SWAMP MONITORING FOR FY 2002-2003 IN THE SANTA ANA REGION

Canyon Lake Water Quality Assessment Monitoring Study

Introduction:

This document is an appendix of the Santa Ana Region's 5 year workplan developed for the Statewide Surface Water Ambient Monitoring Program. During fiscal years 00-01 Anaheim Bay and Huntington Harbor were studied and data analyses is currently under way. Lake Elsinore will be studied during fiscal years 01-02 and sampling preparations are currently underway. Canyon Lake will be studied during fiscal years 02-03. This document describes the monitoring study that will be implemented in Canyon Lake.

Canyon Lake:

Canyon Lake was constructed in 1928 as the Railroad Canyon Reservoir. It is located about 1 mile upstream of Lake Elsinore and water spilled from Canyon Lake is a main source of water for Lake Elsinore. It is a small reservoir (approximate area of 383 acres). Damming the San Jacinto River artificially made Canyon Lake. Due to the dam and its upstream position relative to Lake Elsinore, the lake intercepts a variety of contaminants such as nutrients, and sediment.

Canyon Lake is Y shaped. One of the legs of Canyon Lake receives runoff from Salt Creek and has a mean depth of approximately 7 feet deep. The water that drains into Salt Creek includes runoff from residential, open space and agricultural landuses. The rest of Canyon Lake receives runoff from the San Jacinto River and has an approximate mean depth of 30 feet (40-45 feet in depth near the dam). The watershed that drains to the San Jacinto River includes urban, agricultural, and open space landuses. According to the Santa Ana Region's 1995 Basin Plan the beneficial uses designated for Canyon Lake are body contact and non-body contact recreation, warm fresh water habitat, and wildlife habitat, ground water recharge, municipal water supply, agricultural water supply. The benthic infauna survey component of this study will provide information on the types of habitat that Canyon Lake currently supports.

Canyon Lake was included on the 1998 Clean Water Act Section 303(d) list of impaired water bodies due to excessive nutrients and pathogens. Limited amount of data is available to identify the percent area of Canyon Lake affected by these stressors or to identify additional stressors. The sources of these stressors are currently being studied through the TMDL process. A comprehensive monitoring program is needed to determine the percent area of the lake that meets the water quality objectives and / or beneficial uses.

Existing Data Review:

Analyses of existing water quality data indicate that total and fecal coliform concentrations periodically exceed the Santa Ana Region's Basin Plan water quality objectives for lakes and streams. Total and fecal coliforms are indicators of pathogens in the water column. The source of these coliforms to Canyon Lake is not clear, however; data indicates that high concentrations frequently coincide with large storm events, although recreators may also be an important source of coliform and pathogens to the lake.

Focus of Work

This study focuses exclusively on determining the percent area of Canyon Lake that meets the standards or thresholds. The beneficial use that will be studied through this water quality assessment will be warm fresh water habitat (toxicity, chemistry and benthic infauna). A map of the study area is included in Appendix B. Body contact and non- body contact recreation will be studied through the pathogen TMDL currently under way. Tributaries to Canyon Lake are currently being studied during the source analyses of the TMDL process.

Study Design and Objectives

The overall goal of the study is to attain a comprehensive and current assessment of the water quality at Canyon Lake.

The objectives of this monitoring study are:

- Define the extent (percent of area) and magnitude of deviation from thresholds as these relate to beneficial uses and water quality objectives.
- Describe and depict spatial gradients of contaminants
- Determine seasonal relationships (i.e. dry vs. wet seasons)
- Assess the relationship between biological responses and contaminant exposure
- Compare the ambient water quality at Canyon Lake with the ambient water quality at Lake Elsinore and Big Bear Lake (studies in Lake Elsinore are in the sampling preparation stages and scheduled to begin in August 2002 and studies in Big Bear Lake are to be done in later years).

Sampling will take place in February and August 2003. These months were chosen to represent ambient water quality during both the wet and dry seasons. Sampling in February will allow us to determine the ambient water quality in the wet season after storm events have occurred. The sampling date for February will be chosen so that it does not coincide with a storm event, or immediately after a storm event so that the data will represent a period of time when the indicators are expected to remain stable (ambient water quality).

