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SAN BERNARDINO COUNTY STORMWATER
PROGRAM

Integrated Watershed Monitoring Program (IWMP)

submitted to:

SANTA ANA REGIONAL WATER QUALITY CONTROL BOARD

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Section 1. Purpose

On January 29, 2010, the California Regional Water Quality Control Board - Santa Ana Region (Regional Board) adopted a National Pollutant Discharge Elimination System (NPDES) Permit (No. R8-2010-0036) for the consortium of the San Bernardino County Flood Control District (SBCFCD), the County of San Bernardino, and the incorporated cities of San Bernardino County within the Santa Ana Region (San Bernardino County MS4 Permit, or Permit). The Permit includes the Receiving Waters and Urban Runoff Monitoring and Reporting Program (MRP) which requires the SBCFCD, as Principal Permittee for the San Bernardino County Stormwater Program (Program), to administer and conduct the activities required by the MRP. The Principal Permittee administers all Program activities, including the MRP and associated area-wide stormwater monitoring program.

The MRP describes two types of monitoring programs:

1. An Integrated Watershed Monitoring Program (IWMP) that is to be developed under the MRP; and
2. Regional monitoring efforts where the Permittees participate or make monetary contributions, including TMDL-related monitoring.

The overall objective of the IWMP is to provide data to support the development of an effective watershed and key environmental resources management program that focuses resources on the priority pollutants of concern. The Permittees have identified the priority list of pollutants of concern in the watershed, determined from a risk-based analysis of water quality monitoring results collected during previous permit terms. These pollutants, in order of priority from high to low were: (1) high priority - bacteria; (2) medium priority - metals (zinc, copper, lead); and (3) low priority - nutrients, TSS and COD. This priority ranking provides the basis for a risk-based approach to Program stormwater management and to direct resources to the most important water quality monitoring and improvement activities. Additional objectives of the monitoring programs, as stated in the Permit MRP, include:

1. To provide data to support the development of an effective municipal urban runoff pollutant source control program.
2. To determine water quality status, trends, and pollutants of concern associated with urban runoff and their impact on the beneficial uses of the receiving waters. This includes determining current conditions in the receiving waters including the extent and magnitude of any impairments, and relative urban runoff contribution to the impairment.
3. To assist in identifying the sources of the priority list of pollutants of concern in urban runoff to the maximum extent practicable (e.g., including, but not limited to atmospheric deposition, contaminated sediments, other non-point sources, etc.)
4. To characterize pollutants associated with urban runoff and to assess the influence of urban land uses on receiving water quality
5. To evaluate the effectiveness of existing urban runoff water quality management programs, including an estimate of pollutant reductions achieved by the treatment and source control BMPs implemented by the Permittees.
6. To detect illegal discharges and illicit connections to the MS4s so they can be responded to or eliminated.

7. To identify those waters, which without additional action to control pollution from urban storm water discharges, cannot reasonably be expected to attain or maintain applicable water quality objectives in the Basin Plan.
8. To identify and prioritize the most significant water quality problems resulting from urban runoff. Order No. R8-2010-0036 establishes new program monitoring priorities through the development and implementation of a risk-based, outcome-oriented, compliance-focused program. Monitoring and sampling data shall be used to identify and prioritize the most significant water quality problems in receiving waters.
9. To evaluate costs and benefits of proposed municipal storm water quality control programs to the stakeholders, including the public.

The IWMP described in this document is designed to meet the stated objectives and the requirements of the MRP. The IWMP is organized according to the following components. The corresponding Permit provision is also provided.

Section 1. Purpose - This Section describes the background, objectives, and components of the IWMP document. (MRP Sections I and II)

Section 2. Monitoring Strategy – This Section frames the monitoring program in the context of the Permit monitoring objectives and the SMC Guidance management questions, and proposes a monitoring strategy.

Section 3. Core Monitoring – This Section describes the Core Monitoring component of the IWMP. Core Monitoring consists of receiving water monitoring and monitoring within the MS4s. The monitoring within the MS4s component of Core Monitoring is very similar to urban discharge mass emissions monitoring and has been combined for the purposes of the IWMP. The requirements of both components are covered under Core Monitoring. (MRP Section IV.B.1 and 2)

Section 4. Illegal Discharge/Illicit Connection Monitoring - This Section describes the illegal discharge/illicit connection strategy and associated monitoring component of the IWMP. (MRP Section IV.B.3)

Section 5. Hydromodification Monitoring Plan - This Section describes the Hydromodification Monitoring Plan component of the IWMP. The Hydromodification Monitoring Plan is part of the Watershed Action Plan required under the Permit. (MRP Section IV.B.4)

Section 6. Source Identification and Special Studies. This Section describes the pollutant of concern source identification monitoring and special studies monitoring component of the IWMP. (MRP Section IV.B.5)

Section 7. Regional Watershed Monitoring. The Section describes regional monitoring activities, including TMDL monitoring, in which the Principal Permittee participates. These activities are not considered part of the IWMP, but are part of the monitoring activities covered by the Permit MRP, therefore, are described within this document. (MRP Section V)

The IWMP will be implemented beginning Fiscal Year 2011-12.

Section 2. Monitoring Strategy

A review of Section 1 and the Permit MRP indicates that the IWMP will need to address numerous, and potentially competing, objectives. Thus, it is a significant challenge to the Permittees to develop a monitoring program that meets these objectives and that will be cost effective and generate data that will lead to improvement in water quality through the stormwater management program. In response to this on-going challenge, the Permittees have been participating in the Southern California Stormwater Monitoring Coalition's (SMC) efforts¹ to provide guidance in developing monitoring programs to support municipal stormwater management programs. The SMC guidance is structured around five fundamental management questions, which are listed below:

- Question 1: Are conditions in receiving waters protective, or likely to be protective, of beneficial uses?
- Question 2: What is the extent and magnitude of the current or potential receiving water problems?
- Question 3: What is the relative urban runoff contribution to the receiving water problem(s)?
- Question 4: What are the sources to urban runoff that contribute to receiving water problem(s)?
- Question 5: Are conditions in receiving waters getting better or worse?

The type of monitoring utilized (permanent stations versus short term stations, monitoring frequency, monitored constituents, etc.) depends upon the objective and the beneficial uses being protected. The SMC guidance discusses each question and the supporting type of monitoring required to answer the question.

To help frame the MRP requirements with the approaches recommended in the SMC Guidance, the MRP objectives were compared with the core management questions. This comparison is shown in Table 1.

¹ "Model Monitoring Program for MS4s in Southern California", a report by the Stormwater Monitoring Coalitions, August 2004. SCCWRP Technical Report 419

Table 1. Comparison of Permit Objectives and Management Questions

Permit Defined Monitoring Objectives	Management Questions				
	Q1	Q2	Q3	Q4	Q5
1. To provide data to support the development of an effective municipal urban runoff pollutant source control program.	X	X	X	X	X
2. To determine water quality status, trends, and pollutants of concern associated with urban runoff and their impact on the beneficial uses of the receiving waters.	X				X
3. To assist in identifying the sources of the priority list of pollutants of concern in urban runoff			X	X	
4. To characterize pollutants associated with urban runoff and to assess the influence of urban land uses on receiving water quality	X		X		X
5. To evaluate the effectiveness of existing urban runoff water quality management programs, including an estimate of pollutant reductions achieved by the treatment and source control BMPs	X		X		X
6. To detect illegal discharges and illicit connections to the MS4s				X	
7. To identify those waters, which without additional action to control pollution from urban storm water discharges, cannot reasonably be expected to attain or maintain applicable water quality objectives	X	X			
8. To identify and prioritize the most significant water quality problems resulting from urban runoff	X	X			X
9. To evaluate costs and benefits of proposed municipal storm water quality control programs	N/A				

A review of Table 1 demonstrates that the Program monitoring efforts will need to be comprehensive and include a combination of long and short term monitoring efforts as well as permanent and mobile stations in order to address all of the monitoring objectives of the MRP. To further assist the Program in developing a monitoring strategy, the SMC guidance recommends that the following steps be addressed:

1. Evaluate a program's ability to answer each of the five management questions.
2. Identify critical gaps in knowledge (e.g., inability to document impacts, lack of knowledge about potential sources, absence of trend monitoring component) relevant to each program's circumstances.

Core monitoring efforts by the Program to date have focused primarily on establishing a baseline for water quality conditions throughout the watershed (see Appendix 1, Table A1-3, SMC Guidance). Thus the focus has been primarily on management question #1 and #5, and to a

limited extent #2. To date, the core monitoring program has not appreciably addressed the other management questions.

This IWMP is designed to comply with the MRP requirements and to support the logic and approach recommended in the SMC Guidance. Therefore, the IWMP includes a combination of long term (permanent) stations and short term (rotating) stations (Table 2).

Table 2. Proposed Monitoring Strategy

Monitoring Strategy	Management Questions				
	Q1	Q2	Q3	Q4	Q5
Permanent Stations <ul style="list-style-type: none"> • 1-2 Receiving Water Stations in each Zone or major receiving water • Multiple Years • 3 wet/2 dry events 	X				X
Rotating Stations <ul style="list-style-type: none"> • Multiple complementary receiving water stations and outfalls in each flood zone • Rotate Zone monitored every 1-3 years • 3 wet/2dry events 		X	X	X	

The permanent station should be located at the bottom-of-watershed, be fixed, and provide data to assess cumulative water quality and aggregate loads. The monitoring would primarily be focused on habitat protection, while the MSAR Bacteria TMDL monitoring will support the monitoring needs for recreational uses.

The location and characteristics of the rotating stations depends on the permit objectives, e.g. source identification, urban runoff characterization, BMP implementation, etc., and must meet the mandatory permit requirements.

Section 3. Core Monitoring

Core Monitoring consists of both receiving water and urban discharge/MS4 monitoring². Once approved, Core Monitoring contained in the IWMP replaces the existing core monitoring program. The Core Monitoring contained in the IWMP will not be implemented until the 2011/2012 storm season. The requirement to conduct monitoring within the MS4s (MRP Section IV.B.1.b) under core monitoring has been combined with the urban discharge mass emissions monitoring (MRP Section IV.B.2) and organized under Core Monitoring in the IWMP. The goals of receiving water monitoring and urban discharge /MS4 monitoring are directly related (See Section 2).

One of the primary objectives of receiving water monitoring is to provide data adequate to determine whether urban runoff is causing or contributing to exceedances of water quality standards in the receiving waters. In addition, receiving water monitoring supports the objectives noted in Section 2.

Requirements for receiving water monitoring including the number of sites, events, and constituents are not specified by the MRP. In order to achieve the objective of receiving water monitoring, the Core Monitoring in the IWMP designates the same constituents and events for receiving water monitoring as those required for urban discharge mass emissions monitoring, and assigns receiving water monitoring sites that are complementary to the urban discharge mass emissions monitoring sites.

As discussed above, the urban discharge mass emissions monitoring has been combined with the monitoring within MS4s requirement of Core Monitoring. The overall objective of urban discharge /MS4 monitoring is to determine the pollutant loads from the MS4s and to determine their trends over time. Additional major objectives of Core Monitoring include:

1. Provide data sufficient to estimate the total mass emissions of pollutants of concern from the MS4 to receiving waters.
2. Provide data sufficient to assess trends in mass emissions associated with urban storm water runoff from the MS4s over time and evaluate potential correlations between any trends in mass emission and land use and population changes.
3. Provide data sufficient to determine if the MS4 is contributing to exceedances of water quality standards, by comparing outfall and receiving water results to: (1) Basin Plan Water quality Objectives (WQOs); (2) EPA storm water benchmarks contained in the EPA Multi-Sector Industrial Storm Water Permit; (3) California Toxic Rule (CTR); and (4) other MS4 discharge monitoring data.

However, that Basin Plan WQOs and CTR criteria are applicable only to receiving waters, and EPA storm water benchmarks were intended to be applicable only to industrial stormwater runoff rather than municipal stormwater runoff.

Core Monitoring will include both permanent and rotating sites as discussed in Section 2 and discussed in greater detail below. Rotating sites will be organized by the SBCFCD Zones (Figure

² The terms MS4 monitoring, urban discharge monitoring, and stormwater monitoring are used interchangeably in this document.

1), such that one Zone is sampled at a time for a period of 1-3 years. Zones 1, 2, and 3 will be addressed on a rotating basis. By focusing on one Zone at a time, the Principal Permittee can collect data at a greater spatial detail and that pairs receiving water and urban discharge samples. This type of sample design provides for data collection that leads to improvement of the stormwater management program and pollutant assessment and achieves the goals of the MRP, while maintaining cost effectiveness and economic feasibility.

3.1. MONITORING STATIONS

The MRP requires that urban discharge mass emissions monitoring sites be selected to be representative of characteristics such as flow, duration, and pollutant loading within stormwater conveyance systems, and based on proximity to receiving water monitoring sites, or for other source tracking reasons. The MRP requires that receiving water monitoring sites be selected to be close to MS4 discharge locations and to include locations where chronic or persistent water quality problems have been identified. The number of urban discharge mass emissions and receiving water monitoring sites is not dictated by the MRP.

All Permanent monitoring stations are receiving water stations. Permanent monitoring stations are located in major receiving waters within the Santa Ana Region of San Bernardino County. The objective of the Permanent monitoring stations is to provide long term data to evaluate the water quality of the receiving water and determine if the receiving water is affected by discharges within the drainage area. Permanent monitoring stations were selected to continue long-term data sets and to provide data to be used in conjunction with data collected at rotating monitoring stations. Permanent monitoring stations are presented in Table 3 and Figure 1. Permanent monitoring stations may be adjusted to address management or other program needs.

Table 3. Permanent Monitoring Stations

Site ID	Location	Coordinates	Type	Notes
11	Santa Ana River @ La Cadena Drive	34.0452° N, - 117.3313° W	Receiving Water	Drains Zone 2 and 3
8b	Santa Ana River @ Pedley Avenue	33.9552°N, 117.5328°W	Receiving Water	Long-term Station
3b	Cucamonga Creek @ Hellman Avenue	33.9495°N, 117.6104°W	Receiving Water	Zone 1

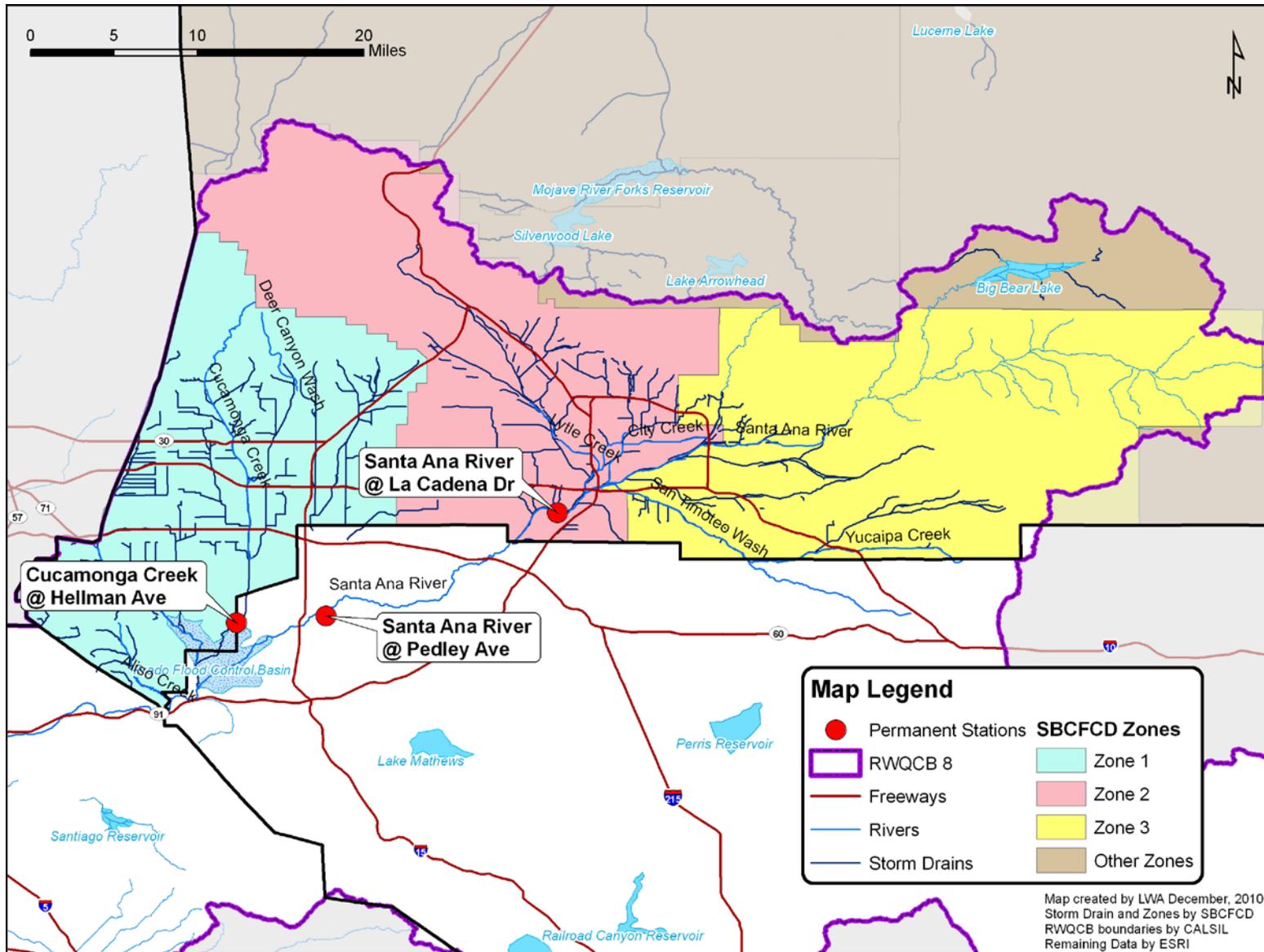


Figure 1. SBCFCD Zones and Permanent Stations

Rotating monitoring stations are located in receiving waters upstream of the Permanent monitoring stations, in tributaries to receiving waters, and in major outfalls or stormwater channels that discharge to the receiving water and tributaries. Therefore, Rotating monitoring stations can be either urban discharge mass emissions sites or receiving water sites.

Furthermore, many receiving water channels primarily convey urban discharge. Receiving water and urban discharge sites are located such that sampling results can be used to further source identification efforts and that the affect of the urban discharge on the receiving water can be evaluated. Monitoring stations may be selected to focus on a single drainage within a Zone in order to collect data that can provide the most benefit for stormwater management activities. In subsequent cycles, Rotating sites in each Zone may be adjusted in an iterative process to focus on problem areas within a drainage area or on alternative drainage areas. Site locations may be adjusted to address management or other program needs, such as the development and implementation of the Comprehensive Bacteria Reduction Plan (CBRP). The Rotating monitoring stations for Zone 1 are presented in Table 4 and Figure 2. The Rotating monitoring stations for Zones 2 and 3 will be developed prior to initiation of sampling within the respective Zone.

