QUALITY ASSURANCE MANUAL

FOR

FRESHWATER BIOASSESSMENT

Revision 0

January 2006

QUALITY ASSURANCE MANUAL

For

FRESHWATER BIOASSESSMENT

Revision 0

Weston Solutions, Inc.
2433 Impala Drive
Carlsbad, California 92008

3150 Paradise Drive, Bldg. 36
Tiburon, California 94920

4770 NE View Drive
Port Gamble, Washington 98364

January 2006

QUALITY ASSURANCE MANUAL

This manual covers Carlsbad Freshwater Bioassessment Support Services

Carlsbad Freshwater Bioassessment Support Service	Carlsbad Operations Support Service	
Bill Isham, Senior Scientist Sheila Holt, Technical Director Damon Owen, Field Manager 2433 Impala Drive Carlsbad, California 92008 (760) 931-8081	Rosabel Dias, Accreditation Coordinator Crystal McCraine, QA Officer Susan D. Watts, Information Systems Manager 2433 Impala Drive Carlsbad, California 92008 (760) 931-8081	
Carlsbad Bioassay Support Service	**Tiburon Bioassay Support Service**	**Port Gamble Bioassay Support Service**
Michelle Anghera, Ph.D., Laboratory Director Christopher Osuch, Technical Director Crystal McCraine, QA Officer 2433 Impala Drive Carlsbad, California 92008 (760) 931-8081	Scott Bodensteiner, Laboratory Director Matt Zinkl, QA Officer/Technical Director Suzan Brander, QA Officer 3150 Paradise Dr., Bldg 36 Tiburon, California 94920 (415) 435-1847	Jack Word, Ph.D., Laboratory Director Brian Hester, QA Officer/Technical Director 4770 NE View Drive Port Gamble, Washington 98364 (360) 297-6903

Approved Signatories:

[signature] — 23 Jan 2006
Bill Isham, Bioassessment Program Director — **Date**

[signature] — 23 Jan 2006
Sheila Holt, Benthic Laboratory Manager, Sample Custodian — **Date**

[signature] — 25 Jan 2006
Damon Owen, Field Manager — **Date**

[signature] — 24 Jan. 2006
Rosabel Dias, Quality Assurance Coordinator — **Date**

[signature] — 23 Jan 2006
Crystal McCraine — **Date**

January 2006

1.0 Table of Contents

GLOSSARY

ASTM	American Society for Testing and Materials
CCB	Continuing Calibration Blank
CCV	Continuing Calibration Verification
DGPS	Differential Global Positioning System
DMR-QA	Discharge Monitoring Report Quality Assurance
EC50	Effects Concentration for 50% of the test organisms
ELAP	California Department of Health Services, Environmental Laboratory Accreditation Program
EPA	United States Environmental Protection Agency
LC50	Lethal Concentration for 50% of the test organisms
LED	Light Emitting Diode
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
MSSD	Matrix spikes and matrix spike duplicates
NELAC	National Environmental Laboratory Accreditation Conference
NIST	National Institute of Standards and Technology
NOEC	No Observable Effects Concentration
OSHA	Occupational Safety and Health Act
PE	Performance Evaluation
QA	Quality Assurance
QC	Quality Control
RFI	Average response factor from initial calibration
RFC	Response factor from continuing verification sample
RPD	Relative Percent Difference
SCAMIT	Southern California Association of Marine Invertebrate Taxonomists
SOP	Standard Operating Procedure
SRM	Standard Reference Material
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WDOE	Washington State Department of Ecology
WP	Water Pollution

2.0 Company Organization and Personnel Responsibilities

2.1 Quality Policy

Weston Solutions, Inc. (Weston) is an environmental services company. We are an organization of exceptional people dedicated to conducting objective, high-quality science. Our mission is to provide both private and public clients with cost-effective field surveys, laboratory analyses, data products, and reports. Our expertise includes ecology, toxicology, taxonomy, microbiology, oceanography, physical sciences, coastal engineering, and environmental document preparation. We specialize in integrating diverse technical disciplines to solve complex environmental problems, being best known for our successes with biological assignments. The realm in which we work extends from marine waters, across the shoreline and into coastal watersheds. Our global focus is on North America, but our interests include the Pacific Rim and Europe. We have a record of integrity and growth we intend to sustain.

Our laboratories' procedures and policies adhere to high standards of quality assurance/quality control. If requirements for a specific project are stricter than those established in this document, then the standard from the project scope of work will be followed.

2.2 Organization and Responsibilities

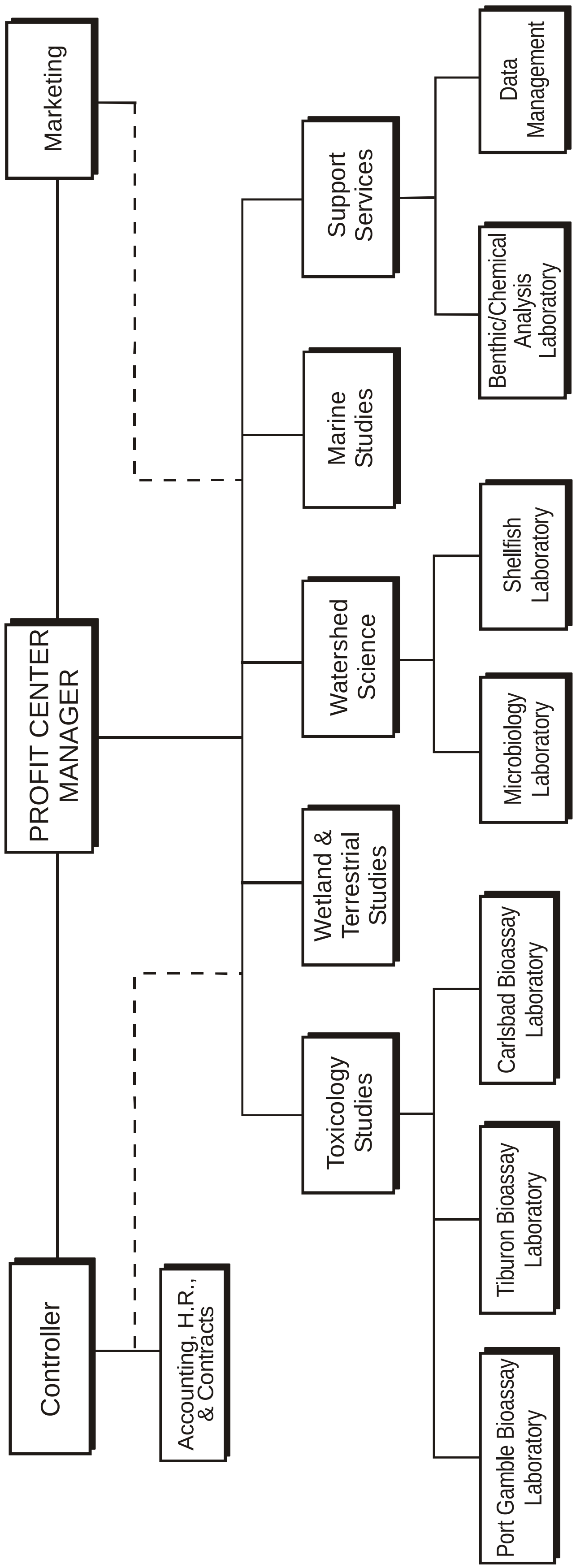
Weston is structured so that all personnel contribute and are responsible for the overall quality of services provided (Figure 2.1). An organizational chart of personnel is presented in Figure 2.2, and resumes of key personnel relating to stream bioassessment activities are provided in Section 2.2. A chart is posted in the laboratory designating the person(s) assigned to take over responsibility in the absence of key personnel.

Bioassessment Program Director. The Bioassessment Program Director is responsible for all activities that support the field collection of macroinvertebrate samples, water quality information, laboratory sample processing, and data compilation/reduction. She/He is responsible for the final evaluation of Quality Assurance (QA) performance and reports submitted to the client. The Program Director oversees field and laboratory activities to ensure compliance with contract protocols, and appropriate QA policies. She/He also works with the Quality Assurance Unit to ensure that laboratory goals for data quality and reporting quality are met.

If the Program Director is away from the laboratory, she/he generally is reachable by cellular phone and also checks in regularly. In the event that the Program Director knows she/he will be unavailable for a particular time period, she/he assigns her/his responsibilities to an interim Project Manager and informs the staff.

Operations Manager. The Operations Manager oversees the personnel responsible for project management, field collection, and laboratory analysis of all biological programs. This person supervises the field and laboratory managers and is the final person responsible for quality of data.

If the Operations Manager is away from the office, a deputy is assigned to assume her/his duties.



08/01/05

Figure 2.1: Weston Solutions, Inc. Main Laboratory Organization Chart

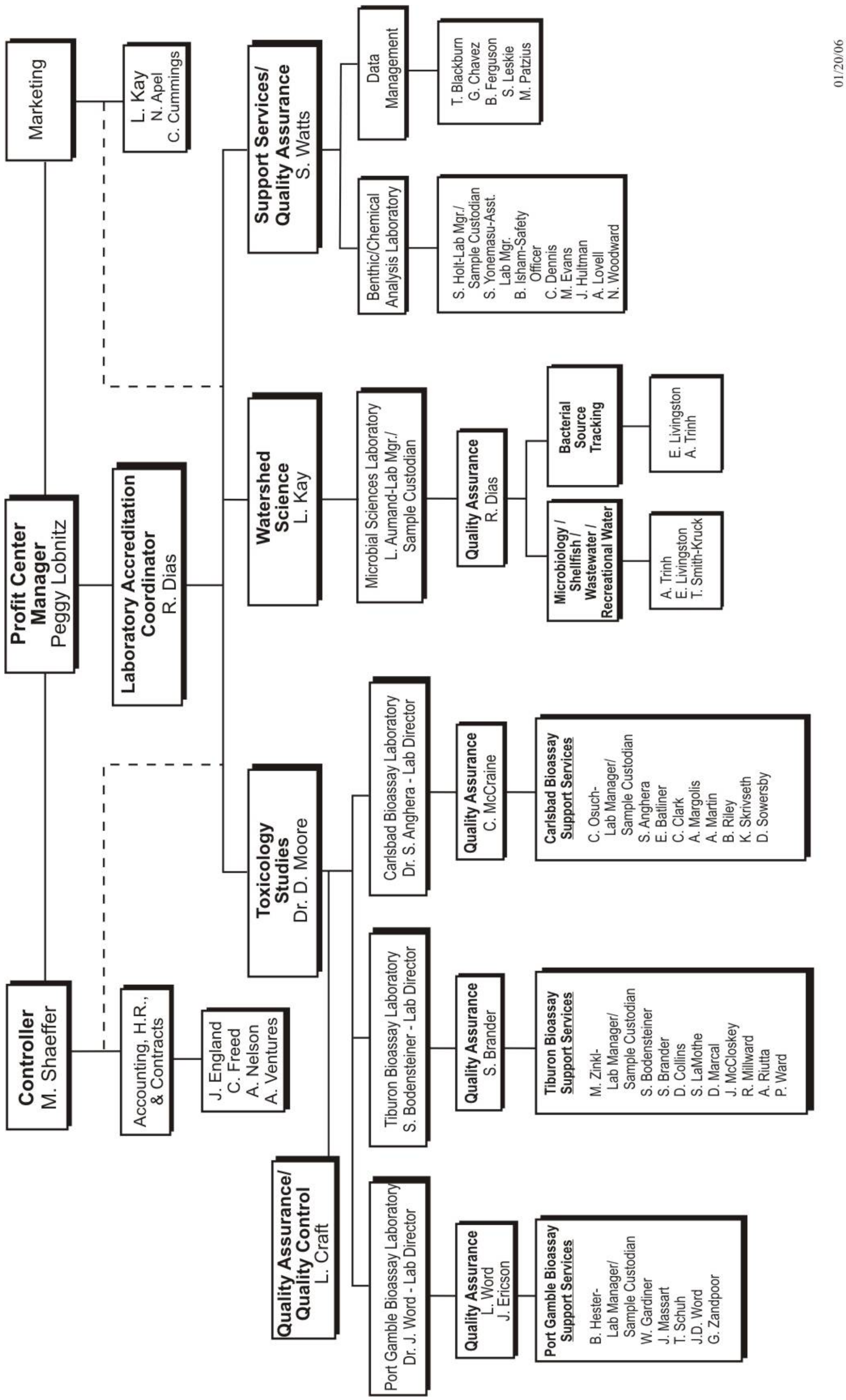


Figure 2.2: Weston Solutions, Inc. Laboratory Operations Organization Chart

Information Systems Manager. The Information Systems Manager is responsible for data management and submittal. This person verifies data entry and quality of data reports. The Information Systems Manager may sign reports for the release of data.

Laboratory Manager. The Laboratory Managers (Technical Directors) supervise the work of laboratory technicians in the analysis of environmental samples. These persons are responsible for the day-to-day activities and scheduling in the laboratory. They have training on the instruments and protocols and are able to perform all analyses. They hire and train technical staff. They also are qualified to sign reports for release of data.

If the Laboratory Manager is away from the office, a deputy is assigned to assume her/his duties.

Field Manager. The Field Manager oversees the collection of samples and initiates chain-of-custody. This person is responsible for ensuring use of proper containers for collection and preservation, as well as proper field handling and transport to the laboratory.

If the Field Manager is away from the office, a deputy is assigned to assume her/his duties.

Quality Assurance Officer. The QA Officers are responsible for guaranteeing the overall quality of the data produced and reported by Weston. Specific duties of the QA Officers include conducting audits of ongoing tests, data packages, and completed reports, conducting audits of the routine quality control documentation of laboratory procedures, communicating potential quality control problems to the staff, and assuring that any problems are resolved. They are responsible for issuing Quality Assurance Reports to Management, maintaining a current Quality Assurance Manual, and issuing Quality Assurance Project Plans as required. The QA Officers also ensure that data reported by Weston have been generated in compliance with the Quality Assurance Manual and the appropriate protocols. The QA Officers are knowledgeable in the quality system standard defined under NELAC. The QA Officers report to the Laboratory Director.

If the Quality Assurance Officer is away from the office, a deputy is assigned to assume her/his duties.

Safety Officer. The duties and responsibilities of the hazardous materials and safety officer include: regulating the proper storage and use of hazardous materials in the laboratory to ensure the safety of all personnel, maintaining an inventory of hazardous materials stored and used in the laboratory, and filing Material Safety Data Sheets (MSDS) sheets on hazardous materials.

The Safety Officer conducts annual inspection of all safety equipment and recharge or replaces safety equipment as necessary. He/She inspects and maintains first aid kits. He/She directs clean-up operations of any spills of hazardous materials. The Safety Officer schedules evacuation drills and would supervise an emergency evacuation of the facility.

The Safety Officer trains new laboratory employees in laboratory safety practices and hazardous materials handling and performs respirator fit tests and training for proper use. He/She maintains records and files of safety related training, hazardous spills, inspections, etc. He/She performs routine inspection for potential for hazards and potential ignition sources. Finally, the Safety Officer is responsible for staying abreast of new state and federal guidelines for hazardous materials handling and Occupational Safety and Health Act (OSHA) compliance.

Sample Custodian. Duties and responsibilities of the sample custodian include: receiving samples and chain-of-custody forms, inspecting sample shipping containers, and verifying agreement or disagreement of information sample documents.

The Sample Custodian initiates paperwork for sample tracking and schedules sample analyses. He/She stores samples and controls access to samples. The Sample Custodian is responsible for returning samples to client (or disposing of samples if appropriate).

Technical Staff

Technical staff include scientists, environmental analysts, and laboratory technicians. Scientists and environmental analysts report to the Bioassay Laboratory Director, Support Services Manager or Quality Assurance Manager, and laboratory technicians report to the respective Laboratory Managers. Duties include laboratory processing of environmental samples, analysis of data, report preparation, and project management.

2.3 Personnel Qualifications, Experience, and Training

Weston's laboratory staff consists of more than 50 scientific/technical employees. Of these personnel, 10% hold a Ph.D. and 18% hold an M.S. Our staff has over 500 years of combined experience, and many are individually recognized as specialists in their fields. While most of Weston's laboratory staff has worked mainly on the West Coast of the continental United States, some have worked in other parts of the world, including Alaska, Hawaii, Guam, and Saudi Arabia.

All personnel are responsible for complying with all quality assurance/quality control requirements that pertain to their organizational/technical function. Each technical staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures, and records management.

At least annually, a review of general laboratory procedures such as sample receipt policy will be conducted to include awareness of expiration dates for standards and reagents, error codes, and proper procedures for error correction.

Weston's laboratory training program begins with reviewing the Standard Operating Procedure (SOP) for a new task. The Laboratory Manager or a Senior Laboratory Technician demonstrates the procedure to the trainee, shows the appropriate steps in the SOP, and explains the significance of each step. The trainee later performs the procedure under the supervision of the Laboratory Manager or Senior Laboratory Technician. At this time, questions are answered and parts of the procedure may be redemonstrated to the trainee. The trainee continues to work under direct supervision until he/she can demonstrate the procedure with competence and full understanding. This process may be short or long depending on the procedure.

At this time the employee can work without supervision.

2.4 Confidentiality

It is the policy of Weston to protect clients' confidential information and proprietary data and property. As such, prior to beginning work at Weston, employees must read and sign an agreement that any client materials must not be disseminated or used in any manner outside the company's premises. Employees agree not to directly or indirectly disclose client property/information/data with anyone outside Weston. This policy applies to the time period while the worker is employed by Weston as well as after cessation of work at Weston.

Weston's doors are locked outside of normal business hours. During business hours if a visitor (client, delivery person, vendor, auditor) is inside the building, she/he must be in the presence of or accompanied by an Weston employee at all times.

Sensitive projects are handled confidentially within Weston. For these projects, limited personnel are assigned to the project. Documents and correspondence are labeled proprietary, and copies are produced in controlled quantities. All materials are stored in locked file cabinets, and may be delivered to the client upon project termination.

2.5 Ethical Responsibility

It is Weston policy that employees are responsible for the integrity and the consequences of their actions. The highest standards of honesty, integrity, and fairness must be followed by all employees when performing laboratory and field duties.

2.5.1 Annual Training

It is Weston's corporate policy that all employees participate in an annual ethics compliance training program. The in-depth program reviews Weston Solutions, Inc. policies with regard to ethical responsibility. The relevant sections of the Weston Employee Handbook are reviewed, including the section on Weston's ethics policy, open door policy, conflict of interest policy, and confidential information policy. Potential penalties for improper, unethical or illegal actions covered as well. Hypothetical cases are presented that employees may be faced with during their work and possible lines of action are discussed in terms of proper ethical and legal judgment. At the end of the training course all employees are required to sign an acknowledgement form certifying that they are familiar with the Weston ethics policy and that they agree to properly report any knowledge or suspicion of non-compliance.

Further information regarding the Weston's annual training session on ethical responsibility can be found on the company intranet web site:
http://westonnet/WSU/Business_Ethics/businessethics.htm

2.6 Quality Assurance Manual

Quality Assurance Manuals are maintained, updated, and revised by the Quality Assurance Officer. Revisions are numbered and dated. The revision date reflects the date the Quality Assurance Manual was first put into effect. When the manual is revised, the earlier version is filed, and the end date is noted on the cover page of the manual. Thus, the time period during which the manual was in place is documented.

Amendments to QA Manuals and SOP's may be made by hand pending the next re-issue of the documentation. Amendments shall be clearly marked, initialed, and dated. QA Manual and SOP production is under the control of the Document Control Officer. Access to the files for producing new or revised documentation shall be under the full control of the Document Control Officer.

William Isham, Bioassessment Program Director

Education/Certifications

B.S. Biological Science, Florida Institute of Technology – 1982
Jurisdictional Wetland Delineation, 1997 - UC Berkely Ext.
California Stream Bioassessment, 1999 - SLSI

OSHA 40-Hour HAZWOPER Training

Qualifications

Mr. Isham is an experienced biologist specializing in marine, wetland, and freshwater stream biology. He is currently program director for freshwater stream bioassessment studies in San Diego, Orange, and Los Angeles Counties in support of NPDES municipal stormwater permit compliance. He is also involved in numerous bioassessment projects related to State of California Propositions 13 and 50 grants. He received certification in the California Stream Bioassessment Procedure (CSBP) in 1999 and has performed work under the protocol since 1998. He is an active member of the California Aquatic Macroinvertebrate Laboratory Network and the California Aquatic Bioassessment Workgroup. He regularly interacts with the California Department of Fish and Game (CDFG) Aquatic Bioassessment Laboratory and presents results of his projects at scientific conferences. His taxonomic experience with insects spans several decades.

