A. Project Management

1. Title and Approval Sheets

Quality Assurance Project Plan

For

The County of San Diego's Dry Weather Monitoring Program and MS4 Program

August, 2009

County of San Diego
Watershed Protection Program
Department of Public Works

APPROVALS SIGNATURES

Title:	Name:	Signature:	Date*:
Project Manager	Jo Ann Weber		9/14/2010
QA Officer	Joanna Wisniewska		9/16/2010
Laboratory QA/QC Manager	Norman Hester		
Laboratory Project Coordinator	Jeff Lee		

** This is a contractual document. The signature dates indicate the earliest date when the project can start.*

QUALITY ASSURANCE PROJECT PLAN
For the County of San Diego's
Dry Weather Monitoring Program and MS4 Program

Prepared by
Joanna Wisniewska

County of San Diego
Watershed Protection Program
Department of Public Works

Revision 8 - August 2009

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3. Distribution List

Table 1: QAPP Distribution List

Title:	Name	Tel. No.:
Environmental Health Specialist Supervisor, Project Manager	Jo Ann Weber	(858) 495-5317
Environmental Health Specialist III,	Joanna Wisniewska	(858) 694-2312
Environmental Health Specialist II	Steven DiDonna	(858) 694-2332
Environmental Health Specialist II	Ken Liddell	(858) 694-2335

B. Project/Task Organization

4. Involved Parties and Roles

The Science and Monitoring Group is part of the Watershed Protection Program in the County of San Diego Department of Public Works. This group:

- Provides trained water quality staff for field observations, field measurements, and water sample collections for laboratory analysis
- Conducts investigations of illicit connections and illegal discharges (IC/IDs).
- Refers any identified IC/IDs to appropriate entities for proper education and/or enforcement.
- Performs data quality assurance and quality control (QA/QC) practices.
- Provides a central location for data reporting and analysis.
- Integrates monitoring results into watershed water quality assessments.

4.1 Monitoring Group Supervisor and Project Manager (Jo Ann Weber)

- Provides overall program coordination, including monitoring design, management, and implementation.
- Provides technical advice on IC/ID investigations, monitoring program designs and data analysis
- Reports and forwards all IC/ID investigation referrals to other groups

4.2 Field Staff

- Suggest addition and deletion of monitoring sites within a watershed.
- Conduct watershed monitoring sampling and assist in other watersheds as needed.
- Download and label photos of monitoring sites to designated folders.
- Transcribe field datasheet entries to the database.
- Calibrate and maintain field equipment.
- Follow sample collection procedures.
- Follow record keeping procedures.
- Follow monitoring project sampling plans.
- Conduct IC/ID investigations as needed
- Deliver samples to the laboratory.

Additional Duties:

4.2.1 Steve DiDonna

- Oversee all aspects of contractor (D-Max Engineering) first round sampling
- Conduct IC/ID investigations
- Conduct MS4 Monitoring
- Schedule and conduct the second round of Dry Weather Monitoring sampling
- Furnish and maintain sampling equipment and supplies.
- Manage and maintain database for the Dry Weather and MS4 Monitoring Programs
- Provide GIS support as necessary

4.2.2 Ken Liddell

- Conduct IC/ID investigations
- Conduct MS4 Sampling

- Schedule and conduct the second round of Dry Weather Monitoring sampling
- Maintain County contract with the Truesdail Laboratories, Inc. (schedules sample pick-up times, orders supplies, tracks invoices, etc.)
- Organize and maintain records, documents, and orders
- Review and enter data into the Dry Weather and MS4 Monitoring Database

4.3 Truesdail Laboratories, Inc. (Truesdail)

- Provide trained laboratory personnel to analyze water samples for physical, chemical, and bacteriological properties as designated by WPP.
- Provide review and verification of laboratory analytical data.
- Provide analytical results in hard copy and in electronic format to WPP.
- Manage and oversee subcontracts for any specialty not performed in-house.
- Act as technical resource to the Science and Monitoring Group and the Watershed Protection Program.

4.4 D-Max Engineering

- Conduct first round of Dry Weather Monitoring sampling
- Provide completed field sheets and the results of laboratory analysis in hard copy and in electronic format to WPP
- Notify WPP of any exceedances within 24h of detection
- Manage and oversee subcontracts for any specialty not performed in-house.

4.5 Quality Assurance Officer Role

The QA Officer, Joanna Wisniewska, works independently and is not involved in the collection of samples or the generations of project data. Her responsibilities are:

- Maintain/ update the Quality Assurance Project Plan (QAPP).
- Ensure compliance with the QAPP.
- Carry out validation and verification of field and laboratory data.
- Assign staff to perform routine quality assurance and quality control (QA/QC) of field equipment, field test kits and laboratory control samples.
- Conduct audits of field procedures.
- Conduct audits of equipment calibration and maintenance.
- Review 20% of field data sheets at random.
- Review the routine quality control documentation of laboratory procedures.
- Communicate pertinent QA/QC issues to Truesdail Laboratories, Inc. and D-Max Engineering and assure that any problems are resolved.
- Communicate pertinent QA/QC problems to the field staff and assure that any problems are resolved.
- Submit QA/AC reports to the Project Manager. Reports will include all requests for corrective action.

4.6 Persons Responsible for QAPP Update and Maintenance

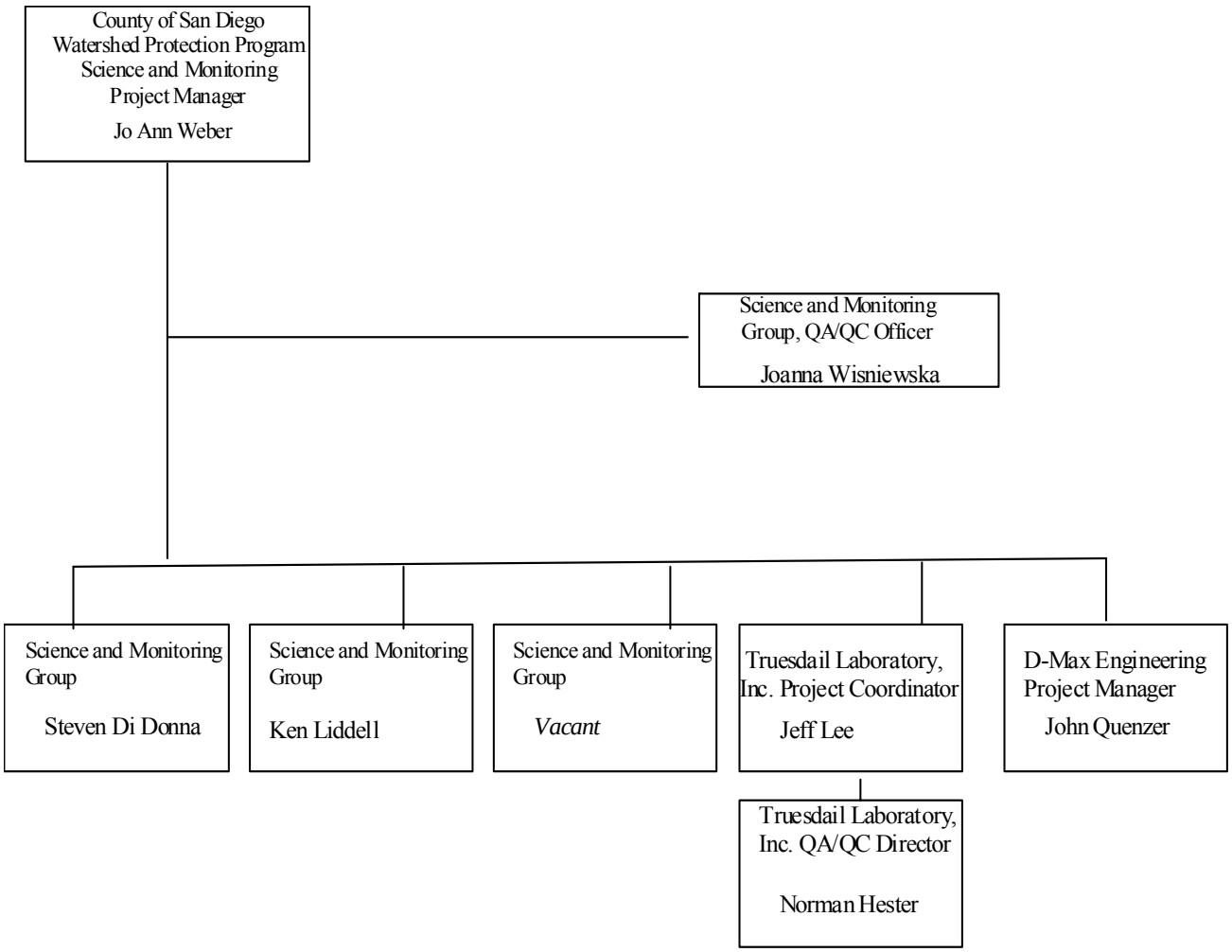
The Quality Assurance Officer reviews and assesses all procedures during the life of the contract against QAPP requirements. Changes and updates to this QAPP may be made after a review of the evidence for change by the Science and Monitoring Group Project Manager and Quality Assurance

Officer. Science and Monitoring Group's Quality Assurance Officer is responsible for making the changes, submitting drafts for review and preparing a final copy.

Table 2. Personnel Responsibilities.

Name	Organizational Affiliation	Title	Contact Information (Telephone Number, fax number, e-mail address)
Jo Ann Weber	County of San Diego, Watershed Protection Program	Project Manager, Supervisor	858-495-5317 858-495-5263 joann.weber@sdcounty.ca.gov
Steven DiDonna	County of San Diego, Watershed Protection Program	Field Staff	858-694-2332 858-495-5263 steven.didonna@sdcounty.ca.gov
Ken Liddell	County of San Diego, Watershed Protection Program	Field Staff	858-694-2335 619-884-8922 ken.liddell@sdcounty.ca.gov
Joanna Wisniewska	County of San Diego, Watershed Protection Program	QA Officer	858-694-2312 joanna.wisniewska@sdcounty.ca.gov
Jeff Lee	Truesdail Laboratories, Inc.	Laboratory Project Manager	714-730-6239 ext 266 lee@truesdail.com
Norman Hester	Truesdail Laboratories, Inc.	Laboratory Manager, QA Director	714-730-6239 714-730-6462 norman@truesdail.com
John Quenzer	D-Max Engineering	Project Manager	858-586-6600 ext. 25 jquenzer@dmaxinc.com

4.7 Organizational Chart and Responsibilities



5. Problem Definition/ Background

5.1 Problem Statement

To protect water quality from degradation that may be caused by urban runoff, San Diego Regional Water Quality Control Board (SDRWQCB) issued the San Diego Region Municipal Storm Water Permit (the Permit), Order No. R9-2007-0001, NPDES No. CAS0108758, as adopted by the California State Water Resources Control on January 24, 2007 (Appendix 5).

5.1.1. Dry Weather Monitoring Program

Section D-4 of Order No. R9-2007-0001 (requires that each Copermittee conduct Dry Weather Field Screening and Analytical Monitoring (Dry Weather Monitoring) of MS4 outfalls and other portions of its MS4 within its jurisdiction to detect illicit discharges and connections in accordance with Receiving Waters and Urban Runoff Monitoring and Reporting Program No. R9-2007-0001. To meet

these requirements, the Science and Monitoring Group of the San Diego County Watershed Protection Program conduct Dry Weather Monitoring of the County's watersheds (Figure 1).

The Dry Weather Monitoring Program is designed to address the illegal discharge of non-storm waters. The overall goal of the program is to identify water quality problems that may be the result of any non-storm water discharges to or from municipal separate storm sewer systems (MS4s). The monitoring focuses on detecting and eliminating illicit connections and illegal discharges (IC/IDs) to the County's MS4s.

The Permit requires that each Copermittee shall conduct dry weather field screening and analytical monitoring at each identified station at least once between May 1st and September 30th of each year. If flow or ponded runoff is observed and there has been at least seventy-two (72) hours of dry weather, observations shall be made and at least one (1) grab sample needs to be collected. Copermittees must record general information such as time since last rain, quantity of last rain, site descriptions (i.e., conveyance type, dominant watershed land uses), flow estimation (i.e., width of water surface, approximate depth of water, approximate flow velocity, flow rate), and visual observations (i.e., odor, color, clarity, floatables, deposits/stains, vegetation condition, structural condition, and biology).

At a minimum, analytical samples of the following constituents need to be collected from at least twenty five percent (25%) of the dry weather monitoring stations where water is present:

- Total Hardness
- Oil and Grease
- Diazinon and Chlorpyrifos
- Cadmium (Dissolved)
- Lead (Dissolved)
- Zinc (Dissolved)
- Copper (Dissolved)
- Enterococcus bacteria
- Total Coliform bacteria
- Fecal Coliform bacteria

At a minimum, field screening analysis needs to be conducted of the following constituents at all dry weather monitoring stations where water is present:

- Specific conductance (calculate estimated Total Dissolved Solids).
- Turbidity
- pH
- Reactive Phosphorous
- Nitrate Nitrogen
- Ammonia Nitrogen
- Surfactants (MBAS)

If the station is dry (no flowing or ponded runoff), applicable observations only need to be recorded.

In addition, copermittees are required to develop and/or update criteria for dry weather field screening and analytical monitoring results whereby exceedance of the criteria will require follow-up investigations to be conducted to identify and eliminate the source causing the exceedance of the criteria.