This monitoring study will involve sampling 60 sites in Canyon Lake (thirty sites per strata). Table 3 lists the sampling sites in Canyon Lake. As stated above, the sampling sites were selected using stratified-random sampling design with a spatially systematic component. Thirty sites were allocated per strata to ensure that the 95% confidence interval is no larger than 15% of the sub-population area assuming about 20% impairment.

Sampling sites were selected randomly, rather than by investigator pre-selection, to ensure representative sampling. The number of sites for Canyon Lake exceeds the original 30 sites per strata by 50%. The reason for the increase is that it may not be possible to sample all of the randomly selected sites because of improper substrate type, depth restrictions, or dredging activities. To prevent an unacceptable loss of statistical power due to lost samples the number of sites allocated was increased by 50%.

Although sites were selected randomly, a systematic component was added to the selection process to minimize clustering of sample sites. The systematic element was accomplished by using an extension of the sampling design used in the Southern California Coastal Bight Pilot Project and in EPA's Environmental Monitoring and Assessment Program (EMAP). A hexagonal grid was placed over a map of the sampling area. The hexagonal grid structure ensures systematic separation of the sampling, while the random selection of sites within grid cells ensures an unbiased estimate of ecological condition. In the field, the stations will be located by using a hand held GPS unit.

Indicators

The Canyon Lake Water Quality Assessment Study will measure multiple indicators (Table 1) at each site to relate contaminant exposure with biological response, and habitat conditions. These indicators were selected based on the following:

- the overall objectives of the study,
- the beneficial uses and the water quality objectives listed in the 1995 Basin Plan for the Santa Ana Region,
- the indicators for which a threshold is available, and
- the indicators known or suspected to be exceeded in Canyon Lake.

It is expected that the benthic infauna identification won't exhibit a significant difference between the February 2003 and the August 2003 months. Consequently, the benthic infauna identification work will be performed only in August. The February 2003 sampling activities will include sediment chemistry, toxicity, water column toxicity, and physical measurements. The August sampling activities will include water column toxicity, physical measurements, benthic infauna identification, sediment chemistry and sediment toxicity.

Beneficial Use	Regional Monitoring Objectives[1]	Category	Indicator
Water contact and non water contact	1, 2, and 3	Contaminant exposure	Total coliform bacteria Fecal coliform bacteria
Aquatic Life	11, 12, 13, 14, 15, 16, and 17	Biological response[2]	Total Chlorophyll Benthic infauna (Animals that live in sediment.) Sediment toxicity Water column toxicity
		Pollutant exposure	Acid volatile - sulfides/simultaneously & extracted metals Debris Organic and inorganic sediment chemistry Total organic carbon Nutrients Turbidity
		Habitat	Dissolved oxygen Sediment grain size and gradations Water temperature Electrical conductivity Salinity Hydrogen sulfide Ammonia

Sampling and Analyses Methods

Uniform sampling and analytical methods will be conducted throughout Canyon Lake. Toxicity data will be correlated with chemistry and benthic infauna data for sediments and with chemistry for water column samples.

- Sediment Chemistry:

  Chemical analyses of the sediment samples provide an assessment of chemical deposition. Sediment chemistry will allow us to determine the concentrations of chemicals that are present and their bioavailability. (If these chemicals are not in bioavailable form then they are of no biological concern). Sediment samples will be collected from the top 2cm using a Petite Pulnar grab sampler. A list of the analyses that will be performed on the sediment samples is on Table 3. Sediment chemistry samples will be collected and analyzed in August 2003 and February 2003.

- Sediment Toxicity:

  Sediment toxicity will allow us to determine if there is a direct impact to the exposure of the chemicals found in the sediment. Sediment samples for toxicity analyses will

[1] The number refers to the monitoring objective discussed previously under regional monitoring approaches. Please see page 13 for an explanation of the numbers.
[2] While the assessment of invasive species is not a focus of SWAMP, these organisms will very likely be identified when biological community measurements are made.

be collected from the top 2cm using a Petite Pulnar grab sampler. *Hyallela azteca* and *Chironomous tentans* sediment bioassays will be conducted on the 60 sediment samples collected in August 2003 and February 2003 from Canyon Lake. The endpoint of the test is survival and growth after a 28 - day exposure to the sediment sample.

