have found that incidences of toxicity significantly increase with increasing mean SQGQs.

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Table 5. Probably and threshold effects concentrations for total recoverable metals in sediments (MacDonald et al 2000) and LC50s for pyrethroids (Maund et al 2002, Amweg et al 2006).

| Contaminant | Probable Effects Concentration (PEC) | Threshold Effects Concentration (TEC) | LC50s (Normalized to TOC) |
|---|---|---|---|
| *Total Metals* | | | |
| Arsenic (mg/kg) | 33 | 9.79 | - |
| Cadmium (mg/kg) | 4.98 | 0.99 | - |
| Chromium (mg/kg) | 111 | 43.4 | - |
| Copper (mg/kg) | 149 | 31.6 | - |
| Lead (mg/kg) | 128 | 35.8 | - |
| Mercury (mg/kg) | 1.06 | 0.18 | - |
| Nickel (mg/kg) | 48.6 | 22.7 | - |
| Zinc (mg/kg) | 459 | 121 | - |
| PCBs (µg/kg) | 676 | 59.8 | - |
| *Pyrethroid Pesticides* | | | |
| Bifenthrin | - | - | 520 |
| Cyflurin | - | - | 1,080 |
| Cypermethrin | - | - | 380 |
| Deltamethrin | - | - | 790 |
| Esfenvalerate | - | - | 1,540 |
| L-Cyhalothrin | - | - | 450 |
| Permethrin | - | - | 10,830 |

### *Sediment Quality Triad*

In order to evaluate the four lines of evidence in a similar way, SCVURPPP developed a SQT index (Table 6). The index includes five condition categories, optimal, good, fair, marginal, and poor. For bioassessments, condition categories developed for the Draft Preliminary Santa Clara B-IBI (SCVURPPP 2007) were used. The possible range of physical habitat assessment (PHAB) scores (0-60) were evenly divided to into five condition categories. The magnitude of sediment toxicity was evaluated based on the percentage of organisms which survived the bioassay relative to the percentage of organisms that survived the control. For sediment chemistry, condition categories were developed based on the incidence of toxicity associated with mean SQGQs as described in Ingersoll et al (2000).

Table 6. Condition categories for each Sediment Quality Triad line of evidence.

| Condition Category | Sediment Chemistry (mean SQGQ) | Sediment Toxicity (% Survival Relative to Control) | BMI Bioassessment (B-IBI) | Physical Habitat Quality (PHAB) |
|---|---|---|---|---|
| Optimal | < 0.1 | ≤ 90 | 60-46 | 60-49 |
| Good | 0.1 -<0.5 | 89-80 | 45-40 | 48-37 |
| Fair | 0.5 - <1.0 | 79-54 | 39-26 | 36-25 |
| Marginal | 1.0- <5.0 | 53-27 | 25-13 | 24-13 |
| Poor | > 5.0 | 26-0 | 12-0 | 12-0 |

It is important to note that because bioassessments and PHABs were only conducted in April and May 2008, sediment chemistry and toxicity data collected in October 2007 were not used in the calculation of the final SQT for each site. However, interpretation of sediment chemistry and toxicity data collected during the fall sampling event is included in the following sections. In addition, results from SQT data collected during FY 06-07 may be used to evaluate inter-annual variability at the 4 Coyote Creek mainstem sites that were sampled again in FY 07-08.

# 3.0 RESULTS

## 3.1 BMI Bioassessments

From the 31 composite samples collected during spring 2008, including the three duplicate samples, 14,895 BMIs were processed comprising 105 taxa.

### 3.1.1 Functional Feeding Groups

Collector-gatherer and collector-filterer relative abundances varied substantially throughout the watershed, ranging from 13 to 99 percent and 0 to 68 percent, respectively (Figure 2). Baetid mayflies, chironomids and oligochaetes were the dominant collector-gatherers at most of the sites. In the upper section of Coyote Creek, many of the collector-gatherers were replaced with collector-filterers, primarily *Americorophium* and hydropsychid caddisflies; the Asiatic clam, *Corbicula*, was another dominant collector-filterer at site COY330.

The variation of scraper and predator relative abundances was similar across the watershed ranging from 0 to 17 percent and 0 to 15 percent, respectively (Figure 3). Gastropods (snails) were the primary scrapers at Coyote Creek sites but aquatic moths (*Petrophila*), and riffle beetles (*Optioservus*) contributed somewhat to the relative abundance of scrapers at sites in the upper section of Coyote Creek. Scrapers consisting of riffle beetles, heptageniid mayflies, and individuals from several caddisfly genera increased with increasing elevation across the sites of Upper Penitencia Creek. Scrapers were absent or sparse at the Lower Silver-Thompson Creek and Lower Penitencia Creek sites; at sites where they were present they consisted of gastropods.

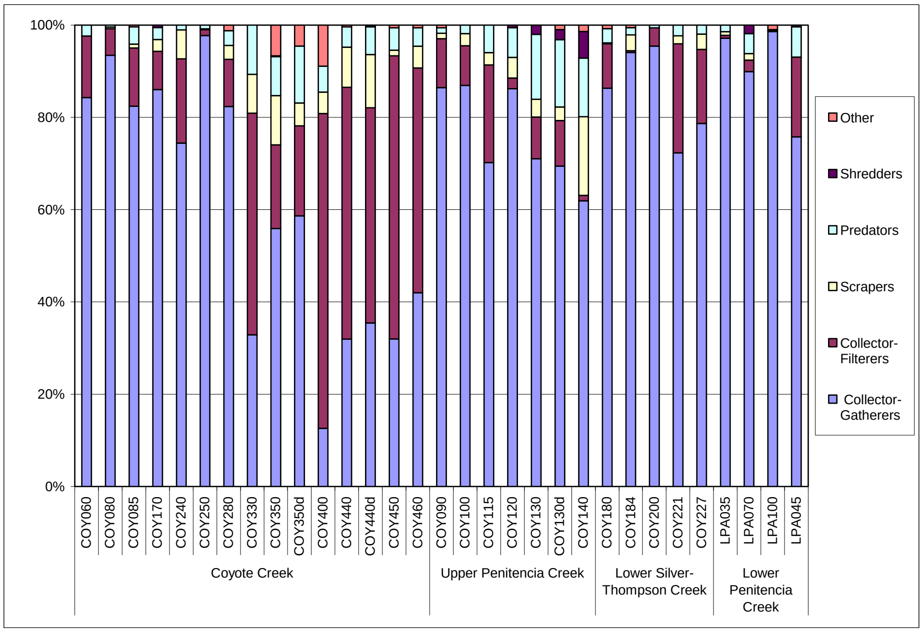

Figure 2. Percentages of benthic macroinvertebrate functional feeding groups sampled from the Coyote Creek and Lower Penitencia Creek watersheds in April/May 2008.

### 3.1.2 Taxonomy

The BMI assemblages of Upper Penitencia Creek were the most complex and demonstrated a strong response to the elevation gradient of the creek system. Metrics associated with richness were particularly responsive to the elevation gradient. From the lowest to highest elevation sites of Upper Penitencia Creek, taxa richness ranged from 18 to 55 and EPT richness ranged from 4 to 25. Taxa and EPT richness values of 55 and 25 documented for site COY140 are unusually high, with nearly 3 times higher than median taxa richness and 6 times higher than median EPT richness for all 31 samples collected in 2008. While stoneflies were absent or scarce in the Coyote Creek watershed and absent from the Coyote Creek sites, site COY140 on Upper Penitencia Creek contained 4 stonefly taxa, two of which are considered long-lived requiring at least one year to complete their life cycles. In addition, site COY140 contained 7 Coleoptera taxa, many of which inhabit the aquatic environment for their entire life cycle

### 3.1.3 Benthic Index Biological Integrity

Total B-IBI scores for sites in Coyote Creek mainstem ranged from 2 – 20 (0-50 possible), sites in Coyote Creek tributaries (i.e., Upper Penitencia and Lower Silver-Thompson Creek) ranged from 6 – 44, and sites in Lower Penitencia Creek watershed ranged from 6-24 (Figure 3). Individual metric scores for all sites are provided in Appendix B.