Beginning in July, 2008, they also need to assess the presence of trash in receiving waters and urban runoff at each dry weather field screening or analytical monitoring station. Assessments of trash shall provide information on the spatial extent and amount of trash present, as well as the nature of the types of trash present. Dry weather field screening and analytical monitoring stations identified to exceed dry weather monitoring criteria for any constituents shall continue to be screened in subsequent years.

Copermittees are required to develop and/or update procedures for source identification follow up investigations in the event of exceedance of dry weather field screening and analytical monitoring result criteria. Procedures to eliminate detected illicit discharges and connections shall also be developed/ updated.

Beginning in fall 2001, initial program development included regular meetings and discussions with the Dry Weather Monitoring Workgroup and the San Diego RWQCB (County of San Diego, 2003). These discussions involved defining site selection criteria, program objectives and detection limits and establishing constituent action levels and field screening and analytical monitoring frequencies. The County's Program incorporates the recommendations of the Dry Weather Monitoring Workgroup and exceeds the minimum recommendation by increasing the number of annual site visits from one to two. This increased effort reflects the County's decision to significantly enhance the Program's overall usefulness to the County Watershed Protection Program.

5.1.2. MS4 Outfall Monitoring

An MS4 outfall monitoring program is also required by the NPDS Permit. The purpose of the program is to characterize pollutant discharges from MS4 outfalls and their relative contributions to the high priority water quality problems identified in the receiving waters during dry and wet weather. This QAPP refers to the dry weather monitoring portion of the MS4 program only. Sixty one (61) MS4 outfalls are monitored as part of this program.

The permit states that the MS4 outfall monitoring program shall at a minimum include collection of samples for those pollutants causing or contributing to violations of water quality standards within the watershed. Therefore, depending on monitoring location, samples of discharges from the MS4 outfalls are analyzed for at least three or more of the following constituents:

- Total Suspended Solids
- Total Dissolved Solids
- Low Dissolved Oxygen
- Total Phosphate-P (Total Phosphate, Orthophosphate)
- Total Nitrogen (Nitrate, Nitrite, TKN, Ammonia)
- Fecal Indicator Bacteria (Total Coliform, Fecal Coliform, Enterococcus)
- Aluminum
- Manganese
- Total Iron
- Total Selenium
- Dissolved Metals (Copper, Zinc, Cadmium, Lead) and Hardness
- Chloride
- Sulfates
- Insecticides (Diazinon, Chlorpyrifos, Malathion)
- pH
- Oil and Grease

Figure 1. San Diego County Watersheds.

5.3 Decisions and Outcomes

All data collected through the Dry Weather and MS4 Outfalls Monitoring Programs are managed and maintained by the Science and Monitoring Group. The data are used by the Science and Monitoring Group to:

- Initiate IC/ID investigations
- Assess the status and trends of water quality conditions within individual watersheds throughout the County
- Characterize pollutant discharges from MS4 outfalls

This will serve to make better and more cost-effective watershed protection and management decisions.

The data will be made available to the public for purposes of water quality education. They will also be made available to the regulatory and resource management agencies to supplement their existing data collection efforts. The information will be shared with the SDRWQCB and, upon request, with other state, federal and local agencies and organizations.

For Dry Weather Monitoring, if and when water quality data from field measurements and/or laboratory analysis exceed (an) established action level(s), an IC/ID investigation is initiated. The action levels for different pollutant concentrations were developed by the Copermittee Monitoring Workgroup in the fall of 2001. Over time, the action levels were readjusted by: the consideration of 90% confidence intervals, the comparison of results to water quality criteria, the use of method detection limits and through the incorporation of the experience of Workgroup participants. Any exceedances of these action levels, and resultant actions/investigations, are summarized in the Annual Jurisdictional Urban Runoff Management Plan Report.

5.4 Dry Weather Monitoring Water Quality or Regulatory Criteria

The action levels employed to initiate IC/ID investigations by the County during the current Dry Weather Monitoring season are summarized in Table 3.

Table 3. Dry Weather Analytical and Field Screening Monitoring Action Levels

Field Screening Analytes	Action Levels	Source	Detection Limit	Reporting Limit
pH	<6.5 or >9.0	Basin Plan, with allowance for elevated pH due to excessive photosynthesis. Elevated pH is especially problematic in combination with high ammonia.	-----	0.5
Orthophosphate-P	2.0 (mg/L)	USEPA Multi-sector General Permit	0.07 mg/L	0.14 mg/L
Nitrate-N	10.0 (mg/L)	Basin Plan and drinking water standards	1.35 mg/L	2.5 mg/L
Ammonia-N	1.0 (mg/L)	Based on Workgroup experience. May also consider unionized ammonia fraction	0.05 mg/L	0.1 mg/L
MBAS	1.0 (mg/L)	Basin Plan, w/ allowance based on Workgroup field experience and possible field reagent interferences	0.13 mg/L	0.25 mg/L
Turbidity	Best Professional Judgment	WQOs relevant to inland surface waters are not available. Base judgment on channel type and bottom, time since last rain, background levels and, most importantly, visual observations (e.g. unusual colors, lack of clarity), and unusual odors.	-----	5 NTU
Temperature	Best Professional Judgment	Base judgment on season, air temperature, channel type, shading, etc.	-----	
Conductivity	Best Professional Judgment	Values > 5,000 ohms/cm may indicate IC/ID however; EC may be highly elevated in some regions due to high-TDS groundwater exfiltration to surface water, mineral dissolution, drought, and seawater intrusion. Normal source ID and discharge elimination work is not effective in these situations. Knowledge of area background conditions is important. Values < 750 may indicate excessive potable water discharge or flushing.	-----	0.5 mS/cm
Laboratory Analytes	**Action Levels**	**Source/ Notes**	**Laboratory Reporting Limits**	
MBAS	1.0 (mg/L)	Basin Plan, w/ allowance based on Workgroup field experience and possible field reagent interferences	0.5 mg/L	
Oil and Grease	15 (mg/L)	USEPA Multi-sector General Permit. If petroleum	5.0 mg/L	

		sheen is observed, the sample should be collected from the water surface. Visual observations may justify immediate investigation.		
Diazinon	0.5 (ug/L)	Response to diazinon and chlorpyrifos levels above 0.5 ug/L should focus on education and outreach to potential dischargers in the target drainage basin. Highly elevated levels should be investigated aggressively as with other potential IC/IDs.	0.05 ug/L	
Chlorpyrifos	0.5 (ug/L)		0.05 ug/L	
Cadmium, dissolved	California Toxics Rule	Use California Toxics Rule Table, 1-hour (CMC) criteria to determine appropriate action level for individual samples. Table provides benchmarks based on hardness and dissolved metals concentration. For example, at ≥400 mg/L hardness the following action levels would apply: Cd - 19 ug/L; Cu - 50 ug/L; Pb - 280 ug/L; and Zn - 380 ug/L.	5 ug/L	
Copper, dissolved	California Toxics Rule		5 ug/L	
Lead, dissolved	California Toxics Rule		5 ug/L	
Zinc, dissolved	California Toxics Rule		20 ug/L	
Total Coliform	50,000 (MPN/ 100 mL)	Action levels are based on upper 90% confidence level of Copermittees 2002 dry weather analytical monitoring data.	20 MPN/100 mL	
Fecal Coliform	20,000 (MPN/ 100 mL)			
Enterococcus	10,000 (MPN/ 100 mL)			

[1]The referenced action levels should not be the sole criteria for initiating a source identification investigation. Dry weather monitoring data should be interpreted using a variety of available information including best professional judgment and within-site and between-site sample variability.

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6. Project/Task Description

6.1 Work Statements and Products

6.1.1 Dry Weather Monitoring

The Urban Runoff Permit requires that each Copermittee conduct analytical and field screening monitoring between May 1st and September 30th of each year. The Copermittees are required to perform field screening at each identified site at least once during the monitoring season. Each Copermittee also needs to collect a grab sample for laboratory analysis at a minimum of 25% of the sites where ponded or flowing water is observed. The County of San Diego has determined that the frequency of field screening is two times for each identified site and the frequency of 25% or more of total sites for analytical monitoring. Monitoring is not conducted during any rain event or within 72 hours of the end of any rain event >0.1 inch. The results of analytical and field screening are analyzed, summarized yearly and discussed in the Dry Weather Monitoring Annual Report.

In addition to the abovemntioned analytical and field screening, a trash assessment is conducted at established dry weather monitoring locations. The Trash Assessment Form (see appendix 16) is completed at each location during each monitoring event. Each of the selected locations is assessed for trash at least once between May 1st and September 30th every year.

IC/ID investigation**s are** initiated when water quality data from field measurements and/or laboratory analysis show an exceedance**(s)** of the established Regional Action Levels (Table 1) for dry weather monitoring. An IC/ID investigation is pursued immediately when visual and/ or field measurement evidence of gross contamination is present at a site (e.g., substantial petroleum sheen, excessive turbidity, extremely high ammonia concentration, evidence of sewage release, etc.) or within 2 business days following the finding. Every attempt is made to identify the pollutant source and provide detailed documentation in order to report the identified IC/ID to the appropriate group for further action. All IC/ID investigations are documented in site reports and forwarded to the Project Manager. All investigations are also summarized in the Annual Jurisdictional Urban Runoff Management Plan Report.

6.1.2. MS4 Outfall Monitoring

The goal of this monitoring program is to characterize pollutant discharges from MS4 outfalls and their relative contributions to the high priority water quality problems identified in the receiving waters. Every year each MS4 outfall is sampled once during an index period beginning 4 weeks following the last significant rainfall (0.2 inches or greater), but after April 30, and ending August 1. No sampling is conducted within 72 hours of any measurable (greater than 0.1 inch) rainfall. Without prior knowledge of rainfall, the default dry index period for this program has been designated from May 1 through August 1. Trash assessment (as described above) is also conducted at the MS4 outfall locations.

6.2 Constituents to Be Monitored and Measurement Techniques

The Science and Monitoring Group monitoring for water quality includes photographic documentation of sample locations, field observations, water sample collection for analytical analysis (if needed), water flow measurements, physicochemical measurements, and field screening tests.

Qualitative field observations are made during each site visit whether or not ponded or flowing water is observed. These observations are intended to provide a general assessment of the site and they include variables like odor, water clarity, the presence or absence of floatable matter, visible deposits / stains, vegetative density and biological status. All field qualitative field observations are recorded on standard Field Data Sheets (Appendix 1).

To provide additional information and documentation of site conditions, each site is photographed. In addition to providing important descriptive information, photographs serve as an official record of site visits; a visual record of the condition of physical structures such as pipes and biological aspects of the surrounding environment. The photographs are also used to assist staff in locating sites on subsequent visits. All photographs are in digital format and are stored in a common directory and fully backed up on a daily basis. All photographs should be properly labeled with site names and the dates on which they were taken.

Flow measurements are conducted at each site where water is flowing. Estimated flow rates are used in pollutant mass loading calculations and to prioritize storm drains for future investigations or to identify significant changes in flow that may be indicative of an illegal release upstream. Since a majority of sample locations lack permanent flow measurement installations, flow is measured using the Global Flow Probe, Model FP101-FP201 (See Appendix 5 for the probe's SOP). If water flow is too slow or the water is too shallow to measure the velocity using the probe the velocity may be estimated by timing the travel of a piece of floating debris (e.g., a leaf). The "apparent" velocity is calculated by dividing the travel distance (feet) by the recorded travel time (second) (See Appendix 5 a more detailed description of different flow measurements methods).

For all Dry Weather Monitoring locations, water physicochemical properties are measured at each site with flowing or ponded water using the Horiba U-10 6-parameter probe (see Appendix 5 for the probe's SOP and calibration procedures). The parameters measured are: pH, conductivity, turbidity, dissolved oxygen (DO), and temperature. If water is deep enough, the probe is placed horizontally on the creek bed, facing upstream. If the water is shallow, a syringe is used to collect water in a beaker to measure the properties. Due to the sampling process involved, DO measurements in a beaker may be different from *in situ* measurements. The concentrations of ammonia (NH_3), nitrate (NO_3^-), and orthophosphate (PO_4^{-3}) are also measured at those sites using CHEMetrics® field test kits (see Appendix 5 for the kits' SOPs). All data are recorded on the Field Data Sheets.

At Dry Weather Monitoring locations, at least 25% of sites with flowing or standing water, analytical samples are collected to test for hardness, methylene blue active substances (MBAS), oil and grease, pesticides (diazinon and chlorpyrifos), dissolved metals (cadmium, copper, lead, and zinc) and bacteria indicators (total coliform, fecal coliform, and *enterococcus*).

At MS4 outfall locations, analytical samples are collected to test for target analytes only. Each MS4 location has a designated list of target analytes that is based on a previously identified list of constituents of concern.

Methods used to measure all above-mentioned parameters are summarized in Table 4.