He has extensive experience leading field surveys in marine waters off Southern California including the Southern California Bight Pilot Project, the Bight ’98 survey, and the Port of Long Beach/Port of Los Angeles Baseline Biological Surveys of 1996 and 2000. He has performed biological studies in many California wetlands, including San Dieguito Lagoon, Agua Hedionda Lagoon, Morro Bay, Napa Sonoma Marsh, and Anaheim Bay. He is responsible for survey design, field collection, taxonomy, laboratory analyses, and reporting. He has demonstrated expertise with fish and insect taxonomy. He has participated in bird, vegetation, and ground water monitoring surveys for impact assessment of construction activity. He has also completed training in wetland delineation using the U. S. Army Corps of Engineers protocol.

Mr. Isham spent 2 ½ years working in the larval fish laboratory of Southwest Fisheries Science Center where he identified icthyoplankton from the CalCOFI surveys of 1985-1994, as well as updated historical sample identifications. Other recent projects include fish and benthos impact assessment at the mouth of the Columbia River and the NAASCO and Southwest Marine Shipyards and benthic recovery assessment in America’s Cup Harbor after remediation dredging. As a technical writer, he has contributed to many EIR/EIS documents, habitat management plans, and reports.

Mr. Isham is currently responsible for corporate compliance with government safety and health regulations. His past work experience includes gas blending chemistry, technical writing, and general laboratory management, as well as hazardous materials handling. Mr. Isham is OSHA certified.

Relevant Experience

Program Director, San Diego County Regional Stream Bioassessment. Manages and conducts field sampling, habitat analysis, and laboratory processing at 23 stream sites in San Diego County following the California Stream Bioassessment Protocol. Performs insect taxonomy and is responsible for data interpretation and reporting.

Program Director, County of Orange Regional Stream Bioassessment. Manages and conducts field sampling, habitat analysis, and laboratory processing at 30 stream sites in Orange County following the California Stream Bioassessment Protocol. Performs insect taxonomy and is responsible for data interpretation and reporting. This project is performed under two separate contracts with the County of Orange to satisfy the San Diego Regional Water Quality Control Board NPDES permit in south Orange County and the Santa Ana Regional Water Quality Control Board permit in the north.

Program Director, Stream Bioassessment Monitoring in Los Angeles County for LACDPW. Manages and conducts field sampling, habitat analysis, and laboratory processing at 20 stream sites in Los Angeles County Under contract to L.A. County Department of Public Works. Responsible for sorting and taxonomic identification of 60 samples collected in the Los Angeles basin and preparing a report of the results. Also provided training for field crews in sample collection.

Program Director, Camp Pendleton Stream Bioassessment Study for the U.S. Navy. Manages and conducts field sampling, habitat analysis, and laboratory processing at five stream sites on Camp Pendleton in San Diego County following the California Stream Bioassessment Protocol. Performs insect taxonomy and is responsible for data interpretation and reporting.

Program Director, Stream Bioassessment in the San Gabriel Watershed. Under contract to the County Sanitation Districts of Los Angeles County to comply with provisions of the Long Beach, Los Coyotes, and Whittier Narrows Water Reclamation Plants (WRP) NPDES permit requirements, responsible for field reconnaissance to determine final sampling locations, field collection of benthic samples and physical habitat assessments at each site, sample processing, taxonomic identification, and data analysis. Also responsible for preparation of a final report in March 2004. The resulting data will be used for future assessments conducted in the watershed such as trend monitoring, evaluating the effectiveness of TMDL's, implementation of BMPs, and design of future monitoring programs.

Project Biologist, Padre Dam Impact Analysis. Collected targeted sport fish species for tissue chemistry analysis as required for NPDES permit issued by the San Diego Regional Water Quality Control Board. Responsible for capture and filet of fish tissue in receiving waters of Padre Dam Municipal Water Treatment Facility to determine levels of contamination in fish populations.

Biologist, Escondido Creek Spill Response. Assisted the California Department of Fish and Game in an assessment of impacts to the benthic macroinvertebrate community of a diesel fuel spill in Escondido Creek.

Project Biologist, Soledad Canyon Creek Point Source Impact Analysis. Performed stream macroinvertebrate collection and analysis following the California Stream Bioassessment Protocol in response to Cease and Desist order issued by the San Diego Regional Water Quality Control Board to the Metropolitan Transportation Development Board. This study was conducted in conjunction with other surface water quality analyses to determine environmental impacts relating to construction activities.

Project Biologist, City of Escondido Stream Bioassessment. Responsible for conducting field sampling, documenting physical site characteristics, conducting laboratory analysis, and reporting for two sites in the Escondido Creek watershed. This stream bioassessment project was conducted as part of a larger project to provide additional baseline information on the biological health of the Creek.

Project Biologist, Cottonwood Creek Mitigation Assessment. Performed stream macroinvertebrate collection and analysis to assess effects of installed water treatment facility in Encinitas, California.

Taxonomist, San Gabriel River Project. Conducted taxonomy for stream insects collected in the San Gabriel River for multi-year study utilizing California Stream Bioassessment Protocol.

Taxonomist, Santa Rosa River Project. Conducted taxonomy for stream insects collected from Santa Rosa River.

Biologist/Taxonomist, San Dieguito Lagoon Restoration Project. Designed and conducted a comprehensive, one year insect survey of San Dieguito Lagoon. Led field surveys and assisted in laboratory analyses of fish, bird, vegetation, water quality, and benthic infaunal samples. Performed taxonomy of insects from benthic samples and fish gut contents.

Project Biologist, NASSCO and Southwest Marine Shipyards Study. Led field surveys for fish histopathology, sediment toxicity, and invertebrate community analysis to assess impacts of shipyard activities. Assisted with fish dissections for histopathological studies to quantify possible bioaccumulation of toxic substances in tissues.

Field Survey Manager, Upper Newport Bay Project. Designed and conducted insect survey and performed habitat functional analysis relating to insect populations. Led fish and benthos field survey, assisted with reporting, and performed taxonomy on insect samples.

Field Biologist, **Environmental Studies at Two Ocean Disposal Sites off the Mouth of the Columbia River.** Assisted in field surveys for fish identification and benthic sample collection, and Dungeness crab population assessments at one shallow and one deep water ocean dredge disposal site at the mouth of the Columbia River.

Project Manager, Napa Sonoma Marsh Pond 2A Monitoring Project. Field biologist/taxonomist for adult and larval fish and coordination of surveys for birds, vegetation, sediment chemistry, and topography surveys. Responsible for quarterly and annual reporting.

Project Manager, Aliso Creek Water Quality Monitoring Program. Managed one year bacterial testing program for Leisure World/Golden Rain Foundation in Laguna Hills.

Project Biologist, Ports of Los Angeles and Long Beach, Biological Baseline in San Pedro Bay. Coordinated and led field surveys for fish, ichthyoplankton, and benthic invertebrates. Responsible for taxonomy of egg, larval, and adult stages of fish.

Project Biologist, Shell Western Impact Analysis in Bolsa Chica Ecological Reserve. Collected *Tilapia* for whole body tissue analysis in various ponds in the Bolsa Chica Reserve to determine biological impacts of oil production facilities within the reserve.

Project Biologist, America's Cup Harbor Benthic Recovery Assessment. Assessed recovery of benthic invertebrates in dredged areas for the Port of San Diego.

Field Biologist, Bight 98 Regional Monitoring Program. Led benthic field survey and assisted with otter trawl fish surveys from San Diego to Point Conception. Assisted with the analysis of laboratory samples.

Project Biologist, Port of Los Angeles Special Study. Coordinated and led field surveys for fish and invertebrates for a comparative study of mitigation sites in the Port of Los Angeles.

Taxonomist, NOAA Icthyoplankton. Identification of larval fish from the CalCOFI surveys of 1985-1994, for the Southwest Fisheries Science Center of the National Marine Fisheries Service. Identification of rockfish larvae from historical CalCOFI Surveys from 1950-1969.

Field Biologist, Naval Sea Systems Command (NAVSEA) Deep Water Sinking Exercise (SINKEX). Environmental assessment of marine habitat adjacent to sunken WWII Destroyer near San Nicholas

Island. Assisted field surveys for sediment toxicity and benthic infaunal analysis. Project conducted in conjunction with the U.S. Navy and Scripps Institution of Oceanography.

Biologist, San Diego Unified Port District, Former Weyerhauser Project Site Paving. Reviewed and approved grading and erosion control plan for paving project with 500 feet of Paradise Marsh.

Biologist, San Diego Unified Port District, Railcar Plaza Project. Reviewed and approved construction and environmental implementation plans for the National City Community Development Commission.

Field Biologist, San Diego Area Governments (SANDAG) Beach Replenishment Project. Conducted beach and intertidal reef surveys in support of proposed San Diego countywide beach replenishment project.

Technical Writer, U.S. Army Corps of Engineers, Seven Oaks Dam Project. Contributing writer on draft Environmental Impact Report.

Field Survey Coordinator, Sycamore Landfill Quino Checkerspot Butterfly Surveys. Provided continuity and assistance on surveys by five different Quino Checkerspot Butterfly permitted biologists.

Field Survey Manager, Morro Bay. Assisted with fish and invertebrate sampling design, led field survey and performed fish taxonomy.

Field Survey Leader, Solar Turbines/San Diego Bay Boxcore Project. Led field survey of benthic infauna for habitat impact analysis.

Biologist/Taxonomist, Preconstruction Monitoring at Batiquitos Lagoon. Participated in field sampling of fish, benthic invertebrates, sediments, and water quality prior to breaching the inlet. Identified fish samples.

Biologist, Anaheim Bay Mitigation Project. Conducted baseline monitoring of fish, benthos, and vegetation. Managed and conducted field surveys, taxonomy and laboratory analysis for baseline monitoring of currents, tides, and water quality.

Biologist/Taxonomist, Minerals Management Service, Phase III Program. Assisted in field surveys, taxonomy on deep sea larval settlement plates, analysis of settlement plate photographs to determine larval growth rates.

Biologist/Taxonomist, Orange County Sanitation District 301(h) Marine Monitoring Project and Encina Wastewater Authority Receiving Water Monitoring Project. Assisted with field surveys and performed laboratory analyses of marine biological samples collected from the Orange County and Carlsbad sewage outfall pipe areas.

Taxonomist, Long Beach Harbor Baseline Survey of Pier J-East Dredging Project. Assisted with taxonomy and field sampling.

Biologist/Taxonomist, Ecological Assessment of Agua Hedionda Lagoon. Responsible for field sampling, fish taxonomy, and taxonomic QA/QC.

Biologist, South Bay Land Outfall Pipeline Construction Monitoring Project. Conducted riparian vegetation and ground water monitoring in the Tijuana River corridor for habitat impact analyses relating to land outfall pipeline construction.

Biologist, NAS Miramar EIS. Biological support for EIS including research and field collections of fairy shrimp in Riverside County and Baja California.

Research Assistant, Manatee Feeding Study, Crane Creek Lagoon, Melbourne, Florida. Monitoring of animal activity, collection and identification of aquatic plants, and analyses of fecal samples to determine food-plant preference of manatees.

Damon Owen

Field Supervisor

Education

B.S. Biology, University of California, Santa Cruz – 1996
OSHA 40-Hour HAZWOPER Training

Qualifications

Mr. Owen is a biologist and field technician specializing in field collections and laboratory analysis of biological samples. He has participated in many estuarine and freshwater benthic ecology projects supporting NPDES permit compliance for municipal clients including the Los Angeles Department of Public Works, County of San Diego, County of Orange, and the Orange County Sanitation District 301(h) Monitoring Program. His expertise includes field surveys for benthic, sediment, and water quality samples. These include stream bioassessment surveys/sample collection and storm water monitoring in San Diego County

Relevant Experience

Field/Laboratory Technician, Stream Bioassessment Monitoring Program, County of San Diego, CA (2004-2005). Performed collection and sorting of benthic samples from urban streams throughout San Diego county as part of the County Co-Permittee stormwater and receiving water monitoring program.

Field/Laboratory Technician, Los Angeles Department of Public Works Stream Bioassessment Monitoring Program, Los Angeles County, CA (2004-present). Responsible for field observations, sample collection, and sorting of samples collected in the Los Angeles basin for the Los Angeles County Department of Public Works (LADPW).

Field/Laboratory Technician, Regional Stream Bioassessment, County of Orange, CA (2004-present). Conducted field collection and sorting of benthic samples from 30 stream sites in Orange County.

Field Technician, Water and Sediment Quality Monitoring in Chollas Creek, San Diego, California (2004-Present). Monitoring automated water quality sampling equipment installed at key points along Chollas Creek to assess potential changes in pesticide use by measuring various water quality constituents in urban runoff.

Laboratory Technician, County Sanitation Districts of Los Angeles County NPDES Permit Monitoring Program (2004-present). Responsible for sorting of benthic infaunal samples collected in the course of the District's NPDES permit monitoring of the Palos Verdes Shelf.

Laboratory Technician, Orange County Sanitation District 301(h) Monitoring Program (2004-Present). Performed sorting of benthic samples collected from the Orange County sewage outfall pipe areas..

Field Technician, County of San Diego and Co-permittee NPDES Storm Water Monitoring Program (2004-2005). Responsible for water quality sampling at mass loading stations throughout San Diego County during wet weather season monitoring.

Qualifications Summary DRAFT

- Three years of professional experience.
- Biologist and field technician responsible for analyzing water, sediment, and vegetation samples for microbial pollution using a variety of methods (membrane filtration, multiple tube fermentation [MPN], and IDEXX Enterolert and Colilert).
- Cross-trained as a bioassay laboratory technician, and provides as-needed assistance in the aquatic toxicology laboratory, as well as regular quality assurance/quality control (QA/QC).
- Responsible for maintaining overall QA/QC practices according to National Environmental Laboratory Accreditation Program (NELAP), and conducts internal audits for compliance with NELAP standards.
- Responsible for obtaining certification of the microbiology laboratory for shellfish testing according to the National Shellfish Sanitation Program.
- Expertise includes field surveys to collect water quality samples and provide visual observations of field conditions.

ROSABEL DIAS, ACCREDITATION COORDINATOR

FIELDS OF COMPETENCE

Analysis of water/sediment/vegetation samples; QA/QC reviews; internal audits; field surveys.

Credentials

B.S., Engineering Agro-Alimentary—College of Agricultural Sciences, Santarem, Portugal (2000)
M.S., Food Quality Assurance—College of Agricultural Sciences, Santarem, Portugal (In Progress)

Employment History

2004-Present WESTON Solutions, Inc.[3-04 to Present; Carlsbad, CA; Technician]
2002-2004 MEC Analytical Systems, Inc. [8-02 to 3-04; Carlsbad, CA; Biological Technician]
2001-2002 (IVV) Portuguese Wine Institute [Santarem, Portugal; Quality Control Engineer]

Key Projects

Phase I Mission Bay Source Identification Survey, California, City of San Diego, Laboratory Technician. Responsible for analysis of water quality samples for bacterial contamination taken from 12 areas of Mission Bay. The study, funded by Proposition 13 Clean Beaches Initiative, investigated sources of human sewage leaks in infrastructure around the Bay, boat moorings, and operation and maintenance practices that may contribute to water quality exceedances in Mission Bay. [2002 to 2003; MEC Analytical Systems]

Phase II Mission Bay Source Identification Survey, California, City of San Diego, Laboratory Technician. Responsible for analysis of water, sediment, and vegetation samples for bacterial contamination. [2003 to 2004]

Stormwater Runoff in San Diego County, California, Field and Laboratory Technician. Responsible for the analysis of stormwater runoff for bacterial contamination. This testing is conducted in support of the monitoring program for the County of San Diego municipal stormwater co-permittees' National Pollutant Discharge Elimination System (NPDES) permit (Order No. 2001-01) issued by the San Diego Regional Water Quality Control Board. Also participates in field sampling to collect the water quality samples. [?-02 to 3-04, Mec Analytical Systems; and 3-04 to Present, WESTON]

San Diego River/Ocean Beach Clean Beaches Initiative Project, Laboratory Technician. Provided analysis of more than 1,500 samples, and contributed to the evaluation of bacterial contamination for this Proposition 13-funded survey designed to determine sources of bacteria in the San Diego River and Ocean Beach. [2002 to 2003; MEC Analytical Systems]

Southern California Bight Regional Monitoring Program, Laboratory Technician. Provided microbial analysis of water quality samples collected in San Diego Bay and along the San Diego River. Conducted bacterial analysis of water quality samples collected along the San Gabriel River. [2003 to Present]

Sample Collection and Laboratory Analysis for San Diego Bay, Various Locations, San Diego Unified Port District, Laboratory Technician. Responsible for bacterial analysis of samples collected under this as-needed contract with the Port of San Diego. Work orders issued under this contract include routine coastal outfall monitoring, an emergency sewage spill evaluation at Spanish Landing Park, and a bacterial source investigation at Shelter Island. [2002 to Present]

Coastal Outfall Monitoring, Various Locations, Port of San Diego, Laboratory Technician. Responsible for bacterial contamination testing of samples collected at flowing storm drain outfalls and nearby beaches. The Port is required to collect samples each month at seven beaches during the wet weather season (October through April) and twice per month during the dry weather season (May through September). [2002 to Present]

Shelter Island Bacterial Source Investigation, California, Port of San Diego, Laboratory Technician. For this work order issued under an as-needed sample collection and laboratory analysis contract, responsible for managing quarterly testing of beach and ocean water quality samples for total and fecal coliforms and enterococci. [2003; MEC Analytical Systems]

Los Angeles Harbor Bacteria Monitoring, Southern California Coastal Water Research Project (SCCWRP)/Los Angeles Regional Water Quality Control Board (RWQCB), California, Laboratory Technician. Responsible for examining water quality samples for bacterial monitoring of storm drains and receiving waters in the Los Angeles Harbor. The goal of the study is to provide data to support 303(d) listings in the Dominguez Channel and Los Angeles Harbor. [2004]

Dry Weather Screening Program, California, City of Carlsbad, Laboratory Technician. Responsible for bacterial contamination testing of samples collected during the dry weather season (June through September). The City is required to conduct a dry weather screening program of illicit discharge connections in the City's storm drain system. [2002; MEC Analytical Systems]

Coastal Outfall Monitoring, California, City of Carlsbad, Laboratory Technician. Responsible for bacterial contamination testing of samples collected at flowing storm drain outfalls. The City is required to collect 20 to 35 samples each month during the wet weather season (October through April). [2002 to 2003; MEC Analytical Systems]

Dry Weather Screening, California, City of Solana Beach, Laboratory Technician. Conducts bacterial analysis of ponded water samples collected near storm drains during an annual dry weather screening program. Provided laboratory testing for an upstream investigation of an illegal discharge in the City's Municipal Separate Storm Sewer Systems (MS4) to determine the source of contamination and also provided emergency testing for sewage spills. [2002 to Present]

Coastal Outfall Monitoring, California, City of Solana Beach, Laboratory Technician. Responsible for bacterial contamination testing of samples collected at flowing storm drain outfalls and nearby beaches. The City is required to collect samples each month during the wet weather season (October through April) and twice per month during the dry weather season (May through September). [2002 to Present]

Dry Weather Screening, California, City of Coronado, Laboratory Technician. Responsible for bacteria testing of ponded water samples collected in storm drains during an annual dry weather screening program. [2002 to Present]

Dominguez Channel Bacteria TMDL Investigation, Laboratory Technician. Conducted analysis of samples collected from the entire 14-mile reach of the Dominguez Channel. The samples were analyzed for total coliform, fecal coliform, *E. coli*, and enterococcus using the IDEXX system (Colilert 18 and Enterolert) and membrane filtration methods. [2002 to 2003; MEC Analytical Systems]

Emergency Response to Sewage Spill at Moonlight Beach, California, City of Encinitas, Laboratory Technician. Provided after-hours emergency bacterial analysis of water quality samples collected at Moonlight Beach. [2003; MEC Analytical Systems]

Dry Weather Field Screening and Analytical Monitoring Program, California, City of Oceanside, Laboratory Technician. Responsible for bacterial analysis of ponded water samples collected in storm drains during an annual dry weather screening program. [2004]

Crystal McCraine, Quality Assurance Officer

Qualifications Summary

- Ensures laboratory technicians properly follow procedures.
- Calibration/maintenance/ repair of laboratory equipment.
- Data entry/final report accuracy review.
- QC inspections of incoming raw materials and outgoing products.
- Trained in chemical hygiene procedures.
- Worked extensively with molecular biology techniques PCR, gel electrophoresis, bacterial gene transformation, protein purification, column chromatography.
- Proficient in laboratory organization and cleanliness.
- Academic instruction and tutelage for college-level biology courses, and
- Dean's list at Texas A&M, graduated Cum laude.