In the context of the overall B-IBI for the Santa Clara Valley creeks, the Coyote main stem sites ranked in the ‘poor’ to ‘marginal’ categories, with scores exhibiting a longitudinal pattern, generally decreasing in a downstream direction. One exception was sites 205COY085 and 205COY170, which had scores that were higher than the adjacent upstream sites. Both sites were directly below tributary confluences (i.e., Upper Penitencia and Lower Silver Creek). These sites exhibited on average higher proportion of riffle and run habitat, larger-sized substrate, and higher dissolved oxygen concentrations compared to adjacent upstream sites, which may have a positive effect on B-IBI scores.

Upper Penitencia Creek also had B-IBI scores that exhibited a longitudinal pattern, with scores increasing in an upstream direction. The upper three sites had the highest scores among all sites sampled during FY 07-08 (ranging 33 – 44) and among all sampling locations, were the only sites ranked as ‘fair’ or ‘good’. B-IBI scores in Lower Silver-Thompson Creek showed no trend with elevation and exhibited a narrow range of scores (6 – 11), all within the ‘poor’ category. Berryessa Creek sites within Lower Penitencia Creek watershed had highest range of B-IBI scores (6 – 24), with the highest score occurring at the highest elevation site.

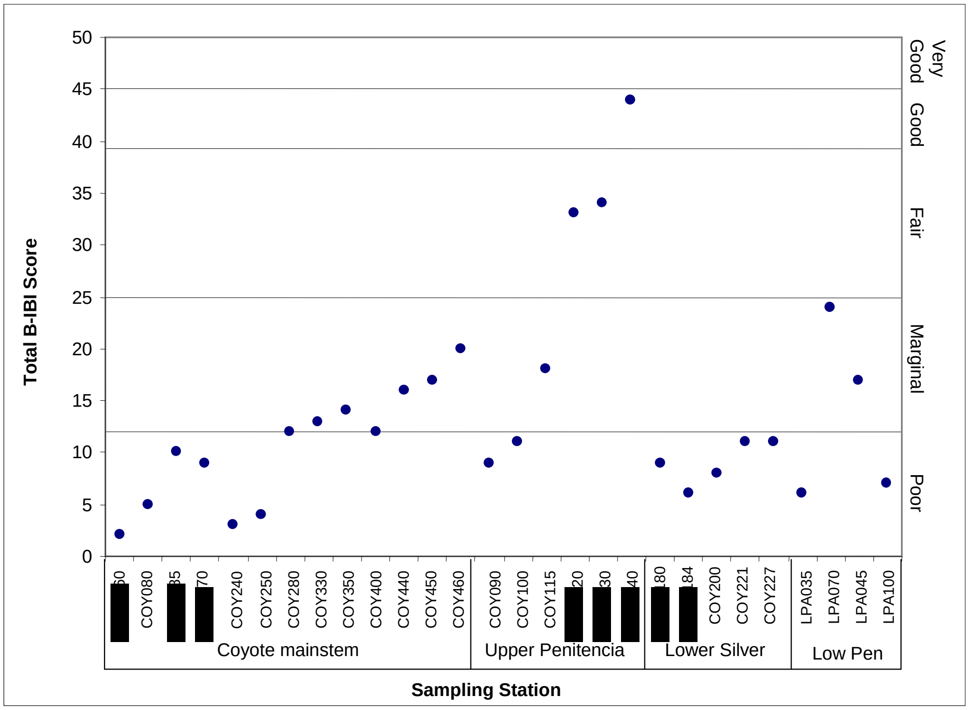

Figure 3. Benthic Index of Biotic Integrity (B-IBI) scores for sites in Coyote Creek and Lower Penitencia Creek watersheds.

## 3.2 Physical Habitat

Physical habitat scores can range from 0 to 60 (score of 60 = most optimal habitat conditions). PHAB scores for Coyote Creek mainstem sites ranged from 13-54, with scores generally increasing in an upstream direction. PHAB scores for Coyote Creek tributaries ranged from 9-49, the highest score occurring in Upper Penitencia Creek (site COY120) and lowest score in Thompson Creek (site COY200). PHAB scores for Lower Penitencia Creek sites ranged from 11-38, with the highest score occurring at the highest elevation site in Berryessa Creek (LPA070).

Average substrate sizes in Coyote Creek mainstem sites ranged from 2mm (sand/silt) to 124 mm (cobble). Average substrate sizes in Upper Penitencia Creek ranged from 22 mm to 208 mm. Lower Silver-Thompson Creek sites had particle sizes that ranged from 8 mm to 79 mm.

Table 7. Physical habitat measurements and assessment score3s for BMI assessment sites.

| Site | Elev. (ft) | Ave Particle Size (mm) | Ave Wetted Width (ft) | Habitat Type (%) | | | | PHAB | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Pool | Glide | Run | Riffle | Epifaunal Substrate | Sediment Deposition | Channel Alteration | Total Score |
| *Coyote Creek Mainstem* | | | | | | | | | | | |
| COY060 | 40 | 16.3 | 37.3 | 65 | 35 | 0 | 0 | 1 | 1 | 11 | 13 |
| COY080 | 45 | 14.8 | 16.2 | 50 | 50 | 0 | 0 | 4 | 5 | 15 | 24 |
| COY085 | 50 | 26.5 | 27.5 | 35 | 45 | 5 | 15 | 6 | 10 | 11 | 27 |
| COY170 | 60 | 10.6 | 19.7 | 23 | 35 | 42 | 0 | 1 | 1 | 16 | 18 |
| COY240 | 70 | 2.1 | 29.0 | 38 | 47 | 15 | 0 | 2 | 2 | 13 | 17 |
| COY250 | 80 | 8.1 | 19.8 | 75 | 5 | 10 | 10 | 3 | 3 | 15 | 21 |
| COY280 | 100 | 36.1 | 17.3 | 15 | 21 | 47 | 17 | 8 | 6 | 14 | 28 |
| COY330 | 135 | 18.9 | 17.5 | 35 | 43 | 18 | 4 | 9 | 10 | 15 | 34 |
| COY350 | 175 | 35.3 | 24.2 | 15 | 40 | 20 | 25 | 11 | 5 | 15 | 31 |
| COY400 | 240 | 33.2 | 24.0 | 50 | 10 | 40 | 0 | 11 | 9 | 17 | 37 |
| COY440 | 340 | 63.1 | 44.8 | 0 | 30 | 70 | 0 | 17 | 12 | 17 | 46 |
| COY450 | 370 | 66.9 | 25.0 | 5 | 0 | 60 | 35 | 18 | 17 | 19 | 54 |
| COY460 | 390 | 123.9 | 37.0 | 10 | 0 | 50 | 40 | 18 | 17 | 18 | 53 |
| *Coyote Creek Tributaries* | | | | | | | | | | | |
| COY090 | 75 | 34.6 | 12.2 | 6 | 15 | 49 | 30 | 8 | 14 | 6 | 28 |
| COY100 | 120 | 22.4 | 23.7 | 31 | 42 | 7 | 20 | 8 | 8 | 10 | 26 |
| COY115 | 170 | 91.0 | 10.4 | 10 | 0 | 62 | 28 | 15 | 14 | 16 | 45 |
| COY120 | 250 | 95.6 | 7.0 | 7 | 34 | 21 | 38 | 16 | 16 | 17 | 49 |
| COY130 | 450 | 207.6 | 8.7 | 19 | 5 | 40 | 36 | 17 | 17 | 14 | 48 |
| COY140 | 600 | 184.8 | 8.9 | 0 | 21 | 40 | 39 | 17 | 10 | 19 | 46 |
| COY180 | 70 | 78.6 | 15.0 | 36 | 0 | 32 | 32 | 1 | 10 | 0 | 11 |
| COY184 | 90 | 35.6 | 14.7 | 0 | 77 | 23 | 0 | 3 | 7 | 8 | 18 |
| COY200 | 140 | 8.3 | 13.0 | 0 | 80 | 10 | 10 | 2 | 1 | 6 | 9 |
| COY221 | 400 | 17.3 | 5.0 | 15 | 40 | 12 | 33 | 13 | 14 | 16 | 43 |
| COY227 | 520 | 16.2 | 4.4 | 16.5 | 49 | 4 | 30.5 | 11 | 11 | 16 | 38 |
| *Lower Penitencia Creek Watershed* | | | | | | | | | | | |
| LPA035 | 15 | 3.1 | 14.1 | 0 | 100 | 0 | 0 | 2 | 3 | 6 | 11 |
| LPA045 | 400 | 22.8 | 6.5 | 8 | 40 | 0 | 52 | 7 | 5 | 16 | 28 |
| LPA070 | 200 | 54.3 | 3.5 | 19 | 34.5 | 18 | 28.5 | 13 | 7 | 18 | 38 |
| LPA100 | 15 | 0.5 | 22.0 | 0 | 100 | 0 | 0 | 0 | 18 | 0 | 18 |