Table 4. Constituents to be Monitored and Corresponding Analytical Methods

Dry Weather Monitoring		
Constituent	**Analytical Method**	**Notes**
pH	Collected in Field	Horiba Multiparameter Water Quality Instrument
Conductivity		

Dry Weather Monitoring		
Constituent	**Analytical Method**	**Notes**
Temperature		
Dissolved Oxygen		
Salinity		
Turbidity		
Ammonia	Field Colorimetric	CHEMetrics® color wheel comparator
Nitrate	Field Colorimetric	CHEMetrics® Multi-Analyte Photometer
Ortho-Phosphate		
Methylene Blue Active Substances (MBAS)	SM 5540 C; Field test kit	Chloroform extraction (for laboratory samples); CHEMetrics® Visual Kit
Total Hardness	EPA 130.2, EPA 200.7, SM 2340 B	Titrimetric / by Calculation
Cadmium, Dissolved	EPA 6010, EPA 200.7, EPA 200.8	Inductively Coupled Plasma Mass Spectrometery
Copper, Dissolved		
Lead, Dissolved		
Zinc, Dissolved		
Diazinon	EPA 8141, EPA 8081	Gas chromatography
Chlorpyrifos		
Malathion		
Total Coliform	SM 9221 C	Multi Tube Fermentation Two additional dilutions made to extend quantification range to include sewage.
Fecal Coliform	SM 9221 C	
Enterococcus	SM 9230 B	
MS4 Outfall Monitoring		
Constituent	**Analytical Method**	**Notes**
Total Dissolved Solids (TDS)	SM 2540C	
Total Suspended Solids (TSS)	SM2540D	
Low Dissolved Oxygen	Measured in the Field	Horiba Multiparameter Water Quality Instrument
Phosphate as P	EPA 365.3	
Orthophosphate as P	EPA 365.2	
Total Phosphate as P (Total Phosphate, Orthophosphate)	Calculation	
Nitrate as N	SM4500NO3E	
Nitrite as N	SM4500NO2B	
Total Kjeldahl Nitrogen (TKN)	Calculation	
Total Nitrogen (sum of TKN, Nitrate as N, and Nitrite as N)	SM4500C	
Ammonia	SM4500D	
Total Coliform	SM 922B	Membrane filtration techniques SM9222B, SM9222D, SM9230C and other approved wastewater methods for Bacteria are acceptable
Fecal Coliform	SM 922E	
Enterococcus	SM 9230	
Aluminum		
Total Manganese	EPA 200.8	Inductively Coupled Plasma Mass Spectrometery
Total Iron (Fe)	EPA 200.8	

Dry Weather Monitoring		
Constituent	**Analytical Method**	**Notes**
Total Selenium (Se)	EPA 200.8	
Dissolved Copper (Cu)	EPA 200.8	
Dissolved Manganese	EPA 200.8	
Dissolved Lead (Pb)	EPA 200.8	
Dissolved Zinc	EPA 200.8	
Dissolved Cadmium	EPA 200.8	
Total Hardness	SM 2340B	
Chloride	SM 4500 Cl C	
Sulfate	SM 4500 SO4 E; EPA300	
Chlorpyrifos	EPA 625	
Malathion	EPA 625	
Diazinon	EPA 625	
pH	Measured in the Field	Horiba Multiparameter Water Quality Instrument
Oil and Grease (O&G)	EPA 1664	

6.3 Project Schedule

Table 5 details the project schedule for the Dry Weather and MS4 Outfall Monitoring, including start and end dates of major tasks, required deliverables and their corresponding due dates. The Dry Weather Monitoring is conducted from May 1 to September 30 of each year. MS4 Outfall Monitoring begins 4 weeks following the last significant rainfall (0.2 inches or greater), but after April 30, and it ends on August 1.

Table 5. Project Schedule and Deliverables

Activity	Date		Deliverable	Deliverable Due Date
	Anticipated Date of Initiation	Anticipated Date of Completion		
Identify or modify sampling locations	03/01/09	04/30/09	List of Monitoring Sites	***04/30/09***
Modify Dry Weather and MS4 Analytical and Field Screening Monitoring Procedures Manual	03/01/09	04/30/09	Updated Procedures Manual	***04/30/09***
QAPP Preparation	01/01/09	05/01/09	QAPP	***05/01/09***
MS4 Outlet Monitoring	5/1/09	8/1/2009	MS4 Outfall Monitoring Annual Report	12/31/2009
Dry Weather Water Quality Monitoring	05/01/09	09/30/09	Dry Weather Monitoring Annual Report	12/31/09

6.4 Geographical Setting

The Science and Monitoring Group is responsible for monitoring in the unincorporated areas of the County of San Diego (Figure 2). The unincorporated areas of the County cross over eight watershed management areas; these are Santa Margarita River, San Luis Rey River, Carlsbad Management Area, San Dieguito River, San Diego River, Sweetwater River, Otay Watershed, and Tijuana Watershed.

6.5 Constraints

The Dry Weather Monitoring is conducted from May 1st till September 30th and is not carried out during rain or within 72 hours since the end of any rain event exceeding 0.1 inch. This monitoring program is designed to monitor urban runoff that may be impacted by illicit discharges and illicit connections.

Dry weather MS4 sampling is conducted from May 1 (but at least 4 weeks after a 0.2 inch or greater rainfall) through August 1 not including any periods less than 72 hours after a rainfall of 0.1 inch or greater.

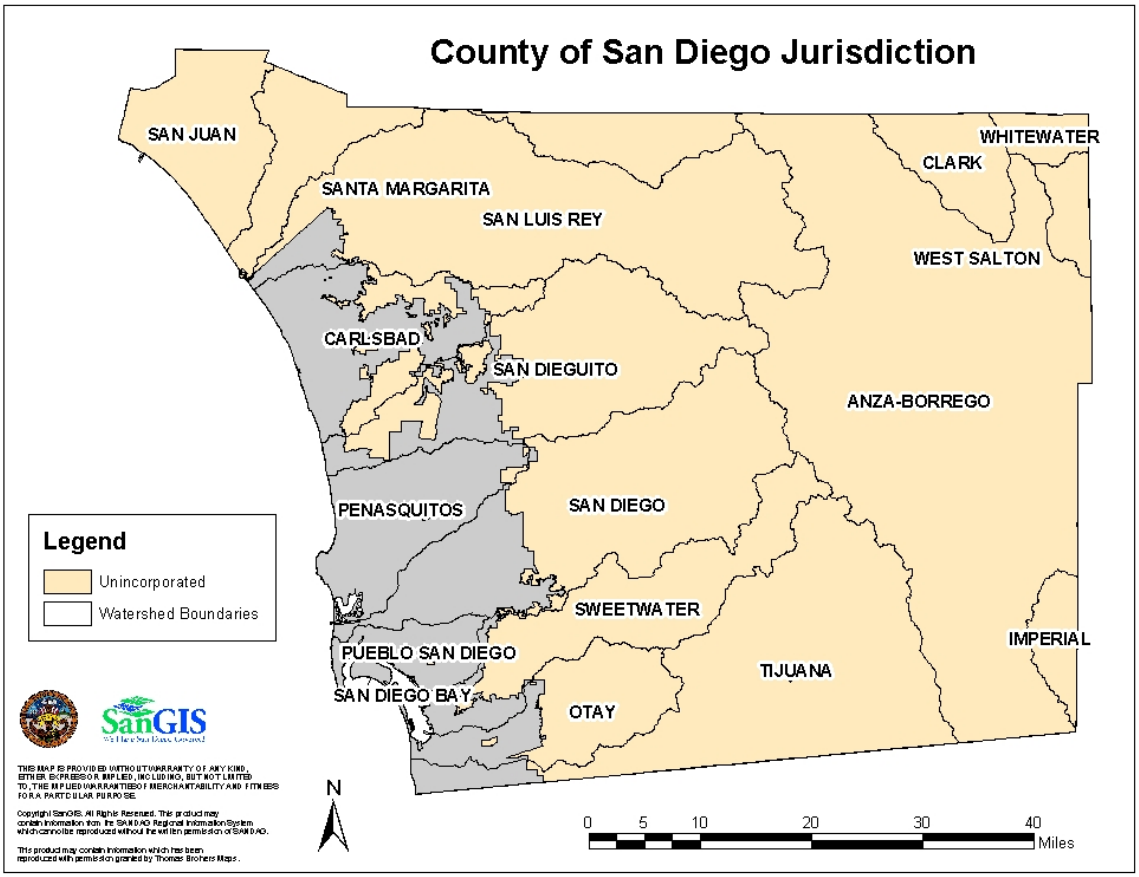

Figure 2. Unincorporated areas of San Diego County subject to the Dry Weather and MS4 Outfall Monitoring.

7. Quality Objectives and Criteria for Measurement of Data

7.1. Data Quality Definitions

7.1.1. Precision

Precision is the degree of mutual agreement among replicate analyses of a sample or standard. The precision is determined with replicate analysis of the same sample or a sample of known analyte concentration (standard sample). It is calculated as the relative standard deviation (% RSD):

$$\%RSD = \frac{s}{\overline{X}} \times 100$$

Where *s* is the standard deviation and $\overline{X}$ is the mean of repeated samples.

Where duplicate samples are used to estimate precision, the Relative Percent Difference (RPD) between the two samples is calculated using the following formula:

$$\text{RPD} = \frac{|x1 - x2|}{((x1 + x2)/2)} \times 100$$ where $x1$ and $x2$ are sample duplicates

7.1.2. Accuracy and Recovery

Accuracy is the degree of agreement between an observed value and a "true" value or an accepted reference (e.g., standard). The accuracy is evaluated by analyzing samples of known concentration (standard sample) or by adding a known concentration of the analyte of interest to field-collected samples (spiked sample). When a standard is used, the accuracy is calculated by comparing the known value to the measured value. When a spiked sample is used, the accuracy is obtained by comparing the added (known) amount against the measured amount. The accuracy is usually expressed as percent recovery (% R).

$$\%R = \frac{\text{Measured value}}{\text{Known value}} \times 100$$

The measured value may be the mean of several replicate analyses of a spiked sample/standard.

7.1.3. Method Detection Limit and Reporting Limit

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. MDLs must be established as defined in 40 CFR Part 136, Appendix B. Reporting limit (RL) or practical quantitation limit (PQL) is the lowest level achievable among laboratories within specified limits during routine laboratory operations. The RL (PQL) is about five times the MDL and represents a practical and routinely achievable detection level with a relatively good certainty that any reported value is reliable. Values less than the MDL are reported as not detected (ND) or <[value of MDL]. Values greater than the MDL and less than the QAPP listed RL are qualified with the "J" character as estimates. Values greater than the RL are reported without qualification unless required because of other QC related issues.

7.1.4. Completeness

Completeness is the percentage of actual measurements that are judged to be valid, over the planned overall measurements. An invalid measurement would be one that does not meet the sampling method requirements and the data quality objectives. Accidental or inadvertent loss of samples during transport or lab activities leads to the loss of original samples, resulting in irreparable loss of data. Percent completeness (%C) for measurement parameters is defined as follows:

$$\%C = V/T \times 100$$

where V is the number of measurements judged valid and *T* is the planned number of measurements. US EPA recommends that monitoring programs should try to achieve a level of completeness in which no less than 95 percent of samples are judged to be valid. This QAPP requires 90% completeness.

7.2. Data Quality Objectives for Field Measurements

Water pH, conductivity, turbidity, dissolved oxygen, and temperature are measured *in situ* using the Horiba U-10 6-parameter probe. The data quality objectives for these parameters are summarized in table 6 and the MDLs are listed in Table 9.

The precision (expressed as % RSD) is determined as follows: After calibration using two standard solutions, the probe is used to measure a third standard solution to obtain multiple readings. The accuracy for each parameter (expressed as % R) is calculated by measuring the standard against its respective known value. The "true" value of temperature for the standard can be obtained by using a calibrated standard thermometer.

Table 6. Data Quality Objectives for Field Measurements

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Field Testing	Dissolved Oxygen	± 20%	± 5%	NA	NA	90%
Field Testing	pH	± 0.2 units	± 0.2 units	NA	NA	90%
Field Testing	Specific Conductivity	± 2 µS/cm	± 10% or ± 10 µS/cm, whichever is greater	NA	NA	90%
Field Testing	Temperature	± 0.5 °C	± 0.5 °C	NA	NA	90%
Field Testing	Turbidity	± 30%	No SWAMP requirement; will use ± 30%	NA	NA	No SWAMP requirement; will use 90%

The data quality objectives for the field measurements of NH_4^+, NO_3^-, and PO_4^{3-} are listed in Table 7. The precision of each measurement (expressed as % RSD) is determined with replicate analyses of a prepared standard solution. The accuracy (expressed as % R) is determined through replicate measurements of standard solutions.

Table 7. Data Quality Objectives for CHEMetrics® Field Test Kits

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Field Test Kit	Ammonia as N	± 20%	No SWAMP requirement – suggest ± 20%	NA	0.05 mg/L	No SWAMP requirement; will use 90%
Field Test Kit	Nitrate as N	± 20%	No SWAMP requirement – suggest ± 20%	NA	1.35 mg/L	No SWAMP requirement; will use 90%
Field Test Kit	Ortho-Phosphate as P	± 20%	No SWAMP requirement – suggest ± 20%	NA	0.07 mg/L	No SWAMP requirement; will use 90%
Field Test Kit	MBAS	± 20%	No SWAMP requirement – suggest ± 20%	NA	0.1 mg/L	No SWAMP requirement; will use 90%

7.3. Data Quality Objectives for Laboratory Analysis

Laboratory analyses include the determination of chemical and bacteriological properties of water samples. Data quality objectives for all analytes are provided by the contract laboratory and presented in Table 8.