Fields of Competence

Quality assurance/quality control (QA/QC), procedures, inspections, and corrective actions; laboratory operations; instrument calibration, maintenance, and repair; data entry verification; report review; tracking laboratory records; molecular biology; course work instruction; standard operating procedure (SOP) development; chemical hygiene; clean room environment; wet chemistry.

Education

B.S., Biology (Cum Laude) – Texas A&M University (2004)

Employment History

2005-present Weston Solutions, Inc.
2004-2005 Sequenom, Inc.

Key Positions

Bioassay Laboratory QA/QC, Carlsbad, California, Weston Solutions, Quality Assurance Officer. Ensures quality of testing, data, and reports developed/conducted in aquatic toxicology laboratory. Reviews data entry records and final reports for accuracy. Tracks laboratory records for testing room through final report. Responsible for calibration, maintenance, and repair of laboratory instruments. Verifies technicians and staff follow standard operating procedure during testing and data analysis. Provides as-needed assistance to laboratory and QA directors in maintaining accreditation.

Genetic Analysis Product Development, San Diego, California, Sequenom, Inc., Manufacturing Chemist. Produced DNA chips in a clean room environment. Duties included wet chemistry testing, solution and reagent preparation, and product packaging. Utilized robotic machinery and other complex equipment. Received training in chemical hygiene procedures. Conducted quality control inspections of incoming raw materials and outgoing products.

Biology 4420: Biological Laboratory Techniques, Corpus Christi, Texas, Texas A&M University, Teaching Assistant. Provided classroom instruction assistance to university faculty for this senior level course. Preparation for laboratory experiments including set up and preparation of chemical solutions. Assisted faculty with supervision of laboratory activities. Responsible for clerical duties and research requests.

Academic Tutoring, Corpus Christi, Texas, Del Mar College, Science Tutor. Assisted science majors and other students in understanding molecular and cellular biology, anatomy and physiology, introductory biology, comparative chordate anatomy, and inorganic chemistry (levels I and II). High success rate on exams for students under Ms. McCraine's tutelage.

Laboratory Operations, Corpus Christi, Texas, Del Mar College, Laboratory Assistant. Coordinated lab activities for cellular and molecular biology, zoology, and comparative chordate anatomy. Maintained laboratory cleanliness and organization. Cared for in-house organisms/animals. Assisted college faculty with instruction of course labs as-needed. Extensive work with molecular biology techniques such as polymerase chain reaction (PCR), gel electrophoresis, bacterial gene transformations, protein purification, and column chromatography.

Effects of Propeller Scarring on Seagrass Associated Fauna, Aransas Bay, Texas, Texas A&M University-Corpus Christi, Research Assistant. Processed benthic samples collected using an epibenthic sled tow. Responsible for sorting, counting, identification and taxonomic classification of nektons.

Kemp's Ridley Sea Turtle Research, Padre Island National Seashore, Texas, National Parks Service, Research Assistant. Conducted various field tasks for this public/private cooperative venture to establish a secondary nesting colony of kemp's ridley turtles on Padre Island. Responsible for egg collection, nest counting and hatching release following egg incubation.

SHEILA HOLT, Benthic Laboratory Manager

Education

B.A. Aquatic Biology, University of California, Santa Barbara – 1994

Qualifications

Ms. Holt has 10 years of experience working in marine, wetland, and freshwater habitats, specializing in sample collection, laboratory analysis, and project management for benthic infauna and sediment projects. As the Benthic Laboratory Manager, she is responsible for hiring and managing laboratory personnel and QA/QC of infaunal sample sorting.

She has participated in the identification of fish and laboratory analysis of benthic infaunal samples for the Bight '98 Regional Monitoring Program, Orange County Sanitation District's 301(h) Marine Monitoring Program, Ports of Long Beach and Los Angeles Year 2000 Baseline Study, Anaheim Bay Long-Term Mitigation Monitoring, and other projects in Southern California. In addition, she has participated in a fresh water study of phytoplankton and water quality of Zaca Lake.

Ms. Holt is experienced in sampling marine communities utilizing traditional collecting methods including Van Veen, box core, otter trawl, seine nets, lampara nets, and Van Dorn bottles. Her expertise includes stream bioassessment field sampling and water quality monitoring and sampling. In addition, she has assisted in test set-up and routine water quality of acute and chronic bioassay testing.

Relevant Experience

Orange County Sanitation District 301(h) Marine Monitoring Program, Biologist. Assisted in field surveys, fish identification, and benthic analyses. Responsible for grain size and total organic carbon testing, and QA/QC of benthic infaunal samples. 1994 -present

Benthic Infaunal Sorting, City of San Diego 301(h) Monitoring Program, Project Manager. Responsible for managing benthic laboratory analysis of samples collected near Point Loma wastewater treatment facility.
2001 -2003

Benthic Sample Sorting and Processing, County Sanitation Districts of Los Angeles County, Project Manager. Responsible for managing benthic laboratory analysis of samples collected near the White's Point wastewater treatment facility in Palos Verdes. This analysis is conducted as part of the County's NPDES permit monitoring program. 2000-2003

Bight 03 Regional Monitoriring Program, Southern California Coastal Water Research Project, Biologist. Assisted with benthic sampling in the field. Responsible for managing, sorting and processing data of benthic samples. 2003-2004

UNOCAL Gulf of Thailand, Tetra Tech, Project Manager. Responsible for managing laboratory analysis of benthic infaunal samples collected in the Gulf of Thailand. Directed grain size and total organic carbon analyses. 2001- present

Bight 98 Regional Monitoring Program, Southern California Coastal Water Research Project, Biologist. Assisted with trawl surveys and fish identification. Responsible for sorting of benthic samples.

Ports of Long Beach and Los Angeles Year 2000 Biological Baseline Study, Biologist. Coordinated and led benthic and sediment field survey. Assisted in fish identification and benthic analysis. Managed grain size and total organic carbon analyses.

Environmental Studies at Two Ocean Disposal Sites off the Mouth of the Columbia River, ACOE, Biologist. Assisted in field surveys including fish identification and benthic collection. Managed benthic, grain size, and total organic carbon analyses. 2002-2003

County of San Diego Municipal Co-Permittees NPDES Stormwater Monitoring Program, Biologist. Assists in field sampling for urban stream bioassessment program and water quality monitoring at mass loading stations throughout San Diego County. Also responsible for conducting freshwater mollusk taxonomy on samples collected in urban streams. 2000-present

NASSCO and Southwest Marine Shipyards Study, Biologist. Assisted with field surveys for fish histopathology and benthic community analysis. Managed benthic, grain size and total organic carbon analyses. 2001

Long Beach Harbor Baseline Survey of Pier J - East Dredging, Biologist. Managed grain size and total organic carbon analysis. Assisted in benthic infaunal analysis. Assisted in field sampling, including box core, lampara nets, and fish identification. Responsible for grain size and TOC analysis.

Agua Hedionda Lagoon Mitigation Monitoring Project, Biologist. Assisted in field sampling and sorting of infaunal samples.

Anaheim Bay Mitigation Monitoring, Biologist. Assisted in wetlands field surveys including fish identification, benthic collection, and infaunal sample sorting.

Port of Oakland, ACOE, Biologist. Assisted with processing of sediment cores involving hazardous sediment for chemical and bioassay analyses.

Pacific Treatment, Project Manager. Manages the grain size analysis of sediment samples collected from various projects.

Remedial Investigation/RCRA Facility Investigation Report, NAS North Island, Biologist. Responsible for grain size and TOC analysis.

SUSAN D. WATTS, Information Systems Manager

Education

B.A. Biology, University of California, San Diego, 1971

Qualifications

Ms. Watts has over 20 years of experience in marine environmental studies, focusing mainly on database management, quality assurance, statistical analysis, and graphical presentation. As Weston's Manager of Information Systems, she is responsible for the design and implementation of large and diverse environmental databases involving physical, chemical, and biological parameters. These databases have been developed for a diverse range of projects, from deep ocean remote monitoring to shallow water wetland projects. She has been database manager for many projects requiring submittal of data to standardized governmental databases. Ms. Watts has experience in all aspects of environmental monitoring. This valuable experience, when applied to database design and statistical analysis, results in databases that are thorough, accurate, and complete.

Ms. Watts has provided data analysis for many large-scale, multi-disciplinary programs, including the County Sanitation Districts' of Orange County 301(h) Ocean Monitoring Program, baseline monitoring programs for the Ports of Los Angeles and Long Beach, biological monitoring programs for Anaheim Bay and San Dieguito Lagoon, several studies for MMS addressing impacts of oil and gas exploration, and San Onofre Nuclear Generating Station environmental monitoring. Recent projects include the use power analysis and repeated measures ANOVA to optimize and support modifications of the County Sanitation Districts' of Orange County 301(h) Ocean Monitoring Program, analyses for the remedial investigation of shoreline sediments at the North Island Naval Air Station, and dredge disposal site evaluations. In addition to data analyses, she has designed and written an interactive program for the comparison of ecological values of coastal marine and estuarine habitats.

Ms. Watts oversees all facets of information management, including statistical analysis, graphical presentation, and database quality assurance. She is knowledgeable about univariate and multivariate statistical procedures and their correct application to environmental data. She keeps abreast of the rapidly changing developments in computer technology and applies them cost-effectively to environmental programs to further the understanding and integration of environmental data.

Relevant Experience

Information Systems Manager, County Sanitation Districts' of Orange County 301(h) Ocean Monitoring Program, a multi-year project. Oversees database management and analysis for biological data, reporting of biological, chemical, and water quality data to EPA and ODES (Oceanographic Data Evaluation System).

Assistant Project Manager, Minerals Management Service (MMS) Mitigation Effectiveness Database Development. Responsible for the design and implementation of an ORACLE database, providing documentation, user guides, and training to users of the database. Participated in the development of criteria to evaluate the environmental effectiveness of mitigation measures.

Developer, design and implementation of scientific visualization techniques applied to marine and estuarine environments using computer simulations and animation to demonstrate spatial and temporal relationships.
Project Manager, Statistical Analyses Supporting Modification of County Sanitation Districts' of Orange County 301(h) Ocean Monitoring Program. Responsible for statistical analyses and interpretation of repeated measures ANOVA and power analyses to determine and support modifications to improve the ocean monitoring program.

Information Systems Manager, Remedial Investigation/RCRA Facility Investigation Report, Site 1, Naval Air Station, North Island remedial investigation. Responsible for database design and statistical analyses of physical and chemical analyses of sediments and toxicity tests for samples collected at nine historical outfalls in San Diego Bay. This project used a unique approach to assess ecological risk by comparing the results of chemistry, toxicity, and bioaccumulation tests on outfall sediments with results from relatively clean, non-toxic reference sediments from San Diego Bay.

Quality Assurance Officer, County Sanitation Districts of Orange County 301(h) Ocean Monitoring Program. Responsible for quality assurance adherence for field and laboratory procedures.

Information Systems Manager, Southern California Bight Pilot Project (SCBPP). Oversaw database establishment and transfer of infauna and water quality data to Southern California Coastal Water Research Project (SCCWRP). Coordinated with CSDOC for transfer of their SCBPP data to SCCWRP.

Data Analyst, MMS Investigation of Long-term Changes in Biological Communities in the Santa Maria Basin Due to Offshore Oil Platform Production and Discharge Effects. Provided statistical analysis and graphics.

Data Analyst, Design and Development of BEST (Biological Evaluation Standardized Technique), a computer program used to compare habitats, to assign an ecological value to habitats, and as an aid to mitigation planning.

Database Manager and Analyst, Baseline Monitoring for Los Angeles Harbor Department. Provided database design, database management, multivariate and univariate statistical analysis of data.

Database Manager and Analyst, San Onofre Nuclear Generating Station Studies of Thermal Effects on Benthic and Planktonic Communities. Provided database design, database management, multivariate and univariate statistical analysis of data.

Data Manager, design of databases for use in submittal of data to EPA's ODES (Oceanographic Data Evaluation System), incorporating specialized formatting, coding, and quality assurance checking to meet ODES specifications.

Data Manager, responsible for programming to create databases and data verification routines for various types of environmental data: water quality, benthic infauna, fish, zooplankton, ichthyoplankton, sediment chemistry, and physical parameters.

3.0 Quality Assurance Objectives for Measurement of Data

The EPA has specified five major characteristics of data quality that must be addressed in environmental sampling and analytical projects:

Accuracy: The degree of agreement of a measurement (or measurement average) with an accepted reference or true value. It is a measure of system bias. It is usually expressed as the difference of "measured" from "true" values, or as a percentage of the difference. Accuracy in the field is determined by collection and analysis of replicate field samples. For chemistry analyses, matrix spike (MS) samples are prepared and analyzed as appropriate; the recoveries of the spiked materials are a measure of the accuracy of the method. Where Standard Reference Materials (SRMs) are available from such sources as the EPA or National Institute of Standards and Technology (NIST), they are prepared and analyzed at the frequencies listed, as further accuracy checks.

Quantitatively, accuracy is measured by the degree of percent spike recovery (percent recovery), where percent recovery is defined as:

$$Recovery\ (\%) = \frac{cf - co}{cs}\ x\ 100$$

cf = measured concentration of the sample containing the spike (mg/L)
co = measured concentration of the sample without the spike (mg/L)
cs = concentration of the spike (mg/L)

Precision: A measure of agreement among individual measurements of the same property under similar conditions. It is expressed in terms of percent difference between duplicates or in terms of the standard deviation. Field duplicates are collected and analyzed to measure precision. For chemistry analyses, laboratory-generated duplicate aliquots of the same sample are analyzed (these duplicate aliquots may be spiked as a matrix spike/matrix spike duplicate (MS/MSD) pair where information indicates the native concentrations are likely to be at detection limit concentrations, thus avoiding the problem of comparing "none detected" results of duplicate samples).

Precision is quantitatively expressed in terms of the relative percent difference (RPD). RPD is defined as follows:

$$RPD = \frac{|x_2 - x_1|\ x\ 100}{(x_1 + x_2)/2}$$

x_1 = value of first duplicate point
x_2 = value of second duplicate point

Completeness: A measure of the amount of valid data obtained compared to the amount expected to be collected under normal correct conditions; it is usually expressed as a percentage.

Completeness is defined quantitatively as follows:

$$\frac{\textit{(Number of acceptable data points) x } 100}{\textit{(Total number of data points)}}$$

where acceptable data points are defined as data points that meet the prescribed QC goals.

Data from samples are considered complete if the samples have been properly collected, preserved, stored, prepared, and analyzed within holding times, and the associated QC criteria have been met. Because of the effects of sample matrices and interferences, lack of sufficient sample volumes, and method limitations, it may not be possible to report data that are 100% complete for each parameter in each survey. Weston and its subcontractors make all reasonable efforts to collect the samples required, preserve, store, prepare, and analyze them within holding times, and to meet the method-specific QC criteria.

Representativeness: A value that expresses the degree to which data accurately and precisely characterize a data population, process condition, a sampling point, or an environmental condition. Collection location and conditions are documented to describe fully each sample's origin and handling history. Further, management/technical review of all data sets is conducted to determined their reasonableness prior to submission.

Comparability: This value expresses the confidence with which one data set can be compared to another. To achieve comparability, the data generated are reported using units specified in the EPA protocols as appropriate for the particular analytical method and sample matrix. Standard reference materials are used to document traceability of calibration standards.

4.0 Field Sampling Procedures

This section provides a summary of the field sampling procedures for freshwater bioassessments designed to provide analytical data of consistent quality that will be representative of the collection site and comparable to other data collected using standardized methods. It is not within the scope of this document to define each type of field collection method, but rather will include general sampling strategies that apply to most protocols.

4.1 Sampling Equipment

Field sampling equipment will consist of the following list, but may be modified for additional project requirements.

- D-shaped kick net (1-ft wide, 0.5mm mesh)
- 1-qt wide mouth sample containers (preferred)
- 95% ethanol preservation solution
- Flow meter (Marsh-McBirney Flowmate 2000)
- Water Quality meter (YSI 6600 Environmental System)
- Stadia rod and hand level, or clinometer
- GPS unit
- Densiometer
- Standard 35 (0.5 mm) sieve, bucket, sorting pan (optional)
- Measuring tape (100 meter)
- Bioassessment field data sheet
- Physical/Habitat Quality data sheets (may vary with project)
- Field log book
- Random number table
- Sample labels
- Writing utensils (pencils, permanent ink pens)
- Digital camera
- Chain of custody forms

4.2 Sampling Locations

Monitoring reaches will generally be established according to project specific goals (e.g., regional ambient monitoring, probabilistic design, or point source impact assessment). Station locations for the collection of samples will be recorded using a Differential Global Positioning System (DGPS). Sampling locations may consist of riffle habitat, pool habitat, or target the full range of habitat types in the sampling reach. Collection of macroinvertebrates typically occurs when the water body is at base flow, and should be avoided during high flows after storm events or planned discharges below reservoirs. Photographs are taken of the sampling site to document conditions at the time of sampling.

4.3 Sampling Methods

4.3.1 Collection of Benthic Macroinvertebrates

Benthic macroinvertebrates are collected using a 1-ft wide d-shaped kick net sampler. Sampling area, habitat type sampled, and method of selection of sampling points can vary depending on the protocol specified by the project. The variety of standard protocols will not be addressed in this document, however, the actual collection technique is consistent, and may consist of two methods; for lotic (flowing) or lentic (still) habitats. Additionally, all monitoring reaches are sampled from downstream to upstream.

Lotic Habitats:
Once the sampling transects or points for macroinvertebrate collection have been roughly established, the stream substrate is examined for a suitable location to place the net. There should be a relatively even bottom contour so the net bottom will fit closely to the substrate to capture the maximum amount of macroinvertebrates. Gaps at the base of the net are highly undesirable. The substrate may be altered to create a good fit with the net, as long as sampling occurs upstream of the disturbance. In situations with highly uneven and consolidated substrates, the net may need to be placed at an angle to fit the bottom contour.

Once the net is in place, the substrate upstream of the net is disturbed by scrubbing all elements of the substrate and allowing the current to sweep organisms and debris into the net. Cobble may be picked up and scrubbed at the net opening, and the substrate may be disturbed to a depth of 4-6 inches. A consistent sampling effort should be maintained at each site, usually 1-3 minutes, but sampling times vary with the complexity of the substrate. For example, layered cobble generally requires a longer time to sample, while sandy or smooth consolidated substrates require less time.

When sampling is complete, the sample may be placed in a bucket or sorting pan and large debris such as rocks, sticks, and leaves may be rinsed, removed, and discarded (if there is little debris, this step may be omitted). Great care must be taken not to discard organisms. If substantial amounts of coarse sand are collected, this may discarded after elutriation of the sample material. This may be done by adding water to the bucket, swirling the contents and pouring the water and organic material through a sieve to separate the organisms. This process is repeated until there appears to be no more floating debris in the overlaying water. The sand is then discarded.

The contents of the net are placed in a sample jar, labeled (see section 5), and 95% ethanol is added. If the sample is mostly organic material, then the jar should not be filled more than ½ the volume of sample material, and it is recommended that the ethanol be decanted and replaced one day after sample collection. If the sample is primarily inorganic (sand, gravel) then the jar may be filled 2/3 full.