## 3.3 Sediment Chemistry

Total organic carbon (TOC) and the percent fines in sediment were not well correlated for sediment collected for all sampling events (Figure 4). The concentration of % total fines was highest in the lowest Coyote Creek mainstem site (COY080) during fall sample event, and highest in lower Thompson Creek site (COY200) during spring sample event (Figure 5). There was no apparent elevation or seasonal trend for total % fine concentration among the four Coyote mainstem sites where sediment was collected.

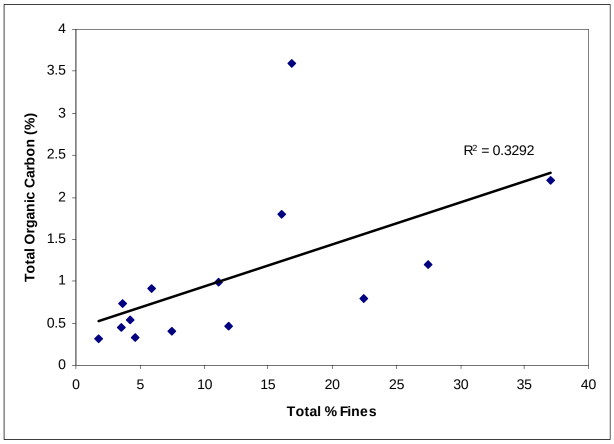

Figure 4. Relationship between Total Organic Carbon and Total % Fines at all sampling events.

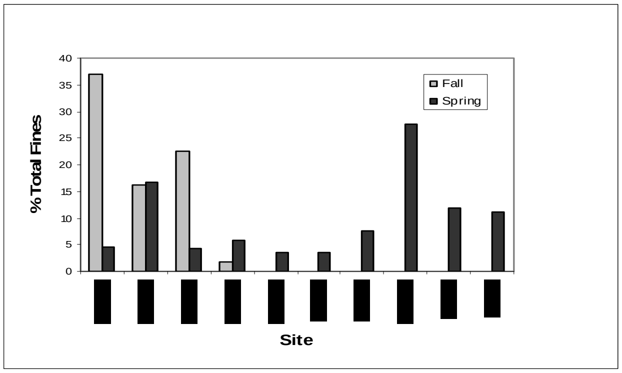

Figure 5. Total percent fines at sampling locations during spring event.

Total recoverable metal concentrations in sediment collected in October and May were above reporting limits for all sites sampled (Table 8). In contrast, pyrethroid pesticide concentrations were all below reporting limits, with the exception of Permethrin in one sediment sample collected during the fall and four pesticides (i.e., bifenthrin, cyfluthrin, cypermethrin, and L-cyhalothrin) in sediment samples collected during the spring event (Table 9).

Concentrations of metals were higher during the spring sampling event in the three upper elevation sites in the Coyote Creek mainstem, with the exception of chromium and nickel at site COY330 (Table 8). In contrast, metal concentrations at the lowest Coyote Creek mainstem site (COY080) were consistently higher in the fall sample for all contaminants. Metal concentrations typically did not show a relationship to elevation at the Coyote Creek mainstem sites, with the exception of nickel during the spring sampling event, which had increasing concentrations with increasing elevation. Metal concentrations were generally higher at the higher elevation sites for Upper Penitencia and Lower Silver-Thompson Creek, however, one site was sampled on each creek.

No seasonal or spatial trends were identified for pyrethroid pesticides due to the lack of samples with concentrations above the reporting limits.

Concentrations of total metals in bedded sediments were consistently below probable effect concentrations (PECs) in all sediment samples, with the exception of nickel. Pyrethroid pesticides were detected in 1 of 10 sites during the Fall sampling event and 6 of 10 sites during the Spring event. Specifically, during the Spring sampling event, Bifenthrin was detected at 5 of 10 sites, Cyfluthrin at 4 of 10 sites, and Cypermethrin at 3 of 10 sites. The concentrations of pyrethroids detected were above LC50 values for bedded sediments in 5 of the 14 samples collected (Table 11).

Table 8. Concentrations of total recoverable metals (mg/kg) in sediments collected at all sites during FY 07-08.

| Site ID | As | | Cd | | Cr | | Cu | | Hg | | Ni | | Pb | | Zn | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr |
| *Coyote Creek Mainstem* | | | | | | | | | | | | | | | | |
| COY080 | 6.7 | 6.1 | 0.36 | 0.21J | 65 | 40 | 42 | 25 | 0.092 | 0.064 | 99 | 86 | 26 | 12 | 130 | 83 |
| COY240 | 5 | 6.2 | 0.35 | 0.5 | 77 | 80 | 34 | 50 | 0.16 | 0.35 | 120 | 130 | 51 | 58 | 160 | 250 |
| COY330 | 4.3 | 7.2 | 0.072J | 0.086J | 91 | 76 | 16 | 21 | 0.07 | 0.074 | 170 | 160 | 9.1 | 11 | 64 | 82 |
| COY400 | 6.1 | 6.6 | 0.048J | 0.085J | 78 | 250 | 19 | 26 | 0.039 | 0.055J | 120 | 450 | 5.3 | 7.1 | 44 | 77 |
| *Coyote Creek  Tributaries* | | | | | | | | | | | | | | | | |
| COY090 | - | 5.4 | - | 0.2J | - | 42 | - | 27 | - | 0.059J | - | 59 | - | 6.9 | - | 71 |
| COY130 | - | 7.5 | - | 0.18J | - | 45 | - | 31 | - | 0.052J | - | 64 | - | 6.7 | - | 67 |
| COY180 | - | 5 | - | 0.33 | - | 40 | - | 21 | - | 0.069J | - | 51 | - | 16 | - | 90 |
| COY200 | - | 12 | - | 0.13J | - | 61 | - | 40 | - | 0.095 | - | 76 | - | 12 | - | 120 |
| *Lower Penitencia Creek* | | | | | | | | | | | | | | | | |
| LPA035 | - | 4.6 | - | 0.26J | - | 47 | - | 16 | - | 0.082 | - | 80 | - | 7.9 | - | 62 |
| LPA100 | - | 4.4 | - | 0.37 | - | 68 | - | 20 | - | 0.043J | - | 95 | - | 12 | - | 110 |