Table 8. Data Quality Objectives for Chemical and Bacteriological Properties of Water

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Chemical Laboratory Analysis	Hardness	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	1.0 mg/L	90%
Chemical Laboratory Analysis	MBAS	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.1 mg/L	90%
Chemical Laboratory Analysis	Ammonia-N	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.05 mg/L	90%
Chemical Laboratory Analysis	Nitrate-N	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.05 mg/L	90%
Chemical Laboratory Analysis	Nitrite-N	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.05 mg/L	90%

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Chemical Laboratory Analysis	TKN	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.1 mg/L	90%
Chemical Laboratory Analysis	Ortho-Phosphate-P	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.05 mg/L	90%
Chemical Laboratory Analysis	Total Phosphate-P	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.05 ng/L	90%
Chemical Laboratory Analysis	Oil and Grease	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	5.0 mg/L	90%
Chemical Laboratory Analysis	**Dissolved Metals** Antimony (Sb) Arsenic (As) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Nickel (Ni) Selenium (Se) Zinc (Zn) Iron (Fe) Manganese (Mn)	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.002 mg/L 0.001 mg/L 0.001 mg/L 0.005 mg/L 0.001 mg/L 0.001 mg/L 0.002 mg/L 0.002 mg/L 0.02 mg/L	No SWAMP requirement; will use 90%
Chemical Laboratory Analysis	**Total Metals** Antimony (Sb) Arsenic (As) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Nickel (Ni) Selenium (Se) Zinc (Zn) Iron (Fe) Manganese (Mn)	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.	0.002 mg/L 0.001 mg/L 0.001 mg/L 0.005 mg/L 0.001 mg/L 0.001 mg/L 0.002 mg/L 0.002 mg/L 0.02 mg/L	90%
Chemical Laboratory Analysis	Chloride	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.		90%
Chemical Laboratory Analysis	Sulfide	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Laboratory duplicate, Blind Field duplicate, or MS/MSD 25% RPD Laboratory duplicate minimum.	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data.		90%
Chemical Laboratory Analysis	Total Dissolved Solids				20 mg/L	

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Chemical Laboratory Analysis	Total Suspended Solids				20 mg/L	
Chemical Laboratory Analysis	Diazinon, Chlorpyrifos, Malathion	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by supplier. If not available, within 80% to 120% of true value	Field replicate or MS/MSD $\pm$ 25% RPD. Field replicate minimum.	Matrix spike 50% - 150% or control limits at $\pm$ 3 standard deviations based on actual lab data.	0.05 µg/L	90%
Chemical Laboratory Analysis	Bacterial Indicators (Total and fecal Coliform, Enterococcus)	Laboratory positive and negative cultures – proper positive or negative response. Bacterial PT sample –within the stated acceptance criteria.	R_{log} within 3.27*mean R_{log} (reference is section 9020B of 18th, 19th, or 20th editions of *Standard Methods*	NA	2 MPN/100mL	90%

* See Appendix 6; Truesdail's "Quality Assurance and Quality Control Manual for Environmental Sample Analysis" (laboratory's QA/QC manual) for a discussion on Accuracy, Precision, Recovery, and Completeness in Section 3 – "Environmental Quality Assurance Program", Pages 19 to 27.

8 Special Training Requirements/Safety

8.1 Specialized Training and Certifications

8.1.1 Photo Documentation

There is no specialized training for photo documentation. At least one photograph should be collected at each site visit. If a site is new, one photograph looking upstream and one looking downstream should be taken. Photographs have to be properly dated, saved and stored.

8.1.2 Water Quality Monitoring

Although there are no special training needs required for these monitoring programs, all field personnel are trained/refresher trained in proper field sampling and sample handling techniques prior to each sampling season by the Quality Assurance Officer. All field personnel are trained and have experience in the collection, handling/storage, and chain of custody procedures as they relate to sample collection. Health and safety training is conducted each month at Watershed Protection Program staff meetings with an annual update of the Illness, Injury Prevention Plan (IIPP) for the Science and Monitoring group.

8.1.3 Analytical Laboratory

Truesdail Laboratories, Inc. is certified by the Environmental Laboratory Accreditation Program (ELAP) for the analyses of inorganics, toxic chemical elements, and organics in wastewater (Certificate 1237).

8.2 Training and Certification Documentation

All personnel are responsible for complying with all quality assurance/quality control requirements pertaining to their organizational/technical function. Each technical staff member possesses 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 record management.

8.2.1 Field Sampling

All field personnel refresher training is documented and records kept in the County of San Diego Department of Public Works, Human Resources Office and on file at Project Manager's office.

8.2.2 Analytical Laboratory

Truesdail Laboratories, Inc. maintains records of their training. Those records can be obtained if needed from Truesdail through the Quality Assurance Manager.

8.3 Training Personnel

The Quality Assurance Officer provides training for field personnel in proper field sampling techniques prior to work initiation to ensure consistent and appropriate sampling, sample handling/storage, and chain of custody procedures.

9 Documentation and Records

Science and Monitoring Group documents and tracks all aspects of the sample collection process which include generating field datasheets at each site and chain of custody forms for all analytical samples collected. Chain of custody (COC) forms accompany water samples to the laboratory for analysis. Truesdail Laboratories, Inc. documents and tracks all aspects of sample receipt and storage, analyses and reporting. Copies of the COC forms are included in the final report.

The Science and Monitoring Group maintains the Dry Weather database for all data collected. Steven DiDonna is in charge of database management. The database and all related electronic files and reports are backed-up daily through the County of San Diego network service provider.

All records generated by this project are stored at the Science and Monitoring Group's office. Truesdail Laboratories, Inc. records pertinent to this project are maintained at Truesdail's main office. Copies of all records held by Truesdail are provided to the Science and Monitoring Group both electronically, in specified format, and by hard copy and stored in the project file.

Copies of this QAPP are distributed to all parties involved. Updates to this QAPP are distributed in like manner, and all previous versions are discarded from the project file.

Record maintenance responsibilities are assigned as follows:

Ken Liddell - maintains all sample collection, sample transport, chain of custody, and field datasheet forms; maintains all records associated with the receipt and analysis of samples processed by Truesdail Laboratories, Inc. and all records submitted by Truesdail.

Steven DiDonna - maintains the database

Norman Hester (Laboratory Manager for Truesdail Laboratories, Inc.) - maintains Truesdail's records

Joanna Wisniewska (QA Officer for the Science and Monitoring Group) – maintain records of QA/QC audits and reports.

Jo Ann Weber (Science and Monitoring Group Project Manager/Supervisor) - oversee the actions of these persons and arbitrate any issues relative to records retention and any decisions to discard records.

Table 9. Document and record retention, archiving and disposition information.

	Document/ Record Type	*Retention*	*Archival*	*Disposition*
Sample Collection Records	*Chain of Custody Forms*	5 years	5 years	5 years
Field Records	*Site photographs*	5 years	5 years	5 years
	Field data sheets	5 years	5 years	5 years
Analytical Records	*Hardcopy laboratory data*	5 years	5 years	5 years
Data Records	*Dry Weather Monitoring Database*	5 years	10 years	10 years
	Laboratory Data – electronic version	5 years	10 years	10 years
Assessment Records	*Calibration Datasheets*	5 years	5 years	5 years
	QA/QC audits	5 years	5 years	5 years
Data Analysis & Reports	*Analysis of data results*	5 years	10 years	10 years
	Annual reports	5 years	10 years	10 years

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B. Data Generation and Acquisition

10. Sampling Process Design

The main objective of the Dry Weather Monitoring program is to identify and eliminate illegal discharge of non-storm waters to and from MS4s, and provide scientific data that can be used to evaluate surface water quality and make cost-effective watershed protection decisions. MS4 Outlet Monitoring focuses on characterization of pollutant discharges from MS4 outfalls and their relative contributions to the high priority water quality problems identified in the receiving waters.

The target population of the Dry Weather Monitoring program are MS4s of the unincorporated portion of the County. A stratified non-random sampling design is employed in the following manner: The unincorporated area of the county is divided into sub regions (watersheds), and samples are collected at various locations in each watershed (i.e. Figure 3) according to the following criteria:

- An outfall or a segment of MS4
- Presence of flowing or ponded water
- Downstream of any sources of suspected illegal or illicit activity
- Information available for historical or current water quality and land use
- Safety and accessibility

The sampling site locations in each watershed are identified by GPS coordinates and Thomas Brothers® map coordinates. Each site is visited at least once during the dry weather season from May 1st to September 30.th Each site is also photographed at least once per season in an effort to identify any physical and/or biological alterations to the site. Field measurements, including the use of Horiba U-10 6 Parameter probe and CHEMetrics® field test kits, are conducted at each visit at locations with flowing or ponded water. Water samples are collected at a minimum of 25% of the selected locations for laboratory analysis of chemical and bacteriological properties. Follow-up re-sampling is conducted for field screening and/or laboratory analysis when an IC/ID investigation is needed. If a site becomes inaccessible, a reasonable attempt is made to locate a replacement site in the area.

The target population of MS4 Outlet Monitoring includes those MS4 outfalls that are most likely to contribute to receiving water problems (e.g., largest potential pollutant loading).
Each of the outfall location must be likely to have dry weather flow and must discharge into receiving water. Additional MS4 outlet selection criteria include: the surrounding land use, concentration of potential source activities, reported exceedances in water quality monitoring, presence on the Clean Water Act 303(d) list of impaired waterbodies, flow rate and best professional judgment and experience.

MS4 Outlets are monitored for specific constituents selected based on each watershed's water quality priorities, and where applicable, the 303(d) listed impairments within the watershed. A map of the 62 MS4 Outlet locations monitored during 2009 is presented in Figure 4.

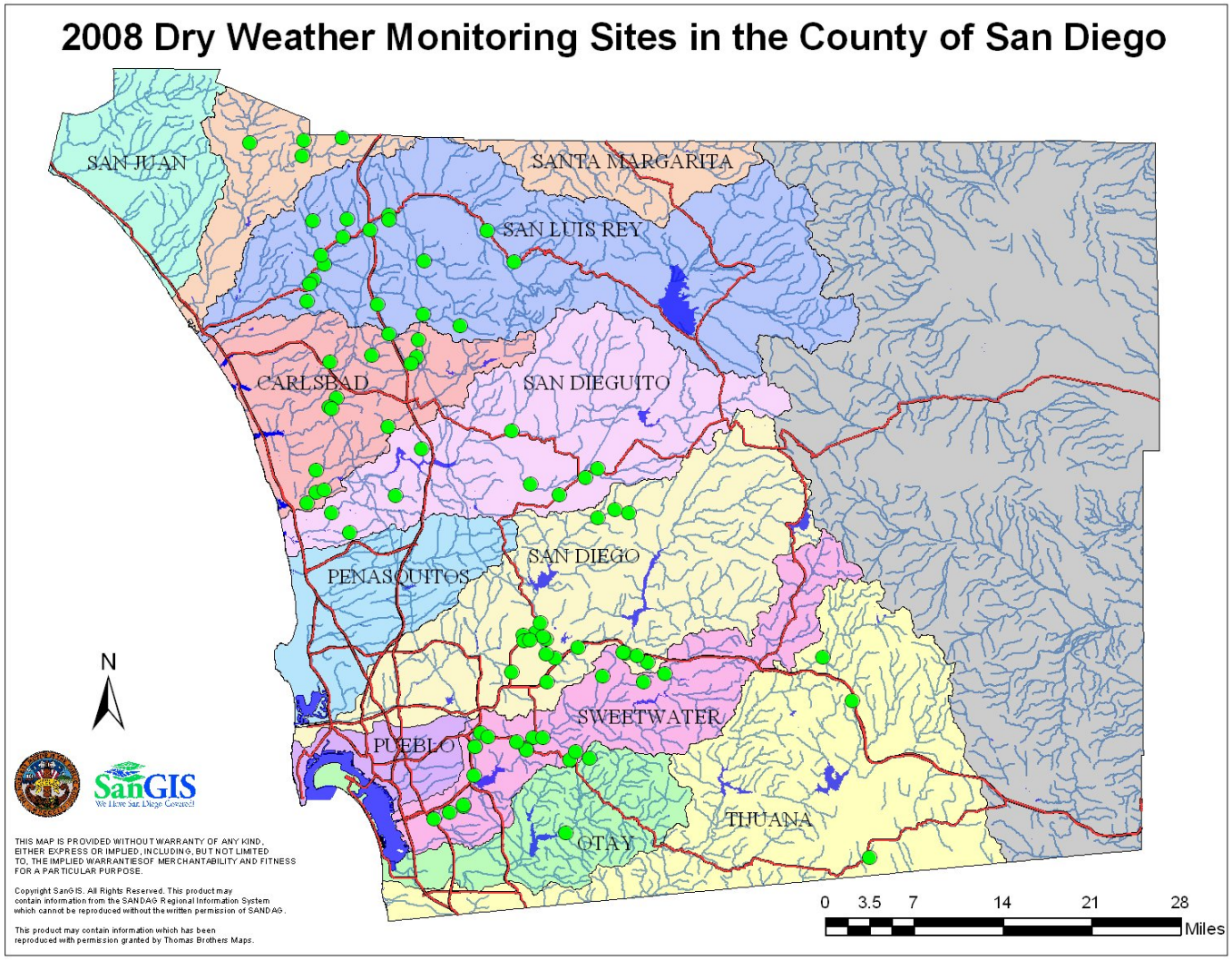

Figure 3. County of San Diego Dry Weather Monitoring Sites for 2009.