- Benthic Infauna:

  Benthic infauna (organisms that live in the sediment) are an important part of the marine food web. They generally reside in one location for most of their life and are chronically exposed to sediment contaminants. Consequently, benthic infauna are excellent indicators of environmental water quality. Samples for infauna analyses will be taken using a Petite Pulnar grab sampler. The benthic infauna analyses will consist of sorting and taxonomic identification, to the species level, of the organisms found in the sediment. The sediment samples will be collected using a Petite Pulnar grab sampler and sieved in the field to 1.0 mm. The benthic infauna samples will be collected in August 2003 and February 2003. In absence of a reference condition for Canyon Lake, the benthic infauna data will be used to compare one season to another and for comparison with future benthic infauna analyses.

- Water Column Chronic Toxicity:

Water column samples will be collected using a water-column depth integrator sampler. *Ceriodaphnia dubia*, *Pimephales promelas*, and *Selenastrum capricornatum* survival and reproduction/growth toxicity tests will be performed on undiluted samples collected from Canyon Lake in August 2003 and in February 2003. The chronic toxicity analyses will include all required reference toxicant testing on the three species listed above. The endpoints for these analyses are as follows:

Species Tested	End point of Analyses
Ceriodaphnia dubia	(7±1 or 6-8) day survival and reproduction
Selenastrum capricornatum	96 hour growth
Pimephales promelas	7 day survival and growth

- Water Column Field Measurements:

  As stated above, the interaction between the water column and the sediment results from changes in physical parameters such as pH, dissolved oxygen, and temperature. Therefore, it is important to measure these parameters during the sampling activities. A YSI 6920 multi-parameter probe will be used to measure pH, dissolved oxygen, temperature, pH, salinity, bottom depth, turbidity, total suspended solids, and chlorophyll a. The multi-parameter probe will be calibrated the same day as the sampling activities. These measurements will be taken in August 2003 and in February 2003.

Responsible Parties

The overall goal of this study is to obtain statistically significant data that is scientifically valid to assess the water quality in Canyon Lake. There is also an opportunity for public outreach including:

1) educating the public about the water quality impacts to the bay and harbor from anthropogenic activities,
2) informing the public of the water quality assessment report, and
3) encouraging stewardship of the area.

In order to carry out the goal and objectives of this study, the Regional Board will be working with various agencies and contractors including SCCWRP, ABC Laboratories, CRG Marine Laboratories, and the Coast Keeper to carry out the monitoring program. The following outlines the roles of each of the participating parties in this monitoring study:

Participants in this water quality source analyses monitoring program include Regional Water Quality Control Board staff who will collect the samples and conduct the field measurements, City of Canyon Lake and Elsinore Valley Municipal Water District staff who will facilitate entrance to the lakes for collection of samples.

- Santa Ana Regional Water Quality Control Board's Role:

    - Obtain the necessary permits to access the sampling sites and collecting samples
    - Collect samples per protocols specified by the statewide-SWAMP QAPP.
    - Ensure that all necessary chain of custody forms are completed prior to surrendering samples to the laboratory
    - Obtain the necessary funding to carry out the study
    - Coordinate with all parties involved in the study
    - Coordinate with California State University Long Beach for data analyses and payment of analytical services.
    - Obtain Petite Pulnar grab sampler.

- Coast Keeper's Role:

    - Organize community volunteers.
    - Assemble informational pollution prevention material for the volunteers
    - Coordinate meetings and training sessions with the volunteers.
    - Provide a registered boat for sampling.

- City of Canyon Lake's Role:

    - Facilitate entrance to Canyon Lake for sampling.

- SCCWRP's Role:

  - Provide the core monitoring design for the study (list of the sampling sites, list of indicators, map of the study area depicting the sampling sites, etc)

- CRG Marine Laboratory's Role:

  - Provide training to regional board staff and volunteers for collection of samples
  - Provide the necessary containers, preservatives, chain of custody forms for the samples.
  - Oversee the sample collection.
  - Transport the samples to the laboratory for processing.
  - Analyze the samples for sediment chemistry, and water column chemistry.