Samples are returned to the laboratory under chain of custody procedures and custody is relinquished to the sample custodian.

Lentic Habitats:
Sampling lentic habitats differs from lotic habitats only in that the lack of current flow requires that organisms be swept into the net by means other than ambient current flow. This is generally accomplished in two ways, and a combination of the two is recommended. The net may be placed on the substrate, the substrate disturbed, and the water forced into the net with arm sweeps by the sampler. The other technique is to disturb the substrate and the net is swept back and forth over the sample area to collect the macroinvertebrates.

4.3.2 Water Quality Measurements

Water quality parameters are measured at the time of macroinvertebrate collection and include at a minimum temperature, specific conductivity, pH, and dissolved oxygen. Additional chemical, biological, or physical parameters may be measured when specified by the project scope of work. All water quality parameters are measured or sampled outside of any stream disturbance created by sampling activities.

The preferred testing instrument is a YSI 6600 unit with a 650 MDS handheld display, although individual meters for each parameter may be used. The unit is carefully placed in a portion of the monitoring reach representative of the ambient conditions, preferably in an area of moderate current flow upstream of sampling activity. All probes must be fully submerged, and the readings allowed to stabilize before being recorded on the field data sheet.

Water quality readings from the YSI are assessed by the Field Supervisor before leaving the site. If measurements appear to be out of the range of normal conditions, the YSI unit is turned off and the parameters re-measured. If continued suspicious readings are seen, a notation is made on the field data sheet, and a water sample is collected for measurement at the laboratory with a different meter. Some measurements will not be valid or stable upon transfer to the laboratory (e.g. temperature and dissolved oxygen). If the site is revisited and the water quality re-measured on a different day than the biological sampling, this will be noted on the field data sheets.

4.3.3 Physical Habitat Assessment

The Stream Bioassessment Field Data Sheet is used to record physical conditions of each individual riffle (Figure 4.1). A Physical/Habitat Quality Form is used to record monitoring reach-scale habitat information, and includes 10 qualitatively assessed parameters (Figure 4.2). Other field data sheets may be used according to specific project requirements. Field data sheets must be completely and legibly filled out, including all header information and measurement units.

Habitat parameter measurements are made using a flow meter, measuring tape, stadia rod, hand level, clinometer, and densitometer. Some parameters are visually estimated.

STREAM BIOASSESSMENT FIELD DATA SHEET

WATERSHED/STREAM ______________________ DATE/TIME ______________

PROJECT ______________ SAMPLE ID ______________________

SITE DESCRIPTION ______________________________________

SAMPLING CREW

SITE INFORMATION
Latitude
Longitude
Elevation
COMMENTS:

WATER QUALITY MEASUREMENTS	
WATER TEMP.	
CONDUCTANCE	
pH	
DISS. OXYGEN	
CHLOROPHYLL	
TURBIDITY	

Additional observations (water odor, color, siltation, algae growth, etc.):

PHYSICAL HABITAT CHARACTERISTICS

REACH LENGTH ______________________

	Riffle 1	Riffle 2	Riffle 3
Riffle Length			
Riffle Depth			
Avg. Riffle Width			
Riffle Velocity			
% Canopy Cover			
Substrate Complex			
Embeddedness			
Substrate Composition			
Silt (<0.1")			
Sand (0.1 -0.2")			
Gravel (0.2 -2")			
Cobble (2-10")			
Boulder (>10")			
Bedrock/Solid			
Substrate consolidation			
Percent Gradient			

Figure 4.1: Stream Bioassessment Field Date Sheet

CALIFORNIA DEPARTMENT OF FISH AND GAME
AQUATIC BIOASSESSMENT LABORATORY

WATER POLLUTION CONTROL LABORATORY
REVISION DATE-- MAY 1999

PHYSICAL HABITAT QUALITY
(California Stream Bioassessment Procedure)

WATERSHED/ STREAM: ______________________ DATE/ TIME: ______________________

COMPANY/ AGENCY: ______________________ SAMPLE ID NUMBER: ______________________

SITE DESCRIPTION: ______________________

Circle the appropriate score for all 20 habitat parameters. Record the total score on the front page of the CBW.

Parameters to be evaluated within the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	**SUBOPTIMAL**	**MARGINAL**	**POOR**
1. Epifaunal Substrate/ Available Cover	Greater than 70% (50% for low gradient streams) of substrate favorable for epifaunal colonization and fish cover; most favorable is a mix of snags, submerged logs, undercut banks, cobble or other stable habitat and at stage to allow full colonization potential (i.e., logs/snags that are not new fall and not transient).	40-70% (30-50% for low gradient streams) mix of stable habitat; well-suited for full colonization potential; adequate habitat for maintenance of populations; presence of additional substrate in the form of newfall, but not yet prepared for colonization (may rate at high end of scale).	20-40% (10-30% for low gradient streams) mix of stable habitat; habitat availability less than desirable; substrate frequently disturbed or removed.	Less than 20% (10% for low gradient streams) stable habitat; lack of habitat is obvious; substrate unstable or lacking.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
2. Embeddedness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are more than 75% surrounded by fine sediment.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
3. Velocity/ Depth Regimes *(deep<0.5 m, slow<0.3 m/s)*	All four velocity/depth regimes present (slow-deep, slow-shallow, fast-deep, fast-shallow).	Only 3 of the 4 regimes present (if fast-shallow is missing, score lower than if missing other regimes).	Only 2 of the 4 habitat regimes present (if fast-shallow or slow-shallow are missing, score low).	Dominated by 1 velocity/ depth regime (usually slow-deep).
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
4. Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% (<20% for low-gradient streams) of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand or fine sediment; 5-30% (20-50% for low-gradient) of the bottom affected; slight deposition in pools.	Moderate deposition of new gravel, sand or fine sediment on old and new bars; 30-50% (50-80% for low-gradient) of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 50% (80% for low-gradient) of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
5. Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or <25% of channel substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Figure 4.2: Physical Habitat Quality Page 1 of 2

CALIFORNIA DEPARTMENT OF FISH AND GAME
AQUATIC BIOASSESSMENT LABORATORY

WATER POLLUTION CONTROL LABORATORY
REVISION DATE-- MAY 1999

Parameters to be evaluated in an area longer than the sampling reach

HABITAT PARAMETER	CONDITION CATEGORY			
	OPTIMAL	**SUBOPTIMAL**	**MARGINAL**	**POOR**
6. Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, usually in areas of bridge abutments; evidence of past channelization, i.e., dredging, (greater than past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shoring structures present on both banks; and 40 to 80% of stream reach channelized and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
7. Frequency of Riffles (or bends)	Occurrence of riffles relatively frequent; ratio of distance between riffles divided by width of the stream <7:1 (generally 5 to 7); variety of habitat is key. In streams where riffles are continuous, placement of boulders or other large, natural obstruction is important.	Occurrence of riffles infrequent; distance between riffles divided by the width of the stream is between 7 to 15.	Occasional riffle or bend; bottom contours provide some habitat; distance between riffles divided by the width of the stream is between 15 to 25.	Generally all flat water or shallow riffles; poor habitat; distance between riffles divided by the width of the stream is a ratio of >25.
	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
8. Bank Stability (score each bank) Note: determine left of right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
9. Vegetative Protection (score each bank) Note: determine left or right side by facing downstream.	More than 90% of the streambank surfaces and immediate riparian zones covered by native vegetation, including trees, understory shrubs, or nonwoody macrophytes; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetation has been removed to 5 centimeters or less in average stubble height.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0
10. Riparian Vegetative Zone Width (score each bank riparian zone)	Width of riparian zone >18 meters; human activities (i.e., parking lots, roadbeds, clear-cuts, lawns, or crops) have not impacted zone.	Width of riparian zone 12-18 meters; human activities have impacted zone only minimally.	Width of riparian zone 6-12 meters; human activities haveimpacted zone a great deal.	Width of riparian zone <6 meters: little or no riparian vegetation due to human activities.
	Left Bank 10 9	8 7 6	5 4 3	2 1 0
	Right Bank 10 9	8 7 6	5 4 3	2 1 0

Figure 4.2: Physical Habitat Quality Page 2 of 2

Many of the measurements of the physical aspects of the stream are qualitatively estimated and thus not precise. Current velocity, riffle depth, substrate size, etc, can be highly patchy or variable, and great care must be taken to get a *representative* measure of the overall conditions. For example, current velocity should be an average of the areas sampled, and not a maximum for the riffle. It is essential that consensus among the field biologists be achieved through discussions of the parameters assessed.

Additional information may be recorded on the field data sheets. Any unique or atypical conditions that occur, or any observation that may impact the macroinvertebrate community (e.g., odors, trash, silt deposits, heavy algae growths) should be recorded.

4.4 Sampling Documentation

Each field sample is uniquely identified with sample labels. All sample labels must include the project title, unique site code or name, and the date of sample collection. Two labels are created for each sample, one is placed inside the sample container and another is place on the sample jar lid. The internal label should be written on Never-tear paper. All information pertinent to field activities is recorded on a series of field sampling log forms maintained in a three-ring binder or similar field notebook. The field biologist records time, station coordinates, and all other information on the field data sheets.

4.5 Data Recording

All data are recorded legibly with permanent ink pens (e.g., Sanford Deluxe, Sakura or Itoya with black waterproof ink) or in pencil. All field log entries must be legible. All records will include correct units, if applicable. The field supervisor will review all data sheets and sample labels at the completion of each station to ensure the data are complete, legible, and recorded properly.

5.0 Custody, Tracking, Holding, and Disposal of Samples

Chain-of-custody and sample tracking establishes the documentation and control necessary to identify and trace a sample from sample collection to final analysis. To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, a chain-of-custody sheet is completed for each sample set at each sampling location.

5.1 Sample Collection

5.1.1 Sample Label

At the time of collection, an adhesive label is attached to the lid of each sample container, and an internal label (preferably on "never-tear" paper) is placed inside the sample container. The label is written in permanent ink or pencil and contains, at a minimum, the following information:

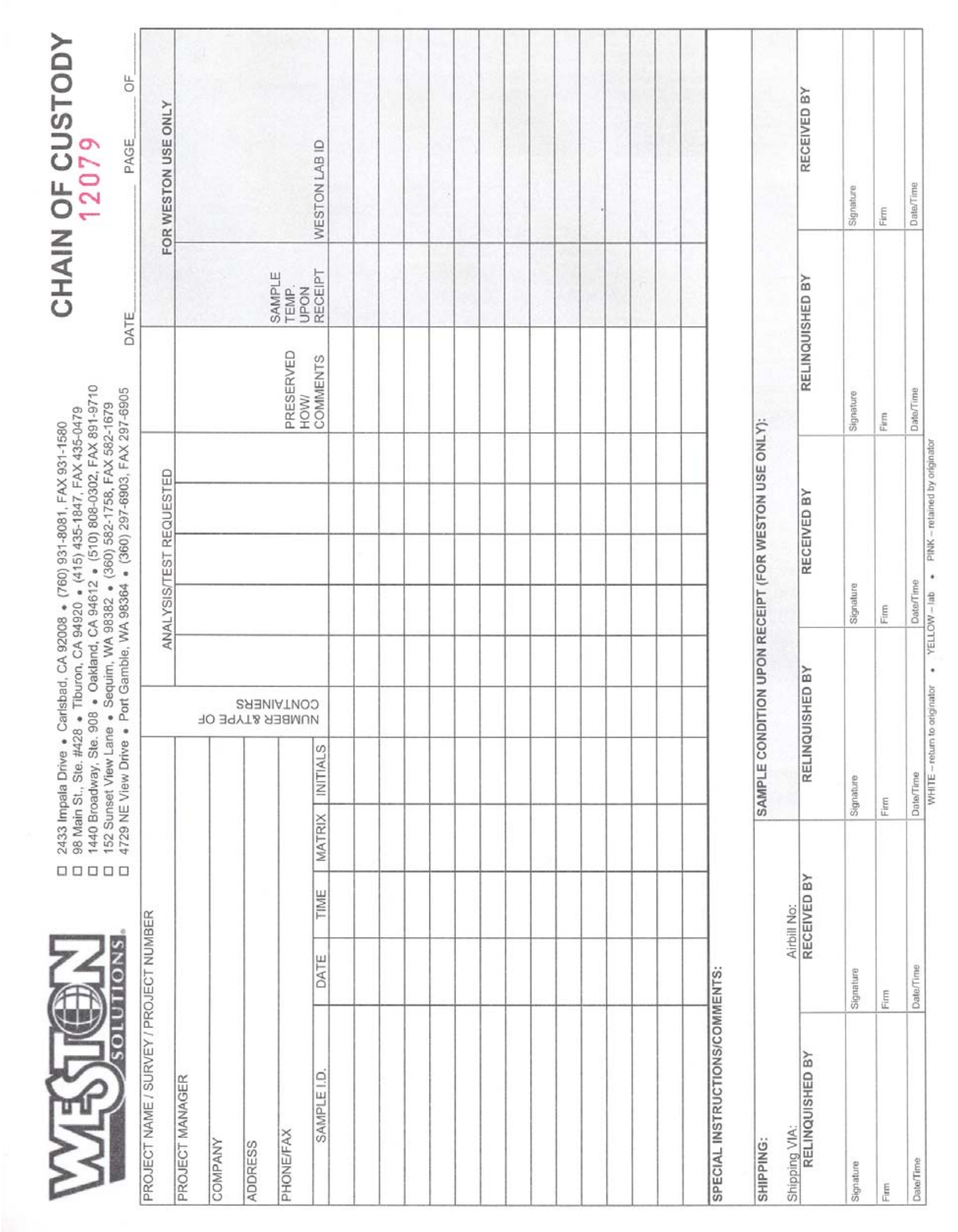
- title of project
- location
- sample identification and replicate number
- type of sample
- date collected

5.1.2 Initiating Custody

The individual in charge of collecting samples or of shipping samples to the laboratory is responsible for completing the chain-of-custody sheet.

A chain-of-custody form is completed for each sample set at each sampling location (Figure 5.1). The chain-of-custody form contains the following information:

- Project identification
- Collection date
- Sample identification
- Sample description
- Number and type of container for each sample
- Preservation method
- Analyses required
- Shipping address
- Custody signatures



WESTON SOLUTIONS

☐ 2433 Impala Drive • Carlsbad, CA 92008 • (760) 931-8081, FAX 931-1580
☐ 98 Main St., Ste. #428 • Tiburon, CA 94920 • (415) 435-1847, FAX 435-0479
☐ 1440 Broadway, Ste. 908 • Oakland, CA 94612 • (510) 808-0302, FAX 891-9710
☐ 152 Sunset View Lane • Sequim, WA 98382 • (360) 582-1758, FAX 582-1679
☐ 4729 NE View Drive • Port Gamble, WA 98364 • (360) 297-6903, FAX 297-6905

CHAIN OF CUSTODY
12079

DATE ____ PAGE ____ OF ____

PROJECT NAME / SURVEY / PROJECT NUMBER

PROJECT MANAGER

COMPANY

ADDRESS

PHONE/FAX

SAMPLE I.D.	DATE	TIME	MATRIX	INITIALS	NUMBER & TYPE OF CONTAINERS	ANALYSIS/TEST REQUESTED						PRESERVED HOW/ COMMENTS	SAMPLE TEMP. UPON RECEIPT	WESTON LAB ID

FOR WESTON USE ONLY

SPECIAL INSTRUCTIONS/COMMENTS:

SHIPPING:

Shipping VIA:

Airbill No:

SAMPLE CONDITION UPON RECEIPT (FOR WESTON USE ONLY):

RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY	RELINQUISHED BY	RECEIVED BY
Signature	Signature	Signature	Signature	Signature	Signature
Firm	Firm	Firm	Firm	Firm	Firm
Date/Time	Date/Time	Date/Time	Date/Time	Date/Time	Date/Time

WHITE – return to originator • YELLOW – lab • PINK – retained by originator

Figure 5.1: Chain of Custody

5.1.3 Sample Acceptance Policy

Weston's sample acceptance policy is made available to all sample collection personnel and those involved with sample receipt. Samples must have the identification; location and date of collection; collector's name; sample type analyses required; and any preservation used. Sample labels must include a unique identification on a durable label. Sample transport and containers must be received in good condition with adequate volume of preservative to maintain sample integrity.

5.1.4 Transfer of Custody and Shipment

Samples are to be accompanied by a chain-of-custody sheet during transfer. When the possession of samples is transferred (for example, from the field supervisor to a driver) the individual relinquishing the samples signs and records the date and time on the chain-of-custody document. The individual receiving the samples repeats the procedure. This record represents the official documentation for all transference of the sample custody until the samples have arrived at the laboratory.

Any sample leaving Weston laboratories or delivered from the field to another laboratory is accompanied by a chain-of-custody form.

5.2 Sample Receipt

Samples delivered by a client or collected in the field are received together with their chain-of-custody forms. The Sample Custodian checks samples received by the laboratory against their chain-of-custody sheets and clarifies any discrepancies with the relinquisher. Immediately after receipt, the Sample Custodian logs in all samples on a log in sheet and then places them in the appropriate storage area (e.g., sample storage room). When sample preservation is not in accordance with the requirements, the appropriate Project Manager is notified for initiation of corrective action. The Project Manager is also responsible for assuming that the samples are processed and tracked to completion of analysis.

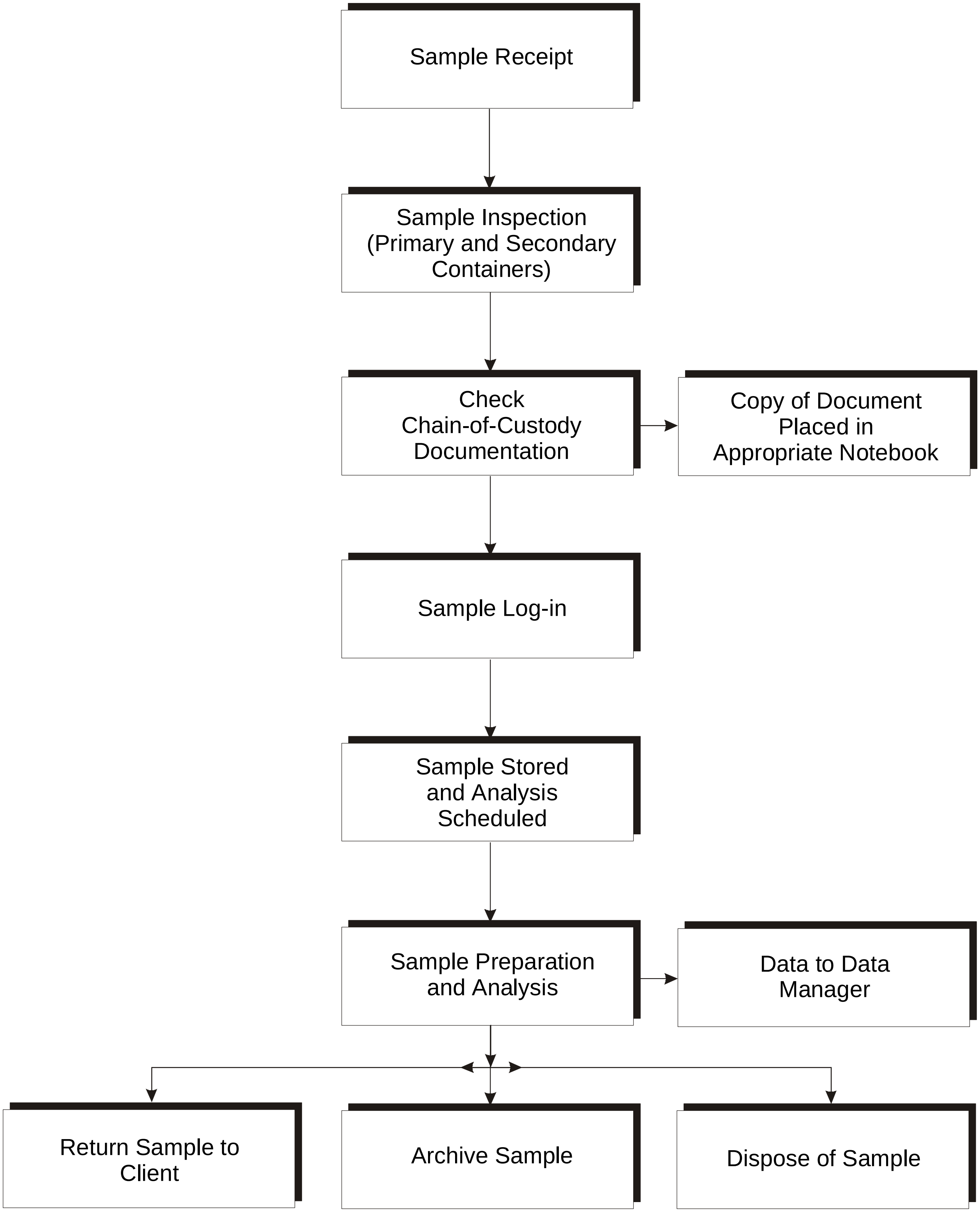


Figure 5.1: Flow chart for sample receipt

5.3 Sample Storage

Samples are kept in designated storage areas except during laboratory analysis. The Laboratory Manager or Project Manager distributes the requested samples. All laboratory personnel who receive samples are responsible for the care and custody of samples from the time each sample is received until samples are returned to the Laboratory Manager.