J = result is an estimated quantity;  "-" = not sampled

Table 9. Concentrations of pyrethroid pesticides (ng/g) in sediments collected at all sites during FY 07-08.

| Site | Allethrin | | Bifenthrin | | Cyfluthrin | | Cypermethrin | | Danitol | | Deltamethrin | | L-Cyhalothrin | | Permethrin | | Prallethrin | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring |
| *Coyote Creek Mainstem* | | | | | | | | | | | | | | | | | | |
| COY080 | ND | ND | ND | 2.1 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| COY240 | ND | ND | ND | 23.4 | ND | 11.1 | ND | 16.5 | ND | ND | ND | ND | ND | 0.5J | 13.2J | ND | ND | ND |
| COY330 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| COY400 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| *Coyote Creek  Tributaries* | | | | | | | | | | | | | | | | | | |
| COY090 | - | ND | - | 2.3 | - | 4.7J | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |
| COY130 | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |
| COY180 | - | ND | - | ND | - | 1.3J | - | 1.9J | - | ND | - | ND | - | ND | - | ND | - | ND |
| COY200 | - | ND | - | 6 | - | 1.3J | - | 1.5J | - | ND | - | ND | - | ND | - | ND | - | ND |
| *Lower Penitencia Creek* | | | | | | | | | | | | | | | | | | |
| LPA035 | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |
| LPA100 | - | ND | - | 6.8 | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |

ND = not measured above reporting limit;  "-" = not sampled

Table 10. SQGQs for total recoverable metals in sediment collected at all sites during FY 07-08. Numbers in bold represent concentrations above the PEC value.

| Site ID | As | | Cd | | Cr | | Cu | | Hg | | Ni | | Pb | | Zn | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr | Oct | Apr |
| *Coyote Creek Mainstem* | | | | | | | | | | | | | | | | |
| COY080 | 0.20 | 0.18 | 0.01 | 0.04 | 0.59 | 0.36 | 0.28 | 0.17 | 0.09 | 0.06 | 2.04 | 1.77 | 0.20 | 0.09 | 0.28 | 0.18 |
| COY240 | 0.15 | 0.19 | 0.07 | 0.10 | 0.69 | 0.72 | 0.23 | 0.34 | 0.15 | 0.33 | 2.47 | 2.67 | 0.40 | 0.45 | 0.35 | 0.54 |
| COY330 | 0.13 | 0.22 | 0.01 | 0.02 | 0.82 | 0.68 | 0.11 | 0.14 | 0.07 | 0.07 | 3.50 | 3.29 | 0.07 | 0.09 | 0.14 | 0.18 |
| COY400 | 0.18 | 0.20 | 0.01 | 0.02 | 0.70 | 2.25 | 0.13 | 0.17 | 0.04 | 0.05 | 2.47 | 9.26 | 0.04 | 0.06 | 0.10 | 0.17 |
| *Coyote Creek Tributaries* | | | | | | | | | | | | | | | | |
| COY090 | - | 0.16 | - | 0.04 | - | 0.38 | - | 0.18 | - | 0.06 | - | 1.21 | - | 0.05 | - | 0.15 |
| COY130 | - | 0.23 | - | 0.04 | - | 0.41 | - | 0.21 | - | 0.49 | - | 1.32 | - | 0.05 | - | 0.15 |
| COY180 | - | 0.15 | - | 0.07 | - | 0.36 | - | 0.14 | - | 0.07 | - | 1.05 | - | 0.13 | - | 0.20 |
| COY200 | - | 0.36 | - | 0.03 | - | 0.55 | - | 0.27 | - | 0.09 | - | 1.56 | - | 0.09 | - | 0.26 |
| *Lower Penitencia Creek* | | | | | | | | | | | | | | | | |
| LPA035 | - | 0.14 | - | 0.05 | - | 0.42 | - | 0.11 | - | 0.08 | - | 1.65 | - | 0.06 | - | 0.14 |
| LPA100 | - | 0.13 | - | 0.07 | - | 0.61 | - | 0.13 | - | 0.04 | - | 1.95 | - | 0.09 | - | 0.24 |

“-“ = not sampled

Table 11. SQGQs for Pyrethroid Pesticides (ng/g) in sediment collected at all sites during FY 07-08. Numbers in bold represent concentrations above the LC50 value.

| Site | Allethrin | | Bifenthrin | | Cyfluthrin | | Cypermethrin | | Danitol | | Deltamethrin | | L-Cyhalothrin | | Permethrin | | Prallethrin | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring | Fall | Spring |
| *Coyote Creek Mainstem* | | | | | | | | | | | | | | | | | | |
| COY080 | ND | ND | ND | 1.22 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| COY240 | ND | ND | ND | 1.25 | ND | 0.29 | ND | 1.21 | ND | ND | ND | ND | ND | 0.03 | 0.07 | ND | ND | ND |
| COY330 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| COY400 | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND | ND |
| *Coyote Creek Tributaries* | | | | | | | | | | | | | | | | | | |
| COY090 | - | ND | - | 0.61 | - | 0.60 | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |
| COY130 | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |
| COY180 | - | ND | - | ND | - | 0.30 | - | 1.25 | - | ND | - | ND | - | ND | - | ND | - | ND |
| COY200 | - | ND | - | 0.96 | - | 0.10 | - | 0.33 | - | ND | - | ND | - | ND | - | ND | - | ND |
| *Lower Penitencia Creek* | | | | | | | | | | | | | | | | | | |
| LPA035 | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |
| LPA100 | - | ND | - | 1.32 | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND | - | ND |

ND = not measured above reporting limit; “-“ = not sampled

Mean sediment quality guideline quotients (SQGQ) were calculated for each sampling event at each site. SQGQs for all sites were below 1.0 during both sampling events, with the exception of COY400 during the spring event (SQGQ = 1.52) (Figure 6). Based on these SQOQs and the corresponding conditions categories presented in Table 6, the sediment quality for all sites with the exception of COY400 are either “good” or “fair”.

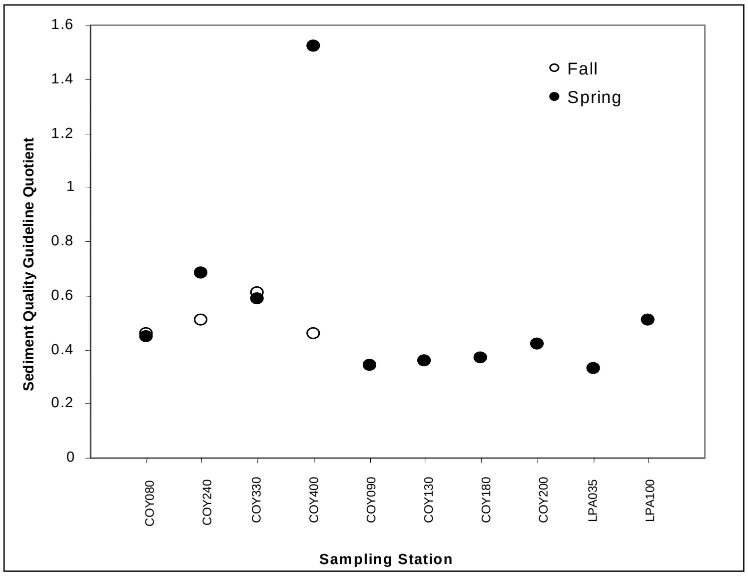

Figure 6. Mean SQGQ of sediments collected from all sites during fall and spring sampling event

## 3.4 Sediment Toxicity

The magnitude of toxicity is based on the percentage of organisms THAT survived the bioassay, relative to the percentage of organisms that survived the control. (Figure 7). Exposure of *Hyalella azteca* to sediment significantly reduced survival in sediments collected during fall and spring at 5 sites (25% of total sampling events), with lowest percent survival occurring at the two lowest elevation sites in Coyote mainstem (during both sampling events) and upper site in Lower Silver-Thompson Creek site. *H. azteca* survival was also significantly reduced in lowest site in Lower Silver-Thompson Creek and Lower Penitencia Creek site.