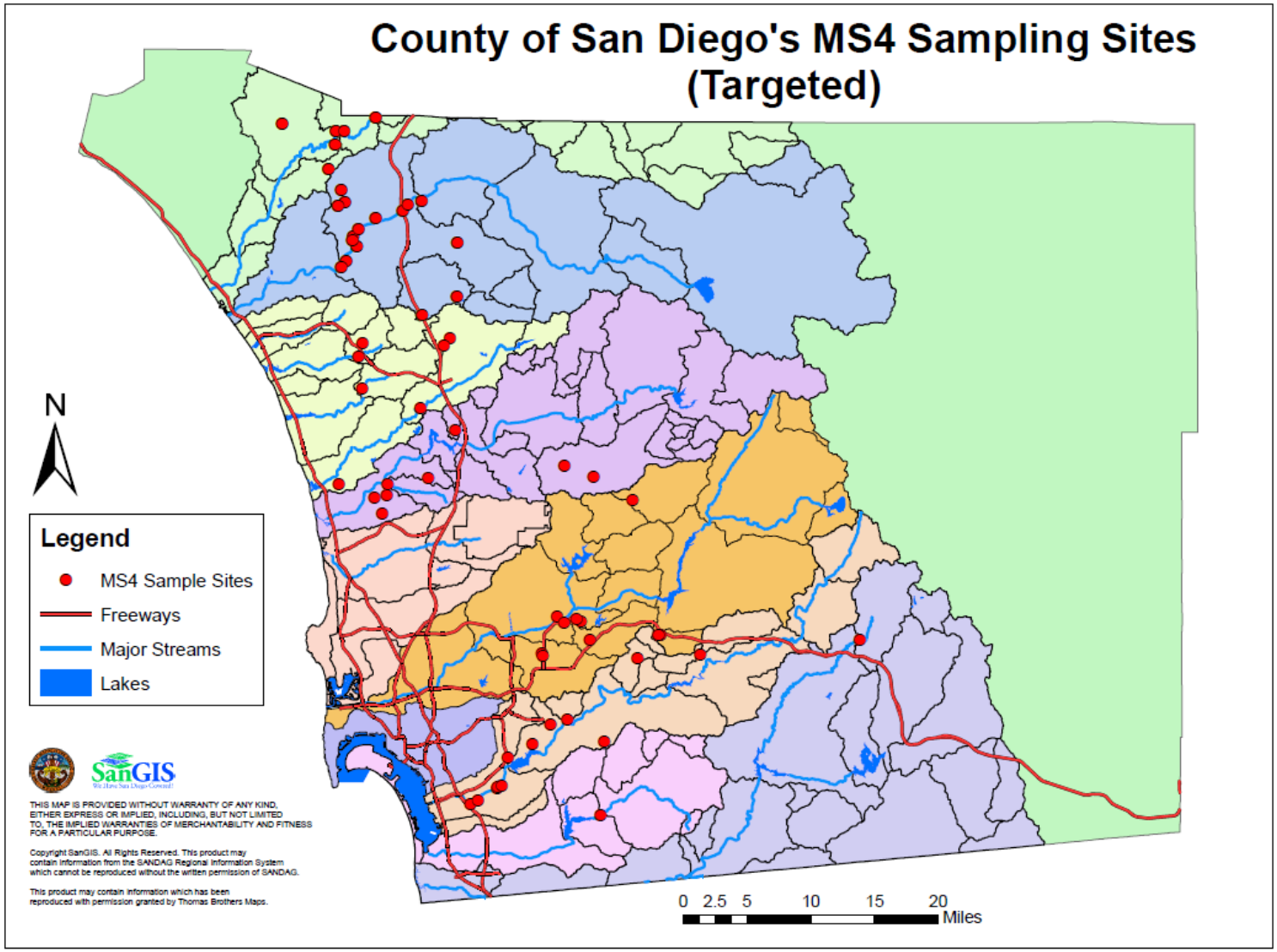

Figure 4. County of San Diego MS4 Outfall Monitoring locations for 2009.

11. Sampling Methods Requirements

For the Dry Weather Monitoring Program, at each site with flowing or ponded water, in-situ measurements of flow, pH, conductivity, turbidity, dissolved oxygen (DO), and temperature are made. In addition, water samples are collected and analyzed in the field for ammonia, nitrate, and ortho-phosphate. Also, for at least 25% of visited sites, grab samples are collected and analyzed in the laboratory for hardness, oil and grease, pesticides (Diazinon and chlorpyrifos), MBAS, dissolved metals (cadmium, copper, lead, and zinc), and bacterial indicators (total coliform, fecal coliform, and *enterococcus*). All Standard Operating Procedures (SOPs) including the proper use, maintenance and calibration of sampling equipment, sampling protocols and safety procedures are described in the "Dry Weather Analytical and Field Screening Monitoring Procedures Manual" (Appendix 5).

Water samples for both laboratory analysis and field screening tests are collected from an outfall or stream/creek at its horizontal and vertical center or at a location that is most representative of its water quality. Samples for laboratory analysis are stored at ≤4°C in an ice cooler. All samples collected for laboratory analysis are collected using the appropriate sample containers (supplied by Truesdail Laboratories, Inc.) with appropriate preservatives and not to exceed specified holding times (Table 10).

When collecting water samples from creeks/streams with wide flow, boots or waders are worn to enter the water just downstream of the designated sampling point. Gloves are also worn during analytical sampling. Samples are collected by pointing the bottle opening upstream lowering it to mid-depth position and allowing the bottle to fill while care is taken to avoid collecting floating debris. In shallow water (less than 6 in deep), bottles are filled from the surface of the stream. A clean syringe may also be used to collect water in very low flow or in ponded water. Oil and grease samples are collected at the air/water interface.

Field data sheets (Appendix 1) are completed for each site visit. The empirical observations of the site and water quality characteristics include: meteorological conditions at the time of sampling; odor, water clarity, presence of floatable matter, visible deposits/ stains and biological status. Each site is also photographed annually to identify any alterations in vegetative coverage or physical status.

For the MS4 program, the dry weather sampling period is defined as the period from May 1 (but at least 4 weeks after a 0.2 inch or greater rainfall) through August 1 not including any periods less than 72 hours after a rainfall of 0.1 inch or greater. Constituents and measurements performed at each MS4 Outlet are specific to that outlet and are based on the watershed's water quality priorities, and where applicable, the 303(d) listed impairments within the watershed.

Table 10. Water Quality Analytical Parameters for Water Quality Monitoring Projects

Analytical Parameter	Analytical Method	Container type	Sample Volume (mL)	Preservative	Maximum Holding Time
pH	N/A	Analyzed in Field	N/A	N/A	N/A
Temperature	N/A	Analyzed in Field	N/A	N/A	N/A
Conductivity	N/A	Analyzed in Field	N/A	N/A	N/A
Dissolved Oxygen	N/A	Analyzed in Field	N/A	N/A	N/A
Ammonia-N	Field colorimetric	Analyzed in Field	N/A	N/A	N/A

Analytical Parameter	Analytical Method	Container type	Sample Volume (mL)	Preservative	Maximum Holding Time
Nitrate-N	Field colorimetric	Analyzed in Field	N/A	N/A	N/A
Ortho-phosphate-P	Field colorimetric	Analyzed in Field	N/A	N/A	N/A
Ammonia-N	EPA 350.2	Plastic	250	Acidify to pH<2 with H2SO4	28 d
Chlorpyrifos	EPA 8141, EPA 8081	Amber Glass	1000	None	7 d/40 d
Coliform/E. Coli	SM 9223B Colilert	Plastic (Sterile)	100	Na2S2O3	6 hrs at 4oC
Diazinon	EPA 8141, EPA 8081	Amber Glass	1000	None	7 d/40 d
Dissolved Cadmium	EPA 6010, EPA 200.7/EPA 200.8	Plastic	250	None	6 months after filtration and preservation w/ HNO3
Dissolved Copper	EPA 6010, EPA 200.7/ EPA200.8	Plastic	250	None	6 months after filtration and preservation w/ HNO3
Dissolved Lead	EPA 6010, EPA 200.7/ EPA200.8	Plastic	250	None	6 months after filtration and preservation w/ HNO3
Dissolved Zinc	EPA 6010, EPA 200.7, EPA200.8	Plastic	250	None	6 months after filtration and preservation w/ HNO3
Aluminum	EPA 200.8				
Total Manganese	EPA 200.8				
Total Iron (Fe)	EPA 200.8				
Total Selenium (Se)	EPA 200.8				
Enterococcus	SM 9230 B	Plastic (Sterile)	100	Na2S2O3	6 hrs at 4oC
Fecal Coliform	SM 9221 C	Plastic (Sterile)	100	Na2S2O3	6 hrs at 4oC
Malathion	EPA 8141, EPA 8081	Amber Glass	1000	None	7 d/40 d
Methylene Blue Active Substances (MBAS)	Field colorometric and SM 5540 C	Plastic	250	None	48 hrs
Nitrate-N	EPA 300.0	Plastic	250	None	48 hrs
Nitrite-N	SM4500NO2B		200		48 hrs
Total Kjeldahl Nitrogen (TKN)	SM4500C		500		28 days
Ortho-phosphate-P	EPA 365.3				
Total Phophate-P	EPA 365.2				
Chloride	SM 4500 Cl C				
Sulfate	SM 4500 SO4 E; EPA300				
Oil and Grease	EPA 1664 A	Amber Glass	1000	HCl	28 d
Ortho-Phosphate-P	EPA 365.2	Plastic	250	None	48 hours
Total Coliform	SM 9221 C	Plastic (Sterile)	100	Na2S2O3	6 hrs at 4oC

Analytical Parameter	Analytical Method	Container type	Sample Volume (mL)	Preservative	Maximum Holding Time
Total Hardness	EPA 130.2 / EPA 200.7, SM 2340 B	Plastic	250	None	6 months
Total Dissolved Solids (TDS)	SM 2540C		100		7 days
Total Suspended Solids (TSS)	SM2540D		100		7 days

12. Sampling Handling and Custody

12.1 Photo Documentation

No special handling or custody procedures are needed. The digital camera is returned to the office and the digital photographs are downloaded, labeled with specific dates and locations and placed in their appropriate folders. All photographic data are backed up daily.

12.2 Water Quality Samples

The grab samples collected during monitoring events are labeled with site location, date, sample time, analysis to be performed, sample preservation (if any) and field sampler's name. Each site visit is assigned a unique sample event ID number and recorded in a logbook. The time, date, site, and event type is also recorded in the logbook next to the sample event ID number. Sample bottles are stored and transported at ≤4°C in an ice cooler until processed. Samples are delivered to Truesdail Laboratories, Inc. within specific holding times (Table 10).

Field data sheets (Appendix 1) and Chain of Custody records (Appendix 7) are employed to document sample identity, handling and possession. The COCs are used to document sample transfer from field collection staff to laboratory staff. One COC record may accompany a group of samples. Persons who have custody of the samples sign the form and ensure that the samples are not left unattended unless properly secured. Documentation of sampling, handling and custody includes the following:

- Sampler identifier
- Sample collection date and time
- Sample Event ID number
- Any special notations on sample characteristics
- Signature of person(s) collecting the sample
- Date and time the sample was received by the Truesdail Laboratories, Inc. staff
- Constituents to be tested, preservatives, and temperature requirements

The COCs must be kept dry and legible. Upon receipt of the samples, Truesdail Laboratories, Inc. staff must note the date and time of receipt, sign the COC and give a copy to the field staff while keeping the original form. At the laboratory, laboratory staff verifies sample and document condition and ensures that sample transport/storage temperature, labels on bottles are in agreement with the description on the COC form. Any discrepancies are noted and discussed with the sample delivery personnel or by contacting the Program QA Officer. The COC records are included in final reports prepared by the analytical laboratory.

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13. Analytical Methods Requirements

Table 11 details the analytical methods for parameters measured in the field for water quality monitoring. Methods to be used for laboratory analysis of chemical and bacteriological parameters are summarized in Table 12. Truesdail Laboratories, Inc. shall follow all analytical procedures described in the methods. The laboratory shall notify WPP of any modification of the methods and procedures.