All samples are kept in secure areas with limited access. The building is kept secure by restricting access to persons other than employees to the front entrance, unless in the company of an employee. Upon request by the client, samples may be further secured by storing them in locked containers within the laboratory.

5.4 Sample Tracking

A sample tracking sheet is initiated and placed in a project notebook (Appendix X). Subsequent removal of the sample from the storage area is recorded on the tracking sheet by initialing the appropriate box. Return of the sample is recorded by checking the appropriate box.

5.5 Sample Disposal

Upon completion of sample processing, any remaining sample material is stored until it is either returned to the client, or the client allows for sample disposal. In either case, the samples should be kept intact until all data has been compiled and reported. During sample disposal, preservative fluid is retained and disposed of in accordance with all hazardous waste regulations. Sample material is thoroughly rinsed with water and placed in appropriate trash receptacles.

6.0 Calibration Procedures and Frequencies

Calibration is the comparison of a measurement standard or instrument with another standard or instrument to report or eliminate by adjusting any variation (deviation) in the accuracy of the item being compared. This section describes the laboratory approach to preparation of calibration standards and calibration procedures used for instrumentation and equipment.

6.1 Laboratory Standards

6.1.1 Traceability of Standards

Analytical standards utilized for instrument/methodological calibration standards must be obtained from reliable, certifiable sources and be of the highest possible purity. Commercially prepared standards are used within the manufacturer's designated shelf life. Documentation for lot numbers and vendors for reagents and standards are kept in three-ring binders in the laboratory in correlation to reagent lots with specific analytical batches.

6.1.2 Expiration or Holding Time Criteria

All standards obtained or purchased from approved commercial vendors, as well as from EPA or NIST, are dated upon receipt. Date of expiration is also noted. Standards are protected from degradation, deterioration, and contamination based on storage requirements (e.g., polyethylene containers for alkali solution, glass containers for organics, and brown glass for light-sensitive solutions; temperature storage and segregation of standards based on reactivity).

6.1.3 Laboratory Supplies

Supplies purchased from outside sources must be of adequate quality to sustain confidence in the use of such supplies. If no independent assurance of the quality of outside supplies is available, the laboratory will first perform tests with the new supplies to be sure that they comply with specified requirements.

6.2 General Field and Laboratory Equipment Calibration

All equipment and instruments used at Weston are operated and calibrated according to the manufacturer's recommendations as well as by criteria defined in individual SOPs. Operation and calibration are performed by personnel properly trained in these procedures. Documentation of all routine and special calibration information is recorded in appropriate log books. If a critical measurement is determined to be suspect during field operations, the results of that measurement will be reported, notation made on the field data sheet, and corrective action will be taken. If the measurement is re-taken at a later time or date, this will be recorded. Brief descriptions of the calibration procedures for field and laboratory equipment are described in sections 6.2.1-6.2.7.

6.2.1 Collection kick-net

The net used to collect macroinvertebrates will be examined before and after each sample is taken. This is done to ensure that there are no tears in the mesh, and that the full width of the net adheres to the 1-ft wide net opening. If a tear is discovered in the net, it will be repaired or replaced before any further samples are taken.

6.2.2 Thermometers

Weston maintains NIST certified thermometers, which are sent out for calibration at temperature points of 37º C and 56º C every two years. Laboratory working thermometers are calibrated once a year side by side with a NIST traceable thermometer.

For calibration of the YSI temperature probe, comparison against a laboratory calibrated thermometer is performed.

6.2.3 pH Meters

The YSI pH probe is calibrated at least monthly using a two-point calibration check as suggested by the manufacturer, usually using pH 7 and pH 10 calibration standards. If the calibration is out of range, the meter should be returned to the manufacturer for service.

6.2.4 Dissolved Oxygen Meters

Oxygen meters are calibrated using a one-point calibration check as suggested by the manufacturer, usually against water-saturated air. All meters are automatically corrected for temperature. Calibration is conducted daily, in the field, before any measurements are taken, or when there is an elevation change greater than 2,000 feet. Calibration may be repeated if any measurement is questioned by the person performing the measurement.

6.2.5 Conductivity Meters

The calibration of the YSI conductivity probe is verified at least monthly by measuring a standard of a known conductance. If the measured conductance is different from the standard, the conductivity coefficient of the meter is adjusted to match the standard. If the measured conductance differs from the value of the standard by more than 5 percent, the meter should be returned to the manufacturer for service.

6.2.6 Flow Meter

The Marsh McBirney flow meter is calibrated by the manufacturer. Calibration should occur one time annually and the records maintained.

6.2.6 Microscopes

No calibration is required for stereoscopic or compound microscopes used for sample processing. Microscopes are serviced and cleaned every two years by Sy Nielsen Services, Inc.

7.0 Laboratory Procedures

Laboratory procedures for stream bioassessment sample processing performed by Weston are summarized in this section. Standard Operating Procedures (SOPs) pertaining to these methods are found in the SOP manuals, or may follow a project specific scope of work.

SOPs are dated and revisions are numbered and dated. The revision date reflects the date that the SOP was first put into effect. When a SOP is revised, the earlier version is filed, and the end date of effect is noted on the filed SOP. Thus, the time period during which the protocol was in place is documented.

Standard Operating Procedures for the laboratories are updated by the quality assurance officer as needed and reviewed at least biannually. If there are no changes, the existing SOP may be resigned and dated. Hand written edits, accompanied by initials and date, are acceptable for minor updates until such time as the document is reissued and assigned a new revision number.

7.1 Benthic Macroinvertebrate Analysis

7.1.1 Sample Transfer

This procedure is for samples received that are preserved in formalin, which is replaced with ethanol for sample processing. The sample is poured over a sieve of appropriate mesh size and then gently rinsed with tap water from a spray nozzle. The sample is returned to the container; which is filled with 70% ETOH. The sample volume is measured by comparison with a calibrated jar of the same total volume as the sample container. The date of transfer, technician's initials, and sample volume are recorded on infaunal sample tracking sheets, and the sample is returned to the proper storage area.

7.1.1.1 Quality Assurance Requirements

During sample transfer, a mesh retainment device is placed over the sink drain that will prevent sample loss in the event that sample material is spilled into the sink. If a sample container is broken during the sample transfer process, the sample contents will be picked-up and placed in a new container. A corrective action form is filed, and documentation of possible sample loss will accompany data subsequently obtained. The laboratory manager is responsible for this documentation.

7.1.2 Benthic Macroinvertebrate Sub-sampling

7.1.2.1 Sorting

For most freshwater bioassessment samples, a subsampling procedure is used to remove a specified number of organisms from the sample. Typically, 300 or 500 organisms are removed from a sample, and the number will be pre-established in the project scope of work. Great care must be taken to remove a random assortment of the organisms present in a sample so that the final results will provide a complete and accurate representation of the biological community of the sampling site.

A sample is logged out of the sample storage location on the infaunal sample tracking sheet (Figure 7.1).

The sample is poured over a 0.5 mm sieve. Proper preservation is assessed by the presence of rotting odors. The sample manager, laboratory manager, or project manager is notified if the sample appears improperly preserved.

The sample is gently rinsed with tap water using a spray nozzle. Debris larger than ½ inch is removed. Green leaves, twigs, and rocks are removed, but filamentous algae or skeletonized leaves are not removed. The material to be discarded is inspected carefully so that animals are not discarded. Large organisms that are present in small numbers are removed from the sample and set aside, to be added to the final organism lot.

The rinsed material is placed into a gridded tray. Excess water is not allowed into the tray. The material is spread in an approximately ½ -inch-thick layer in the tray.

One grid is randomly selected for counting and identification of animals and removed from the tray using a spoon (for sandy material) or a razor blade (for filamentous material). The material is transferred to a suitable container for sorting of all the animals into taxonomic groups. The sample material is kept moist, and, if left overnight or longer, ethanol is added to maintain sample preservation.

Using a stereoscopic dissecting microscope with 6-50X magnification, the total number of animals specified in the scope of work are removed from the sample, using as many grids as necessary. Fractions of grids may be processed. After each grid is complete, the number of animals removed from the grid may be recorded on the Stream Bioassessment Sorting Sheet. Once the animals are tallied, the remaining animals in the grid are removed and counted, but all phyla are placed into one separate vial.

The Stream Bioassessment Sorting Sheet is filled out (Figure 7.2).

Remnant sample collections and the processed portion of the sample are labeled and returned to the sample storage area and logged in on the sample tracking sheet.

Figure 7.1: Stream Bioassessment Lab Sample Tracking Sheet

STREAM BIOASSESSMENT LAB SAMPLE TRACKING SHEET

Project: ______________________

Survey	Station	Rep	Jar #	Vol.	Sorter		QA/QC		Taxonomy										Curation Box #
					Out	In	Out	In	E	T	D	OI	C	M	OP				

Approved by:___________________
Date:_________________________

Stream Bioassessment Sorting Sheet

I. Sample Identification

Project Title **County of Orange Santa Ana Region** Survey **Oct- 05**
Station ____________ Replicate ____________
Date Collected ____________
Sample Sed. Vol. (mL) ____________ No./Type Contr. **1 Qt** Sampler **Kick Net**

II. Sorting

Sort Fraction ________ Sorted By ________ Date(s) Sorted ____________
Total Sort Time ________ # Animals Sorted ________ Animals Remaining ____________
Animals/Grid ______________________________
Comments ______________________________

Distribution of Sorted Material Est. total abundance______________________

	# of Vials	# of Jars	Contents of Jars
Ephemeroptera			
Trichoptera			
Diptera			
Other Insects			
Mollusca			
Crustacea			
Other phyla			
Extra Animals			

III. Sorting QA/QC

Sort Criteria ________________%
QA/QC By ____________ Pass/Re-Sort ____________ Date ________
QA/QC Time ____________ Re-Sort Time ____________ Re-Sort Date ________
No. of Animals QA/QC ________ Removal rate________________
No. of Animals Re-Sort ________________

IV. Sample Qualification Comments (Circle One)

1. Preservation: GOOD FAIR POOR

2. Single Major Component:
Shellhash Tubes Wood Algae Seeds Animals
Fibers Coarse Sand Fine Sand Pea Gravel Organic Material
Sewage Debris Macrodetritus Other:________________

Figure 7.2: Stream Bioassessment Sorting Sheet

Quality assurance of the sorting process begins with the personnel assigned to perform the sorting. Weston assigns only trained sorters to programs with high quality assurance requirements. In addition, all sorters are trained at Weston, and all sorting is done at our corporate headquarters benthic laboratory.

Sorters provide a count of animals during initial sorting (i.e., approximately 300 animals, plus the remainder of the last grid sorted). This number shall become the basis for evaluating sorting efficiency. The sorted portion of at least ten percent of the sample lot will be examined by senior laboratory staff members that have been trained in the QA/QC procedure. Each sorting technician will have at least one sample per sample lot (of a survey) evaluated for sorting efficiency. Less experienced sorters will have more than one sample evaluated. Samples must have a 90 percent removal rate of organisms to pass the QA/QC, i.e., for a 300 organism sample, no more than 30 organisms may be left in the sample.

Each sample is signed out on the Lab Sample Tracking Sheet (Figure 7.1) and poured over a 0.5 mm sieve and the ethanol retained for re-use. The sample is examined by the QA technician until it either passes QA/QC or a number or organisms greater than 10% of the total number has been removed from the sample. Samples that pass QA/QC will have been completely processed by the QA technician and/or the sorting technician. Samples that fail QA/QC may be returned to the sorting technician for completion, and the QA technician will discuss overlooked organisms with the sorting technician.

The QA/QC section of the Stream Bioassessment Sorting Sheet is filled out (Figure 7.2). The sample is logged back in on the Lab Sample Tracking Sheet and replaced back in the sample storage location.

If a technician fails to remove at least 90 percent of the organisms in a sample, at least two more samples sorted by that technician will be evaluated by the QA technician. If both of these samples fail QA/QC evaluation, two more samples will be evaluated. If the technician repeatedly fails the QA/QC evaluation, all the samples sorted by that technician will be re-sorted and the sorting technique of the technician will be evaluated.

7.1.3 Infauna Taxonomy

All organisms are identified using the most recent taxonomic references, literature, and keys. The level of taxonomic identification will be specified in the project scope of work. Species names and counts are recorded on taxonomic keypunch sheets (Figure 7.3), and species are coded using the NODC code system.

7.1.3.1 Quality Assurance Requirements

For most projects, a minimum of 10 percent of the sample lot will be sent for external taxonomic verification, although the level of taxonomic QA may be otherwise specified by the project scope of work. For very small projects conducted in Southern California, taxonomic QA is often limited to individual specimens in which the identification is not known or is made with a low level of confidence. The California Department of Fish and Game's Aquatic Bioassessment Laboratory in Chico, California is the laboratory that performs this function. A complete, detailed report of the results of taxonomic verification and count discrepancies is provided by the QA laboratory, and a copy is kept on file at Weston. Any discrepancies between the original taxonomic identifications and the QA laboratory identifications are corrected on the taxonomic data sheets, and all similar identifications from other stations are checked to ensure consistency.

Taxonomic intercalibration will be assured by conferring, when necessary, on voucher specimens with other taxonomists. This intercalibration is achieved through interactions by taxonomists in the California Aquatic Macoinvertebrate Laboratory Network (CAMLNet) or other groups, and by consultation with recognized authorities on the taxonomy of particular taxonomic groups for discussion of questionable or new taxa.

An in-house voucher collection of all taxa identified has been established. Where possible, the collection includes a size series of specimens, the various life stages, and males and females. This collection forms the basis for maintaining the continuity of taxonomic identifications in future sample examinations.

Weston taxonomists attend CAMLNet meetings pertaining to the animal groups on which they work. Many taxonomic problems are worked out this way on an ad hoc basis.

WESTON SOLUTIONS

Page___of___

BENTHIC INFAUNA DATA SHEET #2
Species Abundance Record

Project: __________________

Taxonomist: __________________

QUAL. CODE
2=Juvenile or Fragment
3=Colonial

TYPE of collection
C=Client
M=MEC
P=Personal
V=Sent for outside verification

NOTE (optional)
A=Approx. No.
C=Colonial
D=Diseased
F=Female
G=Gravid Female
J=Juvenile
M=Male
Q=Questionable ID
S=Special Interest
X=Damaged Specimen

ANIMALS REMOVED (NUMBER VOUCHERED, REP, TYPE, NOTE, SERIAL NO.)

FILE TP	PROJECT CODE	SURVEY	REC TYPE		STATION		NUMBER OF REPS		NODC TAXONOMIC CODE	COUNT 1	QUAL. CODE1	COUNT 2	QUAL. CODE2	COUNT 3	QUAL. CODE3	COUNT4	QUAL. CODE4	COUNT 5	QUAL. CODE5	NUMBER VOUCHERED	REP	TYPE	NOTE	SERIAL NO.	SPECIES
1 2 3	4 5	6 7 8 9	10	11 12	13 14 15	16 17 18	19 20	21 - 26	27 28 29 30 31 32 33 34 35 36 37 38	39 40 41	42	43 44 45	46	47 48 49	50	51 52 53	54	55 56 57	58	59 60	61	62	63	64 65 66 67 68 69 70	
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						
1 3 2			F																						

Figure 7.3: Benthic Infuana Data Sheet#2

8.0 Data Reduction, Validation, and Reporting

Data validation is the process whereby data are filtered and accepted or rejected, based on a set of criteria. It is a systematic procedure of reviewing a body of data against a set of criteria to provide assurance of its validity prior to its intended use. All data are checked for accuracy and completeness. The data validation process consists of data generation, reduction, and review.

Data reduction, validation, and reporting are on-going processes which involve the technicians, Project Managers, Laboratory Managers, and QA personnel.

8.1 Database Generation

After each survey, the field data sheets are removed from the field log books, and all sheets are checked for completeness and accuracy by the Project Manager or designee. All appropriate field sheets must be present. If there are any questions, clarification from the Field Supervisor is obtained as soon as possible. Field data sheets and the field logbook are placed into labeled files with the data type and survey number, and filed in the appropriate filing cabinet.

In the laboratory, technicians document sample preparation activities in bound laboratory notebooks or on benchsheets. Data validation includes dated entries by technicians on the data sheets and logbooks used for all samples; the use of sample tracking systems to track the progress of samples through the laboratory; and the use of quality control criteria to reject or accept specific data.

The technician who generates the data has the prime responsibility for the accuracy and completeness of the data. Each technician reviews the data to ensure that:

- Sample description information is correct and complete
- Analysis information is correct and complete
- Results are correct and complete
- Documentation is complete

Field and laboratory data sheets are turned over to the Project Manager. All data sheets are reviewed and signed by the Project Manager, or returned to the technician for reconciliation of errors and/or omissions of data.

Taxonomic data sheets filled out by taxonomists are relinquished to the Project Manager or QA Officer. For most bioassessment projects, data is entered directly into a Raw Data File in Microsoft Word using NODC taxa codes. The taxa names are not entered in the Raw Data File.

If data sheets are sent to an off-site keypunch service, the data sheets are copied before transmittal to the data entry operator. The originals are kept by the QA Officer; the copies are delivered to the data entry operator. Copies are checked for legibility; these must be used for data entry should the originals be lost or destroyed.

When data return from data entry, they are logged back in with the QA Officer, who checks to be sure all the files have been returned; date of return is recorded. The data files are copied onto the hard disk and titled appropriately.

8.2 Error Checking and Verification

For all projects, a Quality Assurance sheet is printed out from the raw data file. The Quality Assurance sheet includes the taxa names correlating to the NODC codes, all counts, and total counts for each sample and replicate. The Quality Assurance sheet is checked against the original taxonomic data sheets to ensure the proper taxa and counts were entered.

Total sample replicate counts are checked to ensure that the proper number, plus or minus 10%, of organisms were sub-sampled (usually 300 or 500 organisms). If too few organisms were removed, the sort sheet is checked to see if the entire sample was processed. If so, the count is valid. If only a fraction of the sample was processed and a counting error occurred, the sample is further processed until the proper number of organisms is removed. If too many organisms were removed, random elimination of organisms by computer is performed to reduce the data set to the target number.

The QA Officer resolves and corrects on data sheets and in raw data file any errors reported in the files; the printout is notated with corrections, initialed and dated.

After the database has been established, the data entry copies may be discarded, and the original data entry sheets and raw data printouts filed.

Data validation includes dated and signed entries by the technicians and Laboratory Manager on the bench sheets and notebooks used for all samples; the use of sample tracking and numbering systems to track the progress of samples through the laboratory; and the use of quality control criteria to reject or accept specific data.

8.3 Data Reporting

Taxonomic lists, biological metrics and Index of Biotic Integrity scores are then calculated from the Raw Data File. Data tables are created, printed, and submitted to the Program Manager for review. Tables are reviewed for any errors or irregularities; if any are found it may be necessary to correct and reestablish the databases or the dictionaries. Randomly selected metrics and IBI scores are hand calculated from the raw data file to confirm accuracy, and the final taxa list is compared to the original taxonomic data sheets. Errors and discrepancies are corrected by the QA Officer and discussed with data reduction personnel.