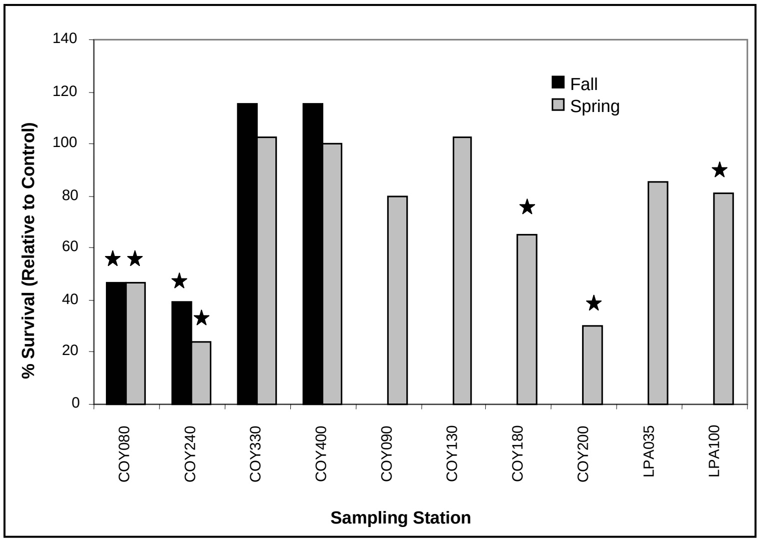

Figure 7. *Hyalella azteca* 10 day survival bioassay results. Star indicates significantly reduced survival compared to lab control.

# 4.0 DISCUSSION

## 4.1 Sediment Quality Triad

Data collected during the pilot study were ranked into five condition categories (optimal, good, fair, marginal and poor) using the sediment quality triad (SQT) index previously described. Rankings for each line of evidence are shown in Table 12 and Figure 8.

Table 12. Condition categories for each Sediment Quality Triad line of evidence.

| Site | Sediment Chemistry (mean SQGQ) | | Sediment Toxicity (% Survival Relative to Control) | | BMI Bioassessment (B-IBI) | | Physical Habitat Quality (PHAB) | |
|---|---|---|---|---|---|---|---|---|
| | Value | Rank | Value | Rank | Value | Rank | Value | Rank |
| Coyote Creek | | | | | | | | |
| COY080 | 0.45 | Good | 47 | Marginal | 5 | Poor | 24 | Marginal |
| COY240 | 0.68 | Fair | 24 | Poor | 3 | Poor | 17 | Marginal |
| COY330 | 0.59 | Fair | 103 | Optimal | 13 | Marginal | 34 | Fair |
| COY400 | 1.52 | Marginal | 100 | Optimal | 12 | Poor | 37 | Good |
| Coyote Creek Tributaries | | | | | | | | |
| COY090 | 0.34 | Good | 80 | Good | 9 | Poor | 28 | Fair |
| COY130 | 0.36 | Good | 103 | Optimal | 34 | Fair | 48 | Good |
| COY180 | 0.37 | Good | 65 | Fair | 9 | Poor | 11 | Poor |
| COY200 | 0.42 | Good | 30 | Marginal | 8 | Poor | 9 | Poor |
| Lower Penitencia Creek | | | | | | | | |
| LPA035 | 0.33 | Good | 85 | Good | 6 | Poor | 11 | Poor |
| LPA100 | 0.51 | Fair | 81 | Good | 7 | Poor | 18 | Marginal |

Each line of evidence used for the weight of evidence (WOE) approach was ranked into five condition categories (optimal, good, fair, marginal and poor). Multiple lines of evidence generally did not agree at most of the sites. Similar rankings (i.e., “poor” or “marginal”) for toxicity, B-IBI scores and physical habitat scores occurred at the two lowest elevation sites in Coyote Creek mainstem and the Thompson Creek site. These sites had the three lowest percentages of survival for *Hyallela azteca,* relative to the control. Mean sediment chemistry values generally ranked good or fair across all sites, except for upper site in Coyote Creek mainstem, which ranked lower due to elevated concentrations of nickel and chromium, both naturally occurring metals.

Conversely, moderate to high rankings (i.e., “fair”, “good” or “optimal”) for all lines of evidence occurred at the upper elevation site in Upper Penitencia Creek (COY130). This site had the highest B-IBI score among the SQT sites and second highest score among all BMI sampling sites sampled in 2008. Site COY400 had the lowest ranking (marginal) for sediment chemistry (mean SQGQ = 1.52) and poor B-IBI scores; however toxicity and physical habitat were rated optimal or good for this site. There were no apparent elevation trends to any of the lines of evidence for the Coyote Creek mainstem sites.