Table 11. Field Analytical Methods

Analyte	Project Action Limit	Analytical Methods		Achievable Laboratory Limits	
		Analytical Method	Modified for Method (Y/N)	Method Detection Limits	Method Reporting Units
pH	<6.5 or >9.0	EPA 150.1	N	0.1	pH units
Conductivity	BPJ	SM 2510, EPA 120.1	N	0.14	umhos/cm
Temperature	BPJ	SM 2550 B	N	0.1	oC
Dissolved Oxygen	BPJ	SM4500 O G	N	0.5	mg/L
Turbidity	BPJ	EPA 180.1	N	0.006	NTU
Ammonia as N	1.0 mg/L	EPA 350.2	N	0.11	mg/L
Nitrate as N	10.0 mg/L	EPA 300.0	N	0.017	mg/L
Ortho-Phosphate as P	2.0 mg/L	EPA 365.2	N	0.004	mg/L
MBAS	1 mg/L	SM 5540 C	N	0.125	mg/L

Table 12. Laboratory Analytical Methods

Analyte	Project Action Limit	Project Quantitation Limit	Analytical Methods		Achievable Laboratory Limits	
			Analytical Method	Modified for Method (Y/N)	Method Detection Limits[2]	Laboratory Reporting Limits
Ammonia-N	1 mg/L		EPA 350.2	N	0.11 mg/L	0.50 mg/L
Chlorpyrifos	0.5 ug/L		EPA 8141, EPA 8081	N	0.0062 ug/L	0.05 ug/L
E. Coli			SM 9223B Colilert	N	10 (MPN/100mL)	10 (MPN/100mL)
Diazinon	0.5 ug/L		EPA 8141, EPA 8081	N	0.0076 ug/L	0.05 ug/L
Dissolved Cadmium	California Toxics Rule		EPA 6010, EPA 200.7/EPA 200.8	N	0.54 / 0.18 ug/L	10.0 / 1.0 ug/L
Dissolved Copper	California Toxics Rule		EPA 6010, EPA 200.7/ EPA200.8	N	2.8 / 0.17 ug/L	10.0 / 1.0 ug/L
Dissolved Lead	California Toxics Rule		EPA 6010, EPA 200.7/ EPA200.8	N	3.5 / 0.27 ug/L	10.0 / 1.0 ug/L
Dissolved Zinc	California Toxics Rule		EPA 6010, EPA 200.7, EPA200.8	N	1.9 / 0.23 ug/L	10.0 / 5.0 ug/L
Aluminum			EPA 200.8	N		
Total Manganese			EPA 200.8	N	1.52 / 0.36 ug/L	10.0 /1.0 ug/L
Total Iron (Fe)			EPA 200.8	N	0.95 ug/L	20.0 ug/L
Total Selenium (Se)			EPA 200.8	N		
Enterococcus	10,000 (MPN/ 100 mL)		SM 9230 B	N	20 (MPN/100mL)	20 (MPN/100mL)

Analyte	Project Action Limit	Project Quantitation Limit	Analytical Methods		Achievable Laboratory Limits	
			Analytical Method	Modified for Method (Y/N)	Method Detection Limits[2]	Laboratory Reporting Limits
Fecal Coliform	20,000 (MPN/ 100 mL)		SM 9221 C	N	20 (MPN/100mL)	20 (MPN/100mL)
Malathion	0.5 ug/L		EPA 8141, EPA 8081	N	0.0074 ug/L	0.05 ug/L
Methylene Blue Active Substances (MBAS)	1.0 mg/L		SM 5540 C	N	0.007 mg/L	0.05 mg/L
Nitrate-N	10.0 mg/L		EPA 300.0	N	0.017 mg/L	0.20 mg/L
Nitrite-N			SM4500NO2B	N	0.001 mg/L	0.005 mg/L
Total Kjeldahl Nitrogen (TKN)			SM4500C	N	0.41 mg/L	0.80 mg/L
Ortho-phosphate-P	2 mg/L		EPA 365.3	N	0.004 mg/L	0.02 mg/L
Total Phophate-P			EPA 365.2	N	0.004 mg/L	0.02 mg/L
Chloride			SM 4500 Cl C	N	0.044 mg/L	0.20 mg/L
Sulfate			SM 4500 SO4 E; EPA300	N	0.031 mg/L	0.5 mg/L
Oil and Grease	15 mg/L		EPA 1664 A	N	1.22 mg/L	5.0 mg/L
Total Coliform	50,000 (MPN/ 100 mL)		SM 9221 C	N	20 (MPN/100mL)	20 (MPN/100mL)
Total Hardness			EPA 130.2 / EPA 200.7, SM 2340 B	N	0.60 (mg CaCO3/mL)	2.0 (mg CaCO3/mL)
Total Dissolved Solids (TDS)			SM 2540C	N	1.28 mg/L	25.0 mg/L
Total Suspended Solids (TSS)			SM2540D	N	0.51 mg/L	2.5 mg/L

[1] Water Quality objective for total and dissolved metal fractions are based on Total Hardness (as CaCO3) and are calculated as described by Title 40 of the Code of Federal Regulations (Part 131) (USEPA 2000).
[2] Method detection limits are subject to change.

14. Quality Control Requirements

Quality control (QC) checks for both the field and laboratory are used to ensure that valid data are collected. Quality Control checks provide data that are used to compute statistical indicators of data quality. Corrective actions will be taken when QC check data exceed control limits that have been established for each analyte of interest. Quality Control checks include the use of blanks, duplicates, matrix spikes, and laboratory control standards (LCS). The frequency of QC checks is presented in Table 13.

Table 13. Quality Control Checks

Category	Blank	Duplicate	Matrix spike	LCS
Field	3 per season	10%	N/A	N/A
Laboratory	1 per batch of 20 samples or less	1 per batch or 10%	1 per batch of 20 samples or less	1 per batch of 20 samples or less

Field blanks are collected at a rate of one per 20 samples for laboratory analysis and field testing. Field blanks are used to monitor contamination originating from the collection, transport or storage of environmental samples. A field blank is prepared by pouring analyte-free water (i.e. deionized water) into the sample collection device and sub-sampling for analytes to verify that field cleansing procedures are adequate and that sampling, handling and transportation do not introduce any analytes

of interest. The results from field blanks are reported in the annual report as part of the Data Quality Control and Quality Assurance discussion; however, they are not used to correct (blank adjust) data. Field blanks are analyzed in the laboratory for Ammonia-N, Nitrate-N, Nitrite-N, Total Kjeldahl, Nitrogen (TKN), Ortho-phosphate-P, Total Phophate-P, Chlorpyrifos, Diazinon, Malathion, Dissolved Cadmium, Dissolved Copper, Dissolved Lead, Dissolved Zinc, Aluminum, Total Manganese, Total Iron (Fe), Total Selenium (Se), Methylene Blue Active Substances (MBAS), Chloride, Sulfate, Oil and Grease, Total Hardness, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), and bacterial indicators (Total Coliform, Fecal Coliform, and E*nterococcus*) and in the field for MBAS, ammonia, nitrate, and ortho-phosphate (by field test kits).

At least one field duplicate is submitted per 10 samples collected for field and laboratory analyses. Field duplicates are two samples collected at the same time and location using two sampling bottles, and processed and analyzed in an identical manner. Field duplicates are analyzed in the laboratory for Ammonia-N, Nitrate-N, Nitrite-N, Total Kjeldahl, Nitrogen (TKN), Ortho-phosphate-P, Total Phophate-P, Chlorpyrifos, Diazinon, Malathion, Dissolved Cadmium, Dissolved Copper, Dissolved Lead, Dissolved Zinc, Aluminum, Total Manganese, Total Iron (Fe), Total Selenium (Se), Methylene Blue Active Substances (MBAS), Chloride, Sulfate, Oil and Grease, Total Hardness, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), and bacterial indicators (Total Coliform, Fecal Coliform, and E*nterococcus*) and in the field for MBAS, ammonia, nitrate, and ortho-phosphate (by field test kits).

All contract laboratory analysis is performed under the guidelines of the quality assurance and quality control programs established by Truesdail Laboratories, Inc. For each batch of 20 or fewer samples, this includes a laboratory duplicate, a laboratory control sample (LCS), a laboratory control sample duplicate (LCS Dup), a matrix spike, and a matrix spike duplicate. Laboratory duplicates are prepared by taking two aliquots of a sample from the same container. The relative percent difference between the two results defines precision of the method evaluated. A matrix spike is a sample prepared by adding a known mass of a target analyte to a specified amount of sample matrix for which an independent estimate of the target analyte concentration is available. Matrix spikes are used to evaluate any bias to the analysis from the sample matrix. A LCS is prepared from a certified standard that is spiked into purified water and analyzed in the same way as the environmental samples. The LCS is used to demonstrate method proficiency irrespective of matrix.

The Science and Monitoring Group submits a blind standard sample to the laboratory once per Dry Weather Monitoring season to check the performance of CHEMetrics® field kits in measuring nitrate, ortho-phosphate and ammonia concentrations.

15. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

All field testing equipment is cleaned and inspected upon return from each sample day/event. The Horiba U-10 6-parameter probe is auto-calibrated prior to field use and upon return and the results recorded in the calibration data sheet (Appendix 4). The Horiba probes are replaced at the first sign of deviation from standard solution concentrations and any deviations/replacements are noted in the instrument logbook.

The CHEMetrix® field test kit reagents are checked quarterly to ensure they have not exceeded their expiration dates. The global flow probe, V-2000 Water Analysis System handheld spectrometer and

digital camera are maintained in proper working order. Batteries are replaced or recharged as necessary.

Truesdail Laboratories, Inc. maintains its equipment in accordance with its standard operating procedures (SOPs) which include those specified by the manufacturer and those specified by the method. Truesdail's "Quality Assurance and Quality Control Manual for Environmental Sample Analysis" standard operating practice manual (Appendix 6) details their equipment and systems testing, inspection, maintenance and calibration specifications and schedule.

Table 14. Testing, inspection, maintenance of sampling equipment and analytical instruments.

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
Horiba U-10 6-parameter probe	Clean, inspect, check with pH7 and pH10 solutions before and after field visit, replace probes as necessary	Field staff	Upon each field visit and replace probes as necessary	Appendix 4, Appendix 5
Global Flow Probe	Clean, inspect, check/replace batteries	Field staff	Upon each field visit	Appendix 2, Appendix 5
CHEMetrix® reagent kits	Inspect reagents for expiration dates	Field staff	4/year	Appendix 5
V-2000 Water Analysis System (handheld spectrometer)	Clean, inspect	Field staff	Upon each field visit	Appendix 5
Field Camera	Clean, inspect, recharge/replace batteries	Field staff	Upon each field visit	

16. Instrument/Equipment Calibration and Frequency

All equipment and instruments used by the Science and Monitoring Group are operated and calibrated according to the manufacturer's recommendations as well as by criteria defined in individual SOPs (Appendix 5). Operation and calibration are performed by field personnel trained in these procedures. Documentation of all routine and special calibration information is recorded in appropriate logbooks. If a critical measurement is found to be out-of-compliance during analysis, the results of that analysis are reported, corrective action is taken and documented, and the analysis repeated if possible.

The Horiba U-10 6-parameter probe is calibrated prior to use each day using the AutoCal procedure (Appendix 5) and tested with pH 7 and pH10 solutions. Upon return from the field, the probe is checked again with the pH 7 and pH 10 solutions and the results recorded. All calibration data are recorded on calibration data sheets (Appendix 4) and filed in the instrument's logbook. If measured results do not meet the DQOs, the multi-meter is recalibrated using the two-point calibration procedure (Appendix 4). Quarterly, a full calibration of the probe is conducted and documented in the instrument logbook.

Field test kits are tested for precision and accuracy two times per year using standard ammonia, nitrate, and ortho-phosphate solutions. Precision is also evaluated in the field by the analysis of duplicate field samples. The flow meter is calibrated using other flow measurement methods.

Truesdail Laboratories, Inc. "Quality Assurance and Quality Control Manual for Environmental Sample Analysis" standard operating practice manual (Appendix 6) details their equipment calibration procedures and schedule.

Table 15. Testing, inspection, maintenance of sampling equipment and analytical instruments.

Equipment / Instrument	***SOP reference***	**Calibration Description and Criteria**	**Frequency of Calibration**	**Responsible Person**
Horiba U-10 6-parameter probe	Appendix 4	Auto-calibrate and check with pH7 and pH10 solutions and conduct full instrument calibration	Auto-calibrate upon each visit; check with pH7 and pH10 solutions before and after each field visit; full calibration 4X/year	Field staff
Global Flow Probe	Appendix 2	Check meter against other flow measurements methods	N/A	Field staff
CHEMetrix® reagent kits	Appendix 5	Check precision and accuracy using standard ammonia, nitrate, and ortho-phosphate solutions	2X/year	Field staff
V-2000 Water Analysis System (handheld spectrometer)	Appendix 5	Check precision and accuracy using standard ammonia, nitrate, and ortho-phosphate solutions	2X/year	Field staff

17. Inspection/Acceptance Requirements for Supplies and Consumables

The County of San Diego only purchases supplies and consumables for approved vendors that meet the County Purchasing and Contracting Department's strict guidelines. Critical supplies for this project include calibration standard solutions, buffer solutions, reagents, CHEMetrics® field test kits and sample collection bottles supplied by Truesdail Laboratories, Inc.

Upon receipt, buffer solutions, standards, reagents, and field test kits used are inspected for leaks or broken seals. Reagents are replaced before they exceed manufacturer's recommended shelf life. These shelf lives are typically one to two years. However, specific replacement dates can be determined by providing the reagent lot number to the manufacturer. Reagent replacement dates are noted in the reagent log sheet. Steve DiDonna is responsible for keeping the reagent log sheet. He also ensures that buffer solutions, standards, and reagents used in the laboratory or field are inspected

for leaks or broken seals and replaced when necessary, and also that consumables are replaced before they exceed manufacturer's recommended shelf life. All supplies and consumables are stored in accordance with manufacture's specifications in a secure location.

All sampling equipment is inspected for broken or missing parts and tested to ensure proper operation on a regular basis.

Table 16. Inspection/acceptance testing requirements for consumables and supplies.