When clients require transmission of test results by telephone, facsimile, or electronic means, it is important that the confidentiality is preserved. If results are to be transmitted by telephone, confirmation that the intended recipient is answering should be obtained. Test results should be left on voice mail only when the intended recipient is clearly identified.

For test results transmitted by facsimile, the Weston facsimile cover sheet must be used with the pre-printed message:

> "The information contained in this facsimile message is privileged and confidential information intended only for the use of the intended recipient named above. If you are not the intended recipient, you are hereby notified that any copying of this communication or dissemination or distribution of it to anyone other than the intended recipient is strictly prohibited. If you have received this communication in error, please immediately notify us by telephone and return the original message to us at the above address via the U.S. Postal Service."

Also, a hard copy record of the telephone number called should be obtained for every facsimile sent that includes test results.

When sending test results via e-mail, always print out a hard copy of transmittal to document the e-mail address to which the message was sent.

8.4 Data File Storage

Data received from outside contractors are kept exactly as received; data are copied into a database for editing as needed based on error checking and verification procedures. After verification and final database establishment, the raw data files and databases are copied onto diskette for storage onsite. All original data sheets, all statistical worksheets, and all reports produced are accumulated into project specific files that are maintained at the Weston testing facility after the report has been submitted. Final report text and tables are also stored on disk. After data submissions, directories are archived on CD for storage offsite. In-house copies of data files are made on diskette when submitted. Records will be maintained for at least five years or transferred according to agreement between the company and the client, should the laboratory transfer ownership. All records and analyses pertaining to accreditation are kept for a minimum of five years. If there is a change in company ownership, accreditation records for at least the last five years must be transferred to the new owner.

8.5 Document Control

Laboratory standard operating and testing procedures (SOPs) will be made available to technical staff only in the most current form. The location of these documents will be made known to the staff and be placed in an easily identifiable location within each laboratory. Obsolete or revised SOPs will be retained for historical reference in either a hard or electronic format and stored in a manner that it will not be confused with a more current revision. Laboratory data sheets including test bench sheets and log forms will also only be made available in the most current form. After revisions or updates to these forms have been reviewed and approved by QA staff, the previous versions will be removed from circulation and replaced by the current form. Obsolete forms will be retained in hard or electronic format and stored for reference.

9.0 Internal Quality Control Procedures

9.1 Field Sampling

9.1.1 Sample Collection

QA/QC procedures for all field activities begin with proper collection of the samples in order to minimize the possibility of sample loss or contamination. Biological samples are collected in appropriately sized containers with secure, leak-proof lids. All chemistry samples are collected in laboratory-certified, contaminant-free containers, appropriate for the analyses (e.g., borosilicate glass, teflon, or polyethylene). Collection devices that are reused in the field, such as Van Veen grabs, are cleaned in the field with appropriate reagent grade solvents and rinsed with deionized water prior to each sampling. Water samplers are rinsed with deionized water prior to each sampling. All samples are shipped with chain-of-custody records. These records are completed by field personnel and become a permanent part of the data file.

9.1.2 Field Data

Physical habitat data in the field may be measured with instruments or visually estimated. The Field Supervisor is responsible for ensuring that all measurements are taken properly and are representative of overall site conditions. Water quality meters are calibrated according to the manufacturers' recommendations. Water quality measures are taken in a flowing portion of the stream, conditions permitting, outside of any sampling activity impacts. Qualitative estimates of site conditions are discussed among all sampling team members until consensus is reached.

9.1.3 Field Duplicates

Field duplicates are collected only if required by the project plan. Field duplicate samples may be taken and analyzed as an indication of overall precision. These analyses measure both field and laboratory precision; therefore, the results may have more variability than laboratory duplicates which measure only laboratory performance. It is also expected that sediment duplicate results will have greater variance than water matrices due to difficulties associated with collecting identical field samples.

9.1.4 Field Blanks

Field chemistry blanks are analyzed as required by the project plan. Field blanks are check samples that monitor contamination originating from the collection, transport, or storage of environmental samples. Field blanks used by Weston include equipment blanks and trip blanks. An equipment blank is analyte-free water that is poured through the sample collection device to verify that field cleansing procedures are adequate. A trip blank is a laboratory control matrix (typically water) that goes through the same shipping and handling processes as analytical samples. The purpose of the trip blank is to assess the impact of field and shipping conditions on the samples. The results from field blanks are reported to the client as samples; however, they are not used to correct any of the analyses on field samples.

9.2 Biological Sample Sorting QA/QC Procedures

The sorting procedure involves removal of a random, specified number of aquatic biological organisms from benthic samples. These organisms are sorted by phyla and transferred to vials. Any processed particulates (grunge) such as sediments and algae are kept in a separate sample jar for QA analysis and appropriately labeled.

A minimum of 10 percent of a sample lot, and two samples per technician, are assessed in-house for sorting efficiency using a sorting QA/QC procedure designed to ensure at least 90% removal of animals from the sorted aliquot. Specific project plans may differ from this minimum requirement. The total counted number of animals removed from each sample is recorded by the sorter. The sorting QA/QC analyst re-examines the grunge and, if the number of animals removed from the grunge is less than or equal to 10 percent of the total number of organisms, then the sample passes the QA assessment and no further re-sort is necessary. However, if the number of animals found in the grunge is greater than 10 percent of the total number, the sample fails the QA assessment and the remaining grunge is returned to the original sorting technician for further processing. The QA/QC analyst may discuss animals left in the sample with the sorting technician if it is suspected that the technician did not recognize the animals as aquatic. Technicians that continually fail QA/QC will be re-trained in the sorting procedure.

9.3 Taxonomic QA/QC Procedures

Taxonomic QA/QC consists of the following series of steps to ensure proper taxonomic designation of each specimen examined:

- Senior taxonomists for each taxonomic group review identifications of questionable taxa. All specimens with questionable identifications are compared with organisms in Weston's voucher collection, and/or may be sent to outside experts for verification.

- On a project specific basis, a percentage of the samples (typically 10 percent) are reidentified and counted by taxonomists at the California Department of Fish and Game Aquatic Bioassessment Laboratory in Chico, California. Voucher specimens are also sent there for verification. QA/QC for projects that have very small sample lots from Southern California areas and which are familiar to Weston taxonomists, typically consists of verifying individual specimens with questionable identifications.

- Taxonomic intercalibration is assured by conferring, when necessary, on voucher specimens with other taxonomists. This intercalibration is achieved at periodic meetings of the California Macroinvertebrate Laboratory Network (CAMLNet) and other select meetings between taxonomists.

- An in-house voucher collection of all taxa identified for various geographic regions has been established. Where possible, the collection includes a size series of specimens, various life stages, and/or males and females. This collection forms the basis for maintaining the continuity of taxonomic identifications in future sample examinations.

10.0 Audit Responsibilities and Procedures

Internal audits are performed as systematic checks to determine the quality of operation of field and laboratory activities. Performance audits are used to determine the accuracy of the total measurement systems or its components. Systems audits are used to verify that all QA/QC practices are being followed and new procedures are fully understood and upheld by field and laboratory personnel. They also are utilized to find faults that may have entered the system or for which the QA/QC program is insufficient. Both systems and performance audits are conducted under the auspices of the Quality Assurance Officer. Audit reports are used to document findings.

Additional audits are performed when identification of nonconformance's or departures casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with NELAC standards. In these situations the quality assurance officer ensures that the appropriate areas of activity are audited. Follow up audits should be performed within 30 days of the recognition of the nonconformance event or the next time the procedure is performed, whichever is sooner.

10.1 Field Performance Audit

Field performance audits are performed as field data are generated, reduced, and analyzed. All field records are taken in permanent ink and are legible, of reproduction-quality, and complete to permit logical reconstruction by a qualified individual other than the originator.

Other indicators of the level of field performance are the analytical results of the duplicate and replicate samples. Results of the field duplicate and replicate analyses are an indirect audit of the field crew to collect representative samples.

10.2 Field Systems Audit

System audits of site activities are accomplished by an inspection of all field site activities by the Quality Assurance Officer. This audit involves comparisons of current field practices with standard procedures. The following is a listing of the criteria to be used in the evaluation of field activities:

- Overall level of organization and professionalism
- All activities conducted in accordance with the SOP
- All procedures and analyses conducted according to procedures outlined in the Quality Assurance Manual
- All records in permanent ink
- Sample documentation complete
- Instruments and equipment in working order
- Contingency plans outlined in case of equipment failure or other event preventing the planned activity from proceeding
- Sample packaging and transport performed properly

After the audit, an audit report is filed, and any deficiencies are discussed with the field staff, and corrections are identified. If any of these deficiencies might affect the integrity of the samples being collected, the Quality Assurance Officer informs the field staff immediately, so that any corrections can be made.

10.3 Laboratory Performance Audit

Internal performance audits are accomplished by data review through the use of blind control samples, replicate measurements, reference materials, control charts, and individual proficiency test samples. Results are compared to "true" values and evaluated for accuracy and/or precision.

Audits are conducted by the Quality Assurance Officer and include the following:

- Verification of written procedures and analyst(s) understanding
- Verification of documentation of procedures and records
- Review of analytical data and calculations

10.4 Laboratory Systems Audit

10.4.1 Internal Systems Audit

In-house surveillances (intensive observation of a part of laboratory operations) are performed by the QA Officer. The overall purpose of an audit is to verify that all QA/QC practices adopted by the laboratory are being followed and that new procedures and protocols are fully understood and upheld by laboratory personnel. It is also utilized to find faults (intentional, unintentional) that may have entered the system or for which the QA/QC program is insufficient. The audits are always intended to improve rather than have a negative effect. Audit Checklists (Figure 10.1) are used for documenting audit and surveillance findings.

Internal System audits will be performed

a. to provide an objective evaluation of compliance with established requirements, methods, and procedures
b. to assess progress in assigned tasks
c. to determine adequacy of Quality Assurance Program performances
d. to verify implementation of recommended corrective action.

Benthic Laboratory

Audits by the Quality Assurance Officer include an evaluation of quality assurance practices, procedures, and instructions; the effectiveness of implementation; and conformance with policy directives. The following is a listing of the criteria to be used in the evaluation of laboratory activities.

INTERNAL AUDIT REPORT

Procedure Audited:	
Audit Performed By:	Date:

CHECK	YES	NO	COMMENTS
Work area satisfactory			
Standards and reagents properly stored and labeled			
Procedures understood			
Good laboratory practices			
Cleanliness			
Procedures followed			
Documents and records in order			
Documents in impermeable ink			
Quality control performed			
SOP up to date			

Comments:

Proposed Corrective Action (if necessary):
Proposed Completion Date:
Verification of Corrective Action:

QA Concurrence:	Date:

Figure 10.1: Internal Audit Checklist.

- Work area satisfactory
- Standards and reagents properly stored and labeled
- Procedures understood and followed
- Cleanliness
- Documents and records in order
- Documents in permanent ink
- Quality control performed
- SOP up-to-date

After the audit, an audit report is filed, and any deficiencies are discussed with the Laboratory Manager and staff. Corrections are made as necessary.

Bioassay Laboratory

Internal Quality Assurance audits are documented by use of QA forms which address the following areas:

Laboratory Condition: The General Lab Audit Checklist form is used to assess the following: condition of in-house organism cultures, lab preparedness, test room temperature and light cycle conditions, and condition of the water quality meters.

Documentation: The Weekly Log Book Quality Checklist is used to verify that the laboratory logs that document sample receipt, organism receipt, sample water quality, test room conditions, calibration of instruments and the master schedule are complete.

Individual Study Quality Assurance: Two forms are used to assess the quality of a particular study. The Quality Assurance Checklist documents that the specific protocol required was followed correctly and includes any problems or deviations. The Study Conduct Audit Checklist is a more inclusive form requiring assessment of the entire project from personnel training to proper acquisition of data.

Routine system audits of laboratory condition and documentation are performed at regular intervals. Individual studies are formally audited as required by the sponsor or no less than several times a year, although the quality of every study is assured as the result of data review, use of controls and reference toxicants, and QA review throughout the data generation and reporting process. Internal audits are the responsibility of the Quality Assurance Officer.

10.4.2 External Systems Audit

Weston participates in interlaboratory comparisons and proficiency testing programs, including DMR-QA toxicity studies, WP chemistry studies, and performance evaluation (PE) sample analyses. Results of these studies are used as verification of laboratory practices.

An on-site inspection may be conducted by other outside audit teams to review the laboratory quality control system that covers sample handling, sample analysis, records control, preventive maintenance, and proficiency testing. After an external system audit of the laboratory, any recommendations made or deficiencies identified will be considered for implementation, and corrective actions will be taken to correct deficiencies.

11.0 Facilities, Equipment, and Preventative Maintenance

Weston's Carlsbad office is located in approximately 13,250 square feet of office and laboratory space in Carlsbad, California. The bioassay laboratory occupies 6,500 square feet and includes facilities for freshwater, marine, and estuarine bioassay testing. It has five bioassay testing rooms, sample preparation rooms, a walk-in freezer/refrigerator, as well as separate storage cabinets for hazardous waste samples (refrigerated) and chemicals (flammables, corrosives) (Figure 11.1). All rooms used for testing or culturing are modulated for air temperature and light cycle, and water baths are modulated for water temperature. The microbiology laboratory is equipped with two water baths, an air incubator, autoclave, and refrigerator.

The laboratory at Tiburon, CA occupies 6,600 square feet and includes facilities for freshwater, marine, and estuarine bioassay testing. It has four bioassay testing rooms, sample preparation rooms, a walk-in freezer/refrigerator, as well as separate storage cabinets for hazardous waste samples and chemicals (Figure 11.2). All rooms used for testing or culturing are modulated for air temperature and light cycle, and water baths are modulated for water temperature.

The laboratory at Port Gamble, WA occupies 3,900 square feet and includes facilities for aquatic toxicological testing with an emphasis on flow-through marine exposures. Additional activities include mycological remediation support, testing, and development. The Port Gamble facility has one temperature controlled test room with a separate large testing area consisting of 10 temperature controlled water baths. All test areas can be modulated for temperature and light cycle. Additional areas include a sample preparation room, a walk-in refrigerator, and separate storage cabinets for chemicals (flammables, corrosives) (Figure 11.3).

We can readily allocate the full range of sampling, processing, and analytical equipment needed for most types of aquatic studies.

Sampling: Equipment includes a research vessel and an extensive inventory of hydrographic, sediment, and biological sampling equipment.

Laboratory Support: Facilities include microscopes; equipment for the analysis of physical and chemical properties of sediment and water, water quality, and chemistry; an extensive taxonomic reference library; and large reference (voucher) collection of marine biota.

Computer System: Systems consist of desktop and notebook computers networked with Windows 2003 server. The system includes several network black and white, and color printers. Data can be transmitted electronically through e-mail and FTP. All systems are automatically backed up daily.

Data Processing: Software includes wide application programs such as SAS, PRODAS, ArcView, and Systat, spreadsheets (Excel) and specialized statistics and graphics programs.

Report Production: Systems consist of word-processing and desktop publishing software linked to graphics and computer-plotting capabilities.

Prior to beginning a new program, the Laboratory Manager reviews the requirements for facilities, equipment, and personnel to ensure we have adequate and appropriate resources available.

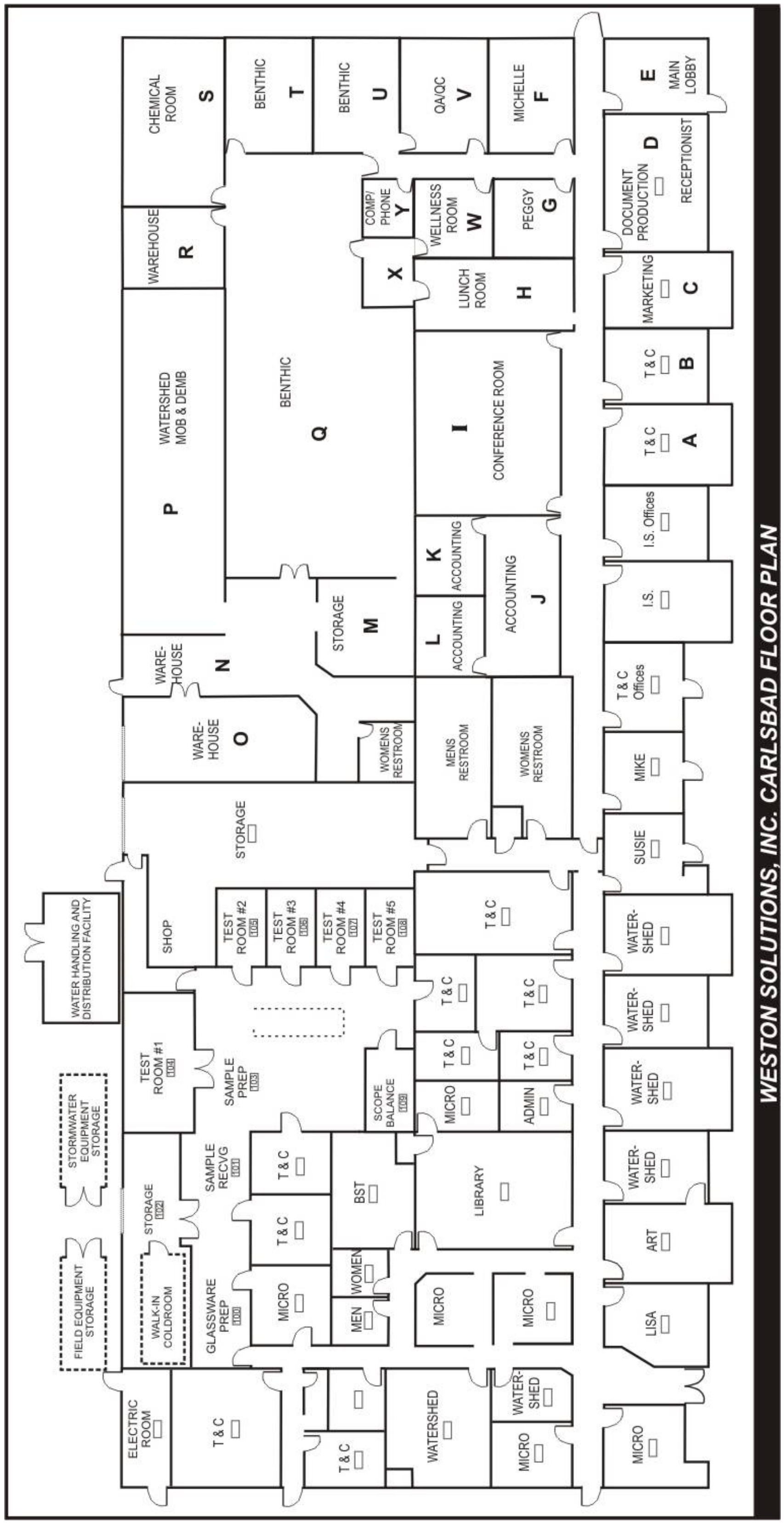


Figure 11.1: Carlsbad Floor Plan.