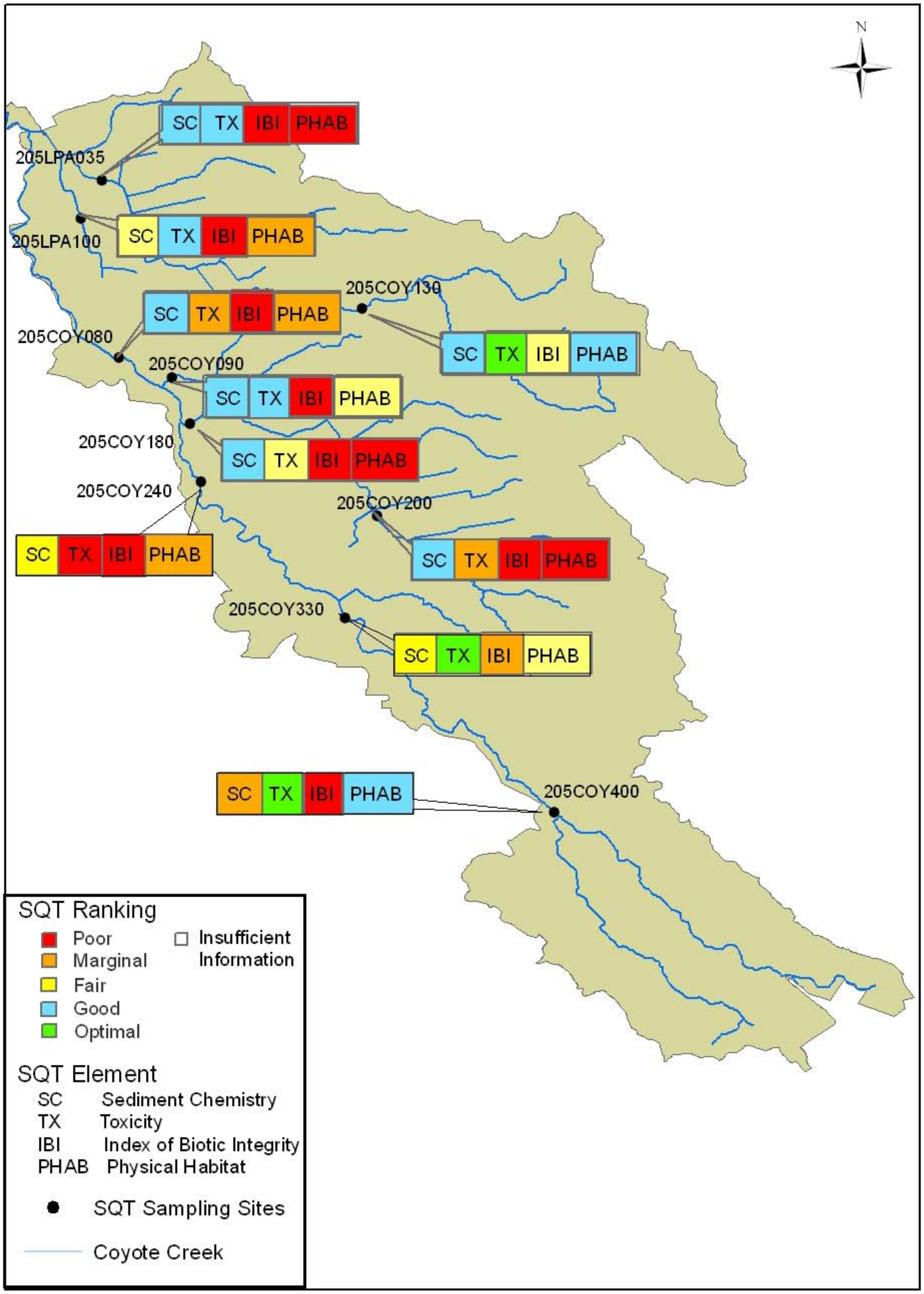

Figure 8. Rankings for each SQT line of evidence for each sampling site in Coyote and Lower Penitencia Creek watershed (May 2008).

## 4.2 Variables Explaining Biological Integrity

To evaluate whether lines of evidence used in the sediment quality triad (SQT) may explain the measured condition of benthic communities (i.e., BMIs), B-IBI scores were compared to sediment quality guideline quotients (mean SQGQs), sediment toxicity and PHAB measurements. The following sections discus the results of these analyses.

### 4.2.1 Sediment Chemistry and Toxicity

Based on the results of regression analyses, a significant relationship was not present between sediment quality (mean SQGQs) and toxicity (mortality). Similarly, mean SQGQ values were not well correlated to B-IBI scores. As a result, it appears that sediment chemistry (in the context of the mean SQGQ) does not explain the condition of benthic communities observed among sites sampled in the Coyote and Lower Penitencia Creek watersheds. A similar lack of correlation between these lines of evidence was also found in Coyote Creek mainstem sites in the SQT Pilot Study conducted during FY 06-07 (SCVURPPP 2007b).

One plausible explanation for the lack of correlation between sediment quality and toxicity or B-IBI scores is that the contaminants that were measured during this study only represent a fraction of the possible contaminants in sediment that may be causing toxicity and adversely affecting resident biota. Therefore, an unmeasured contaminant(s) could be affecting the benthic community. Additionally, it is possible that a combination of metal concentrations may have a synergistic affect that may be impact benthic communities, but that the mean SQGQ is not measuring. Furthermore, using the mean SQGQ as an indicator for sediment quality may be masking the effects from elevated concentrations of a specific contaminant. Based on Probable Effects Concentrations (PEC), metal contaminants were generally well below concentrations that are known to cause impacts to aquatic life, with the exception of nickel (all sites) and chromium (site COY400). These metals, however, often originate from natural sources in upper watershed areas and exhibit concentrations that typically correlate with elevation. In addition, linear regression analyses indicate that concentration of individual metal contaminants do not have significant correlations with toxicity or B-IBI scores.

Similar results were found for pyrethroid pesticides. Existing studies have shown pyrethroid pesticides as a potential cause of toxicity in urban creeks in the Bay Area (Weston et al. 2005). One major issue with evaluating effects of pesticides in the current study is that reporting limits for pyrethroid pesticides used in the analyses (2 – 25 ng/g) are higher than what is recommended. TDC Environmental (2008) recommends that method detection limits for pyrethroid pesticides should be no greater than 1 ng/g and 0.1ng/g is preferred. As a result of the higher than recommended reporting limits used this study, a majority of the pyrethroid pesticide measurements in sediment samples (i.e., approximately 90%) were not detected.

To better evaluate how the high percentage of non-detects for pyrethroid pesticides may have affected the results of this study, an analysis was conducted using the reporting limits as surrogate concentrations for each sample/site. Specifically, samples with non-detects were replaced with reporting limit values, then normalized for TOC and divided by the published LC50 values to generate a SQGQ. The reporting limits were generally 2 ng/g, with the exception of permethrin, which was 25 ng/g. The mean SQGQ for all contaminants across all sites ranged from 0.37 – 0.99 and 117 out of total 126 pesticide concentrations (93%) were less than 1.0 (i.e., below published LC50 values). As a result, using reporting limits values for all non-detects actually resulted in lower mean SQGQ values for 5 sites, and slight increases for the remaining 5 sites.

To analyze the relationship between B-IBI scores and toxicity, a linear regression analysis was conducted. As a result, a moderate to weak relationship was observed between sediment toxicity and B-IBI scores ($r^2 = 0.34$, $p<0.08$). Sediment toxicity and B-IBI scores appear to be the most problematic at sites COY240, COY200 and COY080, with percent survival (in relation to control) ranging from 24-37% and B-IBI scores in the poor range.

Additionally, metrics used in the development in the B-IBI may be less responsive to contaminants in the sediment compared to overall habitat degradation (see next section). The low physical habitat ranking at majority of the sites may be large factor for lower B-IBI scores and may mask B-IBI's ability to show biological response to contaminants or toxicity in sediments.

### 4.2.2 Reach-Scale Physical Habitat

In contrast to sediment quality and toxicity, reach-scale physical habitat quality appears to at least partially explain the condition of the benthic community in Coyote Creek. Specifically, regression analyses suggest that B-IBI scores are correlated with qualitative physical habitat (PHAB) scores ($r^2$=.52, $p<0.05$) and mean substrate diameter ($r^2$ =.75, $p<0.05$) (Figure 9). These results suggest that either natural variations in or anthropogenic changes to substrate size may directly affect B-IBI scores. Additionally, reach level physical habitat quality may also be an important factor controlling the condition of benthic communities.

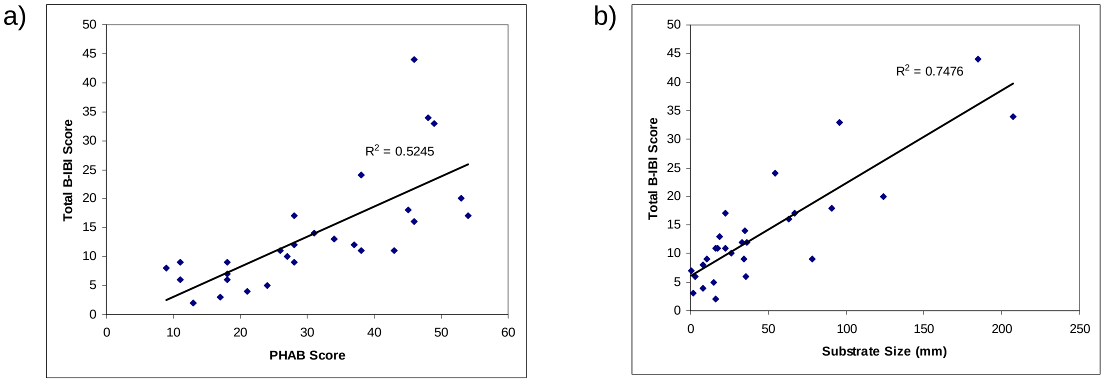

Figure 9. Comparisons of Qualitative Physical Habitat Scores (a) and Mean Creek Substrate Diameter (b) to Benthic Macroinvertebrate Index of Biological Integrity (B-IBI) for sampling sites in Coyote and Lower Penitencia Creek watershed (2008).