Table 4. Zone 1 Rotating Monitoring Stations

Site ID	Location	Coordinates	Type	Notes
TBD	Cucamonga Creek @ Edison Avenue	33.9972°N, 117.5992°W	Receiving Water	Below Lower Deer Creek Channel
TBD	Lower Deer Creek Channel @ above Chris Basin	34.0082°N, 117.5931°W	UDME/Tributary	Site above Chris Basin, Drains to Cucamonga Ck @ Edison
2	Cucamonga Creek @ Highway 60	34.0295°N, 117.5993°W	Receiving Water	Below West Cucamonga Ck
TBD	Deer Ck Channel @ Archibald Avenue	34.0755°N, 117.5935°W	UDME/Tributary	Drains to Cucamonga Creek
TBD	Cucamonga Ck below Turner Basin Diversion	34.0775°N, 117.6010°W	Receiving Water	Above Deer Ck Channel

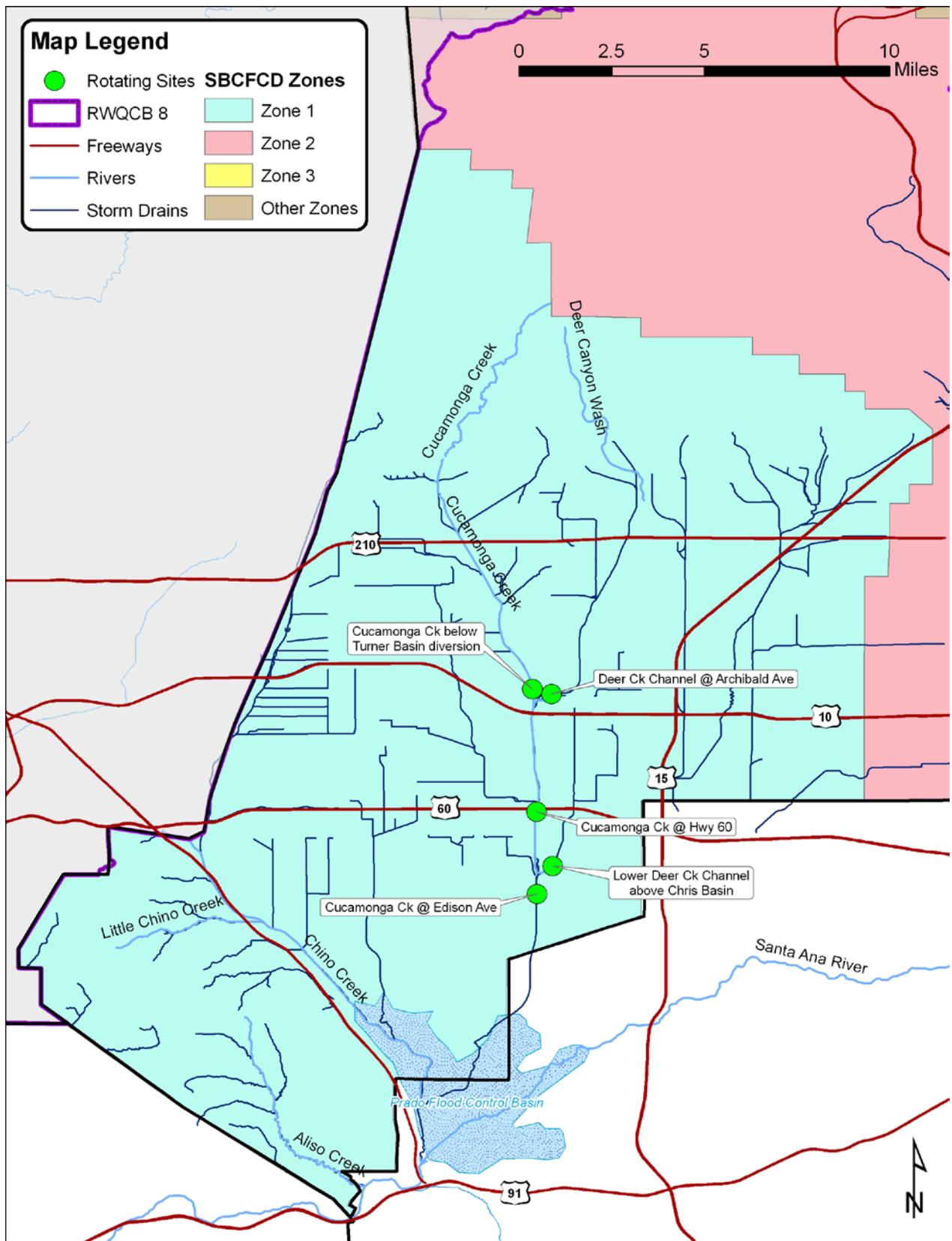


Figure 2. Zone 1 Rotating Stations

3.2. MONITORING CRITERIA AND FREQUENCY

At each urban discharge mass emissions monitoring site the MRP requires at least three wet weather events to be sampled during each wet season (October 1 - May 31, per MRP IV.B.2.b), including the first storm of the wet season. There is no definition regarding the amount of precipitation that constitutes a storm event within the permit. In previous monitoring years, the minimum rainfall constituting qualification for a wet weather event was set to 0.25 inches measured at the Ely Basins rain gauge station (#2866). Therefore, the following criteria, consistent with the previous monitoring effort, define a storm event:

- A minimum of 0.25 inches measured at Ely Basin
- Less than 0.1 inch of rainfall during the 72 hours preceding the monitored event.

The MRP also requires at least two samples to be collected during dry weather conditions at each urban discharge mass emissions monitoring site. As stated above, receiving water monitoring will be conducted at the same frequency as urban discharge mass emissions monitoring. Core Monitoring frequency for both Permanent and Rotating monitoring stations is presented in Table 5.

Table 5. Core Monitoring Frequency

Sample Type	Frequency per Reporting Year
Wet Weather	3 events (including first storm of the season)
Dry Weather	2 events

3.3. MONITORED CONSTITUENTS

The MRP requires that all urban discharge/MS4 samples be analyzed for *E. coli*, nutrients (nitrates and nitrites, potassium, and phosphorous), metals, pH, TSS, TOC, organophosphorus pesticides/herbicides, and any other constituents that are known to have contributed to impairment of local receiving waters by inclusion on the 303(d) list. In addition, all dry weather samples must be analyzed for total petroleum hydrocarbons (by method 8015M) and oil and grease. Additionally, for the first storm event, and one dry weather event, the MRP requires that sample be analyzed for the entire suite of priority pollutants. Table 6 presents the constituents to be analyzed for the first wet and dry event of each reporting year in both receiving water and urban discharge for both Permanent and Rotating monitoring stations, and Table 7 presents the constituents to be analyzed for the subsequent wet and dry events. Although the MRP does not specify the constituents required to be monitored in the receiving water, the IWMP includes the same constituents for the receiving water monitoring that are specified for the urban discharge monitoring in order to provide relevant and comparable results. The MRP also requires that flow in cubic feet per second (cfs) be measured or estimated for each monitoring location.

Table 6. Monitored Constituents for the First Wet Weather and Dry Weather Events

1. PRIORITY POLLUTANTS		
a. Metals		
• Antimony	• Copper, Total	• Selenium, Total
• Arsenic, Total	• Copper, Dissolved	• Selenium, Dissolved
• Arsenic, Dissolved	• Lead, Total	• Silver, Total
• Beryllium	• Lead, Dissolved	• Silver, Dissolved
• Cadmium, Total	• Mercury	• Thallium
• Cadmium, Dissolved	• Nickel, Total	• Zinc, Total
• Chromium (Total)	• Nickel, Dissolved	• Zinc, Dissolved
• Chromium (VI)		• Cyanide
b. Inorganic Substances		
• Asbestos	• 2,3,7,8 Tetrachloro-dibenzo-p-dioxin (TCDD or Dioxin)	
c. Volatile Substances		
• Acrolein	• 1,1-Dichloroethane	• Tetrachloroethylene (Tetrachloroethene)
• Acrylonitrile	• 1,2-Dichloroethane	• Toluene
• Benzene	• 1,1-Dichloroethylene (1,1-Dichloroethene)	• 1,2-Trans-Dichloroethylene
• Bromoform	• 1,2-Dichloropropane	• 1,1,1-Trichloroethane
• Carbon Tetrachloride	• 1,3-Dichloropropylene (1,3-Dichloropropene)	• 1,1,2-Trichloroethane
• Chlorobenzene	• Ethylbenzene	• Trichloroethylene (Trichloroethene)
• Chlorodibromomethane	• Methyl Bromide (Bromomethane)	• Vinyl Chloride
• Chloroethane	• Methyl Chloride (Chloromethane)	• 1,2-Dichlorobenzene
• Chloroform	• Methylene Chloride (Dichloromethane)	• 1,3-Dichlorobenzene
• Dichlorobromomethane	• 1,1,2,2-Tetrachloroethane	• 1,4-Dichlorobenzene
d. Semi-Volatile Substances		
• 2-Chloroethylvinyl ether	• Benzo(k)Fluoranthene	• 2,6-Dinitrotoluene
• 2-Chlorophenol	• Bis(2-Chloroethoxy)Methane	• Di-n-Octyl Phthalate
• 2,4-Dichlorophenol	• Bis(2-Chloroethyl)Ether	• 1,2-Diphenylhydrazine
• 2,4-Dimethylphenol	• Bis(2-Chloroisopropyl)Ether	• Fluoranthene
• 2-Methyl- 4,6-Dinitrophenol	• Bis(2-Ethylhexyl)Phthalate	• Fluorene
• 2,4-Dinitrophenol	• 4-Bromophenyl Phenyl Ether	• Hexachlorobenzene
• 2-Nitrophenol	• Butylbenzyl Phthalate	• Hexachlorobutadiene
• 4-Nitrophenol	• 2-Chloronaphthalene	• Hexachlorocyclopentadiene
• 3-Methyl 4-Chlorophenol	• 4-Chlorophenyl Phenyl Ether	• Hexachloroethane
• Pentachlorophenol	• Chrysene	• Indeno(1,2,3-cd)Pyrene
• Phenol	• Dibenzo(a,h)Anthracene	• Isophorone
• 2,4,6-Trichlorophenol	• 1,2-Dichlorobenzene	• Naphthalene

- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzidine
- Benzo(a)Anthracene
- Benzo(a)Pyrene
- Benzo(b)Fluoranthene
- Benzo(ghi)Perylene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 3,3' Dichlorobenzidine
- Diethyl Phthalate
- Dimethyl Phthalate
- Di-n-Butyl Phthalate
- 2,4-Dinitrotoluene
- Nitrobenzene
- N-Nitroso-dimethyl amine
- N-Nitroso-di n-propyl amine
- N-Nitroso diphenyl amine
- Phenanthrene
- Pyrene
- 1,2,4-Trichlorobenzene

e. Organochlorine Pesticides - PCBs

- Aldrin
- alpha-BHC
- beta-BHC
- gamma-BHC
- delta-BHC
- Chlordane
- 4,4'-DDT
- 4,4'-DDE
- 4,4'-DDD
- Dieldrin
- alpha-Endosulfan
- beta-Endosulfan
- Endosulfan Sulfate
- Endrin
- Endrin Aldehyde
- Heptachlor
- Heptachlor Epoxide
- Aroclor 1016
- Aroclor 1221
- Aroclor 1232
- Aroclor 1242
- Aroclor 1248
- Aroclor 1254
- Aroclor 1260
- Toxaphene

2. OTHER CONSTITUENTS

- | | | |
|----------------------------|--|---|
| a. Conventional | <ul style="list-style-type: none"> • Biological Oxygen Demand (BOD) • Chemical Oxygen Demand (COD) • Total Dissolved Solids (TDS) | <ul style="list-style-type: none"> • Total Suspended Solids (TSS) • Total Organic Carbon |
| b. Bacteria | <ul style="list-style-type: none"> • E. coli • Enterococcus | |
| c. Nutrients | <ul style="list-style-type: none"> • Ammonia-N • Nitrate-N • Nitrite-N • Ortho-Phosphorus | <ul style="list-style-type: none"> • Phosphorus, Total • Phosphorus, Dissolved • Total Kjeldahl Nitrogen |
| d. Pesticides | <ul style="list-style-type: none"> • Organophosphorus Pesticides | |
| e. Hydrocarbons | <ul style="list-style-type: none"> • Oil and grease • Total Petroleum Hydrocarbons (TPH) | |
| f. Other Minerals | <ul style="list-style-type: none"> • Chloride • Fluoride • Potassium | <ul style="list-style-type: none"> • Sodium • Sulfate |
| g. Field Parameters | <ul style="list-style-type: none"> • Conductivity • Dissolved Oxygen • pH | <ul style="list-style-type: none"> • Temperature • Turbidity |

1 TPH and Oil and Grease shall be sampled during dry weather events only

Table 7. Monitored Constituents for Subsequent Events

Category	Constituents
Conventional	<ul style="list-style-type: none"> • Biological Oxygen Demand (BOD) • Chemical Oxygen Demand (COD) • Hardness • Total Suspended Solids (TSS) • Total Organic Carbon • Total Dissolved Solids (TDS)
Bacteria	<ul style="list-style-type: none"> • E. coli • Enterococcus
Metals	<ul style="list-style-type: none"> • Copper, Total • Copper, Dissolved • Lead, Total • Lead, Dissolved • Zinc, Total • Zinc, Dissolved
Nutrients	<ul style="list-style-type: none"> • Ammonia-N • Nitrate-N • Nitrite-N • Ortho-Phosphorus • Phosphorus, Total • Phosphorus, Dissolved • Total Kjeldahl Nitrogen (TKN)
Pesticides	<ul style="list-style-type: none"> • Organophosphorus Pesticides
Hydrocarbons¹	<ul style="list-style-type: none"> • Oil and Grease • Total Petroleum Hydrocarbons (TPH)
Other Minerals	<ul style="list-style-type: none"> • Chloride • Fluoride • Potassium • Sodium • Sulfate
Field Parameters	<ul style="list-style-type: none"> • Conductivity • Dissolved Oxygen • pH • Temperature • Turbidity

¹ TPH and Oil and Grease shall be sampled during dry weather events only

3.4. MONITORING TECHNIQUE

The MRP does not define the monitoring technique to be used for Urban Discharge Mass Emissions or receiving water monitoring. For wet weather monitoring, permanent station samples will be collected as grab samples with the exception of Site 3b samples, which may be collected as composites for consistency with the long-term dataset. Rotating station samples will be collected where feasible using flow-paced composite samplers. Budget and site constraints may prevent composite samplers from being employed at all stations. The alternative technique will be to collect grab samples. All bacteria samples must be collected as grabs due to holding time requirements. Grab samples will be collected at or near the peak of the estimated hydrograph if feasible, within safe working conditions (i.e. daylight), to capture a representative

sample. Flow paced composite samples for the urban discharge sites most accurately reflect the event mean concentration (EMC) which allows comparison to EMCs from other stormwater programs. Dry weather samples will be collected if flow is present as grab samples for both receiving water and urban discharge samples. Sampling techniques will comply with the Quality Assurance Program Plan (QAPP).

3.5. REPORTING REQUIREMENTS

Pursuant to the MRP the Permittees must submit an annual progress report to the Executive Officer and to the Regional Administrator of the USEPA, Region 9, no later than November 15th, of each year. The annual progress report must include the following elements specific to the IWMP:

1. A summary and analysis of monitoring results from the previous year and any changes to the monitoring program for the following year;
2. An assessment of the effectiveness of control measures established under the illicit discharge elimination program;
3. A status report on the development and implementation of the Hydromodification Monitoring Program developed as part of the WAP.

Additionally, the annual report will include summaries of the other IWMP program elements: Source Identification and Special Studies Monitoring and Regional Watershed Monitoring programs. Regional programs include the MSAR and Big Bear Lake TMDLs, LID BMP monitoring and bioassessment monitoring. The various studies and program reports may be included as attachments to the Program annual report, with only a summary included in the annual report.

Section 4. Illegal Discharge/Illicit Connections Monitoring

The Illegal Discharge program consists of a number of control measures (see Section 3 of the MSWMP) to identify, address, and prevent illegal discharges (ID) and illicit connections (IC). These measures include:

- Permittee surveillance of all publicly maintained inlets, open channels, and basins including inspections at least once each permit year, and regular maintenance.
- Permittees monitor and control the quality of discharges entering the storm drain system through the storm drain connection permit process.
- An ongoing surveillance strategy, which includes training all Agency personnel with duties in the field, to observe for and report signs of illegal discharge. Each Permittee has also established and maintains a mechanism for responding to reports of illegal discharges, addressing clean-up issues, and tracking and reporting incidents. Each Permittee has adopted ordinances establishing legal authority to enforce against illegal discharges.

- Maintaining and advertising an area-wide 24-hour hotline, where incidents can be reported by the public. Outreach materials feature the 24-hour hotline.
- Support Household Hazardous Waste program activities.
- Maintain signage at all drain inlets, informing the public that the drains go directly to the creek.

During the dry season in the Santa Ana Region of San Bernardino County, the majority of receiving water bodies and storm drains are dry. Furthermore, the majority of illegal discharges to the storm drains that take place during both dry and wet weather are intermittent and transitory. According to the Guidance Manual for Illicit Discharge, Detection, and Elimination developed by the Center for Watershed Protection³, “the hardest discharges to detect and test are intermittent or transitory discharges...Transitory discharges cannot be reliably detected using conventional outfall monitoring techniques, and are normally found as a result of hotline complaints or spill events.”

In light of these challenges, water quality monitoring specifically for ID/ICs is considered inefficient and ineffective. Rather, the Permittees would submit that visual inspections of the storm drains for the presence of unusual flowing water, or evidence of discharge, is a more effective strategy for detecting and correcting ID/ICs during dry weather. Identification of problem areas can be addressed through more frequent visual inspections and targeted outreach and education. All monitoring data collected under the Core Monitoring program, TMDL monitoring activities, and source identification monitoring during both dry and wet weather will be examined to look for samples that report significantly higher values than typically observed in the long-term dataset (Orange County uses 3.9 standard deviations above the mean for each site, or above a determined tolerance interval about the “average” condition determined from the dataset). If such samples are identified, additional follow-up activities, which could include additional monitoring, will be conducted to determine if ID/ICs can be detected and corrected.