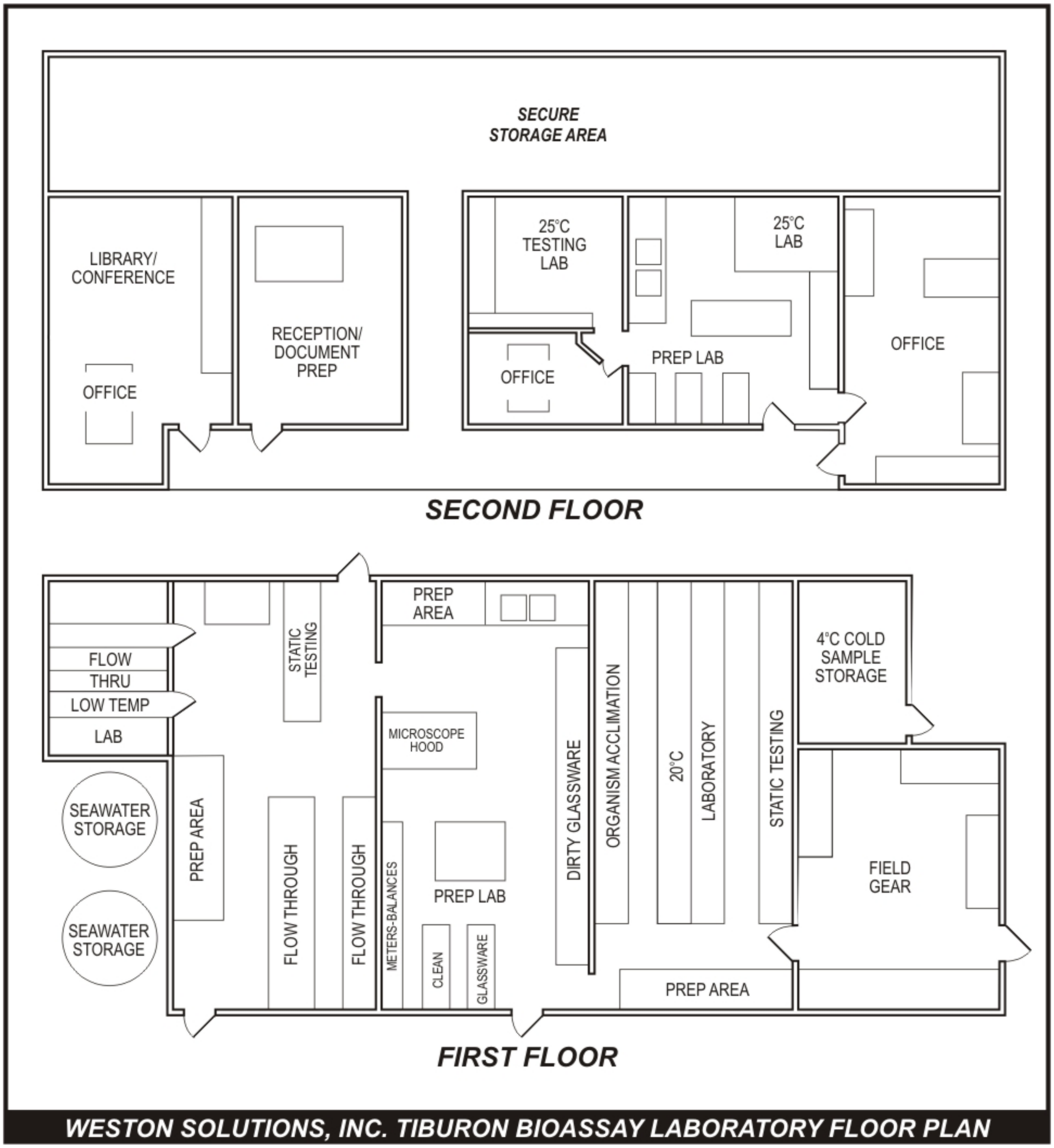


Figure 11.2: Tiburon Floor Plan

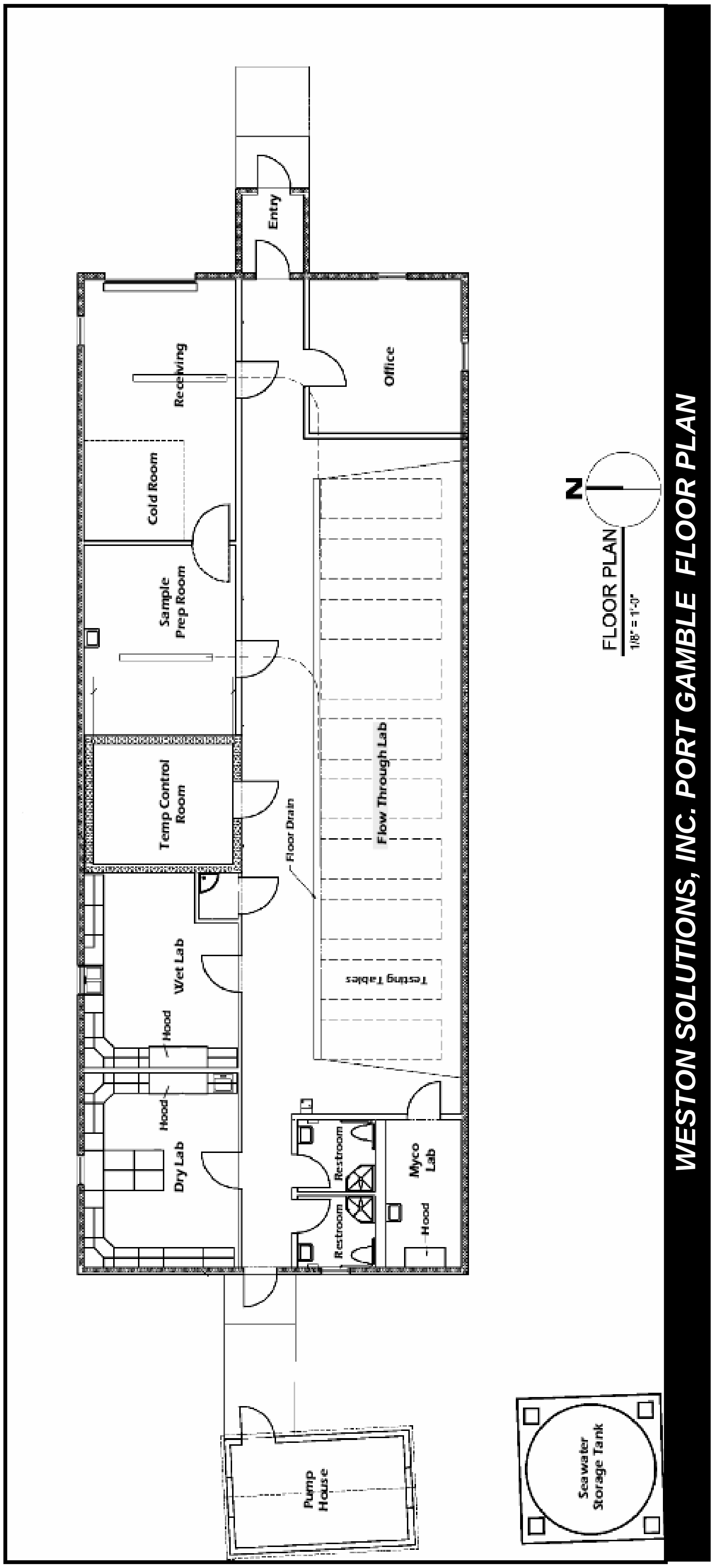


Figure 11.3: Port Gamble Floor Plan

11.1 Purchasing Services and Supplies

Weston personnel will ensure, to the best of their ability, that laboratory supplies, reagents, and consumable materials will not affect the quality of the environmental tests and/or calibrations for which they are intended. Supplies will be selected and purchased primarily from reputable suppliers (i.e., VWR, Thermo Orion, Hach, Fisher, Cole-Parmer, etc.). Other factors for selecting supplies include meeting specific method or project requirements. All purchased chemicals will be reagent grade or better (when required) to ensure chemical purity. Other supplies may be selected based on their ability to not contribute to the toxicological, bacterial, or chemical contamination of their particular purpose.

Contracted services involving the certification of calibration standards (i.e., thermometers, weights, etc.) will utilize vendors that adhere to established standards for their field. Prior to the performance of calibration services, it will be confirmed that the vendor follows standards such as those developed by the National Institute of Standards and Technology (NIST). Other related services will be investigated prior to execution for evidence of specific technical expertise and adherence to developed guidelines.

11.2 Subcontracting of Environmental Tests

When Weston Solutions Inc. subcontracts work because of the need for further expertise, temporary incapacity, or on a continuing basis through a permanent subcontracting agency, this work shall be placed with a laboratory accredited under NELAP for the tests to be performed or with a laboratory that meets applicable statutory and regulatory requirements for performing and submitting the results. The laboratory that performs subcontracted work for Weston Solutions Inc. shall be identified in the final report and non-NELAP work shall be clearly identified as well.

Weston Solutions Inc. maintains a register of all subcontractors used for environmental tests and a record of the laboratories certificates and or accredited fields of testing.

11.3 Equipment List

Below is a list of Weston's corporate equipment used in the field and laboratory.

FIELD EQUIPMENT

Boats
25-foot Portable Vibracore Barge with heavy duty trailer
24-foot Skipjack Cudy Cabin with trailer
19-foot Vessel ("MATADORA") with davit winch, trailer, and 200 HP Yamaha
12-foot Vessel (Avon Inflatable Boat) (2) (1-Tib)
10-foot Vessel (Achilles Inflatable Boat)
8-foot Vessel (Avon Inflatable Boat)
Outboard Motors; 15, 9.9, and 4 HP and 8 HP 4 Stroke; 8 HP 2 Stroke (Tib)

Communications and Positioning
Differential Correction GPS (3)
Cellular Telephones (32)
ICom Hand Held VHF 2003
Video Depth Finder (one per boat)

Collection and Sampling Equipment
Portable Hydraulic Winch
Pumps
Field VCR Unit
Marinovich Otter Trawls (6)
Mesh Gill Nets
Mysid Nets and Sleds
Bongo Net Samplers
Auriga Net Samplers
Plankton Nets
Beach Seines
Purse Seine
1-m Beam Trawl (2)
Lampara Nets
Seabird Water Quality CTD Instrument with Automatic Data Recording (2)
Computer for direct link to Seabird (2)
Hydrolab Water Quality CTD Instrument
Sea Tech Transmissometer (2)
Seapoint Rhodamine Fluorometer (2)
Honda Generators 4 kw and 1 kw
GenPro Generators 9500 w and 1300 w
Coleman Progen Generator 5 kw
12-Bottle Rosette Multiple 8-liter Water Sample Instrument
4-liter Van Dorn Water Bottles (12)
SCUBA Tanks (27)
Underwater Scooters (2)
SCUBA Diver Comunication System (2 Divator masks and 1 deck topside unit)
Phleger Gravity Corer

Ponar Grab
Single and Double Van Veen Grabs
Clamshell Box Corer
9” Box Corers (3)
9” Cable Box Corers (3)
Flow Meters
Nikon 8008S 35 mm Camera with Nikon 60 mm macro lens
Nikonos MK5 Underwater 35-mm Camera
MCD Underwater Strobe System
Sony 8-mm Video Camera with Underwater Housing
Hewlett Packard Digital Camera 715
Hewlett Packard Digital Camera 735
PVC Corers (0.8 + 0.4 liter)
Benthic Organism Wash Boxes and Sieves
Fish Weighing Scales and Measuring Boards

Vehicles
Dodge Van B-2500 1998
Ford Expedition 2001
Ford Ranger Pickup 2003
Hyundai Elantra 2000
Ford F250 Pickup 2002
Ford F250 4x4 Pickup 1987

LABORATORY EQUIPMENT

Microscopes
Nikon Dissecting Microscopes (8)
Wild M-5 Stereomicroscopes (9)
AO Fifty (2-Tiburon)
Bausch/Lomb Compound Microscopes (2)
Olympus Compound Microscopes (2-Carlsbad & 1-Tiburon)
Nikon TS-100 Inverted Microscope (1-Carlsbad & 1-Port Gamble)
Nikon Inverted Microscopes (Tiburon)
Motic Model M-100 Dissecting Microscope
Reichert-Jung Biostar Inverted Phase Microscope
Fiber Optic Illuminators (11)
Sunnex Model 710 Illuminators (8)
Dyna-Lume #240-351 Illuminators (3)
Incubator (± 0.5°C)
Water baths (± 0.1°C) (2)

Balances
Mettler PM600 Analytical Balance
ASP Z400-DR Balance
A&D HM202 Electronic Balance
Acculab Model V-6000
Denver TR-8102D Analytical Balance
Denver P-8002D Balance (Port Gamble)
Denver SI-215D (Port Gamble)
Acculab Model V-1200

O'Haus Corp. Model E400 (Tiburon)
Sartorius Corp. Model R200D (Tiburon)

<u>Analytical Equipment</u>
DC-190 High Temperature TOC Analyzer
Sediment Grain Size Analytical Equipment
Millipore Triple Manifold, Vacuum Pump (2), and Funnels
Orion 140 Conductivity Meter (2-Tiburon)
Orion 142 Conductivity Meter (2-Carlsbad)
Orion 830 Dissolved Oxygen Meter (1)
Orion 830A Dissolved Oxygen Meter (2-Carlsbad)
Orion 5-Star Multimeter (4-Port Gamble)
YSI 57 Dissolved Oxygen Meter (2-Tiburon)
YSI 58 Dissolved Oxygen Meter (Tiburon)
Beckman pH Meter (2-Tiburon)
Orion 230A pH Meter (4-Carlsbad)
Hach SesIon1 pH Meter (Carlsbad)
Corning 106 pH Meter (2-Tiburon)
Orion 720A ISE Meter w/Ammonia and Sulfide ISE Electrodes (2-Carlsbad & 1-Tiburon), ISE Electrodes (NH_4 (2),Ca, K, Na) (Carlsbad)
HACH DR 2000 Spectrophotometer (Tiburon)
HACH DR/700 Colorimeter (Carlsbad)
HACH 2100N Turbidimeter
LiCor 185 Photometer (Tiburon)
Spectra Candela II Light Meter (Carlsbad)
Extech Radiometer (Carlsbad)
Turner Designs AguaFluor Fluorometer
Master Flex Easy Load 45 Peristatic Pump
Geotech Easy Load II Peristaltic Pump

<u>Other Equipment</u>
Market Forge Sterilmatic Autoclave
Lab-Line Incubator
Thelco Ovens (2)
Blue M Oven
VWR Oven (Tiburon)
Refrigerators (5)
Freezer (Carlsbad & Tiburon)
Walk-in Cold Room (Carlsbad & Tiburon)
Plankton Sample Splitters
Clean Bench
Fume Hood (Carlsbad & Tiburon)
Zimmer Bone Cement Centrifugation System HN-S II (Carlsbad)
Beckman J-6B Centrifuge (Tiburon)
Beckman 5-21C Centrifuge (Tiburon)
Corning Hot Plate/Stirrers (3)
Mini Vortexer – Thermolyne Maxi Mix II
Oxford Adjustable Pipettes (15)
Eppendorf Micropipettors (2)
Miscellaneous Glassware/Hardware for Bioassay Testing, Taxonomy, and Microbiology
NIST Calibrated Thermometers (2)

Springfield Wireless Digital Thermometer
Portable Sieve Shaker
Mercury Thermometer (3)
Alcohol Thermometers (6)
Tempscribe Recording Thermometer (2)
Flow-Through Seawater System (Carlsbad & Tiburon)
Nanopure-Filter Deionizing Water System
Temperature and Photoperiod Controls
Portable Storage 20 x 8 ft.; 40 x 8 ft.

REFERENCE SUPPORT

In-house taxonomic keys and literature (benthos, fish, plankton, algae, insects, and birds)
In-house reference library (books, journals, and articles) indexed within a ProCite database
In-house marine organism voucher collection including plankton, benthos, and fish

DOCUMENT PRODUCTION

Canon CLC 1150 Digital Color Copier/Printer (Carlsbad)
Canon Imagerunner 3220 Digital Color Copier/Printer (1-Carlsbad & 1-Port Gamble)
Canon Imagerunner 7200 Digital Copier/Printer (Carlsbad)
Canon 330 (Tiburon)
GBC Comb Binding Machines (4)
Letrex Professional Lettering Machine

COMMUNICATIONS SUPPORT EQUIPMENT

Computers
Pentium Desktop Computers (40)
Pentium Notebook Computers (6)
Windows 2000 Servers (3)

Printers
Hewlett-Packard LaserJet 4 (5)
Hewlett-Packard LaserJet IVsi
Hewlett-Packard LaserJet IIIsi
Epson Stylus Color InkJet Printers (3)

Communications Equipment
Canon Laser Class 7000 FAX (Tiburon)
Canon Laser Class 730I FAX (Carlsbad)
NorTel Phone System and Voice Mail
T-1 Internet Connection
Electronic Communications via Internet

Other Equipment
Sharp Multimedia LCD Projection Panel
Sharp Digital Multimedia Projector
Del Digital Multimedia Projector
Hewlett-Packard Scanjet 5590 Scanner

11.4 Equipment and Instrument Maintenance

11.4.1 Analytical Balances

Analytical balances are serviced on an annual or biannual basis as recommended by the manufacturer or by a professional balance maintenance organization. Calibration and service information for each balance are recorded in the appropriate log books.

11.4.2 Carbon Analyzer

The Dohrmann DC-190 TOC Analyzer is serviced by a Dohrmann Technician on an annual basis. Machine filters, the combustion tube, drying tubes, and all connections are checked periodically, but not to exceed one month of use. Machine filters and the combustion tube are changed as needed. Drying tubes are cleaned, and connections are secured as needed. Oxygen supply is checked prior to use and replaced as needed.

11.4.3 Temperature Control

Temperatures are monitored and recorded in all bioassay testing rooms twice daily. Temperatures for microbiological equipment, including incubators and water baths, are monitored and recorded twice daily when in use. Notebooks are kept that contain date, temperature, any special circumstances, and the initials of the technician performing the checks. All thermometers and temperature data loggers (HOBOS) are checked annually (semi-annually for microbiology) for accuracy using a certified NIST thermometer.

11.4.4 Dissolved Oxygen Meters

Dissolved oxygen meters are serviced by the manufacturer on an as needed basis. Oxygen meters are calibrated daily using a one-point calibration check as suggested by the manufacturer. All meters are automatically corrected for temperature and are manually corrected for salinity. Calibration is conducted daily before any measurements are taken. Calibration and service information for each meter are recorded in the appropriate log books.

11.4.5 Conductivity/Salinity Meters

Salinity meters are serviced by the manufacturer as needed. Salinity meters are calibrated by the manufacturer only. The calibration is verified monthly by measuring a standard of a known conductance. The conductivity coefficient is adjusted as needed to match the known conductivity standard, however, if the measurement is greater than ± 10% of the standard, the meter is returned to the manufacturer for recalibration. Calibration and service information for each meter are recorded in the appropriate log books.

11.4.6 pH Meters

pH meters are sent to the manufacturer for servicing as needed. The pH/specific-ion meters are calibrated before use with a minimum of two standard solutions. All combination pH electrodes are stored in buffer solutions with a pH 7.

11.4.7 Water System

The high purity water system is checked for total dissolved solids and maintained at a purity of 10-18 megohm/cm by using a resistivity meter. New deionizing and filtration cartridges are installed if purity falls below 10 megohm/cm.

11.4.8 Ammonia Meter

The ammonia meter is calibrated daily (when in use) with a two-point calibration curve bracketing the expected ammonia concentration values. If initial calibration does not generate an acceptable slope, an internal calibration is performed as described in the manual. If the required slope is still not achieved after changing fluid in the probe, the meter is serviced. Calibration and service information are recorded in the appropriate log books.

11.4.9 Light Meter

The light meter is serviced and calibrated by a professional light calibration organization on an annual basis.

11.4.10 Autoclave

The effectiveness of sterilization by autoclave is checked monthly using *Bacillus stearothermophilus* self-contained, biological indicator spore tests. The autoclave is always packed so as not to inhibit proper flow of air throughout the chamber. Cultures and laboratory discard are not autoclaved in the same run as media. A log is kept of all autoclave runs, including date, technician's initials, items sterilized, time in and out, cycle time, temperature, and indication of fast or slow exhaust. Autoclave timing is calibrated quarterly against a separate measuring device, and results recorded.

11.4.11 Microscopes

Compound and dissecting microscopes are serviced (cleaned and calibrated) on an annual (bioassay) or biannual (benthic) basis by a professional microscope service organization. Certificates of calibration are kept on file.

11.5 Preventive Maintenance

Preventive maintenance is defined as an orderly program of positive actions for preventing failure of equipment and ensuring that the equipment is operating with the reliability required for quality results. The actions include specification checks, calibrating, cleaning, lubricating, reconditioning, adjusting, and checking.

A preventive maintenance program for the instrumentation ensures fewer interruptions of analyses, personnel efficiency, and lower repair costs. It eliminates premature replacement of parts and reduces discrepancy among test results. It increases reliability of results.

The following preventive maintenance program has been established:

1. Each type of equipment/instrument has a written SOP that describes the methods for routine inspection, cleaning, maintenance, testing, calibration, and/or standardization of the equipment. Instrument operating manuals are kept near the instrument or where analysts have easy access.