- ABC Laboratory's Role:

  - Provide training to regional board staff and volunteers for collection of samples.
  - Provide the necessary containers, preservatives, chain of custody forms for the samples.
  - Oversee the sample collection.
  - Transport the samples to the laboratory for processing.
  - Analyze the samples for water column and sediment toxicity, and benthic infauna.

- Volunteers:

  - Record data
  - Label the sample bottles
  - Assist in sample collection

- State Water Resources Control Board Volunteer Monitoring Coordinator:
  - Assist Regional Board staff in training sessions of volunteers and participate in the sampling activities as needed.

The following table depicts the working relationships pertaining to the study.

Task	Responsible Organization		
	SWRCB	RWQCBs	Contractors
Develop contract(s) for monitoring services.	●	●	●
Identify water bodies or sites of concern and clean sites to be monitored.		●	
Identify site-specific locations with potential beneficial use impacts or un-impacted conditions that will be monitored.		●	
Decide if concern is related to objectives focused on location or trends of impacts.		●	
Select monitoring objective(s) based on potential beneficial use impact(s) or need to identify baseline conditions.		●	
Identify already-completed monitoring and research efforts focused on potential problem, monitoring objective, or clean conditions.		●	●
Make decision on adequacy of available information.		●	●
Prepare site-specific study design based on monitoring objectives, the assessment of available information, sampling design, and indicators.	● (Work Plan Review Role)	●	●
Implement study design. (Collect and analyze samples.)			●
Track study progress. Review quality assurance information and make assessments on data quality. Adapt study as needed.	● (Review Role)	●	●
Report data through SWRCB web site.	●	● (Coordination Role)	●
Prepare written report of data.	●	●	●

Equipment:

The boat necessary for the study will be equipped with a winch capable of handling the Petite Pulnar grab sampler. The Coast Keeper will supply the boat. The Petite Pulnar grab sampler will be used to collect the sediment samples for benthic infauna characterization, sediment chemistry, and sediment toxicity analyses. The water column samples will be collected using a depth integrator sampler that collects a composite sample of the water column. Field measurements of the water column will be taken by using a YSI 6929 multi-parameter probe. The probe will be calibrated the same day the measurements will be taken. Calibration date and measurements will be recorded in a waterproof field log. While on the boat, the locations will be verified by using a handheld GPS.

Chain of Custody and Field Methods

The Regional Board will be responsible for tracking all samples collected during the study. Chain of custody forms will be used to track each sample from the time it is collected to its final destination in the laboratory. The field crew will complete a chain of custody form in duplicate for each set of samples to be transferred to the laboratory. This form will be signed by the crewmember transferring the samples. Subsequently, the laboratory staff member will sign the chain of custody form. A copy of the chain of custody form will be kept in the Regional Board Canyon Lake Water Quality Assessment 2003 File and the original will accompany the samples.

Quality Assurance and Quality Control

Quality assurance/quality control (QA/QC) is an important part of any environmental monitoring project. A carefully planned QA/QC program ensures that the data collected are scientifically valid and adequate to meet the goals of the study.

Quality assurance activities for the study include but are not limited to:

- Standardization of sample collection, processing, and analytical methods
- Training workshops for field personnel by CRG Laboratories and ABC Labs.

The quality control activities are outlined below:

- CRG Marine Labs and ABC Labs staff will be present during the sample collection activities to ensure that the samples are collected in accordance with the state wide SWAMP QAPP protocols.
- Sample processing and analyses will follow the statewide SWAMP QAPP.

- In the laboratory, the quality control activities will consist of reference matrix samples, spiked samples laboratory duplicates and blanks at a frequency of 10% of all the batch of samples analyzed. Also, initial calibration verification and continuous calibration verification will be performed. The continuous calibration verification will be done at a frequency of 10% of the samples analyzed. Please see attachment C for method detection limits.

Data Management and Data Availability

All data will be inputted into the database developed and designed for SWAMP when it becomes available. In the mean time, field and laboratory data will be reported to SCCWRP by CRG Marine Laboratories and ABC Laboratories for input into their database in accordance with the Bight '98 Information Management Plan. SCCWRP will store the data in the same database structure that was developed and used in the Bight '98 Monitoring Survey.