4.1. NITROGEN-TDS DRY WEATHER MONITORING

The Permit requires a plan be developed to determine baseline concentration of nitrogen and TDS in dry weather run-off. Furthermore, the plan must be developed within 18 months of Permit adoption (July 29, 2011). The plan may include evaluation of existing data and data planned to be collected as part of Core Monitoring. This section will be updated to include relevant sections of the plan.

Section 5. Hydromodification Monitoring Plan

The MRP requires that a Hydromodification Monitoring Plan (HMP) be developed as part of the Watershed Action Plan (WAP) to evaluate hydromodification impacts on channels susceptible to degradation. The WAP will identify vulnerable streams and possible control measures for hydrologic changes and tools to measure hydrologic impacts. The HMP will include monitoring

³ USEPA (Illicit Discharge Detection and Elimination - A Guidance Manual for Program Development and Technical Assessments) by the Center for Watershed Protection and Robert Pitt, University of Alabama, October 2004, updated 2005).

protocols to assess the drainage channels deemed most susceptible and the efficacy of prevention measures, as well as urbanization impact models.

The first phase of the WAP is on schedule to be developed by January 29, 2011, 12 months after the adoption of the NPDES Permit. This section of the IWMP will be updated with relevant sections of the HMP once the HMP is prepared.

Section 6. Source Identification and Special Studies Monitoring

The Permittees have developed a priority list of pollutants of concern based on the findings of water quality monitoring efforts (Table 8). The Permit requires that the Permittees assess each of the pollutants of concern (except bacteria, which is addressed by a TMDL) and develop a strategic plan for addressing each pollutant. It is proposed that the data collected at the Rotating monitoring stations as part of Core Monitoring serve as source identification monitoring. The locations of the Rotating monitoring stations are designed to allow locations of sources of pollutants to be identified, therefore this data can be used to isolate and locate sources and stretches of problematic waterbodies and urban discharges. If additional special study monitoring is conducted beyond the Core Monitoring or other identified monitoring in the document, the results will be reported as part of the Annual Progress Report.

Table 8. Priority List of Pollutants of Concern

Parameter	Ranking
Bacteria	High
Zn	Medium
Cu	
Pb	
Nitrate as N	Low
Total P	
TSS	
COD	

Additionally, the Permit requires that the Pollutant Source Identification and Control Plan for the Site 5 drainage area continue to be developed and implemented, including annual reporting and BMP effectiveness evaluation. Accordingly, the Site 5 Plan will continue to be implemented and the results reported in Annual Progress Report.

6.1. SEVEN OAKS DAM MONITORING

Supplementary monitoring upstream of Seven Oaks Dam has been conducted by the Flood Control District since 2006. The purpose of this monitoring is to ensure that river water quality is not affected by the impoundment of river flows behind the Dam. Monitoring has been conducted monthly in locations in the Dam pool area for the same constituents analyzed under the previous

MS4 Permit, as well as for OP pesticides and color. Periodic storm events have also been sampled. Additionally, the District has coordinated with the Army Corps of Engineers to conduct DO and temperature monitoring at different depths within the pool to characterize the ponded conditions, and monitored Dam release during gate testing. This body of data should adequately characterize background conditions for the Santa Ana River.

Section 7. Regional Watershed Monitoring

Regional watershed monitoring refers to the collaboration among many agencies in and around southern California that are interested in watershed- to regional-scale water quality monitoring. The MRP specifies several types of regional watershed monitoring efforts, including TMDL monitoring, Low Impact Development (LID) BMP monitoring, and regional bioassessment monitoring. Each of these regional monitoring programs will be discussed below, including the main responsible entity for each regional monitoring program and the Principal Permittee's responsibility in the regional monitoring activities.

7.1. TMDL MONITORING

Two TMDLs are currently in effect for water bodies within San Bernardino County: The Middle Santa Ana River (MSAR) Bacteria Indicator TMDL and the Big Bear Lake Nutrient TMDL. TMDL Task Forces have been created with the responsibility for implementation of each TMDL. The Principal Permittee represents the San Bernardino County Flood Control District, which is named as a TMDL task force partner for both TMDLs, and performs certain aspects of the required TMDL monitoring activities on each Task Forces' behalf.

TMDL monitoring plans define sampling schedules and protocols agreed to by the TMDL permittees and the Regional Board in order to comply with the requirements of the associated TMDLs. The monitoring plans are enforceable by the Regional Board.

7.1.1. MSAR Bacteria Indicator TMDL

The Bacteria Indicator TMDL for Middle Santa Ana River Watershed Waterbodies (MSAR TMDL) was adopted by the Regional Board on August 26, 2005 and was approved by USEPA on May 16, 2007. The MSAR TMDL Task Force was formed to coordinate TMDL implementation efforts and is comprised of many key stakeholders in the watershed.

In June 2007, the Regional Board adopted Resolution No. R8-2007-0046, which approved the MSAR Water Quality Monitoring Plan submitted by the MSAR TMDL Task Force. The MSAR Water Quality Monitoring Plan describes all monitoring programs implemented to support TMDL compliance. These programs include the Watershed-Wide Monitoring Program, the Urban Source Evaluation Plan (USEP) Monitoring Program, the Agricultural Source Evaluation Plan (AgSEP) Monitoring Program, and the BMP Effectiveness Monitoring Program. The monitoring activities described in the MSAR Water Quality Monitoring Plan for the USEP were completed in March 2008, the monitoring activities described for the AgSEP were completed in March 2009, and the monitoring activities for BMP Effectiveness were completed in June 2008.

The only MSAR Bacteria Indicator TMDL monitoring plan described further in this document is the Watershed-Wide Monitoring Program. The other monitoring plans are not implemented by

the Principal Permittee. The MSAR TMDL Task Force will continue to conduct source evaluations in accordance with the approved plans and report the findings in accordance with the schedules specified in the approved plans or as updated by subsequent Regional Board approved revisions. Triennial reports summarizing all data collected for the TMDL will be generated by the MSAR Task Force, and submitted per Permit MRP requirements (V.B.1.a.ii).

The goal of the MSAR TMDL Watershed-Wide Monitoring Program is to assess compliance with the REC-1 use water quality targets for bacterial indicators described in the TMDL and to conduct monitoring and reporting consistent with the MS4 Permit to evaluate the effectiveness of the BMPs implemented in the watershed and determine progress towards attaining compliance with the interim WQBELs and final BMP-based WQBELS, if approved, or the final numeric WQBELs/WLAs. This section describes the sampling procedures for the MSAR Bacteria Indicator TMDL Watershed-Wide Monitoring Program.

The Principal Permittee performs the monitoring activities for the Watershed-Wide Monitoring Program on behalf of the TMDL Task Force. A summary of the Watershed-Wide Monitoring Program is presented in Table 9.

Table 9. MSAR Bacterial Indicator TMDL Sampling Overview

Sample Type	Sample Frequency	Number of Events	Number of Sites	Sample Type
Dry Season (April 1 - October 31)	Weekly	20	5	Grab
Wet Season (November 1 - March 31)	Weekly	11	5	Grab
Storm Event (Option A)	Once during Wet Season	1	5	Time-paced grab (x4)
Storm Event (Option B)	Weekly in March if there are no storms during Wet Season	4	5	Grab

Monitoring Sites

Five receiving water compliance sites comprise the Watershed-Wide Monitoring Program and are listed in Table 10. A sixth site, Icehouse Canyon Creek (WW-C1), was originally included in the Monitoring Plan, but has subsequently been removed. Note that the site still appears in Figure 3.

Table 10. MSAR Bacterial Indicator TMDL Monitoring Sites

Site ID	Location	Longitude	Latitude
WW-C3	Prado Park Lake @ Lake Outlet	-117.6473	33.9400
WW-C7	Chino Creek @ Central Avenue	-117.6884	33.9737
WW-M5	Mill Creek @ Chico-Corona Road	-117.6156	33.9460
WW-S1	Santa Ana River Reach 3 @ MWD Crossing	-117.4479	33.9681
WW-S3	Santa Ana River Reach 3 @ Hamner Avenue	-117.5327	33.9552

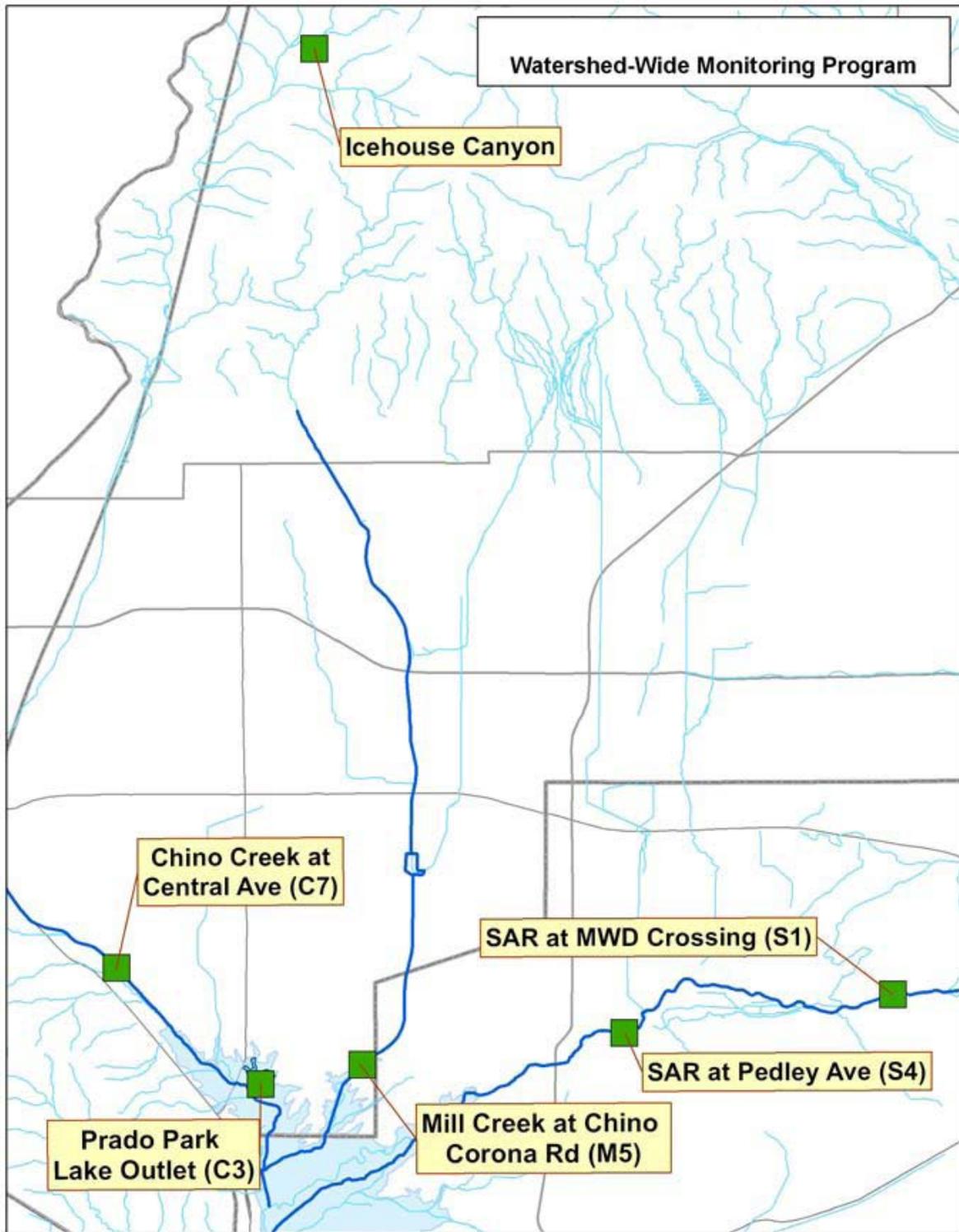


Figure 3. MSAR Bacteria Indicator TMDL Site Map

Monitoring Frequency

Under this monitoring plan, a sample event is defined as the week in which samples are collected. Sample events are scheduled by week ending dates, meaning that for a given week, samples could be collected any day between Sunday and Saturday (weeks are considered to begin on Sunday for this monitoring plan) , however, every effort will be made to collect samples from Monday through Wednesday of each week.

During the dry season (April 1 to October 31), five samples will be collected during each 30-day period, approximately weekly. This will result in four 30-day intervals sampled with 20 samples collected over 20 consecutive weeks. Table 11 details the required start and end dates for dry season sampling for the coming years.

During the wet season (November 1 to March 31), samples will be collected in both dry and wet weather conditions. Eleven samples will be collected over an 11-week period from mid-December to mid-February and will occur regardless of weather. This sampling will allow the calculation of a rolling geometric mean. Additionally, one storm will be sampled. Storm sampling will include collection of a set of four samples at each of the sites: Sample 1 on the day of the storm event when flow is elevated, and samples 2, 3, and 4 at 48, 72, and 96 hours, respectively, following the storm event. If no wet weather events occur by the end of February, an additional four weeks of wet season sampling will be appended to the 11-week period for a total of 15 weeks. The schedule for each year of sampling is detailed in Table 11.

The decision to conduct wet weather sampling shall be approached by reviewing National Weather Service forecasts for the area on Accuweather.com. If rain develops, rainfall shall be monitored at the Riverside Municipal Airport and Ontario International Airport. For safety and to ensure compliance with laboratory holding times, monitoring will occur only during daylight hours. Wet weather samples shall not be collected if conditions are determined to be unsafe by the field team leader's on-site assessment.

Table 11. MSAR Bacterial Indicator TMDL Start and End Weeks for Seasonal Sampling

Start / End Weeks for Wet and Dry Season Sampling in Future Years		
Sampling Year	Dry Season	Wet Season
2009 - 2010	May 16 / Oct 3	Dec 19 / Mar 6
2010 - 2011	May 15 / Oct 2	Dec 18 / Mar 5
2011 - 2012	May 14 / Oct 1	Dec 17 / Mar 3
2012 - 2013	May 19 / Oct 6	Dec 15 / Mar 2
2013 - 2014	May 18 / Oct 5	Dec 14 / Mar 1
2014 - 2015	May 19 / Oct 6	Dec 13 / Feb 28
2015 - 2016	NA	Dec 19 / Mar 5
2016 - 2017	NA	Dec 17 / Mar 4
2017 - 2018	NA	Dec 16 / Mar 3
2018 - 2019	NA	Dec 15 / Mar 2
2019 - 2020	NA	Dec 14 / Feb 29
2020 - 2021	NA	Dec 19 / Mar 6
2021 - 2022	NA	Dec 18 / Mar 5
2022 - 2023	NA	Dec 17 / Mar 4
2023 - 2024	NA	Dec 16 / Mar 2
2024 - 2025	NA	Dec 14 / Mar 1

Quality Assurance/Quality Control Schedule

For each sample event, one field equipment blank should be collected at one of the five sites on a rotating basis. To collect a field equipment blank, sterile deionized water is poured through any equipment used to collect fecal coliform or *E. coli* samples at the site where the field equipment blank is being collected, and then into the respective sample container. For TSS, the same process is used with distilled water if any field equipment is used to collect the TSS sample. If no field equipment is used in the collection of the TSS sample, the distilled water should be poured directly into the TSS container.

Field replicates (or field duplicates) should be collected for one site out of every ten sites visited during each sample event. If less than ten sites are visited during a sample event, then one replicate should be collected. Field replicates are taken by collecting two sets of samples at the same location within five minutes of each other.

The site where the field equipment blank and field replicate should be collected rotates according to the following pattern:

1. Prado Park Lake at Lake Outlet
2. Chino Creek at Central Avenue
3. Mill Creek at Chino-Corona
4. Santa Ana River Reach 3 at Hamner Avenue
5. Santa Ana River Reach 3 at MWD Crossing

Monitored Constituents

Table 12 presents the parameters to be collected during each sampling event.

Table 12. MSAR Bacterial Indicator TMDL Watershed-Wide Monitoring Parameters

Parameter	Laboratory	Units	Analytical Method	Target Reporting Limits
Temperature	Field	°C	YSI or equivalent	NA
Dissolved Oxygen	Field	mg/L	YSI or equivalent	NA
pH	Field	standard units	YSI or equivalent	NA
Conductivity	Field	mS/cm	YSI or equivalent	NA
Turbidity	Field	NTU	YSI or equivalent	NA
<i>E. Coli</i>	OC Public Health	cfu/100 mL	EPA 1603	10 cfu/100 mL
Fecal Coliform	OC Public Health	cfu/100 mL	SM 9222D ^[1]	2 cfu/100 mL
Total Suspended Solids	OC Public Health	mg/L	SM 2540D ^[1]	0.5 mg/L

[1] APHA, 1998

Monitoring Technique

All samples should be collected as individual grabs at each sampling site, for both dry and wet weather conditions.

As fecal coliform and *E. coli* sample bottles will contain sodium thiosulfate for chlorine elimination, the bottle cannot be held under the water to collect a sample. Therefore, a new sterilized bottle should be used to collect water for these parameters at each site. Water can then be decanted from this bottle into the preserved sample containers. Bacteria samples shall be placed in a cooler with cold packs immediately after sampling for transport to the laboratory. The maximum holding time prior to water quality analysis for bacteria indicator concentrations is 6 hours.

Reporting Requirements

A Wet Season Data Analysis Report will be submitted on May 31 of each year, and a Dry Season Data Analysis Report will be submitted on December 31 of each year. The Dry season report may be included with the triennial comprehensive report due every third year on February 15th, beginning in 2010.

7.1.2. Big Bear Lake Nutrient TMDL - Watershed-Wide Monitoring Program

The Big Bear Lake Nutrient TMDL was adopted by the Regional Board in April 2006 and was approved by the EPA in September 2007. The Big Bear Lake TMDL Task Force was formed to coordinate TMDL development and implementation efforts and is comprised of all the named dischargers and additional key stakeholders in the watershed.

Two Monitoring Plans were adopted for the Big Bear Lake TMDL, the In-Lake Nutrient Monitoring Plan approved in July 2008 and the Watershed-Wide Nutrient Monitoring Plan approved in May 2009. The Principal Permittee, under the direction of the Big Bear Lake TMDL Task Force and Brown and Caldwell, implements the Watershed-Wide Monitoring Plan.

The following sections describe the monitoring activities conducted for the Watershed-Wide Monitoring Plan. The Big Bear Municipal Water District implements the In-Lake Monitoring Program, which is not considered part of the IWMP.

The watershed-wide Monitoring Plan is intended to continue and enhance previous efforts to characterize water quality in the runoff draining to Big Bear Lake. The objectives for the Watershed-Wide Monitoring Plan include:

1. To review and update the Big Bear Lake Nutrient TMDL.
2. To determine specific sources of nutrients.
3. To develop TMDLs for other hydrologic conditions (wet & moderate years).
4. To determine compliance with the Big Bear Lake Dry Nutrient TMDL, including the load and waste load allocations.