Project-Related Supplies / Consumables	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Calibration standard solutions	Check seals and containers for breaks, check expiration dates; ensure proper storage	Containers properly stored; seals and containers intact; used containers properly closed; solutions not expired	Upon receipt and each use	Steve DiDonna & other field personnel who use the supply/consumable
Buffer solutions	Check seals and containers for breaks, check expiration dates; ensure proper storage	Containers properly stored; seals and containers intact; used containers properly closed; solutions not expired	Upon receipt and each use	Steve DiDonna & other field personnel who use the supply/consumable
Reagents	Check seals and containers for breaks, check expiration dates; ensure proper storage	Containers properly stored; seals and containers intact; used containers properly closed; reagents not expired	Upon receipt and each use	Steve DiDonna & other field personnel who use the supply/consumable
CHEMetrics® field test kits	Check seals and containers for breaks, ensure proper storage and transportation; check expiration dates	Containers and seals intact; solutions not expired; test kits properly stored and transported, cleaned and maintained	Upon receipt and each use	Steve DiDonna & other field personnel who use the supply/consumable
Sample collection bottles	Check seals and containers for breaks; ensure proper storage	Bottles and seals intact; bottles properly stored and transported	Upon receipt and each use	Steve DiDonna & other field personnel who use the supply/consumable

18. Non-direct Measurements

Non-direct measurements are used to support the selection of sampling sites and to assist in the development of monitoring plans for Watershed Water Quality Monitoring. These measurements include data collected during previous years of Dry Weather Monitoring, special projects, Regional Water Quality Control Board Surface Water Ambient Monitoring Program (RWQCB SWAMP) data, and data obtained from other agencies. In addition, photo documentation, topographical maps, land use maps, and hydrological maps generated from San Diego Association of Governments and County of San Diego GIS databases, are used.

Data collected during previous years of Dry Weather Monitoring, special projects, RWQCB SWAMP and data acquired from other agencies will be reviewed against data quality objectives stated in section 7 and only those data that meet all of the criteria are used in this project.

19. Data Management

Field data sheets are checked and initialed in the field by field staff. Following initial data entry into the appropriate database, the QA Officer reviews electronic data. The QA Officer reviews 20% or the

datasheets for completeness, accuracy and for data entry and transcription errors. After performing checks, and ensuring that data quality objectives have been met, analysis can be performed.

Data is maintained as described in section 9. All original field data sheets, statistical worksheets, and reports produced are accumulated into project specific files that are maintained at the Science and Monitoring Group's office. Data files, databases and final report text and tables are maintained on the County of San Diego network in project specific folders and are backed up daily for storage offsite.

Truesdail Laboratory, Inc. records pertinent to this project are maintained at Truesdail's main office. Copies of all records held by Truesdail are provided to the Science and Monitoring Group both electronically, in specified format, and by hard copy and stored in the project file. Truesdail Laboratory, Inc. also reports laboratory analytical results to the QA Officer who verifies sample identification information, reviews the chain-of-custody forms, and identifies the data appropriately in the report. The QA Officer is responsible for identifying any results where holding times have been exceeded, sample identification information is incorrect, samples were inappropriately handled, or calibration information or quality control data are missing or inadequate. Such data are marked as unacceptable and will not be entered into the database.

C. Assessment/Oversight

20. Assessments and Response Actions

The use of approved equipment and methods when obtaining water samples and conducting field measurements and/or laboratory analyses, must undergo periodic verification that proper sampling and measurement methods are, in fact, being employed as planned. The internal and/or external verification is required to ensure that:

- All elements of the QAPP are correctly implemented as prescribed.
- The quality of data generated by implementation of the QAPP is adequate.
- Corrective actions, when needed, are implemented in a timely manner and their effectiveness is confirmed.

Although external assessments including a 3rd party audit may be employed when needed, internal assessments provide sufficient information about the degree to which QAPP is implemented. All assessments and reviews are conduced by the Science and Monitoring Group's QA Officer, Joanna Wisniewska. She conducts quarterly reviews of field activities and reports the results to the Project Manager, Jo Ann Weber. The reviews include, but are not limited to: the examination of equipment, record keeping, locating a sample site, sampling procedures, Horiba 10-U 6-parameter probe calibration, sample handling and transportation, and field documentation.

For Truesdail Laboratories, Inc., the technical systems audits are thorough, systematic onsite qualitative assessments. The audits include, but are not limited to the examination of facilities, equipment, personnel, training, procedures (SOPs), and record keeping for conformance to the QAPP. The Science and Monitoring Group QA Officer routinely audits Truesdail Laboratories, Inc. yearly. During the laboratory systems audit, it should be clear what equipment is used, what personnel are involved, and what procedures are followed for data quality verification.

Assessments are accomplished by conducting performance evaluation and technical systems audits of field sampling, field measurement, and laboratory analysis. "Blind" samples are used for performance evaluation. "Blind" samples are those whose identity is unknown to those operating the measurement

system. These can be standards or duplicate samples. Use of these materials allows for assessment of data quality objectives such as precision and accuracy.

The QA Officer has the power to halt all sampling and analytical work conducted by both the Science and Monitoring Group and Truesdail Laboratories, Inc. if the deviation(s) noted are considered detrimental to data quality.

20.1 Field Corrective Actions

The initial Responsibility for monitoring the quality of field measurements lies with the field personnel. The QA Officer is responsible for verifying that all QA/QC procedures are followed. This requires that the Officer assess the correctness of the field methods and the field staff's ability to meet QA/QC objectives. Consequently, the QA Officer has to make a value judgment regarding the impact a given problem may have upon data quality.

If a field situation occurs that jeopardizes the integrity of the project, misses a QA/QC objective, or significantly impacts data quality, the field staff must immediately notify the QA Officer or the Project Manager. Corrective action measures are then decided upon and implemented. The QA Officer documents the situation, the field objective affected, the corrective action taken, and the results of the action. Copies of the documentation are filed in the project binder.

20.2 Laboratory Corrective Action

If any discrepancy is discovered during an audit, the Science and Monitoring Group QA Officer will discuss the observed discrepancy with the person(s) responsible for the activity (see organization chart, Figure 1). Issues discussed should include enquiries such as: whether the information collected is accurate, what were the cause(s) leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered.

Any practices or procedures that do not conform to the written QAPP must be addressed in a timely manner. Any inadequacy(ies) must be documented and communicated in writing to the laboratory Project Manager. The laboratory Project Manager is then responsible for making corrections needed and for reporting these actions in writing to the Science and Monitoring Group QA Officer. Copies of the documentation are filed in the project binder. Follow-up inspections may be used to confirm that deficiencies have been addressed and corrected.

If an internal laboratory process is out-of-control, corrective action(s) shall be taken and documented (see Appendix 7, Truesdail Laboratories, Inc. Corrective Action Form), with regard to:

- Indication/description of the out-of-control situation
- Cause that was discovered
- Action taken to resolve problem
- Was the corrective action acceptable?

If the out-of-control process or out of calibration conditions affected project data results, notification from the laboratory Project Manager must sent to the Science and Monitoring Group QA Officer and filed in the project binder.

21. Reports to Management

Table 19 outlines the schedule of reports due to the Project Manager.

Table 17. Management Reports

Type of Report	Frequency	Projected Delivery Dates(s)	Person(s) Responsible for Report Preparation	Report Recipients
Dry Weather Site Reports	Annually	December 1, 2009	Steven DiDonna Ken Liddell	Jo Ann Weber, Project Manager
Dry Weather General Watershed Assessment	Annually	December 1, 2009	Steven DiDonna Ken Liddell	Jo Ann Weber, Project Manager
IC/ID Investigation Reports	Annually	December 1, 2009	Steven DiDonna Ken Liddell	Jo Ann Weber, Project Manager
IC/ID Referrals	As Needed	---------	Steven DiDonna Ken Liddell	Jo Ann Weber, Project Manager
Dry Weather Procedures Manual	As Needed	June 7, 2009	Steven DiDonna	Jo Ann Weber, Project Manager
Quality Assurance Project Plan	As Needed	June 7, 2009	Joanna Wisniewska	Jo Ann Weber, Project Manager
Dry Weather Monitoring Annual Report	Annually	December 30, 2009	Steven DiDonna Ken Liddell	Jo Ann Weber, Project Manager
Data Quality Control and Quality Assurance Report	Annually	December 30, 2009	Joanna Wisniewska	Jo Ann Weber, Project Manager

D. Data Validation and Usability

22. Data Review, Verification and Validation

Data validation is the process whereby data are filtered and accepted or rejected, based on a set of criteria. The data validation process consists of data generation, reduction, and review and it is an on-going process involving field and laboratory staff, Laboratory Managers, and QA/QC personnel. The Science and Monitoring Group QA Officer is responsible for the data review, verification, and validation.

22.1 Data Verification

Data Verification is confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. It is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method and procedural, or contractual, requirements. The process of data verification effectively ensures the accuracy of data using validated methods and protocols and is often based on comparison with reference standards.

Questions that may be asked in data verification are:

- Have the data been collected according to a specified method?
- Have the collected data been faithfully recorded and transmitted?

22.2 Data Validation

Data Validation is confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Data validation is an analyte-and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set.

Data meeting verification and validation criteria are accepted for inclusion in the database. Data that do not meet these requirements are excluded.

23. Verification and Validation Methods

23.1 Database Generation

All data collected in the field are recorded on-site using filed data sheets (Appendix 1). All data sheets are completed in waterproof ink, reviewed for accuracy and completeness and initialed by the field staff present.

The field staff member who generates the data is primarily responsible for its accuracy and completeness and must review 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

Upon return from the field or as soon as possible thereafter, the data are entered into the Dry Weather Monitoring database. Once data entry is completed, the person entering the data dates and initials the top of the pertinent datasheet. The datasheets are then placed in the appropriate project binder labeled with the data type and project name. Note: a long-term project being carried out by the Laboratory Coordinator aims to cross-check 100% of the field data sheets with the data entered into the DWM database. After each sheet is checked, it is marked "QA/QC" and dated and initialed in red ink in the lower right corner.

23.2 Error Checking and Verification

On a weekly basis, 20% of the data entries are screened by the QA Officer or designee. If any errors are found they are corrected and noted on original datasheet(s). If no errors are found, the datasheets are marked with a "√" and initialed.

Laboratory data validation is performed by the Laboratory Manager and reviewed by the QA Officer. If an outlier or other issues arise, the QA Officer will contact the Laboratory Manager and attempt to resolve any discrepancies. Data validation is accomplished through routine audits of the data collection procedures and by monitoring of QA/QC sample results.

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.

The minimum requirements for each analytical run area are:

- Matrix spike and duplicate analyses per concentration level and per matrix for every sample batch analyzed (where appropriate).
- Reference materials analyses compared with "true" values and acceptable ranges. Values outside the acceptable ranges indicate that the sample values are invalid. Following correction of the problem, the reference material should be reanalyzed.

24. Reconciliation with User Requirements

The QA Officer reviews data after each survey to determine if data quality objectives (DQOs) are met. If data do not meet the project's specifications, the QA Officer will determine if the problem is due to calibration/maintenance, sampling techniques, or other factors and suggest corrective action. It is expected that encountered problems can be corrected by retraining, revision of techniques, or replacement of supplies/equipment. If not, then the DQOs will be reviewed for feasibility. If specific DQOs are not achievable, the QA Officer will recommend appropriate modifications. Any revisions require approval by the Project Manager, Jo Ann Weber.

All data collected by the Science and Monitoring Group and other organizations will be analyzed using basic statistics and used by the County for the establishment of action levels, IC/ID investigations, and water quality assessment. The data will be utilized to characterize and analyze water quality conditions, for example, to compare water quality between different watersheds and different sites, and/or analyze water quality trends over time. The data collected from these projects will allow for identification of waterbodies where pollution controls may be needed or for determining the effectiveness of controls already in place. These objectives are accomplished by comparing measurement results to the established water quality objectives or action levels

25. References

County of San Diego. 2004. Dry Weather Analytical and Field Screening Monitoring Procedures Manual.

County of San Diego. 2004. Dry Weather Monitoring Report for 2003.

County of San Diego. 2005. Dry Weather Monitoring Report for 2004.

San Diego Regional Water Quality Control Board, 2001. Waste Discharge Requirements for Discharges of Urban Runoff from the Municipal Separate Storm Sewer Systems (MS4s) Draining the Watersheds of the County of San Diego, the Incorporated Cities of San Diego County, and the San Diego Unified Port District.

US EPA, 1998. EPA Guidance for Quality Assurance Project Plans. EPA/600/R-98/018.

APHA, AWWA, and WEF, 1998. Standard Methods for Examination of Water and Wastewater. 20th edition.

Puckett, M. 2002. Quality Assurance Management Plan for the State of California's Surface Water Ambient Monitoring Program (SWAMP). December 2002.