SCCWRP will forward the formatted data set to the Regional Board. The final data set will be stored in Microsoft Access 97.
All data from this study will be available to the public via the Santa Ana Regional Water Quality Control Board's website (WWW.SWRCB.CA.GOV/RWQCB8).

Project Reporting

A water quality assessment report, in draft form, specific to Canyon Lake describing the conclusions of the study will be available through the Regional Board's website for review and comment. The reports will also be disseminated for peer review. The final report will address any comments received and will be available to the public through the Regional Board's website.

Deliverable Products:

The deliverable for this project will include the sample results in electronic format and in hard copy format from the analyses of sediment and water column samples from Canyon Lake and a report that will be prepared in conjunction with Regional Board staff for the interpretation of the data. Regional Board staff will submit the report with the findings to State Board SWAMP staff as a deliverable.

Sample Collection Dates and Laboratory Reporting:

The sampling dates for Canyon Lake will depend on the timeliness of the approval of the contract for this project. The desired sample collection dates are February 2003 and August 2003. The milestones for this study will include generation of a draft report (August 2003), peer review of the draft report (October 2003), finalizing the draft report (November 2003), and submittal of the draft report to the State Board and release of the report to the public (December 2003).

Budget:

The total cost for the Canyon Lake Water Quality Assessment Monitoring Study will be $336,600. Depending on the availability of funds, the study could be scaled to try to fit the available funding.

Indicators:

Indicator	Sediment	Water Column
Benthic infauna taxonomy	✔	
Toxicity	✔	✔
Arsenic	✔	
Cadmium	✔	
Chromium	✔	
Copper	✔	
Iron	✔	
Lead	✔	
Mercury	✔	
Nickel	✔	
Silver	✔	
Zinc	✔	
Acenaphthene	✔	
Acenaphthylene	✔	
Anthracene	✔	
Benz[a]anthracene	✔	
Benzo[a]pyrene	✔	
Benzo[b]flouranthene	✔	
Benzo[e]pyrene	✔	
Benzo[g,h,I]perylene	✔	
Benzo[k]flouranthene	✔	
Biphenyl	✔	
Chrysene	✔	
Dibenz[a,h]anthracene	✔	
Flouranthene	✔	
Flourene	✔	
Indeno(1,2,3-c,d)pyrene	✔	
Naphthalene	✔	
Perylene	✔	
Phenanthrene	✔	
Pyrene	✔	
2,6-Dimethylnaphthalene	✔	
1-Methylnaphthalene	✔	
2-Methylnapthalene	✔	
1-Methylphananthrene	✔	
1,6,7-Trimethylnaphthalene	✔	
LMW PAH's	✔	
HMW PAH/s	✔	
Total PAH/s	✔	
Chlordane	✔	
PCB Congeners	✔	
Total DDT	✔	
4,4'-DDT	✔	
2,4'-DDT	✔	
DDT	✔	
4,4'-DDD	✔	

Indicator	Sediment	Water Column
2,4'-DDD	✔	
DDD	✔	
4,4'-DDE	✔	
2,4'-DDE	✔	
DDE	✔	
Salinity		✔
Bottom Depth		✔
Light Transmission (turbidity)		✔
Total Suspended Solids		✔
Oxygen Saturation		✔
Bacteria		✔
Visual inspection for sheen (oil & grease)		✔
Total Organic Carbon	✔	
Grain size	✔	
Acid Volatile Sulfides and simultaneously extracted metals (SEM)	✔	
Percent Solids	✔	
Dissolved Oxygen (vertical profile)		✔
pH (vertical profile)		✔
Temperature (vertical profile)		✔
Chlorophyll a (vertical profile)		✔
Aluminum		
Manganese		
p'p' DDD		
p'p' DDE		
p'p' DDT		
dachtal		
Total chlordane		
Total PCB		
Specific conductance (vertical profile)		✔

REGIONAL MONITORING

The overall goal of this activity of SWAMP is to develop statewide and regionwide picture of the status and trends of the quality of California's surface water resources. It is intended that this portion of SWAMP will be implemented in each hydrologic unit (including coastal waters) of the State at least one time every five years. This portion of SWAMP is focused on collecting information on water bodies for which the State presently has little information and to determine the effects of diffuse sources of pollution and the baseline conditions of potentially clean areas.