Table 13 presents an overview of the Watershed-Wide Monitoring Plan. This plan is applicable until December 31, 2012, following which it may be revised.

Table 13. Big Bear Lake Watershed-Wide Monitoring Program Overview

Sample Event	Sample Frequency	Number of Events	Number of Sites	Sample Type
Baseflow Event	Monthly, when flow is present	12	7	Grab
Snowmelt Event ¹	Monthly, when flows from snowmelt are present	4	7	Grab
Winter Storm Event ²	Once per season	1	7	Composite
Summer Storm Event ³	Once per season	1	7	Composite

¹ The snowmelt season is defined as February 1 to May 31

² The winter season is defined as October 1 to March 31

³ The summer season is defined as April 1 to September 31

Monitoring Sites

The TMDL specified seven mandatory sampling stations for the Big Bear Lake Watershed-Wide Nutrient Monitoring Plan, which are presented in Figure 4 and Table 14. The stations are located in six major tributaries to Big Bear Lake. Each tributary has one station, except Rathbun Creek which has two stations. One of these two stations is located upstream in Rathbun Creek and the other one is located downstream of a zoo. Stakeholders may recommend deleting or moving the site below the zoo (MWDC6) as the zoo is planning to move to the North Shore of Big Bear Lake, and would thus no longer be a potential source of nutrients and other constituents to Rathbun Creek. Additionally, monitoring at the Bear Creek Dam outlet site has been suspended until further notice. No sampling point may be deleted from the list without advanced authorization from the Regional Board. However, the stakeholders may add more sampling locations at any time without the need for Regional Board approval.

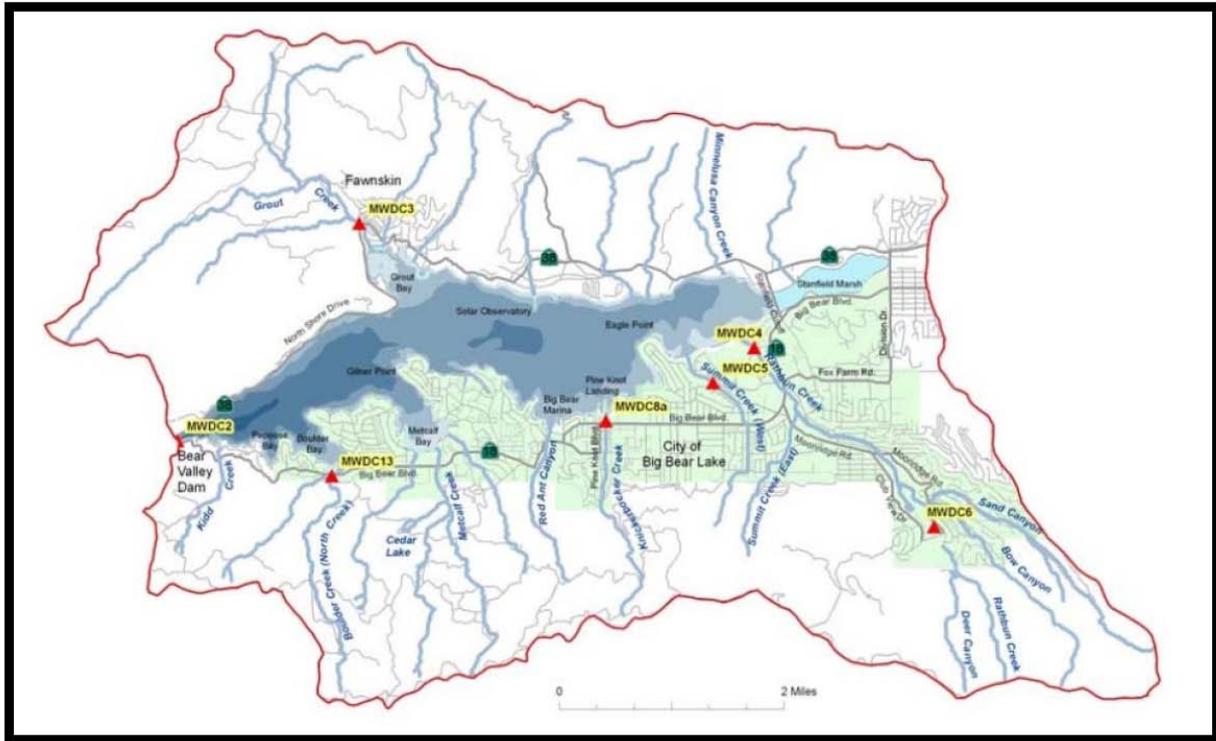


Figure 4. Map of Big Bear Lake Watershed-Wide Nutrient Monitoring Plan Sites

Table 14. Big Bear Lake Watershed-Wide Nutrient Monitoring Sites

Station ID	Site Description	Latitude	Longitude
MWDC2	Bear Creek Dam Outlet	34.242056	-116.977056
MWDC3	Grout Creek at Hwy. 38	34.269447	-116.948437
MWDC4	Rathbun Creek at Sandalwood Ave.	34.2531	-116.887354
MWDC5	West Summit Creek at Swan Dr.	34.248679	-116.893777
MWDC6	Rathbun Creek below the Zoo	TBD	TBD
MWDC8	Knickerbocker Creek at Hwy 18	34.243998	-116.910525
MWDC13	Boulder Bay Creek at Hwy 18	34.237411	-116.953122

Monitoring Frequency

Table 15 presents the sampling schedule for all Big Bear Lake watershed monitoring sites.

Table 15. Big Bear Lake Watershed-Wide Nutrient Monitoring Schedule

Sampling Type	Sampling Period	Frequency
Baseflow	January 1 – December 31	Monthly when baseflow is present
Snowmelt Event	February 1 - May 31 ^[1]	Monthly when snowmelt is observed
Winter Storm Event	October 1 - March 31	One storm per season, 8 samples over the hydrograph
Summer Storm Event	April 1 - September 31	One storm per season, 8 samples over the hydrograph

¹ In winter months when snowmelt is present.

The Big Bear Lake Nutrient TMDL Watershed-wide Monitoring Plan defines a storm event as either precipitation of more than 0.25 inches (projected to be more than 0.5 inches) in a 24-hour period or a doubling of a stream flow within a 24-hour period (either measured by a stream gauge or visually estimated). The snow melt sampling period will begin after the first substantial snowfall event resulting in an accumulation of 1.0 foot or more of snow.

This Monitoring Plan specifies that samples will be collected when representative flow is present. Extreme low flow and flash flood conditions will not be sampled. Samples will only be collected when it is safe and prudent to do so. Low flows usually percolate before reaching the lake and are, therefore, irrelevant to assessing TMDL compliance.

It may not be possible to collect samples from all locations during a single storm event. Sampling may be divided, with some locations being collected during an early season storm and remaining locations during a late season storm. This fragmented schedule will make best use of available staff and resources (particularly automated samplers).

Quality Assurance/Quality Control

The Big Bear Lake Watershed-Wide Monitoring Plan requires field duplicates to be collected at the rate of 5 percent of the total project sample count and for one equipment blank to be submitted for analysis (all methods) during each sampling event.

Monitored Constituents

Table 16 presents the parameters to be collected during each sampling event and analytical methods.

Table 16. Big Bear Lake Watershed-Wide Nutrient Monitoring Plan Water Quality Parameters and Analytical Methods

Parameter	Laboratory	Units	Analytical Method	Modification	MDL	Target Reporting Limit
Temperature	Field Staff	°C	Thermometer (-5 to 500C)	None	NA	NA
Dissolved Oxygen	Field Staff	mg/L	Field -Horiba Meter	None	NA	0.2 mg/L
pH	Field Staff	S.U.	Field -Horiba Meter	None	NA	NA
Conductivity	Field Staff	mS/cm	Field -Horiba Meter	None	NA	2.0 µS/cm
Turbidity	Field Staff	NTU	Field -Horiba Meter	None	NA	5.0 NTU
Total Suspended Solids ¹	E.S. Babcock	mg/L	SM 2540 D	None	0.5 mg/L	0.5 mg/L
Volatile Suspended Solids ¹	E.S. Babcock	mg/L	SM 2540 E	None	1.0 mg/L	1.0 mg/L
Biochemical Oxygen Demand ¹	E.S. Babcock	mg/L	SM 5210B	None	1.0 mg/L	2.0 mg/L
Chemical Oxygen Demand (COD) ¹	E.S. Babcock	mg/L	SM 5220 D	None	--	5 mg/L
Total Organic Carbon ¹	E.S. Babcock	mg/L	SM 5310B	None	0.1 mg/L	0.6 mg/L
Dissolved Organic Carbon ¹	E.S. Babcock	mg/L	SM 5210B	None	0.1 mg/L	0.6 mg/L
Total Nitrogen ²	GEI	µg/L	4500-N B	None	4 µg/L	calc
Total Dissolved Nitrogen ³	GEI	µg/L	4500-N B	Quick Chem with durapore HV 0.45 Om filter	4 µg/L	calc
Ammonia Nitrogen	GEI	µg/L	SM 4500-NH3, 10-107-06-3-D	QuickChem with durapore HV 0.45 Om filter	3 µg/L	0.1 µg/L
Nitrate/Nitrite Nitrogen	GEI	µg/L	SM 4500-N02B 10-107-04-1-B	QuickChem with durapore HV 0.45 Om filter	5 µg/L	0.1 µg/L
Total Phosphorus	GEI	µg/L	SM4500 PBE 10-115-01-1-U	QuickChem Modification	2 µg/L	2 µg/L
Total Dissolved Phosphorus	GEI	µg/L	SM 4500 PBE 10-115-01-1-U	QuickChem with durapore HV 0.45 Om filter	2 µg/L	2 µg/L
Ortho-Phosphate	GEI	µg/L	SM 4500 PE 10-115-01-1-T	QuickChem with durapore HV 0.45 Om filter	3 µg/L	0.01 µg/L
Alkalinity as CaCO3	E.S. Babcock	mg/L	SM 2320 B	None	0.2 mg/L	1.0 mg/L
Hardness as CaCO3	E.S. Babcock	mg/L	SM 3120 BHACH 8266	None	0.2 mg/L	1.0 mg/L

¹ This parameter should be sampled at all sites with the exception of Bear Creek Outlet (MWDC2).

² Total Nitrogen is calculated as the sum of Nitrate, Nitrite, and Total Kjeldahl Nitrogen (TKN).

³ TKN has been analyzed instead of Total Dissolved Nitrogen.

E.S. Babcock & Sons Laboratory is listed as the primary laboratory for the Big Bear Lake Watershed defined in the MRP, additional laboratories may be used for analysis along with an explanation of why the deviation from the plan occurred. For example, GEI Consultants has been

used for Big Bear Lake sampling efforts because of the laboratory's ability to obtain lower reporting limits on certain constituents (Table 16).

In addition to water quality parameters, corresponding tributary flows at the time of sampling will be recorded by the available flow equipment (i.e., pressure transducers). Flow velocity is also to be recorded with all manual grab samples. In the absence of flow measuring equipment, tributary flows will be estimated by water depth flowing over the constructed weir or a flow equation/calculation using dimension information about the channel. Stream access is dependent upon receiving all necessary permits and authorization.

Monitoring Technique

The Watershed-Wide Monitoring Plan includes a set of standard operating procedure (SOP) detailing how field parameters should be sampled, the equipment needed, maintenance routines, and record keeping. The SOP is Appendix B of the Watershed-Wide Monitoring Plan.

Samples will initially be collected as instantaneous manual grabs (IMGs) for all sampling types, however, automated equipment (AE) sampling technique is anticipated to be used as available.

For storm events, samples will be designated as one of the following:

First Flush (FF): This sample captures the first 30 minutes of tributary discharge during a storm event. The highest concentrations of contaminants (e.g., nutrients and sediments) are often found in the "first flush" discharges, which occur during the first major storm event after an extended dry period. First flush samples may be collected either as instantaneous grab samples or using automated samplers.

Hydrograph Discreet: These samples are discrete samples that will be intended to characterize water quality concentrations at discrete points along the hydrograph. Ideally, the storm event sampling program will enable the collection of 8 discrete water quality samples over the entire hydrograph associated with a given storm event. These 8 samples will be submitted for individual analysis, and then later combined for a flow composite analysis.

Flow Composite: These samples are flow-weighted composite samples collected by automated samplers during the entire period of the hydrograph. Storm samples will be combined into 24-hour flow-weighted composites for laboratory analysis.

For storm event, snow melt, and/or baseflow samples collected manually, the person sampling will document the exact date and time of sample collection, type of flow observed, and flow velocity. For snow melt and rain events, the sampler will make every attempt to document the start time of the event, the start time of the first observed discharge, the duration of the event, and any other informational observations. A field data collection sheet will be provided for this purpose.

Reporting Requirements

The results of watershed nutrient sampling and analysis shall be reported annually to the Regional Board on February 15 of every year in combination with the In-Lake nutrient monitoring results.

7.2. SMC MONITORING

The Southern California Stormwater Monitoring Coalition (SMC) is a coalition of stormwater management agencies and stormwater regulators throughout southern California. The goal of the SMC is to develop the technical information necessary to better understand stormwater mechanisms and impacts, and then develop the tools that will effectively and efficiently improve stormwater decision-making. The Principal Permittee is a member agency of the SMC.

The SMC supports a number of projects as part of the Research Agenda. The MS4 Permit MRP requires that the Permittees participate in the following SMC monitoring projects. Participation in the required monitoring projects may be accomplished through participation in and funding of the SMC where not otherwise noted.

7.2.1. Low Impact Development (LID) BMP Monitoring

The Principal Permittee shall continue to participate in data collection and monitoring to assess the effectiveness of LID techniques in semi-arid climate as part of the SMC project titled, "Quantifying the Effectiveness of Site Design/ Low Impact Development Best Management Practices in Southern California".

7.2.2. Regional Bioassessment Monitoring (SCCWRP Technical Report 539)

The Principal Permittee, on behalf of the co-Permittees, participates (through a memorandum of understanding and cooperative agreements) with the SMC Bioassessment Working Group to conduct bioassessments on a regional basis. Bioassessments integrate the effects of multiple stressors in receiving waters to confirm the biological integrity and beneficial use of the waters. SCCWRP Technical Report 539 describes the protocols for the Regional Bioassessment Monitoring Program. The Program is overseen by State Board's Stormwater Ambient Monitoring Program (SWAMP) and the SMC, and coordinated by the Southern California Coastal Water Research Project (SCCWRP). Technical Report 539 consists of two approaches: (1) Spatial Extent and Stressor Identification and (2) Trends. Within the 5-year permit cycle, the SMC is responsible for monitoring conducted for the Spatial Extent and Stressor Identification approach, and the Principal Permittee is responsible for the monitoring conducted for the Trends approach. This section of the IWMP describes Trends monitoring.

Monitoring Sites

The Trends monitoring consists of targeted monitoring sites located in watersheds throughout southern California selected for 1) location near the terminus of the river to integrate upstream discharges, and 2) previous monitoring efforts. The MS4 Permit MRP specifies that the Upper Santa Ana River watershed site be located at the Santa Ana River Reach 3 station ID WW-S1 (MWD Crossing). However the Program requests that this site be relocated to the long-term Program monitoring site lower down on the Santa Ana River at Pedley Avenue (Site 8b).

Monitoring Frequency

A minimum of one sample per year shall be collected from the Santa Ana River Reach 3 during a dry weather index period. The default index period will be from May 15 to July 15.

Monitored Constituents

Monitoring parameters will consist of water chemistry constituents and aquatic toxicity. Both of these indicators will be measured in a manner comparable to SWAMP to ensure integration with statewide data sets. Water chemistry shall include conventional water quality, nutrients, trace metals, PAHs, and pyrethroid pesticides (Table 17). The second indicator is aquatic toxicity to the water flea, *Ceriodaphnia dubia*. Chronic toxicity shall be measured as a 7-day exposure with effects endpoints of lethality and reproduction according to US EPA (1993).

Table 17. Monitored Constituents for SCCWRP Trends Approach

Constituent	Method	Accuracy	Precision	Reporting Limit
Aquatic Toxicity				
<i>Ceriodaphnia dubia</i>	EPA 1993	NA	Lab dup frequency 10%	NA
Water Chemistry				
Conventional				
Temperature		NA	± 0.5 °C	NA
pH	Probe	± 0.5 units	± 0.5 units	0 - 14 pH units
Conductivity		±5%	±5%	2.5 mS/cm
Dissolved Oxygen		±0.5 mg/L	±0.5 mg/L	0.5 mg/L
Alkalinity	-	±10%	±10%	10 mg/L
Hardness	-	-	-	-
Nutrients				
Ammonia				0.1 mg/L
Nitrite				0.01 mg/L
Nitrate	-	80-120%	Field dup, lab dup frequency 10%	0.1 mg/L
Total Nitrogen			25% RPD	0.1 mg/L
Orthosphosphate				0.01 mg/L
Total Phosphorus				0.1 mg/L
Major Ions				
Calcium	-	80-120%	Field dup, lab dup frequency 10%. 25% RPD	0.05 mg/L
Sulfate				0.25 mg/L
Metals (dissolved and total)				
Arsenic				1.0 µg/L
Cadmium				0.5 µg/L
Chromium			Field dup, lab dup, or MS/MSD.	1.0 µg/L
Copper	EPA 200.8	80-120%	20% RPD.	1.0 µg/L
Iron			Laboratory duplicate minimum.	10 µg/L
Lead				1.0 µg/L
Nickel				1.0 µg/L
Zinc				1.0 µg/L

Constituent	Method	Accuracy	Precision	Reporting Limit
Organics				
Pyrethroid Pesticides	-			1.0 ng/L
Organophosphate Pesticides	-	50-150%	Field dup or MS/MSD. 25% RPD.	1.0 ng/L
PCBs	8081/82		Field dup minimum.	1.0 ng/L
PAHs	EPA 8270			0.5 - 1.0 ng/L

JANUARY 2011

SAN BERNARDINO COUNTY STORMWATER
PROGRAM

Integrated Watershed Monitoring Program (IWMP) Quality Assurance and Project Plan (QAPP)

Submitted to:

SANTA ANA REGIONAL WATER QUALITY CONTROL BOARD

Prepared by:

LARRY WALKER ASSOCIATES

A. PROJECT MANAGEMENT

1. TITLE AND APPROVAL SHEETS

SAN BERNARDINO COUNTY STORMWATER PROGRAM INTEGRATED WATERSEHD MONITORING PROGRAM (IWMP) QUALITY ASSURANCE PROJECT PLAN (QAPP)

Project Manager	_____ Dan Ilkay, San Bernardino County Stormwater Program Manager	Date
Project QA Manager	_____ Janet Dietzman, San Bernardino County Flood Control District	Date
Lab QA Officer	_____ Stacey Fry, E.S Babcock and Sons	Date
Lab QA Officer	_____ Dave Dawes, TestAmerica Irvine	Date
SARWQCB Project Manager	_____ Milasol Gaslan, SARWQCB	Date
SARWQCB QA Officer	_____ Pavlova Vitale, SARWQCB	Date

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3. DISTRIBUTION LIST

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Debbie Wilson	Test America	949-261-1022	dwilson@testamericainc.com

4. PROJECT ORGANIZATION

On January 29, 2010, the California Regional Water Quality Control Board - Santa Ana Region (SARWQCB or Regional Board) adopted a National Pollutant Discharge Elimination System (NPDES) Permit (No. R8-2010-0036) for the consortium of the San Bernardino County Flood Control District (SBCFCD), the County of San Bernardino, and the incorporated cities of San Bernardino County within the Santa Ana Region (San Bernardino County MS4 Permit, or Permit). The Permit includes the Receiving Waters and Urban Runoff Monitoring and Reporting Program (MRP) which requires the San Bernardino County Flood Control District (SBCFCD), as Principal Permittee for the San Bernardino County Stormwater Program (Program), to administer and conduct the activities required by the MRP. The Principal Permittee administers all Program activities, including the MRP and associated area-wide stormwater monitoring program.