### 4.2.3 Temporal Variation in Sediment Contaminant Concentrations and Toxicity

Sediment chemistry results in FY 07-08 show very little variation in contaminant concentrations between the fall 2007 and spring 2008 sampling events in Coyote Creek mainstem. This result is very different from FY 06-07 results, where metal and pesticide concentrations were typically much higher during spring compared to fall sampling event. Limited high flow events during the spring 2008 may have some influence on the lack of variation in contaminant concentrations. Sediment samples in 2008 had much lower concentrations of fine substrate and total organic carbon (TOC) compared to 2007. Lower peak flows during winter season of FY 06-07 may have resulted in less fine sediment deposition and reduced conveyance of contaminants in the watershed.

SQT values for data collected during spring season of 2007 and 2008 at four Coyote creek mainstem sites were very similar (Table 13). For both years, there were no longitudinal trends observed for any of the lines of evidence. Important to note though, site COY240 showed consistently high toxicity during both years. Additionally, B-IBI and PHAB scores were very consistent for all 4 sites across the two years, suggesting that biological communities and physical habitat quality is relative stable on the short-term at these sites.

Table 13. SQT data values for Coyote mainstem sites during spring 2007 and 2008.

| Site | Mean SQGQ[1] | | Sediment Toxicity (% Survival Relative to Control)[2] | | B-IBI | | PHAB | |
|---|---|---|---|---|---|---|---|---|
| | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 | 2007 | 2008 |
| COY080 | 0.25 | 0.45 | 88 | 47 | 2 | 5 | 27 | 24 |
| COY240 | 0.56 | 0.68 | 27 | 24 | 1 | 3 | 13 | 17 |
| COY330 | 0.87 | 0.59 | 109 | 103 | 13 | 13 | 45 | 34 |
| COY400 | 0.51 | 1.52 | 102 | 100 | 17 | 12 | 37 | 37 |

[1] Mean SQGQ values for spring 2007 were originally calculated in SCVURPPP (2007b). These SQGQ values were recalculated for inclusion in this table for comparison with 2008 data (i.e., PCBs were removed from previously calculated 2007 SQGQ values)

[2] Percent survival values used for SQT in 2007 data were recalculated to include relativity to control sample to allow for comparison with 2008 data.

## 4.3 Potential Causes of Sediment Toxicity

To examine the potential causes of sediment toxicity observed in sites within the Coyote Creek and Lower Penitencia Creek watersheds, occurrences of sediment toxicity were compared to SQGQs calculated for individual metals and pyrethroid pesticides. As previously discussed, metal concentrations were consistently below PECs (i.e., SQGQ >1) during both sampling events, with the exception of nickel. Considering that nickel is a naturally occurring metal in Bay Area soils, and concentrations were inversely related to elevation, suggests that nickel is not likely the cause of sediment toxicity observed during Spring 2008.

In contrast to metals, observed sediment toxicity appears to be correlated with concentrations of pyrethroid pesticides above published LC50s (i.e., SQGQ >1). In 4 of the 6 samples where significant toxicity was observed, a least one pyrethroid pesticide was above the LC50, suggesting that pyrethroid pesticides are at least partially causing the sediment toxicity at these sites. Although pyrethroid concentrations were not above LC50s in the two remaining sites where toxicity was observed, samples contained detectable concentrations of at least one pyrethroid.

Table 14. A comparison of sediment toxicity occurrences and pyrethroid pesticide detections in bedded sediment samples collected in Coyote Creek and Lower Penitencia Creek watersheds in Spring 2008.

| Sampling Site | Sediment Toxicity (% Survival Relative to Control) | Pyrethroid Concentration Greater than LC50 (SQGQ)?[1] | | | |
|---|---|---|---|---|---|
| | | Bifenthrin | Cyfluthrin | Cypermethrin | L-Cyhalothrin |
| Coyote Creek | | | | | |
| COY080 | Yes (47%) | Yes (1.22) | - | - | - |
| COY240 | Yes (24%) | Yes (1.25) | No (0.29) | Yes (1.21) | No (0.03) |
| COY330 | No | - | - | - | - |
| COY400 | No | - | - | - | - |
| Coyote Creek Tributaries | | | | | |
| COY090 | Yes (80%) | No (0.61) | - | - | - |
| COY130 | No | - | - | - | - |
| COY180 | Yes (65%) | - | - | Yes (1.25) | - |
| COY200 | Yes (30%) | No (0.96) | - | No (0.33) | - |
| Lower Penitencia Creek | | | | | |
| LPA035 | No | - | - | - | - |
| LPA100 | Yes (81%) | Yes (1.32) | - | - | - |

[1] Dash (-) = pyrethroid not detected.

# 5.0 CONCLUSIONS AND RECOMMENDATIONS

The following preliminary conclusions were based on the results and interpretation of chemical, physical, biological and toxicological indicator data collected during FY 07-08 by SCVURPPP.

1. **Sediment Quality**

   With the exception of nickel (which is a naturally occurring metal at relatively high concentrations in Bay Area watersheds), metals measured in bedded sediments collected at sites in Coyote Creek and Lower Penitencia Creek watersheds appear to be consistently below concentrations that one would expect to observe some degree of toxic response (i.e., PECs). These results suggest that metals are not a primary driver of the condition of aquatic life in Coyote and Lower Penitencia Creek watersheds, although potential for impacts due to the synergism between metals can not be discounted.

   At least one pyrethroid pesticide was detected at a majority of the sites sampled in Coyote and Lower Penitencia Creek watersheds. In particular, either Bifenthrin or Cypermethrin concentrations in samples collected in Spring 2008 were above levels that one would expect to observe a significant toxic response (i.e., LC50s). Additionally, reporting limits continue to be slightly greater than recommended, although lowering detection limits appears to have little impact on conclusions presented in this report.

   <u>Recommendation</u>: Continue to monitoring a relative small suite of metals and pyrethroid pesticides in bedded sediment and compare concentrations to PECs, TECs and LC50s to determine if concentrations may be at problematic levels. Additionally, continue to work with contract laboratories to achieve the lowest possible method detection limits for pyrethroid pesticides (i.e., <1 ng/g).

2. **Sediment Toxicity**

   Significant toxicity was observed in sediments collected at 6 of 10 sites during Fall 2007 and/or the Spring 2008, including the two lowest elevation sites on Coyote Creek mainstem (COY080 and COY240) during both sampling events. T he co-occurrence of pyrethroid concentrations above LC50s and sediment toxicity suggests that pyrethroids may be causing (at least partially) the toxicity at observed at 4 of the 6 sites.

   Recommendation: Conduct follow-up analyses at Coyote Creek and Lower Penitencia Creek sites to better determine the cause(s) and sources of toxicity. High priority should be given to sites COY080 and/or COY240 due to the high degree of toxicity observed during multiple sampling events. Increasing the extensiveness of sampling (both spatially and temporally) should be considered as well as conducting toxicity identification evaluations (TIEs) to evaluate the causes of observed toxicity.

3. **Biological Integrity**

   As measured by a Draft Benthic Index of Biotic Integrity (B-IBI) for Santa Clara Creeks, conditions of benthic macroinvertebrate (BMI) communities in sites within Coyote Creek mainstem are poor to marginal. Sites in Upper Penitencia had the highest B-IBI scores and the greatest response to changes in elevation. BMIs at sites sampled in Lower Silver-Thompson Creek were also in poor condition. B-IBI scores were significantly correlated to average substrate size and reach-scale physical habitat scores.