For inland waters (watersheds), the program will implement a rotating basin framework where each Region will be divided into five areas consisting of one or more hydrologic units. The major watercourses and tributaries in one of these areas would be monitored for a one-year period at least once every five years. In coastal waters, a smaller amount of probabilistic monitoring will be completed.

Need for Regional Monitoring

Monitoring is needed that defines the larger scale condition of beneficial uses. This regional monitoring can determine if known local impacts can be observed over large distances and allows the assessment of regionwide or statewide water resource conditions. The result of regional monitoring will help the SWRCB and RWQCBs to determine clearly the effectiveness of the State's water quality control program.

The California Legislature is also very interested in establishing a closer link between budgeted water quality program activities and the impact those activities have on protecting and improving water quality. The Supplemental Report Language to the 1999 Budget Act directed the SWRCB to "… develop performance measures for its core regulatory programs …. that relate directly to water quality outcomes …." While the SWRCB and RWQCBs have established performance measures to manage many activities, the ability to relate directly the performance of their programs to water quality outcomes has been hampered by limited data management capabilities and fragmented and incomplete water quality monitoring data collection, evaluation, and management.

Since 1995, the SWRCB has used several performance objectives and measures for its programs. The measures are generally output related and designed to measure program efficiency and timeliness (such as percent of total inspections completed versus the number of permitted sites, number of Cleanup and Abatement Orders (CAOs); median time required to issue new NPDES permits and WDRs).

Regional monitoring will provide the SWRCB and RWQCBs with a better picture of the water quality outcome of their programs. The information needed to assess program performance and support CWA Section 305(b) reporting focuses on the area or percentages of the area of the State's surface water that fully or partially support the associated beneficial uses.

Monitoring Objectives

In developing the SWAMP monitoring objectives, the SWRCB used a modified version of the model proposed by Bernstein et al. (1993) for developing clear monitoring objectives. The model makes explicit the assumptions and/or expectations that are often embedded in less detailed statements of objectives such as those presented in the SWRCB Report to the Legislature on comprehensive monitoring submitted in February 2000 (SWRCB, 2000). This section is organized by each major question posed in the January 2000 report.

Is it safe to swim?

Beneficial Use: Water Contact Recreation

1. Throughout water bodies that are used for swimming, estimate the concentration of pathogenic contaminants above and below screening values, health standards, or adopted water quality objectives.

2. Estimate the percent of beach area that poses potential health risks of exposure to pathogens in streams, rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of potential human impact (pathogen indicators).

3. Throughout water bodies that are used for swimming, estimate the concentration of bacterial contaminants from month-to-month above and below screening values, health standards, or adopted water quality objectives.

Is it safe to drink the water?

Beneficial Use: Municipal and Domestic Water Supply

4. Throughout water bodies, estimate the area of lakes, rivers, and streams that are sources of drinking water where the concentration of microbial or chemical contaminants are above and below screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.

5. Throughout water bodies that are used as a source of drinking water, estimate the concentration of microbial or chemical contaminants from month-to-month above and below screening values, drinking water standards, or adopted water quality objectives used to protect drinking water quality.

Is it safe to eat fish and other aquatic resources?

Beneficial Uses: Commercial and Sport Fishing, Shellfish Harvesting

6. Estimate the area of streams, rivers, lakes, nearshore waters, enclosed bays, and estuaries where the concentration of chemical contaminants in edible fish or shellfish tissue exceeds several critical threshold values of potential human impact (screening values or action levels).

7. Assess the geographic extent of chemical contaminants in selected size classes of commonly consumed target species that exceed several critical threshold values of potential human impact (screening values or action levels) (Adapted from USEPA, 1995).

8. Throughout water bodies (streams, rivers, lakes, nearshore waters, enclosed bays, and estuaries), estimate the concentration of chemical contaminants in fish and aquatic resources from year to year using several critical threshold values of potential human impact (advisory or action levels).

9. Throughout water bodies that are used for shellfish harvesting, estimate the concentration of bacterial contaminants from month to month above and below health standards or adopted water quality objectives.