The MRP describes two types of monitoring programs:

1. An Integrated Watershed Monitoring Program (IWMP) that is to be developed under the MRP; and
2. Regional monitoring efforts where the Permittees participate or make monetary contributions, including Total Maximum Daily Load (TMDL)-related monitoring.

The MRP further requires that all IWMP monitoring be conducted under a Quality Assurance and Project Plan (QAPP) approved by the Regional Board. The MRP requires that an IWMP and a QAPP be submitted within one year of the January 29, 2010 Permit adoption date. The Program is submitting an IWMP and this QAPP to fulfill the requirements of the MRP.

Program responsibilities are as follows:

- Project Manager: Dan Ilkay, San Bernardino County Stormwater Program Manager
- Project Quality Assurance Manager: Janet Dietzman, San Bernardino County Flood Control District
- Laboratory Quality Assurance Officer: Stacey Fry, E.S Babcock and Sons, Dave Dawes, TestAmerica Irvine
- Sample Collection: Program or SBCFCD Staff or contractors
- QAPP changes / updates: Changes to the QAPP may be made upon concurrent approval of necessary changes by the Project Manager, Project Quality Assurance Manager and the Regional Board's Quality Assurance Officer. The Project Manager will be

responsible for making the changes, submitting drafts for review, preparing a final copy, and submitting the final revision for signature and distribution.

This QAPP describes the quality assurance requirements for the IWMP developed by the Program to comply with the MRP. However, this QAPP does not describe the quality assurance requirements for any Regional Watershed Monitoring efforts where the Permittees participate or make monetary contributions, including TMDL-related monitoring, as they are covered by other Regional Board-approved QAPPs. Any contractors selected to perform the sampling and laboratory analyses must meet the quality control criteria necessary to satisfy the data quality objectives of this program, including those for precision, accuracy, detection and reporting. This QAPP is based on the State's Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Management Plan (Puckett 2002) and was prepared in accordance with the State Water Resources Control Board's SWAMP QAPP Template (SWRCB, 2004a) and the SWAMP QA Checklist (SWRCB, 2004b). A general organizational structure for the IWMP is illustrated in Figure 1.

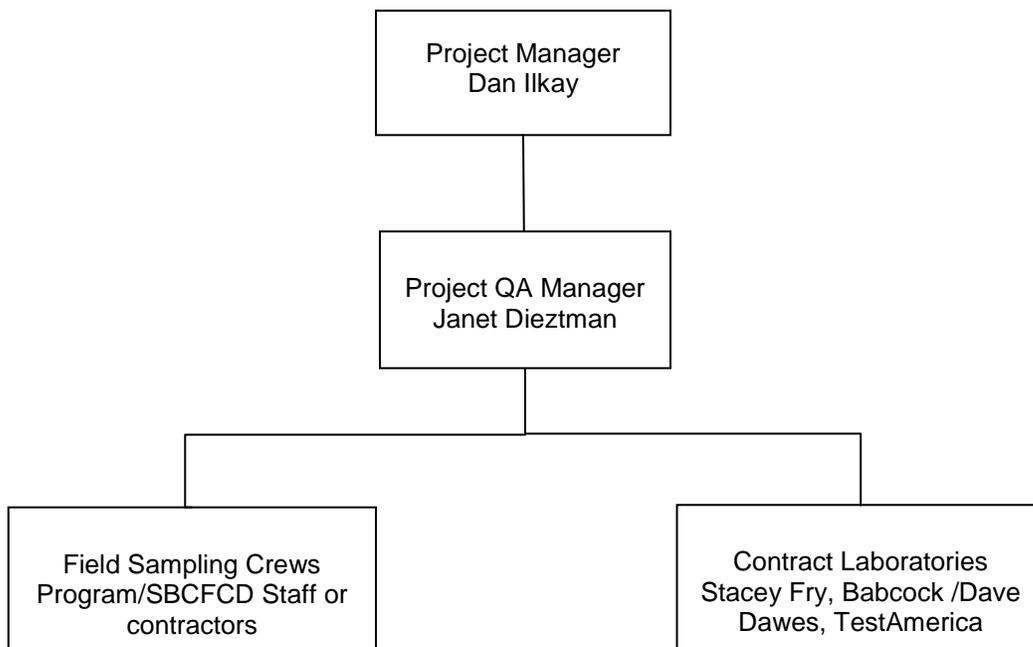


Figure 1. San Bernardino County Stormwater Program IWMP Management Structure

5. PROBLEM DEFINITION/BACKGROUND

The Santa Ana Region includes the Upper and Lower Santa Ana River Watersheds, the San Jacinto River Watershed, as well as several other smaller drainage areas covering parts of southwestern San Bernardino County, western Riverside County, and northwestern Orange County (SARWQCB, 1995). The Permit for San Bernardino County, under which the IWMP and QAPP are required, regulates approximately 620 square miles of land with a population of approximately 1.5 million. The Municipal Separate Storm Sewer Systems (MS4s) in this area

include an estimated 863 miles of storm drain system with 378 miles consisting of above-ground channels and 485 miles consisting of underground conveyances (San Bernardino County Stormwater Program, 2006). Stormwater flows from the MS4 discharge into various water bodies of the state that are governed by the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan). The ultimate goal of the Permit and the MRP is to protect the beneficial uses of the receiving waters as outlined in the Basin Plan. However, several water bodies within the region do not meet the water quality objectives (WQOs) set forth in the Basin Plan, which has led to their inclusion on the United States Environmental Protection Agency’s (USEPA) 303(d) list of impaired waters. Two of these water bodies have TMDLs developed for them including the Middle Santa Ana River (pathogens)¹ and Big Bear Lake (nutrients)².

Cooperation and coordination among stakeholders is imperative in order to cost effectively protect and improve the water quality of the water bodies of the state. There are 18 permittees covered under the Permit with the SBCFCD identified as the Principal Permittee as listed in Table 1. The creation and use of an IWMP is one example of how cooperation and coordination between stakeholders can cost effectively protect and improve water quality.

The overall objective of the IWMP is to provide data to support the development of an effective watershed management program. The Program is developing this QAPP to ensure that monitoring efforts conform to the same quality assurance, data management, validation, and verification standards so that there is confidence in using the acquired data for watershed management. As previously stated, this QAPP does not describe the quality assurance requirements for any monitoring projects that already have approved QAPPs developed for them. This includes the Middle Santa Ana Bacteria Indicator TMDL (MSAR TMDL) and the Big Bear Lake Nutrient TMDL as well as any other Regional Watershed Monitoring including southern California Stormwater Monitoring Coalition (SMC) monitoring.

Table 1. NPDES Permittees

Principal Permittee	San Bernardino County Flood Control District	
Co-Permittees	County of San Bernardino	City of Montclair
	City of Big Bear Lake	City of Ontario
	City of Chino	City of Rancho Cucamonga
	City of Chino Hills	City of Redlands
	City of Colton	City of Rialto
	City of Fontana	City of San Bernardino
	City of Grand Terrace	City of Upland
	City of Highland	City of Yucaipa
	City of Loma Linda	

¹ California Regional Water Quality Control Board, Santa Ana Region, Resolution No. R8-2005-0001, Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate Bacterial Indicator Total Maximum Daily Loads (TMDLs) for Middle Santa Ana River Watershed Waterbodies, April 2005.

² California Regional Water Quality Control Board, Santa Ana Region, Resolution No. R8-2006-0023, Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate a Nutrient Total Maximum Daily Load (TMDL) for Dry Hydrological Conditions for Big Bear Lake, April 2006.

Monitoring Program Objectives

As stated in the previous section, the overall objective of the IWMP is to provide data to support the development of an effective watershed and key environmental resources management program that focuses resources on the priority pollutants of concern. The Program has identified a priority list of pollutants of concern in the watershed, determined from a risk-based analysis of water quality monitoring results collected during previous permit terms. These pollutants, in order of priority from high to low were: (1) high priority - bacteria; (2) medium priority - metals (zinc, copper, lead); and (3) low priority - nutrients, total suspended solids (TSS) and chemical oxygen demand (COD). This priority ranking provides the basis for a risk-based approach to stormwater management and to direct resources to the most important water quality monitoring and improvement activities. Additional objectives of the monitoring programs, as stated in the Permit MRP, include:

1. Providing data to support the development of an effective municipal urban runoff pollutant source control program;
2. Determining water quality status, trends, and pollutants of concern associated with urban runoff and their impact on the beneficial uses of the receiving waters. This includes determining current conditions in the receiving waters including the extent and magnitude of any impairments, and relative urban runoff contribution to the impairment;
3. Assisting in identifying the sources of the priority list of pollutants of concern in urban runoff to the maximum extent practicable (e.g., including, but not limited to atmospheric deposition, contaminated sediments, other non-point sources, etc.);
4. Characterizing pollutants associated with urban runoff and to assess the influence of urban land uses on receiving water quality;
5. Evaluating the effectiveness of existing urban runoff water quality management programs, including an estimate of pollutant reductions achieved by the treatment and source control BMPs implemented by the Permittees;
6. Detecting illegal discharges and illicit connections to the MS4s so they can be responded to or eliminated;
7. Identifying those waters, which without additional action to control pollution from urban stormwater discharges, cannot reasonably be expected to attain or maintain applicable water quality objectives in the Basin Plan;
8. Identifying and prioritize the most significant water quality problems resulting from urban runoff. Order No. R8-2010-0036 establishes new program monitoring priorities through the development and implementation of a risk-based, outcome-oriented, compliance-focused program. Monitoring and sampling data shall be used to identify and prioritize the most significant water quality problems in receiving waters; and
9. Evaluating costs and benefits of proposed municipal stormwater quality control programs to the stakeholders, including the public.

Water Quality or Regulatory Criteria

Applicable Basin Plan objectives and CTR criteria will be used to assess monitored receiving waters. Urban mass emissions/MS4 discharges are not receiving waters and, therefore, will not be compared to Basin Plan objectives. Urban mass emissions/MS4 discharges may be compared to other metrics to help guide stormwater management practices.

6. PROJECT DESCRIPTION

The primary purpose of the QAPP is to outline the process for collecting data to meet the goals of the IWMP. The monitoring programs covered by this QAPP include Core Monitoring, Illegal Discharge/Illicit Connection Monitoring, Hydromodification Monitoring, and Source Identification and Special Studies Monitoring.

Core Monitoring

Core Monitoring consists of receiving water and urban discharge/MS4 monitoring³. The goals of receiving water monitoring and urban discharge/MS4 monitoring are directly related. One of the primary objectives of receiving water monitoring is to provide adequate data to determine whether urban runoff is causing or contributing to exceedances of water quality standards in the receiving waters. In addition, receiving water monitoring may support stormwater management objectives. The primary objective of urban discharge/MS4 monitoring is to determine the pollutant loads from the MS4s and to determine their trends over time. Additional major objectives of Core Monitoring include:

1. Provide data sufficient to estimate the total mass emissions of pollutants of concern from the MS4 to receiving waters.
2. Provide data sufficient to assess trends in mass emissions associated with urban storm water runoff from the MS4s over time and evaluate potential correlations between any trends in mass emission and land use and population changes.
3. Provide data sufficient to determine if the MS4 is contributing to exceedances of water quality standards, by comparing outfall and receiving water results to: (1) Basin Plan Water quality Objectives (WQOs); (2) EPA storm water benchmarks contained in the EPA Multi-Sector Industrial Storm Water Permit; (3) California Toxic Rule (CTR); and (4) other MS4 discharge monitoring data.

However, Basin Plan WQOs and CTR criteria are applicable only to receiving waters, and EPA storm water benchmarks were intended to be applicable only to industrial stormwater runoff rather than municipal stormwater runoff.

Monitoring will be conducted during dry and wet weather for a large suite of constituents including priority pollutants such as metals, inorganic substances, volatile substances, semi-volatile substances, pesticides and polychlorinated biphenyls (PCBs); conventional pollutants; nutrients; hydrocarbons; bacteria; minerals; and field parameters. The MRP requires that all urban discharge/MS4 samples be analyzed for *E. coli*, nutrients (nitrates and nitrites, potassium, and phosphorous), metals, pH, TSS, TOC, organophosphorus pesticides/herbicides, and any

³ The terms MS4 monitoring, urban discharge monitoring, and stormwater monitoring are used interchangeably in this document.

other constituents that are known to have contributed to impairment of local receiving waters by inclusion on the 303(d) list. In addition, all dry weather samples must be analyzed for total petroleum hydrocarbons (by method 8015M) and oil and grease. Table 2 lists the constituents to be analyzed for the first wet and dry weather event of each reporting year and Table 3 lists the constituents to be analyzed for subsequent monitoring events.

Table 2. Monitored Constituents for the First Wet Weather and Dry Weather Events

1. PRIORITY POLLUTANTS		
a. Metals		
• Antimony	• Copper, Total	• Selenium, Total
• Arsenic, Total	• Copper, Dissolved	• Selenium, Dissolved
• Arsenic, Dissolved	• Lead, Total	• Silver, Total
• Beryllium	• Lead, Dissolved	• Silver, Dissolved
• Cadmium, Total	• Mercury	• Thallium
• Cadmium, Dissolved	• Nickel, Total	• Zinc, Total
• Chromium (Total)	• Nickel, Dissolved	• Zinc, Dissolved
• Chromium (VI)		• Cyanide
b. Inorganic Substances		
• Asbestos	• 2,3,7,8 Tetrachloro-dibenzo-p-dioxin (TCDD or Dioxin)	
c. Volatile Substances		
• Acrolein	• 1,1-Dichloroethane	• Tetrachloroethylene (Tetrachloroethene)
• Acrylonitrile	• 1,2-Dichloroethane	• Toluene
• Benzene	• 1,1-Dichloroethylene (1,1-Dichloroethene)	• 1,2-Trans-Dichloroethylene
• Bromoform	• 1,2-Dichloropropane	• 1,1,1-Trichloroethane
• Carbon Tetrachloride	• 1,3-Dichloropropylene (1,3-Dichloropropene)	• 1,1,2-Trichloroethane
• Chlorobenzene	• Ethylbenzene	• Trichloroethylene (Trichloroethene)
• Chlorodibromomethane	• Methyl Bromide (Bromomethane)	• Vinyl Chloride
• Chloroethane	• Methyl Chloride (Chloromethane)	• 1,2-Dichlorobenzene
• Chloroform	• Methylene Chloride (Dichloromethane)	• 1,3-Dichlorobenzene
• Dichlorobromomethane	• 1,1,2,2-Tetrachloroethane	• 1,4-Dichlorobenzene
d. Semi-Volatile Substances		
• 2-Chloroethylvinyl ether	• Benzo(k)Fluoranthene	• 2,6-Dinitrotoluene
• 2-Chlorophenol	• Bis(2-Chloroethoxy)Methane	• Di-n-Octyl Phthalate
• 2,4-Dichlorophenol	• Bis(2-Chloroethyl)Ether	• 1,2-Diphenylhydrazine
• 2,4-Dimethylphenol	• Bis(2-Chloroisopropyl)Ether	• Fluoranthene
• 2-Methyl- 4,6-Dinitrophenol	• Bis(2-Ethylhexyl)Phthalate	• Fluorene
• 2,4-Dinitrophenol	• 4-Bromophenyl Phenyl Ether	• Hexachlorobenzene
• 2-Nitrophenol	• Butylbenzyl Phthalate	• Hexachlorobutadiene

- 4-Nitrophenol
- 3-Methyl 4-Chlorophenol
- Pentachlorophenol
- Phenol
- 2,4,6-Trichlorophenol
- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzidine
- Benzo(a)Anthracene
- Benzo(a)Pyrene
- Benzo(b)Fluoranthene
- Benzo(ghi)Perylene
- 2-Chloronaphthalene
- 4-Chlorophenyl Phenyl Ether
- Chrysene
- Dibenzo(a,h)Anthracene
- 1,2-Dichlorobenzene
- 1,3-Dichlorobenzene
- 1,4-Dichlorobenzene
- 3,3' Dichlorobenzidine
- Diethyl Phthalate
- Dimethyl Phthalate
- Di-n-Butyl Phthalate
- 2,4-Dinitrotoluene
- Hexachlorocyclopentadiene
- Hexachloroethane
- Indeno(1,2,3-cd)Pyrene
- Isophorone
- Naphthalene
- Nitrobenzene
- N-Nitroso-dimethyl amine
- N-Nitroso-di n-propyl amine
- N-Nitroso diphenyl amine
- Phenanthrene
- Pyrene
- 1,2,4-Trichlorobenzene

e. Organochlorine Pesticides - PCBs

- Aldrin
 - alpha-BHC
 - beta-BHC
 - gamma-BHC
 - delta-BHC
 - Chlordane
 - 4,4'-DDT
 - 4,4'-DDE
 - 4,4'-DDD
 - Dieldrin
 - alpha-Endosulfan
 - beta-Endosulfan
 - Endosulfan Sulfate
 - Endrin
 - Endrin Aldehyde
 - Heptachlor
 - Heptachlor Epoxide
 - Aroclor 1016
 - Aroclor 1221
 - Aroclor 1232
 - Aroclor 1242
 - Aroclor 1248
 - Aroclor 1254
 - Aroclor 1260
 - Toxaphene
-