   Recommendation: Continue to conduct bioassessments using BMIs to assess biological integrity and detect long-term changes in benthic communities in Santa Clara Valley creeks. The Program should consider conducting a study (either county-wide or regionally) to determine the optimal sampling design (e.g., target or stratified-random) and timeframe (e.g., annually, triennially, etc.) that will facilitate both the efficient and effective assessment of biological integrity of Santa Clara Valley creeks overtime.

## 4. Sediment Quality Triad

Using a sediment quality triad (SQT) approach continues to provide a robust and holistic method to assessing the magnitude and extent of impacts on aquatic life uses in Santa Clara Valley creeks. As demonstrated in FY 06-07 and FY 07-08, each line of evidence provides unique information that assist managers in determining what creek sites/reaches have the greatest impacts, and which stressors may be causing the observed biological responses.

Recommendation: As practicable, continue to collect multiple lines of evidence at specific creek sites/reaches to better assess aquatic life use impacts and evaluate causes of biological responses.

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**Appendix A. Sediment Analytical Chemistry Methods, Reporting Limits, and Holding Times.**

| Analyte | Analytical Method | Reporting Limit | Hold Time |
|---|---|---|---|
| **SEDIMENT SAMPLES** | | | |
| ***TOTAL RECOVERABLE METALS* (mg/kg)** | | | |
| Aluminum | EPA 6020 | 1 | 6 months |
| Arsenic | EPA 6020 | 0.1 | 6 months |
| Cadmium | EPA 6020 | 0.1 | 6 months |
| Chromium | EPA 6020 | 0.1 | 6 months |
| Copper | EPA 6020 | 0.1 | 6 months |
| Lead | EPA 6020 | 0.1 | 6 months |
| Mercury | EPA 7471M | 0.02 | 6 months |
| Manganese | EPA 6020 | 0.1 | 6 months |
| Nickel | EPA 6020 | 0.1 | 6 months |
| Selenium | EPA 6020 | 0.1 | 6 months |
| Silver | EPA 6020 | 0.1 | 6 months |
| Zinc | EPA 6020 | 1 | 6 months |
| ***NUTRIENTS AND ANIONS*** | | | |
| Total Organic Carbon | EPA 9060 | 0.1% | 28 days |
| Percent Solids | EPA 160.3 | 0.1% | 28 days |
| Sediment Grain Analysis | Plumb, 1981 | NA | 6 months |
| **Pyrethroid Pesticides (ng/g)** | EPA 8270C(m) | 2-25 | 40 days |
| *Piperonyl butoxide* (ng/g) | EPA 8270C(m) | 5 | 40 days |
| ***TOXICITY TESTING*** | | | |
| *Hyalella azteca* | EPA-600-R-99-064 2nd Edition | NA | 8 weeks |

**Appendix B. Preliminary Benthic Index of Biotic Integrity (B-IBI) Calculation Tables for Coyote and Lower Penitencia Creek Sites.**

| Site | Collection Date | EPT Taxa | IBI Score | Number Diptera Taxa | IBI Score | Number Predator Taxa | IBI Score | % Collectors | IBI Score | % Non-Insecta Taxa | IBI Score | Total IBI Score | Rank |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 205COY060 | 5/7/2008 | 2 | 0 | 1 | 0 | 3 | 1 | 98 | 1 | 77 | 0 | 2 | Poor |
| 205COY080 | 5/7/2008 | 2 | 0 | 2 | 1 | 1 | 0 | 99 | 1 | 56 | 3 | 5 | Poor |
| 205COY085 | 5/9/2008 | 4 | 1 | 3 | 2 | 4 | 2 | 95 | 2 | 56 | 3 | 10 | Poor |
| 205COY170 | 5/9/2008 | 3 | 1 | 3 | 2 | 3 | 1 | 94 | 2 | 54 | 3 | 9 | Poor |
| 205COY240 | 5/12/2008 | 1 | 0 | 2 | 1 | 2 | 0 | 93 | 2 | 79 | 0 | 3 | Poor |
| 205COY250 | 5/12/2008 | 1 | 0 | 2 | 1 | 0 | 0 | 100 | 0 | 57 | 3 | 4 | Poor |
| 205COY280 | 5/14/2008 | 5 | 2 | 3 | 2 | 5 | 3 | 93 | 2 | 55 | 3 | 12 | Poor |
| 205COY330 | 5/14/2008 | 2 | 0 | 3 | 2 | 7 | 5 | 83 | 4 | 67 | 2 | 13 | Marginal |
| 205COY350 | 5/15/2008 | 7 | 3 | 2 | 1 | 5 | 3 | 77 | 5 | 66 | 2 | 14 | Marginal |
| 205COY400 | 5/15/2008 | 6 | 2 | 1 | 0 | 6 | 4 | 82 | 4 | 62 | 2 | 12 | Poor |
| 205COY440 | 5/16/2008 | 7 | 3 | 4 | 3 | 4 | 2 | 86 | 3 | 43 | 5 | 16 | Marginal |
| 205COY450 | 5/19/2008 | 6 | 2 | 4 | 3 | 6 | 4 | 93 | 2 | 33 | 6 | 17 | Marginal |
| 205COY460 | 5/19/2008 | 7 | 3 | 7 | 6 | 6 | 4 | 91 | 2 | 40 | 5 | 20 | Marginal |
| 205COY090 | 4/30/2008 | 4 | 1 | 3 | 2 | 4 | 2 | 97 | 1 | 56 | 3 | 9 | Poor |
| 205COY100 | 4/30/2008 | 3 | 1 | 4 | 3 | 4 | 2 | 95 | 2 | 59 | 3 | 11 | Poor |
| 205COY115 | 5/1/2008 | 9 | 4 | 2 | 1 | 9 | 7 | 92 | 2 | 48 | 4 | 18 | Marginal |
| 205COY120 | 5/1/2008 | 13 | 6 | 9 | 8 | 10 | 8 | 90 | 3 | 24 | 8 | 33 | Fair |
| 205COY130 | 5/2/2008 | 15 | 7 | 8 | 7 | 11 | 9 | 86 | 3 | 23 | 8 | 34 | Fair |
| 205COY140 | 5/2/2008 | 25 | 10 | 9 | 8 | 15 | 10 | 64 | 7 | 17 | 9 | 44 | Good |
| 205COY180 | 4/21/2008 | 4 | 1 | 2 | 1 | 2 | 0 | 96 | 2 | 45 | 5 | 9 | Poor |
| 205COY184 | 4/21/2008 | 3 | 1 | 1 | 0 | 2 | 0 | 94 | 2 | 56 | 3 | 6 | Poor |
| 205COY200 | 4/23/2008 | 1 | 0 | 3 | 2 | 2 | 0 | 99 | 1 | 43 | 5 | 8 | Poor |
| 205COY221 | 4/23/2008 | 1 | 0 | 5 | 4 | 3 | 1 | 97 | 1 | 42 | 5 | 11 | Poor |
| 205COY227 | 4/23/2008 | 1 | 0 | 5 | 4 | 2 | 0 | 96 | 2 | 46 | 5 | 11 | Poor |
| 205LPA035 | 4/17/2008 | 2 | 0 | 2 | 1 | 0 | 0 | 99 | 1 | 50 | 4 | 6 | Poor |
| 205LPA070 | 4/17/2008 | 11 | 5 | 5 | 4 | 5 | 3 | 96 | 2 | 11 | 10 | 24 | Marginal |
| 205LPA045 | 4/17/2008 | 4 | 1 | 5 | 4 | 5 | 3 | 97 | 1 | 21 | 8 | 17 | Marginal |
| 205LPA100 | 4/16/2008 | 2 | 0 | 2 | 1 | 1 | 0 | 99 | 1 | 43 | 5 | 7 | Poor |