2. Analysts using the instruments are properly trained and have developed troubleshooting skills that will enable them to recognize problems, their causes, and appropriate corrective actions, quickly and accurately to reduce equipment failure and reduce dependence upon outside servicing agencies. In complicated cases, the servicing agency or supplier is called to solve the problem.

3. Written equipment records are kept to document all inspection, maintenance, troubleshooting, calibration, or modifications. The records contain the date, description of the maintenance done, the actual findings, and the name of the person doing the maintenance.

4. Performance criteria are established for judging when data from instrument performance checks indicate the need to make adjustments in the instrument operating conditions.

The Laboratory Manager is responsible for implementing the preventive maintenance program.

12.0 Assessment of Precision and Accuracy

Following are the procedures recommended for evaluating the precision and accuracy of all environmental measurement data generated for a project. Many freshwater bioassessment projects may not require the quality control samples described in this section, but it is included to provide guidance for projects that may require additional water chemistry measurements. Quality control sample analyses are performed as appropriate for sample analyses as discussed in Section 11.0. The protocol used will be in accordance with specific analytical procedures.

12.1 Field QA/QC Samples

Equipment rinseates and field blanks are analyzed for parameters similar to samples associated with these QA/QC samples. Field QA/QC samples provide a mechanism to determine sampling precision as well as whether contamination was introduced into the sample during the field operations or transportation to the laboratory.

12.1.1 Field Duplicate

Samples are collected in duplicate from selected locations and analyzed as a check on field collection technique and sample variability (homogeneity). The duplicate samples are submitted to the laboratory with a unique sample number in a manner such that it will not be readily identified as a duplicate. Results from duplicate samples are used to calculate RPD and assess the precision of the sampling effort.

12.1.2 Equipment Rinseate

Equipment rinseates are taken by filling the decontaminated sampling equipment with deionized water and collecting a sample of the water. The presence of any parameters indicates possible field contamination or incomplete sample collection equipment cleaning, in-between sampling. There may be carry over contamination from a highly-contaminated sampling location to another location, if not properly cleaned. If the equipment blank is contaminated, the associated samples collected (before and after the blank) are evaluated for the presence of the same parameter(s) and levels.

12.1.3 Field Blank

Field blanks are prepared by collecting a sample of deionized water at the time of sampling. This deionized water is from the same source as the deionized water used in the final rinse during decontamination procedures. The field blanks are handled and analyzed in the same manner as environmental samples. Because field blanks and environmental samples are collected under the same conditions, field blank analyses are used to indicate the presence of external contaminants that may have been introduced into samples during collection. Field blanks also may become contaminated during transport, but this may be assessed by the simultaneous use of trip blanks. Field blank results are evaluated for high readings. If high field blank readings are encountered, the procedure for sample collection, shipment, and laboratory analysis should be reviewed. If both the reagent and/or method blanks and the field blanks exhibit significant background contamination, the source of contamination is probably within the laboratory.

12.2 Chemistry QA/QC Samples

The specific types, frequencies, and processes for QC sample analyses are described in detail in method-specific SOPs. These sample types and frequencies have been adopted for each method and a definition of each type of QC sample is provided below.

12.2.1 Analytical Batch

The basic unit for analytical QC is the analytical batch. All the samples in a batch, both field samples and QC samples, are to be handled and processed in exactly the same way.

12.2.2 Method Blank

The method blank is either analyte-free water or analyte-free soil, subjected to the entire analytical process. The method blank is analyzed to demonstrate that the analytical system itself is not contaminated with the analyte(s) being measured. One method blank is analyzed per batch of samples (not to exceed 20 samples). The method blank consists of a sample of American Society for Testing and Materials (ASTM) type II water, which is processed following the same analytical procedure as the field-collected samples. This sample is used to detect the presence and magnitude of contamination or other anomalies resulting from preparation and analytical procedures. The method blank results should be below the Method Reporting Limit (MRL) for the analyte(s) being tested. A method blank is processed and analyzed with each analytical batch in order to monitor potential contamination resulting from laboratory solvents, reagents, glassware, and processing procedures.

The method blank results are evaluated for high readings characteristic of background contamination. If high blank values are observed, laboratory glassware, air, and reagents are checked for contamination, and the analysis halted until the system is brought under control. A high background is defined as a background value sufficient to result in a difference in the sample value.

12.2.3 Blank Spike or Laboratory Control Sample

A laboratory control spike (blank spike) sample is processed and analyzed to observe the accuracy of the analytical procedure in recovering selected compounds within a compound class of interest. One blank spike is prepared and analyzed for each batch of samples (not to exceed 20 samples). The blank spikes is prepared by spiking a known amount of an analyte representative of the compound class of interest in a sample of ASTM type II water. The blank spike is then carried through the same analytical procedure as the field-collected samples. The percent recovery of the spiked compound is used to determine if the laboratory process is within acceptable control limits, which is an indication of the accuracy of the method.

12.2.4 Matrix Spike/Matrix Spike Duplicate

One MS/MSD is prepared and analyzed for every 20 samples. Matrix spiked samples are aliquots of samples to which a known amount of the target analyte (or analytes) has been added. The samples are then prepared and analyzed in exactly the same manner as the field-collected samples. The stock solutions used for spiking the sample(s) are purchased and prepared independently of calibration standards. The spike recovery measures the effects of interferences caused by the sample matrix and reflects the accuracy of the method for the particular matrix in question. Spike recoveries are calculated as follows:

$$Recovery\ (\%) = \frac{cf - co}{cs}\ x\ 100$$

Where: cf = The observed concentration of analyte in the spiked sample;
co = The analyte concentration in the original sample; and
cs = The theoretical concentration of analyte added to the spiked sample.

The MSD sample is a duplicate of the MS sample. The percent recovery of the spiked compound is used as an indication of accuracy and appropriateness of the method for the matrix tested. Duplicates are additional replicates of samples that are subjected to the same preparation and analytical scheme as the original sample. Depending on the method of analysis, either a duplicate analysis (and/or a matrix spiked sample) or MS/MSD are analyzed. The relative percent difference between duplicate analyses or between an MS and MSD is a measure of the batch precision for the given method.

If the observed recovery of the spike accuracy and/or precision values exceeds the acceptance criteria for the given parameters, the sample set may be reanalyzed for the parameter in question.

12.2.5 Calibration Blank

Calibration blanks are prepared along with calibration standards in order to create a calibration curve. Calibration blanks are free of the analyte of interest, and provide the zero point of the calibration curve.

12.2.6 Continuing Calibration Blank

Continuing calibration blanks are solutions of either analyte-free water or solvent that are analyzed in order to verify the zero point of the analytical system. The frequency of CCB analysis is either once every 10 samples, or as indicated in the method, whichever is greater.

12.2.7 Calibration Standard

Calibration standards are solutions of known concentration prepared from primary standard solutions, which are, in turn, prepared from stock standard materials. Calibration standards are used to calibrate the instrument response with respect to analyte concentration. The calibration curve is evaluated to determine linearity through its full range and to verify that sample values are within the range defined by the low and high standards. If the curve is nonlinear, sample concentrations are plotted on a graph or an appropriate algorithm is used to fit a nonlinear curve to the standard. Standards are analyzed in accordance with the requirements stated in the particular method being used.

12.2.8 Continuing Calibration Verification Standard

Continuing calibration verification standards are midrange standards that are analyzed in order to verify the calibration of the analytical system. The frequency of analysis is either once every 10 samples, or as indicated in the method, whichever is greater.

12.2.9 Duplicate Sample Evaluation

Duplicate sample analysis for the sample set is used to determine the precision of the analytical method for the sample matrix. The duplicate results are used to calculate the precision as defined by the RPD or coefficient of variation. If the precision value exceeds the acceptance criteria for the given parameter in question, the sample set may be reanalyzed for the parameter in question. Attainable precision limits will be specified and updated periodically following review of data.

13.0 Corrective Action Plans

An out-of-control event is defined as any occurrence failing to meet pre-established criteria. A nonconformance is a deficiency in characteristic, documentation, or procedure sufficient to make the quality indeterminate or unacceptable. An out-of-control event is a subcategory of nonconformance.

When either situation is identified, it will be categorized as:

Deficiency: Recognition of a specific requirement (e.g., program, process, or procedure) that has been violated.

Observation: Recognition of an activity or action that might be improved but is not in violation of a specific requirement. Left alone, the activity or action may develop into a deficiency.

13.1 Criteria Used for Determination of an Out-of-Control Event

Factors that affect data quality (failure to meet calibration criteria, inadequate recordkeeping, improper storage, or preservation of samples) require investigation and corrective action.

When a nonconformance is recognized, each individual involved with the analysis in question has an interactive role and responsibility. These are as follows:

- **Technician:** He/She must be able to recognize nonconformances and immediately notify the Laboratory Manager and work with the Quality Assurance Officer to solve the problem. Each technician is responsible for documenting and correcting problems that might affect quality.

- **Laboratory Manager:** He/She must review all analytical and QC data for reasonableness, accuracy, and clerical errors. In an out-of-control event, the Laboratory Manager works with the analyst and Quality Assurance Officer to solve the problem and prevents the reporting of suspect data by stopping work on the analysis in question and insuring that all results that are suspect are repeated, if possible, after the source of the error is determined and remedied. Clients are notified in writing when their work is affected by an out-of-control event or results of an internal audit. In the event that a QC measure is out-of-control and the data are to be reported, qualifiers are reported together with sample results.

- **Quality Assurance Officer:** In the event that an out-of-control situation occurs that is unnoticed at the bench or supervisory level, the Quality Assurance Officer will notify the Laboratory Manager; help identify and solve the problem where applicable; ensure the work is stopped on the analysis; and verify that no suspect data are reported. The Quality Assurance Officer must review and approve all corrective action reports and submit them to the Laboratory Manager for review. The Quality Assurance Officer is responsible for reviewing nonconformance report forms, recommending or approving proposed corrective actions, maintaining an up-to-date nonconformance log, and verifying that corrective actions have been completed.

13.2 Procedures for Stopping Analysis

Whenever the analytical system is out-of-control, investigation and correction efforts are initiated by all concerned personnel as outlined in Table 13.1.

If the problem is instrumental or specific only to preparation of a sample batch, samples are reprocessed after the instrument is repaired and recalibrated.

13.3 Corrective Action

The need for corrective action comes from several sources: equipment malfunction; failure of internal QA/QC checks; failure of follow-up on performance or system audit findings; and noncompliance with QA requirements.

When measurement equipment or analytical methods fail QA/QC requirements, the problems will immediately be brought to the attention of the Laboratory Manager and Quality Assurance Officer. Corrective measures to be taken will depend entirely on the type of analysis, the extent of the error, and whether the error is determinant or not. The corrective action to be taken is determined by either the Laboratory Manager, technicians, the Project Manager, and the Quality Assurance Officer or by all of them in conference, if necessary; but final approval is the responsibility of the Quality Assurance Officer and/or Project Manager.

If failure is due to equipment malfunction, the equipment will not be used until repaired; precision and accuracy will be reassessed, and the analysis will be rerun. All attempts will be made to reanalyze all affected parts of the analysis so that in the end, the product is not affected by failure of QC requirements.

When a performance audit detects deficiencies, the auditor will identify the problems and the laboratory will implement corrective action within 30 days of receiving the audit report or the next time the procedure is performed, whichever occurs sooner. Follow up audits to verify the completion and success of the corrective action should be conducted within 30 days. A step-by-step analysis and investigation to determine the cause of the problem shall take place as part of the corrective action program. If the problem cannot be controlled, the laboratory will analyze the impact on the data. Clients will be notified if their data are affected.

When a system audit reveals an unacceptable performance, work shall be suspended until corrective action has been implemented and performance has been proven to be acceptable.

If an external audit (system or performance) report identifies deficiencies that require corrective action, the Quality Assurance Officer shall notify the responsible supervisor and log the pertinent information. The Quality Assurance Officer and the responsible supervisor shall assure that corrective action is taken. The Quality Assurance Officer shall verify that the problem has been corrected. The Laboratory Manager shall transmit the response to the external organization, with copies to the Quality Assurance file.

Table 13.1: Laboratory Corrective Action Plan for Potential Analytical Problems

	Problems in Lab Area	Actions to be Taken
A.	**Sample Receipt, Log-in, and Labeling**	
1.	Sample containers received broken	Notify Laboratory Manager
2.	Sample cannot be located	Notify Laboratory Manager
3.	Samples received without proper refrigeration of preservation	Notify Project Manager
4.	Illegible sample numbers or label missing from sample containers	Notify Project Manager
5.	No instructions received with samples	Notify Project Manager
6.	Shipment container received damaged upon arrival	Notify Laboratory Manager
7.	Chain-of-custody document does not match information indicated on sample label and containers received	Notify Laboratory and Project Managers
8.	Samples received past the holding time requirement	Notify Project Manager
B.	**Sample Refrigeration and Preservation**	
1.	No indication on the chain-of-custody or sample container that the sample was preserved	Notify Project Manager
2.	Discovery of sample storage (i.e., refrigeration) malfunction	Notify Laboratory and Project Managers
C.	**Analytical Method**	
1.	If at anytime you are not in agreement with the method to be used or some portion of the method	Notify Laboratory Manager
D.	**Sample Preparation**	
1.	Loss of sample	Notify Laboratory Manager
2.	Knowledge of making a mistake in analysis	Notify Laboratory Manager
3.	Calibration mistake	Notify Laboratory Manager
E.	**Storage**	
1.	Label or labels have come off of the storage container	Notify Laboratory Manager
F.	**Standard Preparation**	
1.	Doubt as to the purity of the standard material	Notify Laboratory Manager
2.	Question whether standard (stock or working) is "too old" (expired)	a. Check expiration of the standard if available; if not, check SOP on standard expiration. b. Notify Laboratory Manager
G.	**Instrument Analysis**	
1.	Blank or reference are out-of-compliance	a. Check instrument operating condition b. Do corrective maintenance c. Reanalyze affected samples as necessary
H.	**Data Review**	
1.	The recovery of material from spiked sample is not within the limits set prior to analysis (e.g., outside control chart limits)	a. Notify Laboratory Manager b. Check standard solutions c. Check instrument performance d. If no explanation, reprepare and reanalyze QC and affected samples
2.	The data are contrary to that expected (historical background does not agree)	Notify Laboratory and Project Manager

All incidents of QA failure and corrective action tasks will be documented, and reports will be placed in the appropriate contract file. Also, corrective action will be taken promptly for deficiencies noted during the spot-check of raw data. When corrective actions are implemented, evidence of correction of deficiencies will be presented. Corrective action documentation will be forwarded to the Quality Assurance Officer and the Project Manager for evaluation and approval.

13.4 Procedures for Preventing Unauthorized Amendment of Computer Records

To protect the integrity of finalized electronic reports, certain steps have been implemented to prevent the unauthorized alteration of these documents. The primary security measure is that all Weston computer workstations are password protected to ensure that only authorized personnel are allowed access to electronic files. Workstations revert to a timed lockout after 15 minutes of inactivity and require the reentry of a password to regain access to the computer. Weston's computer system requires passwords to be changed on each computer every 90 days.

Upon completion of reports and delivery to client, electronic reports will be transferred to a secure folder accessible to limited personnel and password protected. This folder will be called Finalized Reports and include the respective year (i.e., 2003). The act of transferring the final electronic report to this secure status will take place immediately after delivery of report to the client. Personnel authorized to perform this duty and thus have access to the password will be the Data Management Director, Quality Assurance Officer, Laboratory Manager, and Assistant Laboratory Manager. Authority for the transfer of files from an unsecured to a secure format after project completion is the responsibility of the Laboratory Manager. In the event that revisions are made to the finalized report to be delivered to the client those revisions will be properly identified in the report and the report identified as a "second" version. The revision date and version number will be noted on the report and it will be saved accordingly as a separate file from the original document.

Electronic files are periodically saved at an off-site facility. This allows recovery of data in the event of a catastrophic failure at the corporate facility.

13.5 Documenting Corrective Action

If, at any time during analyses, a process is out-of-control, corrective action shall be taken, and documented, with regard to:

- What actions were taken to bring the process back into control
- What actions were taken to prevent recurrence of the out-of-control situation
- What was done with the data obtained while the process was out-of-control

This is accomplished by filling out a corrective actions form (Figure 13.1). This form is initiated either by the Laboratory Manager or the Quality Assurance Officer depending on where the problem is recognized. The report will include the following information:

- Nature of the problem
- Sample lot affected
- Corrective action measure(s) taken and final resolution of the problem
- Dates (date recognized, date occurred, date corrected)
- Signature of the Quality Assurance Officer, Project Manager, Reporter, and Laboratory Manager.

13.6 Field Corrective Action

The initial responsibility for monitoring the quality of field measurements lies with the field personnel. The Field Supervisor is responsible for verifying that all QC procedures are followed. This requires that the Field Supervisor assess the correctness of the field methods and the ability to meet QA objectives and make a value judgement regarding the impact a procedure has upon the field objectives and subsequent data quality. If a problem occurs that might jeopardize the integrity of the project, cause a QA objective not to be met, or impact data quality, the Field Supervisor will immediately notify the Project Manager. Corrective action measures are then decided upon and implemented. The Field Supervisor documents the situation, the field objective affected, the corrective action taken, and the results of that action. Copies of the documentation are provided to the Project Manager and the Quality Assurance Officer.

13.7 Complaints

Following submission of reports, it is Weston’s policy to follow-up with clients to be certain they have received all deliverables and their expectations have been met. If a complaint is received that concerns the quality of data received, the Quality Assurance Officer shall promptly audit that area of the laboratory. Documentation of the complaint, the audit, and subsequent activities shall be maintained.

CORRECTIVE ACTION

Job Number/Project:______________________________

Procedure:________________________________ Prepared by:________________________

Description of problem encountered:

Samples affected (Sample ID):

Date Recognized:____________________ By:___________________________________

Date Occurred: _____________________ By:___________________________________

Date Corrected: _____________________ By:___________________________________

Reported to:____

Description of corrective/preventive action taken to remedy problem:

Notification and approval of final corrective action (signatures):

Reporter:____ Date:_________________________

Lab Manager:______________________________________ Date:_________________________

QA Officer:_______________________________________ Date:_________________________

Program Manager:__________________________________ Date:_________________________

Follow up audit date: ______________________________Performed by: _________________

Problem corrected: ___ Yes ___ No

Corrective action affective: ___Yes ___ No

COMMENTS:____

Figure 13.1: Corrective Action form.

14.0 Quality Assurance Reports to Management

14.1 Scope

On an annual basis, the results of the quality assurance program are reported to management. Reports to be included are results of internal and external audits, corrective action reports, performance evaluation sample acceptability results, client feedback, and other information. Management reviews the quality system to evaluate its effectiveness and any areas for improvement.

14.2 Preparation of Quality Assurance Report

During the first quarter of the calendar year, the Quality Assurance Officers will prepare a summary of findings with regard to various quality assurance measures from the previous calendar year.

Audit Findings: A report will be prepared to summarize findings for all internal and external audits conducted during the calendar year.

Corrective Action Findings: A report will be prepared to list non-conformances, date of occurrence, and effectiveness of corrective action taken.

Performance Evaluation Sample Acceptability: A report will be prepared to list the results for performance evaluation samples and their acceptability.

Protocol Deviations: A report will be prepared to organize and list protocol deviations from key procedures.

Reference Toxicant Tests: Results of reference toxicant tests for key procedures will be summarized.

QA Manual: Any revisions to the Quality Assurance Manual will be summarized.

Client/Staff Feedback: Feedback from clients or staff performing tests will be organized and summarized.

Overall Findings and Recommendations: Information from each of these reports will be reviewed and evaluated. Trends and consistent findings will be reported. Major findings that have the potential to affect test results, if not corrected, will be highlighted. A report of overall findings will be prepared, with each of the smaller reports included as appendices. The Quality Assurance Officers will make recommendations for improving the quality of the laboratory's performance and for addressing client or staff concerns.

Management Review: Management will review the Report on Overall Findings and Recommendations. They will provide a written response to the report during the second quarter. Decisions as to appropriate actions will be at the discretion of Management.

14.3 Records

Reports on Overall Findings and Recommendations as well as the Managers' Response will be maintained by the Quality Assurance Officer.