2. OTHER CONSTITUENTS

a. Conventional	<ul style="list-style-type: none"> • Biological Oxygen Demand (BOD) • Chemical Oxygen Demand (COD) • Total Dissolved Solids (TDS) 	<ul style="list-style-type: none"> • Total Suspended Solids (TSS) • Total Organic Carbon
b. Bacteria	<ul style="list-style-type: none"> • E. coli • Enterococcus 	
c. Nutrients	<ul style="list-style-type: none"> • Ammonia-N • Nitrate-N • Nitrite-N • Ortho-Phosphorus 	<ul style="list-style-type: none"> • Phosphorus, Total • Phosphorus, Dissolved • Total Kjeldahl Nitrogen
d. Pesticides	<ul style="list-style-type: none"> • Organophosphorus Pesticides 	
e. Hydrocarbons	<ul style="list-style-type: none"> • Oil and grease • Total Petroleum Hydrocarbons (TPH) 	
f. Other Minerals	<ul style="list-style-type: none"> • Chloride • Fluoride • Potassium 	<ul style="list-style-type: none"> • Sodium • Sulfate
g. Field Parameters	<ul style="list-style-type: none"> • Conductivity • Dissolved Oxygen • pH 	<ul style="list-style-type: none"> • Temperature • Turbidity

Table 3. Monitored Constituents for Subsequent Events

Category	Constituents
Conventional	<ul style="list-style-type: none"> • Biological Oxygen Demand (BOD) • Chemical Oxygen Demand (COD) • Hardness • Total Suspended Solids (TSS) • Total Organic Carbon • Total Dissolved Solids (TDS)
Bacteria	<ul style="list-style-type: none"> • E. coli • Enterococcus
Metals	<ul style="list-style-type: none"> • Copper, Total • Copper, Dissolved • Lead, Total • Lead, Dissolved • Zinc, Total • Zinc, Dissolved
Nutrients	<ul style="list-style-type: none"> • Ammonia-N • Nitrate-N • Nitrite-N • Ortho-Phosphorus • Phosphorus, Total • Phosphorus, Dissolved • Total Kjeldahl Nitrogen (TKN)
Pesticides	<ul style="list-style-type: none"> • Organophosphorus Pesticides
Hydrocarbons¹	<ul style="list-style-type: none"> • Oil and Grease • Total Petroleum Hydrocarbons (TPH)
Other Minerals	<ul style="list-style-type: none"> • Chloride • Fluoride • Potassium • Sodium • Sulfate
Field Parameters	<ul style="list-style-type: none"> • Conductivity • Dissolved Oxygen • pH • Temperature • Turbidity

¹ TPH and Oil and Grease shall be sampled during dry weather events only

Illegal Discharge/Illicit Connection Monitoring

Illegal Discharge/Illicit Connection Monitoring will entail visual inspections of the MS4 to identify and eliminate all illegal discharges and illicit connections (See Section 4 the IWMP for further explanation). During the dry season in the Santa Ana Region of San Bernardino County, the majority of receiving water bodies and storm drains are dry. The Permittees would submit that visual inspections of the storm drains for the presence of unusual flowing water, or evidence of discharge, is a more effective strategy for detecting and correcting ID/ICs during dry weather. All monitoring data collected under other Program activities will be examined to look for samples that report significantly higher values than typically observed in the long-term dataset (Orange County uses 3.9 standard deviations above the mean for each site, or above a determined tolerance interval about the “average” condition determined from the dataset). If

such samples are identified, additional follow-up activities, which could include additional monitoring, will be conducted to determine if ID/ICs can be detected and corrected.

Nitrogen-TDS Dry Weather Monitoring

The Permit requires a plan be developed to determine baseline concentration of nitrogen and TDS in dry weather run-off. The plan is required to be developed within 18 months of Permit adoption (July 29, 2011). The plan may include evaluation of existing data and data planned to be collected as part of Core Monitoring. This section will be updated to include relevant sections of the plan.

Hydromodification Monitoring

The MRP requires the Permittees to develop a Hydromodification Monitoring Plan (HMP) as part of the Watershed Action Plan (WAP) to evaluate hydromodification impacts on channels susceptible to degradation arising from increased development. The WAP will identify vulnerable streams and possible control measures for hydromodification as well as tools to measure hydrologic impacts. The HMP will include monitoring protocols to assess the drainage channels deemed most susceptible and the efficacy of prevention measures, as well as urbanization impact models.

The first phase of the WAP is on schedule to be developed by January 29, 2011, 12 months after the adoption of the NPDES Permit. This section of the IWMP will be updated with relevant sections of the HMP once the HMP is prepared.

Source Identification and Special Studies Monitoring

The Permittees have developed a prioritized list of pollutants of concern based on the findings of previous water quality monitoring efforts (Table 4). The Permit requires the Permittees to assess each of the pollutants of concern (except bacteria, which is addressed by a TMDL) and develop a strategic plan for addressing each pollutant. It is proposed that the data collected at the rotating monitoring stations as part of Core Monitoring serve as source identification monitoring data. The locations of the rotating monitoring stations are designed to allow locations of sources of pollutants to be identified, therefore these data can be used to isolate and locate sources and stretches of problematic waterbodies and urban discharges. If additional special study monitoring is conducted beyond the Core Monitoring or other identified monitoring in the document, the results will be reported as part of the Annual Progress Report.

Additionally, the Permit requires that the Pollutant Source Identification and Control Plan for the Site 5 drainage area continue to be developed and implemented, including annual reporting and BMP effectiveness evaluation. Accordingly, the Site 5 Plan will continue to be implemented and the results reported in Annual Progress Report.

Table 4. Pollutants of Concern and Priority Ranking

Pollutant of Concern	Ranking
Bacteria	High
Zinc	Medium
Copper	
Lead	
Nitrate as N	Low
Total Phosphorus	
TSS	
COD	

Project Schedule

The Effective Date of the Permit is January 29, 2010. The MRP states that the IWMP must be submitted to the SARWQCB within 12 months of the Effective date must be implemented within six months of approval by the Executive officer. However, several of the monitoring programs required by the MRP have specific dates that may not coincide with the IWMP approval date.

Core Monitoring

Core Monitoring outlined in the IWMP will be implemented beginning in the 2011/2012 fiscal year. Existing Core Monitoring will be conducted during the interim. Core monitoring activities will be conducted during both the dry and wet seasons annually. Pursuant to the MRP the Permittees must submit an annual progress report to the Executive Officer and to the Regional Administrator of the USEPA, Region 9, no later than November 15th, of each year.

Illegal Discharge/Illicit Connection Monitoring

Pursuant to the MRP, the Permittees will review and update their existing illegal discharge/illicit connection policies within six months after IWMP adoption. The Nitrogen-TDS Dry Weather Monitoring Plan will be developed within 18 months of Permit adoption. This section will be updated to include scheduling requirements included in the developed plan.

Hydromodification Monitoring

The first phase of the WAP is on schedule to be developed by January 29, 2011, 12 months after the adoption of the NPDES Permit.

Source Identification and Special Studies Monitoring

Monitoring activities are conducted annually as part of Core Monitoring that will serve as source identification monitoring. These results, and any other additional special studies monitoring conducted, will be reported annually in the Annual Program Report. Additionally, the Program will continue to implement the Site 5 Plan and the results will be reported in the Annual Progress Report.

7. QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The objective of the IWMP, in terms of data quality, is to produce data that represent as closely as possible, *in situ* conditions of waterbodies from which samples are collected. This objective will be achieved by using accepted standard methods for sample collection and laboratory analysis. Assessing the IWMP's ability to meet this objective will be accomplished by evaluating the resulting laboratory measurements in terms of detection limits, precision, accuracy, representativeness, comparability, and completeness, as discussed in Element 14 (Quality Control).

The data quality objectives for the constituents to be measured during Core Monitoring and Source Identification and Special Studies Monitoring are presented in Table 5. Other monitoring types included in this QAPP do not have identified data quality objectives at this time. This section will be updated if appropriate to include additional data quality objectives.

Table 5. Data Quality Objectives for Core Monitoring

Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness	Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness
Metals											
Antimony	80-120%	20 %	70-130%	0.5 µg/L	See Element 14	Mercury	80-120%	20 %	70-130%	See Element 13	See Element 14
Arsenic, Total	80-120%	20 %	70-130%	2 µg/L	See Element 14	Nickel, Total	80-120%	20 %	70-130%	10 µg/L	See Element 14
Arsenic, Dissolved	80-120%	20 %	70-130%	2 µg/L	See Element 14	Nickel, Dissolved	80-120%	20 %	70-130%	10 µg/L	See Element 14
Beryllium	80-120%	20 %	70-130%	1 µg/L	See Element 14	Selenium, Total	80-120%	20 %	70-130%	5.0 µg/L	See Element 14
Cadmium, Total	80-120%	20 %	70-130%	1 µg/L	See Element 14	Selenium, Dissolved	80-120%	20 %	70-130%	5.0 µg/L	See Element 14
Cadmium, Dissolved	80-120%	20 %	70-130%	1 µg/L	See Element 14	Silver, Total	80-120%	20 %	70-130%	See Element 13	See Element 14
Chromium, Total	80-120%	20 %	70-130%	1 µg/L	See Element 14	Silver, Dissolved	80-120%	20 %	70-130%	See Element 13	See Element 14
Chromium, VI	80-120%	20 %	80-120%	1 µg/L	See Element 14	Thallium	80-120%	20 %	70-130%	1 µg/L	See Element 14
Copper, Total	80-120%	20 %	70-130%	1 µg/L	See Element 14	Zinc, Total	80-120%	20 %	80-120%	10 µg/L	See Element 14
Copper, Dissolved	80-120%	20 %	70-130%	10 µg/L	See Element 14	Zinc, Dissolved	80-120%	20 %	70-130%	10 µg/L	See Element 14
Lead, Total	80-120%	20 %	80-120%	5 µg/L	See Element 14	Cyanide	80-120%	30 %	70-130%	5.0 µg/L	See Element 14
Lead, Dissolved	80-120%	20 %	80-120%	5 µg/L	See Element 14						
Inorganic Substances											
Asbestos	75-125%	25%	75-125%	See Element 13	See Element 14	2,3,7,8 Tetrachloro-dibenzo-p-dioxin (TCDD or Dioxin)	75-125%	25%	75-125%	See Element 13	See Element 14
Volatile Substances											
Acrolein	Non-core compound ^a	40%	Non-core compound	10 µg/L	See Element 14	Ethylbenzene	37-162%	40%	37-162%	0.5 µg/L	See Element 14
Acrylonitrile	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Methyl Bromide (Bromomethane)	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14
Benzene	37-151%	40%	37-151%	0.5 µg/L	See Element 14	Methyl Chloride (Chloromethane)	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14
Bromoform	45-169%	40%	45-164%	0.5 µg/L	See Element 14	Methylene Chloride (Dichloromethane)	Non-core compound	40%	Non-core compound	3 µg/L	See Element 14
Carbon Tetrachloride	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14	1,1,2,2-Tetrachloroethane	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14
Chlorobenzene	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14	Tetrachloroethylene (Tetrachloroethene)	64-148%	40%	64-148%	0.5 µg/L	See Element 14
Chlorodibromomethane	53-149%	40%	53-149%	0.5 µg/L	See Element 14	Toluene	47-150%	40%	47-150%	0.5 µg/L	See Element 14

Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness	Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness
Chloroethane	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14	1,2-Trans-Dichloroethylene	0.5-234%	40%	0.5-234%	0.5 µg/L	See Element 14
Chloroform	51-138%	40%	51-138%	0.5 µg/L	See Element 14	1,1,1-Trichloroethane	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14
Dichlorobromomethane	53-149%	40%	53-149%	0.5 µg/L	See Element 14	1,1,2-Trichloroethane	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14
1,1-Dichloroethane	59-155%	40%	59-155%	0.5 µg/L	See Element 14	Trichloroethylene (Trichloroethene)	71-157%	40%	71-157%	0.5 µg/L	See Element 14
1,2-Dichloroethane	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14	Vinyl Chloride	0.5-251%	40%	0.5-251%	0.5 µg/L	See Element 14
1,1-Dichloroethylene (1,1-Dichloroethene)	0.5-234%	40%	0.5-234%	0.5 µg/L	See Element 14	1,2-Dichlorobenzene	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14
1,2-Dichloropropane	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14	1,3-Dichlorobenzene	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14
1,3-Dichloropropylene (1,3-Dichloropropene)	Non-core compound	40%	Non-core compound	0.5 µg/L	See Element 14	1,4-Dichlorobenzene	18-190%	40%	18-190%	0.5 µg/L	See Element 14

Semi-Volatile Substances

2-Chloroethylvinyl ether	Non-core compound	40%	Non-core compound	5 µg/L	See Element 14	Chrysene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
2-Chlorophenol	23-134%	40%	23-134%	10 µg/L	See Element 14	Dibenzo(a,h)Anthracene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
2,4-Dichlorophenol	39-135%	40%	39-135%	10 µg/L	See Element 14	1,2-Dichlorobenzene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
2,4-Dimethylphenol	32-119%	40%	32-119%	10 µg/L	See Element 14	1,3-Dichlorobenzene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
2-Methyl- 4,6-Dinitrophenol	Non-core compound	40%	Non-core compound	50 µg/L	See Element 14	1,4-Dichlorobenzene	20-124%	40%	20-124%	10 µg/L	See Element 14
2,4-Dinitrophenol	Non-core compound	40%	Non-core compound	50 µg/L	See Element 14	3,3' Dichlorobenzidine	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
2-Nitrophenol	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	Diethyl Phthalate	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
4-Nitrophenol	Non-core compound	40%	Non-core compound	50 µg/L	See Element 14	Dimethyl Phthalate	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
3-Methyl 4-Chlorophenol	Non-core compound	40%	Non-core compound	20 µg/L	See Element 14	Di-n-Butyl Phthalate	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
Pentachlorophenol	14-176%	40%	14-176%	See Element 13	See Element 14	2,4-Dinitrotoluene	39-139%	40%	39-139%	See Element 13	See Element 14
Phenol	5-112%	40%	5-112%	10 µg/L	See Element 14	2,6-Dinitrotoluene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14

Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness	Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness
2,4,6-Trichlorophenol	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Di-n-Octyl Phthalate	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
Acenaphthene	47-145%	40%	47-145%	10 µg/L	See Element 14	1,2-Diphenylhydrazine	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
Acenaphthylene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	Fluoranthene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
Anthracene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	Fluorene	59-121%	40%	59-121%	10 µg/L	See Element 14
Benzidine	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Hexachlorobenzene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
Benzo(a)Anthracene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Hexachlorobutadiene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
Benzo(a)Pyrene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Hexachlorocyclopentadiene	Non-core compound	40%	Non-core compound	50 µg/L	See Element 14
Benzo(b)Fluoranthene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Hexachloroethane	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
Benzo(ghi)Perylene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	Indeno(1,2,3-cd) Pyrene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
Benzo(k)Fluoranthene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Isophorone	21-196%	40%	21-196%	10 µg/L	See Element 14
Bis(2-Chloroethoxy)Methane	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	Naphthalene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
Bis(2-Chloroethyl)Ether	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Nitrobenzene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
Bis(2-Chloroisopropyl)Ether	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	N-Nitroso-dimethylamine	10-230%	40%	10-230%	See Element 13	See Element 14
Bis(2-Ethylhexyl)Phthalate	Non-core compound	40%	Non-core compound	3 µg/L	See Element 14	N-Nitroso-di n-propyl amine	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
4-Bromophenyl Phenyl Ether	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	N-Nitroso diphenyl amine	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
Butylbenzyl Phthalate	4-152%	40%	4-152%	10 µg/L	See Element 14	Phenanthrene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14
2-Chloronaphthalene	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	Pyrene	52-115%	40%	52-115%	10 µg/L	See Element 14
4-Chlorophenyl Phenyl Ether	Non-core compound	40%	Non-core compound	10 µg/L	See Element 14	1,2,4-Trichlorobenzene	44-142%	40%	44-142%	10 µg/L	See Element 14

Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness	Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness
Organochlorine Pesticides - PCBs											
Aldrin	42-122%	40%	42-122%	See Element 13	See Element 14	Endrin	30-147%	40%	30-147%	0.06 µg/L	See Element 14
alpha-BHC	37-134%	40%	37-134%	See Element 13	See Element 14	Endrin Aldehyde	40-184%	40%	10-210%	0.23 µg/L	See Element 14
beta-BHC	17-147%	40%	17-147%	See Element 13	See Element 14	Heptachlor	34-111%	40%	34-111%	See Element 13	See Element 14
gamma-BHC	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Heptachlor Epoxide	37-142%	40%	37-142%	See Element 13	See Element 14
delta-BHC	19-140%	40%	19-140%	0.09 µg/L	See Element 14	Aroclor 1016	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
Chlordane	Non-core compound	40%	Non-core compound	See Element 13	See Element 14	Aroclor 1221	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
4,4'-DDT	25-160%	40%	25-160%	See Element 13	See Element 14	Aroclor 1232	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
4,4'-DDE	30-145%	40%	30-145%	See Element 13	See Element 14	Aroclor 1242	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
4,4'-DDD	31-141%	40%	31-141%	See Element 13	See Element 14	Aroclor 1248	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
Dieldrin	366-146%	40%	36-146%	See Element 13	See Element 14	Aroclor 1254	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
alpha-Endosulfan	45-153%	40%	45-153%	0.14 µg/L	See Element 14	Aroclor 1260	8-127%	40%	8-127%	See Element 13	See Element 14
beta-Endosulfan	10-202%	40%	10-202%	0.04 µg/L	See Element 14	Toxaphene	Non-core compound	40%	Non-core compound	See Element 13	See Element 14
Endosulfan Sulfate	Non-core compound	40%	Non-core compound	0.66 µg/L	See Element 14						
Conventional Substances						Bacteria					
Biological Oxygen Demand (BOD)	66-121%	20%	NA	2 mg/L	See Element 14	<i>E. coli</i>	SM 9223B	140%	NA	2 MPN/100 mL	See Element 14
Chemical Oxygen Demand (COD)	80-120%	20%	80-120%	10 mg/L	See Element 14	Fecal coliform	SM 9221B,C,E	140%	NA	2 MPN/100 mL	See Element 14
Total Dissolved Solids (TDS)	80-120%	20%	NA	5 mg/L	See Element 14	<i>Enterococcus</i>	SM 9230B	140%	NA	2 MPN/100 mL	See Element 14
Total Suspended Solids (TSS)	80-120%	20%	NA	5 mg/L	See Element 14	Total coliform	SM 9221B,C,E	140%	NA	2 MPN/100 mL	See Element 14
Total Organic Carbon	80-120%	20%	80-120%	0.7 mg/L	See Element 14						

Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness	Constituent	Accuracy LCS Recovery	Precision RPD	Recovery MS/MSD	Target Reporting Limits	Completeness
Other Minerals						Field Parameters					
Chloride	80-120%	20%	80-120%	1 mg/L	See Element 14	Conductivity	+/- 1 NTU	+10% or 0.1 ^b	NA	1 umhos/cm	See Element 14
Fluoride	80-120%	20%	80-120%	0.1 mg/L	See Element 14	Dissolved Oxygen	+/- 0.1 mg/L	+0.5 or 10% ^c	NA	0.1 mg/L	See Element 14
Potassium	80-120%	20%	80-120%	1 mg/L	See Element 14	pH	+/- 0.1 s.u.	+0.5 or 10% ^c	NA	NA	See Element 14
Sodium	80-120%	20%	70-130%	1 mg/L	See Element 14	Temperature	+/- 0.1°C	+0.5 or 10% ^c	NA	NA	See Element 14
Sulfate	80-120%	20%	80-120%	0.5 mg/L	See Element 14	Turbidity	+/- 1 NTR	+10% or 0.1 ^b	NA	5 NTU	See Element 14
Nutrients						Hydrocarbons					
Ammonia-N	80-120%	20%	80-120%	0.1 mg/L	See Element 14	Oil and grease	78-114%	18%	78-114%	2.5 mg/L	See Element 14
Nitrate-N	80-120%	20%	80-120%	0.2 mg/L	See Element 14	Total Petroleum Hydrocarbons (TPH)	79-116%	22%	33.9-124%	1mg/L	See Element 14
Nitrite-N	80-120%	20%	80-120%	0.1 mg/L	See Element 14	Organophosphorus Pesticides					
Ortho-Phosphorus	80-120%	20%	80-120%	0.05 mg/L	See Element 14	Atrazine	44-142%	40%	33-150%	4 µg/L	See Element 14
Phosphorus, Total	80-120%	20%	80-120%	0.05 mg/L	See Element 14	Chlorpyrifos	70-130%	40%	70-130%	4 µg/L	See Element 14
Phosphorus, Dissolved	80-120%	20%	80-120%	0.05 mg/L	See Element 14	Diazinon	70-130%	40%	70-130%	4 µg/L	See Element 14
Total Kjeldahl Nitrogen	80-120%	20%	49-150%	0.1 mg/L	See Element 14						

Notes:

- a. Non-core compound: Test methods with a long list of target analytes will spike only a core group of compounds. This core group of spiking compounds represents all chemistries, elution patterns, and masses. Every two years a set of four LCS's is analyzed containing all other NELAP analytes per method, per matrix.
- b. No SWAMP requirement; will use +10% or 0.1, whichever is greater.
- c. No SWAMP requirement; will use +0.5 or 10%.

8. TRAINING AND CERTIFICATION

No specialized training or certifications are required for sampling personnel. However, the Project Manager or designee will ensure that all personnel conducting sampling activities have monitoring experience or are adequately trained prior to initiation of sampling. All sampling shall be performed under the supervision of experienced staff. No volunteers will be used for sampling.

At minimum, laboratories selected to perform analysis for this program must maintain current certification through the California Department of Health Services – Environmental Laboratory Accreditation Program (ELAP) or the National Environmental Laboratory Accreditation Program (NELAP).

9. DOCUMENTS AND RECORDS

Integrated Watershed Monitoring Program (IWMP)

The Project Manager is responsible for the development and revision of the IWMP. The IWMP serves as the document specifying all Program monitoring activities under the Permit, as well as the field document for monitoring activities.

Quality Assurance Project Plan (QAPP)

The Project Manager or designee is responsible for the development, management and distribution of the QAPP to those individuals listed in Element 3 (Distribution List).

Annual Progress Report

The MRP requires the Program to submit an Annual Progress Report to the SARWQCB's Executive Officer and to the Regional Administrator of the USEPA, Region 9, no later than November 15th of each year. The Annual Progress Report must include the following elements specific to the IWMP:

- A summary and analysis of monitoring results and any changes to the monitoring program for the following year;
- An assessment of the effectiveness of the control measures used to eliminate illegal discharges; and
- A status report on the development of the HMP as part of the WAP.

Additionally, the Annual Progress Report will contain summaries of the other IWMP program elements including Source Identification and Special Studies Monitoring as well as Regional Watershed Monitoring programs consisting of MSAR TMDL monitoring, Big Bear Lake Nutrient TMDL monitoring, and SMC programs such as Low Impact Development (LID) Best Management Practices (BMPs) monitoring and Bioassessment Monitoring.

Distribution and Management of Documents

The Project Manager, or designee, is responsible for the development, distribution, and management of the approved QAPP, Annual Report, and other relevant documentation. All hard copy and electronic data will be stored by the Project Manager, or designee. Data will be maintained for the length of the program and will be available for review.

B. DATA GENERATION AND ACQUISITION

Sample collection and analysis will be the most involved and resource intensive aspect of the monitoring program. The numerous requirements and considerations which must be taken into account are described below.

10. SAMPLING PROCESS DESIGN

The MRP requires the Program, through the IWMP, to address numerous and potentially competing monitoring objectives. It is a significant challenge for the Program to develop a monitoring program that meets these objectives and that will be both cost effective and generate data that will lead to protection and improvement of water quality. The Program has relied on the SMC's guidance for developing monitoring programs to support municipal stormwater management programs. The type of monitoring utilized (permanent stations and short-term, rotating stations) reflects the attempt to achieve multiple objectives in a single program.

Sampling Sites

Sampling sites are specified for each monitoring component as applicable.

Core Monitoring

The MRP requires that receiving water monitoring sites be positioned close to MS4 discharge locations and include areas with chronic or persistent water quality problems. The MRP also requires urban discharge/MS4 monitoring sites to be representative of stormwater conveyance systems characteristics including flow, duration, and pollutant loading and be located based on proximity to receiving water monitoring sites. Core monitoring will consist of permanent and rotating monitoring sites.

All Permanent monitoring stations are receiving water stations. Permanent monitoring stations are located in major receiving waters within the Santa Ana Region of San Bernardino County. The objective of the Permanent monitoring stations is to provide long term data to evaluate the water quality of the receiving water and determine if the receiving water is affected by discharges within the drainage area. Permanent monitoring stations were selected to continue long-term data sets and to provide data to be used in conjunction with data collected at rotating monitoring stations. Permanent monitoring stations are presented in Table 6 and Figure 2. Permanent monitoring stations may be adjusted to address management or other program needs.

Table 6. Permanent Monitoring Sites

Site ID	Location	Coordinates	Type	Notes
11	Santa Ana River @ La Cadena Drive	34.0452° N, -117.3313° W	Receiving Water	Drains Zone 2 and 3
8b	Santa Ana River @ Pedley Avenue	33.9552°N, 117.5328°W	Receiving Water	Long-term Station
3b	Cucamonga Creek @ Hellman Avenue	33.9495°N, 117.6104°W	Receiving Water	Zone 1

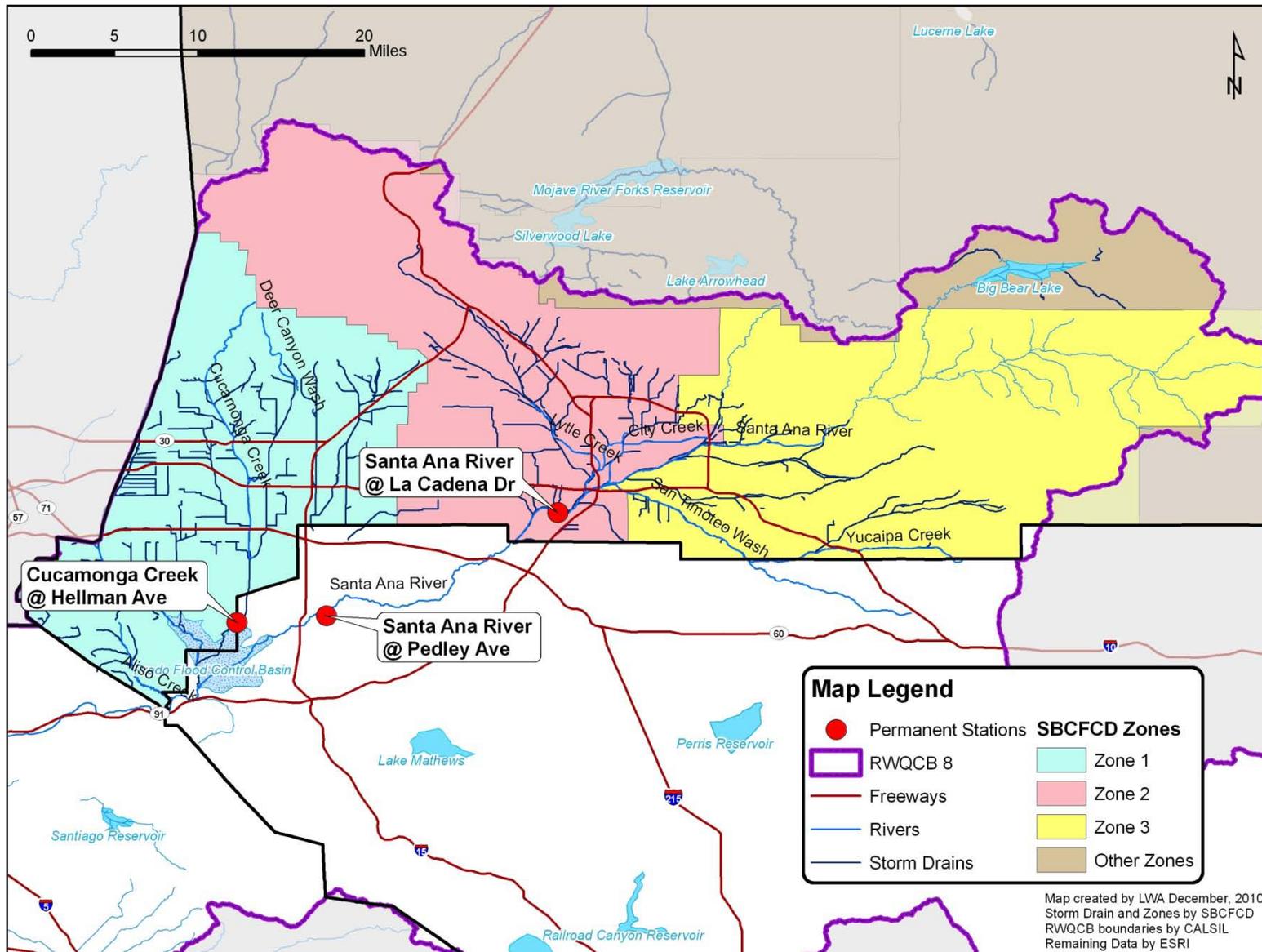


Figure 2. SBCFCD Zones and Permanent Stations

Rotating monitoring stations are located in receiving waters upstream of the Permanent monitoring stations, in tributaries to receiving waters, and in major outfalls or stormwater channels that discharge to the receiving water and tributaries. Therefore, Rotating monitoring stations can be either urban discharge mass emissions sites or receiving water sites.

Furthermore, many receiving water channels primarily convey urban discharge. Receiving water and urban discharge sites are located such that sampling results can be used to further source identification efforts and that the affect of the urban discharge on the receiving water can be evaluated. Monitoring stations may be selected to focus on a single drainage within a Zone in order to collect data that can provide the most benefit for stormwater management activities. In subsequent cycles, Rotating sites in each Zone may be adjusted in an iterative process to focus on problem areas within a drainage area or on alternative drainage areas. Site locations may be adjusted to address management or other program needs, such as the development and implementation of the Comprehensive Bacteria Reduction Plan (CBRP).

Rotating sites will be organized by the SBCFCD Zones (Figure 2), such that one Zone is sampled at a time for a period of 1-3 years. Zones 1, 2, and 3 will be addressed. By focusing on one Zone at a time, the Principal Permittee can collect data at a greater spatial detail and that pairs receiving water and urban discharge sample. This type of sample design provides for data collection that leads to improvement of the stormwater management program and pollutant assessment and achieves the goals of the MRP, while maintaining cost effectiveness and economic feasibility.

Table 7 and Figure 3 present the rotating monitoring sites for Zone 1. Rotating monitoring sites for Zones 2 and 3 will be determined prior to initiating sampling within the respective Zones.

Table 7. Zone 1 Rotating Monitoring Sites

Site ID	Location	Coordinates	Type	Notes
TBD	Cucamonga Creek @ Edison Avenue	33.9972°N, 117.5992°W	Receiving Water	Below Lower Deer Creek Channel
TBD	Lower Deer Creek Channel @ above Chris Basin	34.0082°N, 117.5931°W	UDME/Tributary	Site above Chris Basin, Drains to Cucamonga Ck @ Edison
2	Cucamonga Creek @ Highway 60	34.0295°N, 117.5993°W	Receiving Water	Below West Cucamonga Ck
TBD	Deer Ck Channel @ Archibald Avenue	34.0755°N, 117.5935°W	UDME/Tributary	Drains to Cucamonga Creek
TBD	Cucamonga Ck below Turner Basin Diversion	34.0775°N, 117.6010°W	Receiving Water	Above Deer Ck Channel

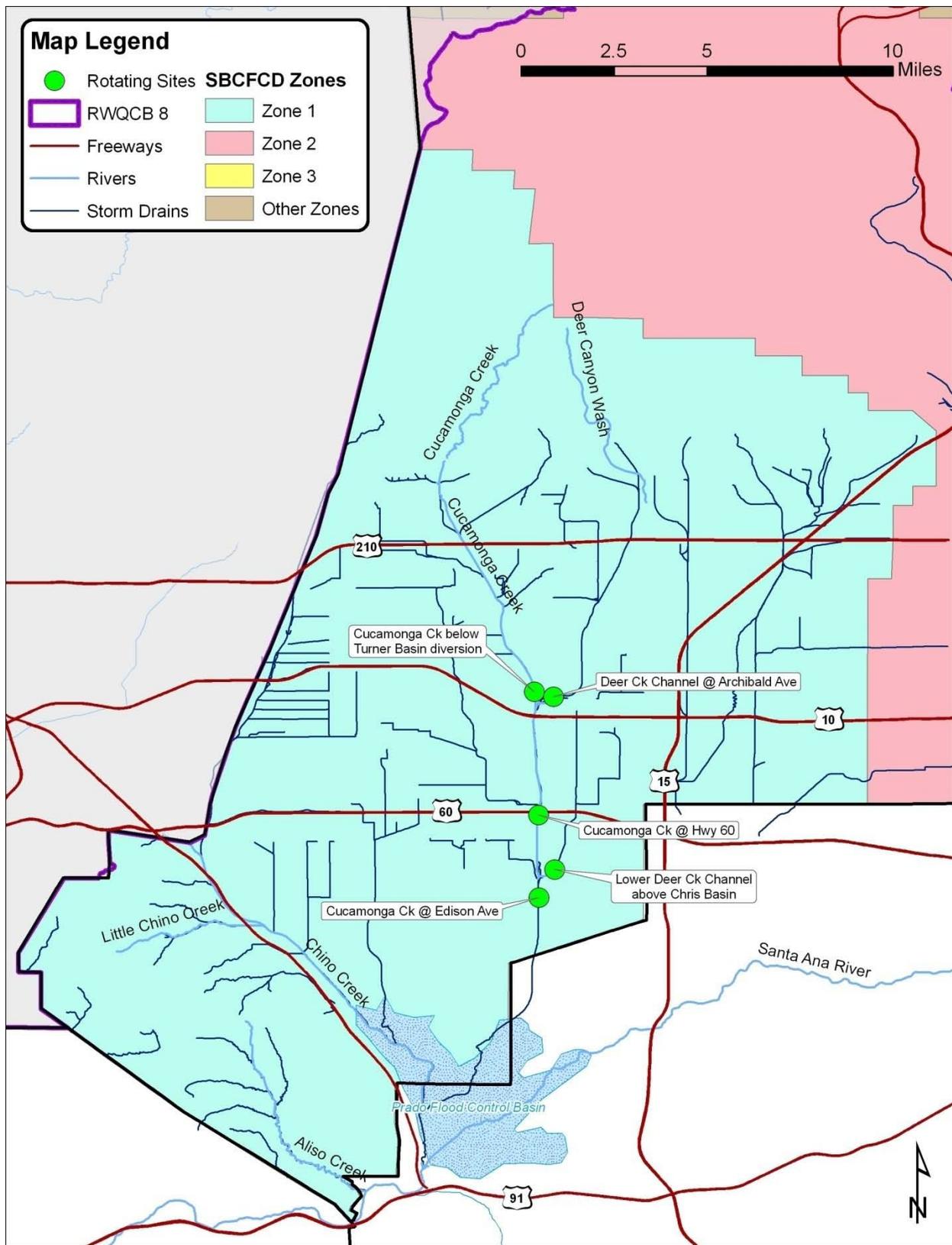


Figure 3. Zone 1 Rotating Stations

Illegal Discharge/Illicit Connection Monitoring

The IWMP does not include specific sites for conducting Illegal Discharge/Illicit Connection Monitoring. Rather, the Permittees will conduct visual inspections of MS4 infrastructure throughout the Permit area. Sites monitored through the other Program monitoring activities will be evaluated for ID/IC. If such samples that may indicate ID/IC are identified, additional follow-up activities, which could include additional monitoring, will be conducted to determine if ID/ICs can be detected and corrected.

Hydromodification Monitoring

The HMP is being developed as part of the WAP. This site will be updated as applicable to include HMP monitoring sites.

Source Identification and Special Studies Monitoring

Data collected as part of Core Monitoring will be used as source identification monitoring data. The locations of the rotating monitoring stations are designed to allow locations of sources of pollutants to be identified, therefore these data can be used to isolate and locate sources and stretches of problematic waterbodies and urban discharges. If additional special study monitoring is conducted beyond the Core Monitoring or other identified monitoring in the document, the sites and results will be reported as part of the Annual Progress Report.

Additionally, the Permit requires that the Pollutant Source Identification and Control Plan for the Site 5 drainage area continue to be developed and implemented. Accordingly, the Site 5 Plan will continue to be implemented and the sites and results reported in Annual Progress Report.