10. Throughout water bodies that are used for shellfish harvesting, estimate the concentration of bacterial contaminants above and below health standards or adopted water quality objectives.

Are aquatic populations, communities, and habitats protected?

Beneficial Uses: Cold Freshwater Habitat; Estuarine Habitat; Inland Saline Water Habitats; Marine Habitat; Preservation of Biological Habitats; Rare, Threatened or Endangered Species; Warm Freshwater Habitat; Wildlife Habitat

11. Estimate the percent of degraded water area in lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, water or benthic community analysis, habitat condition, and chemical concentration.

12. Estimate the percent of degraded sediment area in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

13. Identify the areal extent of degraded sediment locations in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

14. Estimate the percent of degraded sediment area from year to year in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, benthic community analysis, habitat condition, and chemical concentration.

15. Estimate the percent of degraded water area from year to year in rivers, lakes, nearshore waters, enclosed bays, and estuaries using several critical threshold values of toxicity, water column or benthic community analysis, habitat condition, and chemical concentration.

Beneficial Use: Spawning, Reproduction and/or Early Development

16. Estimate the area of degraded spawning locations and water or sediment toxicity associated with toxic pollutants in rivers, lakes, nearshore waters, enclosed bays, and estuaries using critical threshold values of early life-stage toxicity, chemical concentration, and physical characteristics

17. Estimate the area degraded spawning locations and water or sediment toxicity associated with toxic pollutants from year to year in rivers, lakes, nearshore waters, enclosed bays, and estuaries using critical threshold values of early life-stage toxicity, chemical concentration, and physical characteristics.

Is water flow sufficient to protect fisheries?

Beneficial Use: Migration of Aquatic Organisms; Rare, Threatened or Endangered Species; Wildlife Habitat

18. Throughout water bodies, estimate the area with the conditions necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

19. Throughout water bodies, estimate the area with the conditions from month to month necessary for the migration of aquatic organisms, such as anadromous fish, using measures of habitat condition including water flow, watercourse geomorphology, sedimentation, temperature, and biological communities.

Is water safe for agricultural use?

Beneficial Use: Agricultural supply

20. Throughout water bodies, estimate the area of lakes, rivers and streams that are used for agricultural purposes where the concentration of chemical pollutants are above or below screening values or adopted water quality objectives used to protect agricultural uses.

21. Throughout waterbodies that are used for agricultural purposes, estimate the concentration of chemical pollutants from year-to-year above or below screening values or adopted water quality objectives used to protect agricultural uses.

Is water safe for industrial use?

Beneficial Use: Industrial Process Supply; Industrial Service Supply

22. Throughout water bodies, estimate the area of coastal waters, enclosed bays, estuaries, lakes, rivers and streams that are used for industrial purposes where the concentration of chemical pollutants are above or below screening values or adopted water quality objectives used to protect industrial uses.

23. Throughout water bodies that are used for industrial purposes, estimate the concentration of chemical pollutants from year to year above or below screening values or adopted water quality objectives used to protect industrial uses.

Are aesthetic conditions of the water protected?

Beneficial Use: Non-Contact Water Recreation

24. Throughout water bodies, estimate the area of coastal waters, enclosed bays, estuaries, lakes, rivers and streams where the aesthetic conditions are above or below screening values or adopted water quality objectives used to protect non-contact water recreation. Throughout water bodies, estimate the aesthetic condition from year-to-year above or below screening values or adopted water quality objectives used to protect non-contact water recreation.

Canyon Lake Analyses	***Media***	***Price per site***	***Cost for 60 sites one season***	***Cost for 60 sites two seasons***
chemistry	sediments	$625	$37,500	$75,000
toxicity using hyallela azteca	sediments	500	$30,000	$60,000
toxicity using hyallela chironomous	sediments	550	$33,000	$66,000
benthic biology	sediments	250	$15,000	$30,000
chemistry	water	200	$12,000	$24,000
toxicity using ceriodaphnia dubia	water	425	$25,500	$51,000
toxicity using selenastrum capricornatum	water	255	$15,300	$30,600
GRAND TOTAL		$2,805	$168,300	$336,600