Appendix 1. Field Data Sheet

COUNTY OF SAN DIEGO
WATERSHED PROTECTION PROGRAM

DEPARTMENT OF PUBLIC WORKS
5201 RUFFIN ROAD, SUITE P
SAN DIEGO, CA 92123

Dry Weather Monitoring Field Datasheet

New Site? ☐ Yes ☐ No ☐ **IC/ID Follow-up for**_____

GENERAL SITE DESCRIPTION

Site ID		**Site Type**		**Sample Event ID**		**Sample Event Type**	
Location	(NAD 83 decimal degrees to 5th place)				**Watershed**	**Hydrologic Unit**	
Date		**Time**		**Latitude**	° N	**Hydrologic Area**	
Field Staff		**Thomas Guide**		**Longitude**	° W	**Hydrologic Subarea**	

QC Sample	☐ None	☐ Original	☐ Duplicate	☐ Blank	☐ Split	☐ Lab Standard
Land Use (Primary) (Check one only)	☐ Residential	☐ Rural Resid.	☐ Commercial	☐ Indusial	☐ Agriculture	☐ Parks ☐ Open
Land Use (Secondary) (Optional, >10%)	☐ Residential	☐ Rural Resid.	☐ Commercial	☐ Indusial	☐ Agr.	☐ Parks ☐ Open ☐ None
Conveyance (Check one only)	☐ Concrete Channel	☐ Natural Creek	☐ Earthen Channel	☐ Manhole	☐ Catch Basin	☐ Outlet ☐ Curb/Gutter

WATER FLOW ☐ Flowing ☐ Ponded ☐ Dry **REFERRED FOR**

GENERAL CONDITION

Weather ☐ Sunny ☐ Partly Cloudy ☐ Overcast ☐ Fog **Last Rain** ☐ > 72 hours ☐ < 72 hours ☐ None ☐ ≤ 0.1 inches

OBSERVATIONS **N/A**

Odor	☐ None	☐ Musty	☐ Rotten Eggs	☐ Chemical	☐ Sewage	☐ Other
Color	☐ None	☐ Yellow	☐ Brown (Silty)	☐ White (Milky)	☐ Gray	☐ Other
Clarity	☐ Clear	☐ Slightly Cloudy	☐ Opaque			☐ Other
Floatables	☐ None	☐ Trash	☐ Bubbles/Foam	☐ Sheen ☐ Algae	☐ Fecal Matter	☐ Other
Deposit	☐ None	☐ Coarse Particulate	☐ Fine Particulate	☐ Stain	☐ Oily Deposit	☐ Other
Vegetation	☐ None	☐ Limited	☐ Normal	☐ Excessive		☐ Other
Biology	☐ None	☐ Insects ☐ Algae	☐ Snails	☐ Fish ☐ Birds	☐ Cray Fish	☐ Other

FLOW MEASUREMENT **N/A**

Flowing Creek **Average**

Width		ft
Depth		ft
Velocity		ft/sec (enter 0 if water is ponded)
Length of Ponded Area		ft

Evidence of Overland Flow? ☐ Yes ☐ No ☐ Irrigation Runoff ☐ Other _____

Outlet Diameter _____ Liters/Second _____

Leaf Float Distance_____ft Time_____sec

FIELD MEASUREMENT **N/A**

Horiba Meter: ☐ In Stream ☐ In Bucket ☐ Agitated (DO)

Sample Filtered for Test Kits? ☐ Yes ☐ No

Analytical Lab Sample Collected? ☐ Yes ☐ No

Parameter	Reading	Parameter	Reading	Parameter		1st Reading	Dil. Factor	Dil. Reading	Final
pH (Unit)		DO (mg/L)		Phosphate (PO_4)					
Cond. (mS/cm)		Temp (°C)		Nitrate (NO_3)	mg/L				
Turb. (NTU)		Salinity (%)		Ammonia (NH_3-N)					
				MBAS					

COMMENTS: _____

Completed by_____

Appendix 2. Flow Probe User Instruction

1. The FP101 probe handle is a two-piece rod expandable from 3' to 6'. To expand the rod for correct placement in flow, loosen the locking nut on the handle, pull out the top piece, and retighten the nut.
2. Make sure the Flow Probe's propeller turns freely by blowing strongly on the prop.
3. Point the propeller directly into the flow you wish to measure. Face the arrow inside the prop housing downstream.
4. Scroll with the right button until the "V" for velocity appears on the left hand of the screen. The top number in "V" mode is the instantaneous velocity to the nearest 0.1 ft/sec. Push the left button to toggle the bottom number between maximum ("mx") and average ("av") velocities to the nearest 0.01 ft/sec.
5. With the propeller placed at your measuring point, push both the right and left buttons simultaneously and release to clear the computer and reset the average and maximum velocities.
6. For small streams, the probe can be moved slowly and smoothly throughout the flow during average velocity measurement. Move the probe smoothly and evenly back and forth from top to bottom of the flow so that the probe stays at each point in the flow for approximately the same amount of time. Keep moving the probe for 20-40 seconds to obtain an accurate average value that accounts for surging. (Move the probe as if you were spray painting and attempting to get an even coat of paint over the entire surface.).

   The Flow Probe uses true velocity averaging. When the average and maximum velocities are zeroed by pushing both buttons, a running average is started. As long as the probe remains in the flow, the averaging continues. One reading is taken per second, and a continuous average is displayed. For example, after 10 seconds, 10 readings are totaled and then divided by 10 and this average is displayed. Once the average reading becomes steady, the true average velocity of the stream is obtained. When you pull the probe from the water, this average value is frozen on the display until it is reset.

7. Measure/calculate the cross-sectional area of your flow stream in square feet.
8. The average velocity (calculated with the Flow Probe in feet/second) times the cross-sectional area (square feet) equals flow in cubic feet per second (cfs), or $Q = V \times A$.
9. If the propeller gets fouled while measuring flow, clean it until the prop turns freely and start over.

Computer Set-up

The computer's set-up sequence is entered automatically when the batteries are changed. You can also enter the set-up sequence at any time by holding both buttons simultaneously for 8 seconds. During the set-up sequence, all of the display segments are displayed first, and then "mi" appears for English units and "km" appears for metric units. The left button toggles between English and Metric units.

If you wish to measure in English units (standard), or in "feet per second", toggle to "mi". Push the right button to enter "CAL" mode. This is your Flow Probe calibration function. Set the calibration at 33.31. When you change your batteries, you must reset this number. Pushing the left button increases the number when the arrow points up and decreases the number when the arrow points down.

If you wish to measure in Metric units, or in "meters per second", toggle to "km". Push the right button to enter "CAL" mode. This is your Flow Probe calibration function. Set the calibration at 1603. When you change your batteries, you must reset this number. Pushing the left button increases the number when the arrow points up and decreases the number when the arrow points down. NOTE: Unless Metric units are specified when ordering, then measuring in metric units (meters per second) the numbers on the display read 10 times higher than actual measurements (2.23 meters per second reads 22.3).

To continue the set-up sequence after you have set your English or Metric calibration:

1. Push the Right button - be sure "CAD" is not displayed.
2. Push the Right button - SLEEP will appear. If you are not using your Flow Probe for 1-2 month, leave it in this SLEEP mode, to reduce battery drain.
3. Push the Right button - push the Left button to toggle between 24 hr and 12 hr clock.
4. Push the Right button - push the Left button to set HOUR (time of day).
5. Push the Right button - push Left to set the MINUTE (time of day).
6. Push the Right button - you are now out of Set Up and back in Velocity ("V").

Appendix 3. Chain of Custody Form

Need to insert Truesdail Chain of Custody here in pdf format.

Appendix 4. Horiba U-10 Meter Calibration Procedures

(Revised February 2005)

1. Set **S.SET** to ***A*** (Auto-salinity)
2. Calibrate the meter using the *AutoCal* solution
3. Verify the meter using second calibration solutions (Table 1).
4. If the relative percent difference (RPD) is <±5% for all parameters (Table 2), calibration is complete.
5. Record all the readings in the logsheet.

6. If RPD is >±5% for a parameter, recalibrate the parameter using the solutions and values provided in Table 1.
7. After recalibration, verify the meter using the same solutions.
8. If RPD is <±5% for recalibrated parameters, calibration is complete.
9. Record all the reading in the logsheet.

Table 1. Calibration solutions and values

Parameter	*AutoCal*	2nd Solutions	Note
pH	4.00	7.00	At room temperature (~22°C)
Conductivity	4.49 mS/cm	5.87 mS/cm	25 °C
Turbidity	0 NTU	100 NTU	
DO	8.52 mg/L	0.0 (Zero oxygen)	Set to *A* (Auto-salinity)

Table 2. Standard values and ranges with ±5% error

Parameter	Value	-5%	+5%
pH	4.00	3.80	4.20
	7.00*	6.80	7.20
Conductivity	4.49	4.27	4.71
	5.87	5.58	6.16
Turbidity	100	95	105
DO	8.52	8.09	8.95

*N/A

Table 3. pH values at different temperatures

Temperature	pH 4	pH 7
20	4.00	7.00
22	4.00	7.00
25	4.01	7.00

Horiba U-10 Calibration Logsheet

CALIBRATED BY_____ DATE_____ TIME:_____

Calibration		pH	Cond. (mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp. (^{o}C)	Salinity (%)
1st AutoCal	Std. Value	4.00	4.49	0.0	8.52	@ 22	
	Reading						
2nd Solutions	Std. Value	7.00	5.87	100			
	Reading						
DO*	0.0 mg/L	N/A	N/A	N/A		N/A	N/A

*Zero DO calibration only.

CALIBRATED BY_____ DATE_____ TIME:_____

Calibration		pH	Cond. (mS/cm)	Turbidity (NTU)	DO (mg/L)	Temp. (^{o}C)	Salinity (%)
1st AutoCal	Std. Value	4.00	4.49	0.0	8.52	@ 22	
	Reading						
2nd Solutions	Std. Value	7.00	5.87	100			
	Reading						
DO*	0.0 mg/L	N/A	N/A	N/A		N/A	N/A

*Zero DO calibration only.

Parameter	Value	-5%	+5%
pH	4.00	3.80	4.20
	7.00*	6.80	7.20
Conductivity	4.49	4.27	4.71
	5.87	5.58	6.16
Turbidity	100	95	105
DO	8.52	8.09	8.95

*N/A.

Appendix 5. Dry Weather Analytical and Field Screening Procedures Manual

Appendix 6. Truesdail Laboratories, Inc. "Quality Assurance and Quality Control Manual for Environmental Sample Analysis"

Appendix 7. Truesdail Laboratories, Inc. Corrective Action Form

TRUESDAIL LABORATORIES, INC.
QUALITY ASSURANCE - CORRECTIVE ACTION REQUEST (CAR)

1. Number:	
Revision:	
2. Date:	

3. Item / System Description:	
4. Client/Responsible Party:	5. Lab Record No. / P. O. No.:
6. Description of Condition:	
7. Condition Noted In: Department	8. Initiator: _____ Date: _____
9. ***The above condition requires your prompt attention for corrective action.***	Reply Requested From: _____ Reply Due Date: **ASAP**

10. Action Taken to Resolve Problem:			
11. Effective Date:	12. Signature: Title: Date:		
13. Cause of Condition:		15. Corrective Action to Prevent Recurrence:	
14. Signature: Date:		16. Effective Date:	17. Signature: Date:

18. Corrective Action Acceptable: _____ Yes _____ No (See 20.)	Quality Assurance Signature: Date:
19. Corrective Action Implementation Verified: _____ Yes _____ No	Quality Assurance Signature: Date:
20. Remarks / References:	
21. ***QA Final Review (CAR Closed):***	Quality Assurance Signature: Date:
22. Distribution: President - Technical Director - Environmental Manager - CAR Logbook	

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Appendix 8. Trash Assessment Form

Trash Assessment Form

SITE ID: _____ **DATE:** _____

LOCATION: _____ **TIME:** _____

OBSERVER: _____

PREVIOUS TRASH ASSESSMENT RATING (IF APPLICABLE):_____

ESTIMATED AREA OF ASSESSMENT L X W (FT):_____

Amount and Extent of Trash	
EVALUATION OF TRASH INCLUDES*: ☐ **MS4** ☐ **RECEIVING WATER** ☐ **BOTH**	
☐ **Optimal**	On first glance, no trash visible. Little or no trash (<10 pieces) evident when evaluated area is closely examined for litter and debris.
☐ **Suboptimal**	On first glance, little or no trash visible. After close inspection small levels of trash (~10-50 pieces) evident in evaluated area.
☐ **Marginal**	Trash is evident in low to medium levels (~51-100 pieces) on first glance. Evaluated area contains litter and debris. Evidence of site being used by people: scattered cans, bottles, food wrappers, blankets, or clothing present.
☐ **Submarginal**	Trash distracts the eye on first glance. Evaluated area contains substantial levels of litter and debris (>100- 400) . Evidence of site being used frequently by people: many cans, bottles, food wrappers, blankets, or clothing present.
☐ **Poor**	Site is significantly impacted by trash. Evidence of trash accumulation behind a constriction point or evidence of excessive dumping. Evaluated area contains substantial levels of litter and debris (>400 pieces).

* In areas where receiving water is accessible and adjacent to dry weather site, trash evaluation must include receiving water.

Site Evaluation for Threat to Human Health and/or Aquatic Health	
☐ **Threat Human Health**	Site poses a threat to human health via swimming, wading, or walking through the area. Trash and debris has the potential to contain chemicals that may bioaccumulate, transmit dangerous bacteria (e.g. medical waste, diapers, human waste), or has the potential for physical harm (sharps, entanglement, nails, etc…). Comments should be added for clarification.
☐ **Threat to Aquatic Health**	Site poses a threat to aquatic health or other wildlife (via contact, ingestion, entanglement, etc...) from the trash and debris present. Trash and debris such as small floatable material that is persistent and can be transported long distances may resemble food and may be ingested. Wire, plastic, fishing line, and other material that has the potential for entanglement. Oil and other visible chemicals or chemical containers falls in this category. Comments should be added for clarification.

- **Complete the following section for Submarginal, and Poor Evaluations ONLY**

TYPE	Ranking or Count by Type *	POTENTIAL ROUTE (CHECK UP TO 2)				POTENTIAL SOURCE (CHECK UP TO 2)						
		Dumping	Littering	Upstream	Unable to determine	Household	Construction	Commercial	Industrial	School	Transient	Unable to determine
Automotive												
Biohazard Waste												
Business Related												
Cigarette Butts												
Construction												
Fabric/Clothing												
Food Packaging												
Food Waste												
Household												
Shopping Carts												
Toxic												
Yard Waste												

* Only rank the types of trash PRESENT in evaluated area from 1 through 12 (1 is most prevalent – 12 is least prevalent). DO NOT rank types of trash that are not present in evaluated area.

Comments:_____