Sampling Schedule

Sampling schedules vary depending on the type of monitoring required to meet the monitoring objectives. The sampling frequencies are such that sufficient data will be produced to adequately meet the monitoring objectives. Core Monitoring frequency for both Permanent and Rotating monitoring stations is presented in Table 9. Criteria for wet weather events includes that the event take place during the wet season (October 1 - May 31, per MRP IV.B.2.b), including the first storm of the wet season. There is no definition regarding the amount of precipitation that constitutes a storm event within the permit. In previous monitoring years, the minimum rainfall constituting qualification for a wet weather event was set to 0.25 inches measured at the Ely Basins rain gauge station (#2866). Therefore, the following criteria consistent with the previous monitoring effort define a storm event:

- A minimum of 0.25 inches measured at Ely Basin
- Less than 0.1 inch of rainfall during the 72 hours preceding the monitored event.

Table 8. Core Monitoring Frequency

Sample Type	Frequency per Reporting Year
Wet Weather	3 events (including first storm of the season)
Dry Weather	2 events

Storm Mobilization Determination

The MRP requires the sampling of at least three wet weather events during each wet season (October 1-May 31) with one of the events being the first storm of the wet season. There is no guidance in the Permit with regards to what constitutes a storm event. The Permittees have previously used a minimum rainfall amount of 0.25 inch measured at the Ely Basins rain gauge station (#2866) as the determining factor for a wet weather event. To be consistent with previous monitoring efforts, the following criteria define a storm event:

1. A minimum of 0.25 inches of rainfall measured at Ely Basins rain gauge station; and
2. Less than 0.1 inch of rainfall for 72 hours before the monitoring event.

Classification of Measurements

Because the IWMP is intended to be a long term monitoring program, data that are not successfully collected for a specific monitoring event will not be collected at a later date. Rather, subsequent events conducted over the course of the program will provide a data set of sufficient size to appropriately characterize conditions at individual sampling sites. For these reasons, most of the data planned for collection cannot be considered absolutely critical. All information collected as outlined in the QAPP will be reported.

Validation of Non-Standard Methods

For non-standard sampling and analytical methods or other unusual situations, appropriate method validation study information will be documented to confirm the performance of the method for the particular need. The purpose of this validation is to assess the potential impact on the representativeness of the data generated. Such validation studies may include the initial demonstration of capability, split samples sent to another laboratory for analysis by a standard method, or round-robin studies performed by USEPA or other organizations. If previous validation studies are not available, some level of validation study will be performed during the project and included as part of the project's final report.

11. SAMPLING METHODS

All samples will be collected in a manner appropriate for the specific analytical methods to be used. Proper sampling techniques must be used to ensure that samples are representative of environmental conditions. Field personnel will adhere to established sample collection protocols in order to ensure the collection of representative and uncontaminated (*i.e.*, contaminants not introduced by the sample handling process itself) samples for laboratory analyses. Deviations from the standard protocols must be documented. Standard operating procedures (SOPs) for collection of samples are summarized below.

Field Protocols

Briefly, the key aspects of quality control associated with sample collection for eventual chemical analyses are as follows:

- Field personnel will be thoroughly trained in the proper use of sample collection gear and will be able to distinguish acceptable versus unacceptable water samples in accordance with pre-established criteria;

- Field personnel will be thoroughly trained to recognize and avoid potential sources of sample contamination (*e.g.*, engine exhaust, ice used for cooling);
- Sampling gear and utensils which come in direct contact with the sample will be made of non-contaminating materials (*e.g.*, borosilicate glass, high-quality stainless steel and/or Teflon™, according to protocol) and will be thoroughly cleaned between sampling stations according to appropriate cleaning protocol (rinsing thoroughly with laboratory reagent water at minimum);
- Sample containers will be of the recommended type and will be free of contaminants (*i.e.*, pre-cleaned);
- Conditions for sample collection, preservation and holding times will be followed.

Samples will be collected in a manner that minimizes the possibility of sample contamination. These sampling techniques are summarized below:

- Samples are collected only into rigorously pre-cleaned sample containers.
- At least two persons are required on a sampling crew.
- Clean, powder-free nitrile gloves must be worn while collecting samples and must be changed whenever something not known to be clean has been touched.
- To reduce the potential for contamination and to ensure crew safety, field crews must observe the following precautions while collecting samples:
 1. Smoking is prohibited.
 2. Collecting samples near a vehicle, running or otherwise, is prohibited.
 3. Eating or drinking during sample collection is prohibited.
 4. Sampling personnel should avoid breathing, sneezing or coughing in the direction of an open sample container.

Each person on the field crew will wear clean clothing that is free of dirt, grease, or other substances that could contaminate the sampling apparatus or sample bottles.

Field crews (2 persons per crew, minimum) will be mobilized for sampling only when weather conditions and flow conditions are considered to be safe. For safety reasons, sampling will occur only during daylight hours. Sampling events should proceed in the following manner:

1. Before leaving the sampling crew base of operations, confirm number and type of sample containers as well as the complete equipment list.
2. Proceed to the first sampling site.
3. Record the general information on the field log sheet.
4. Collect the samples indicated on the event summary sheet in the manner described herein. Collect additional volume and blank samples for field-initiated Quality Control (QC) samples, if necessary. Place filled sample containers in coolers and carefully pack and ice samples as described herein. Using the field log sheet, confirm that all appropriate containers were filled.
5. Collect field measurements and observations, and record these on the field log sheet.
6. Repeat the procedures in steps 3, 4, and 5 for each of the remaining monitoring sites.
7. Complete the chain of custody (COC) forms using the field log sheets.

8. After sample collection is completed at all monitoring sites, deliver and/or ship samples to the appropriate laboratory.

Water Sample Collection

For wet weather monitoring, all receiving water samples will be collected as grab samples and all urban discharge samples will be collected using flow-paced composite samplers, wherever feasible. The exception is for bacteria samples, which must be collected as grabs due to holding time requirements. Grab samples will be collected at or near the peak of the estimated hydrograph, within safe working conditions (i.e. daylight), to capture a representative sample. Flow paced composite samples for the urban discharge sites most accurately reflect the event mean concentration (EMC) which allows comparison to EMCs from other stormwater programs. Dry weather samples will be collected as grab samples for both receiving water and urban discharge samples, if flow is present. However, it may take several years to install the sampling devices used for flow-paced composite sampling at all appropriate locations. If necessary, grab samples will be used in the interim to acquire samples.

Grab Samples

Grab samples will be collected at approximately mid-stream, mid-depth at the location of greatest flow (where feasible) by direct submersion of the sample bottle. This is the preferred method for grab sample collection; however, due to monitoring site configurations and safety concerns, direct filling of sample bottles may not always be feasible, especially during wet events. Monitoring site configuration will dictate grab sample collection technique. Grab samples will be collected directly into the appropriate bottles whenever feasible (containing the required preservatives as outlined in **Table 8**). Clean, powder-free nitrile gloves will be worn while collecting samples. In the event that a peristaltic pump and priority-cleaned silicone and Teflon™ tubing are used as a last resort to collect samples (i.e., due to unsafe conditions during wet events), the sample collection tubing and the sample bottle and lid shall come into contact only with surfaces known to be clean, or with the water sample.

The potential exists for monitoring sites to lack discernable flow. The lack of discernable flow may generate unrepresentative data as standing puddles will not appropriately characterize discharges. To address the potential confounding interference that can occur under such conditions, sites monitored under the guidance of this QAPP should be assessed for the following conditions and sampled (or not sampled) accordingly:

- Pools of water with no flow or visible connection to another surface water body should **NOT** be sampled. The field log should be completed for non-water quality data (including date and time of site visit), and the site condition should be photo-documented.
- Flowing water (i.e., determined by visual observations, flow meter data, and a photo-documented assessment of conditions immediately upstream and downstream of the sampling site) should be sampled.

Some channels and drains may not contain sufficient flow to collect samples by direct submersion. Intermediate containers will be used in instances where flows are too shallow for the direct submersion of sampling containers, and in instances where sheet flow is present. In these instances, a HDPE bottle free of preservative will be used to fill sample bottles.

It is considered very important to not scoop up algae, sediment, or other particulate matter on the bottom of the channel because such debris is not representative of surface flows. To prevent collection of such debris:

- A location should be found where the channel bottom is relatively clean and allows for the intermediate container to fill, or
- A clean Ziploc bag should be placed on the bottom of the channel and water should be collected from on top of the bag. A fresh Ziploc bag pre-rinsed with site water should be used at each site, when required, or
- For certain manholes, a temporary device that would serve to impede flows and create a pool (*e.g.*, a sandbag) may be employed during the sampling event.

Field personnel will adhere to established sample collection protocols in order to ensure the collection of representative and uncontaminated (*i.e.*, contaminants not introduced by the sample handling process itself) samples for laboratory analyses. Deviations from the standard protocols must be documented. Sampling gear and utensils which come in direct contact with the sample will be made of non-contaminating materials and will be thoroughly cleaned between sampling stations according to appropriate cleaning protocols. Sample containers will be of the recommended type and will be free of contaminants (*i.e.*, pre-cleaned). Conditions for sample collection, preservation and holding times will be followed.

It is the combined responsibility of all members of the sampling crew to determine if the performance requirements of the specific sampling method have been met, and to collect additional samples if required. If the performance requirements outlined above or documented in sampling protocols are not met, the sample will be re-collected. If contamination of the sample container is suspected, a fresh sample container will be used. The Project Manager will be contacted if at any time the sampling crew has questions about procedures or issues based on site-specific conditions.

Flow-Paced Composite Samples

All flow-paced composite samples will be collected using an automated sampling device in the correct manner as specified in the device's instructional manual. Before the onset of any sampling regime, the sampling device will be thoroughly cleaned, and internal pumping suction lines will be replaced if appropriate. The intake will be placed in a location in the liquid source so that the sample collected will be representative of the entire liquid source (not in an eddy or near edge flow, etc). Clean, powder-free nitrile gloves will be worn while the correct, clean sample bottles are placed in the sampling device according to the specifications. Sample containers will be of the recommended type and will be free of contaminants (*i.e.*, pre-cleaned). Conditions for sample collection, preservation and holding times will be followed. If it is required to keep the sample bottles cold, ice will be added to the sampling device per the instruction manual. The sampling device will be programmed to ensure that it operates correctly during the sampling event.

Field personnel will adhere to established sample collection protocols in order to ensure the collection of representative and uncontaminated (*i.e.*, contaminants not introduced by the sample handling process itself) samples for laboratory analyses. Deviations from the standard protocols must be documented. It is the combined responsibility of all members of the sampling crew to determine if the performance requirements of the specific sampling method have been met, and

to collect additional samples if required. If the performance requirements outlined above or documented in sampling protocols are not met, the sample will be re-collected. If contamination of the sample container is suspected, a fresh sample container will be used.

Quality Control Sample Collection

Quality control (QC) samples will be collected in conjunction with environmental samples to verify data quality. QC samples collected in the field include field blanks and field duplicates. The frequency of QC sample collection is presented in Element 14 (Quality Control).

Field Measurements and Observations

Field measurements (listed in Table 11) will be taken, and observations made, at each sampling site. All field measurement results and field observations will be recorded on a field log. Field measurements will include conductivity, Dissolved Oxygen, pH, temperature, and turbidity. Measurements (except for flow) will be collected at approximately mid-stream, mid-depth at the location of greatest flow (if feasible) with a multi-probe meter, or comparable instrument(s). For measurements of relatively deep flows, the sensors will be placed directly into the flow path. For measurements of shallow flows, water will be collected in a rinsed intermediate container prior to measurement.

Prior to each day of each sampling event, water quality meters will be calibrated using fresh calibration solutions. After each calibration, the sensor will be checked to verify the accuracy is within an acceptable range. Otherwise, this process will be repeated until the calibration is verified. The acceptable range of accuracy will be included on a calibration sheet included in the field log.

Flow measurements will be taken at each site following water sample collection. The following section describes the field methods that may be used to measure or estimate flow rates. The method of flow rate measurement will be dependent on the depth/flow at the sampling site and sampling site configuration.

Dry Weather Flow Determination

Velocity Meter Flow Measurements

During dry weather, the water is likely deep enough (>0.1 foot) to allow for use of a velocity meter. When using a velocity meter, velocity is measured at approximately equal increments across the width of the flowing water. A “flow pole” is used to measure the water depth at each measurement point and to properly align the sensor so that the depth of each velocity measurement is 0.6 * total depth (for electromagnetic meters), which is representative of the average velocity, or on the bottom (for Doppler velocity meters). The distance between velocity measurements taken across the stream is dependent on the total width. No more than 10% of the flow will pass through any one cross section.

Shallow Sheet Flow Measurements

If the depth of flow does not allow for the measurement of flow with a velocity meter (<0.1-foot), or other reasons prevent the use of a flow meter, a “float” may be used to measure the velocity of the flowing water. The width, depth, velocity, cross section, and corresponding flow rate will be estimated. Below is a method that may be used for calculating shallow sheet flow.

Sheet flow width: The width (W) of the flowing water (not the entire part of the channel that is damp) is measured using a tape measure at the “top”, “middle”, and “bottom” of a marked-off distance – generally 10 feet (e.g., for a 10-foot marked-off section, W_{Top} is measured at 0-feet, W_{Mid} is measured at 5 feet, and W_{Bottom} is measured at 10 feet).

Sheet flow depth: The depth of the sheet flow is measured at the top, middle, and bottom of the marked-off distance. Specifically, the depth (D) of the sheet flow is measured at 25%, 50%, and 75% of the flowing width (e.g., $D_{50\%}^{Mid}$ is the depth of the water at the middle of the section in the middle of the sheet flow) at each of width measurement locations. It is assumed that the depth at the edge of the sheet flow (i.e., at 0% and 100% of the flowing width) is zero.

Representative cross-section: Based on the collected depth and width measurements, the representative cross-sectional area across the marked-off sheet flow is approximated as follows:

Representative Cross Section =

$$\begin{aligned} \text{Average} \left\{ \left[\frac{W_{Top}}{4} \times \left(\frac{D_{25\%}^{Top}}{2} + \frac{(D_{50\%}^{Top} + D_{25\%}^{Top})}{2} + \frac{(D_{75\%}^{Top} + D_{50\%}^{Top})}{2} + \frac{D_{75\%}^{Top}}{2} \right) \right], \right. \\ \left. \left[\frac{W_{Mid}}{4} \times \left(\frac{D_{25\%}^{Mid}}{2} + \frac{(D_{50\%}^{Mid} + D_{25\%}^{Mid})}{2} + \frac{(D_{75\%}^{Mid} + D_{50\%}^{Mid})}{2} + \frac{D_{75\%}^{Mid}}{2} \right) \right], \right. \\ \left. \left[\frac{W_{Bottom}}{4} \times \left(\frac{D_{25\%}^{Bottom}}{2} + \frac{(D_{50\%}^{Bottom} + D_{25\%}^{Bottom})}{2} + \frac{(D_{75\%}^{Bottom} + D_{50\%}^{Bottom})}{2} + \frac{D_{75\%}^{Bottom}}{2} \right) \right] \right\} \end{aligned}$$

Sheet flow velocity: Velocity is calculated based on the amount of time it took a float to travel the marked-off distance (typically 10-feet or more). Floats are normally pieces of leaves, litter, or floatables (suds, etc.). The time it takes the float to travel the marked-off distance is measured at least three times. Then average velocity is calculated as follows:

$$\text{Average Surface Velocity} = \frac{\text{Distance Marked off for Float Measurement}}{\text{Average Time for Float to Travel Marked off Distance}}$$

Flow Rate calculation: For sheet flows, based on the above measurements/estimates, the estimated flow rate, Q , is calculated by:

$$Q = f \times (\text{Representative Cross Section}) \times (\text{Average Surface Velocity})$$

The coefficient f is used to account for friction effects of the channel bottom. That is, the float travels on the water surface, which is the most rapidly-traveling portion of the water column. The average velocity, not the surface velocity, determines the flow rate, and thus f is used to “convert” surface velocity to average velocity. In general, the value of f typically ranges from 0.60 – 0.90. Based on flow rate measurements taken during the LA River Bacteria Source Identification Study a value of 0.75 will be used for f .

Wet Weather Flow Determination

Various methods exist to determine flow during wet weather, which vary in terms of level of effort, planning, cost, and accuracy. Each monitoring site has a different configuration (concrete channel, natural channel, etc) that may restrict or dictate the methodology used. The intent of flow determination is to estimate the flow rate when the sample was taken to be used for relative comparisons between samples. A protocol may be established for each site so that the measurement will be consistent from event-to-event. However, it may take more than one monitoring season before these protocols can be developed.

Potential options to be used by the Program include:

- Estimate velocity using a float and timer over a marked distance. Estimate width and depth.
- Utilize or install velocity and/or depth loggers. Various types and applications exist.
- Install a weir or flume at one or more sites.

12. SAMPLE HANDLING AND CUSTODY

Documentation Procedures

The Project Manager is responsible for ensuring that each field sampling team adheres to proper custody and documentation procedures. Field log sheets documenting sample collection and other monitoring activities for each site will be bound in a separate master logbook for each event. Field personnel have the following responsibilities:

- Keep an accurate written record of sample collection activities on the field log sheets;
- Ensure that all field log sheet entries are legible and contain accurate and inclusive documentation of all field activities;
- Note errors or changes using a single line to cross out the entry and date and initial the change;
- Ensure that a label is affixed to each sample collected and that the labels uniquely identify samples with a sample ID, site ID, date and time of sample collection and the sampling crew initials; and
- Complete the COC forms accurately and legibly.

Field Documentation/Field Logs

Field crews will keep a field log book for each sampling event. The field log book will contain a calibration log sheet, a field log sheet for each site, and appropriate contact information. The following items should be recorded on the field log sheet for each sampling event:

- Monitoring station location (Site ID);
- Date and time(s) of sample collection;
- Name(s) of sampling personnel;
- Sampling depth;
- Sample ID numbers and unique IDs for any replicate or blank samples;

- QC sample type (if appropriate);
- Requested analyses (specific parameters or method references);
- Sample type, (*i.e.*, grab);
- The results of any field measurements (*e.g.*, flow, temperature, dissolved oxygen, pH, conductivity, turbidity), and the time that field measurements were made;
- Qualitative descriptions of relevant water conditions (*e.g.*, water color, flow level, clarity) or weather (*e.g.*, wind, clouds) at the time of sample collection; and,
- A description of any unusual occurrences associated with the sampling event, particularly those that may affect sample or data quality.

Container Labeling and Sample Identification Scheme

All samples will be identified with a unique identification code to ensure that results are properly reported and interpreted. Samples will be identified such that the site, sampling location, and sample type (*i.e.*, environmental sample or QC sample) can be distinguished by a data reviewer or user. Sample identification codes will consist of a site identification code and a unique sample ID number assigned by the monitoring manager.

Sample Containers, Storage, Preservation, and Holding Times

Sample containers must be pre-cleaned and certified free of contamination according to the USEPA specification for the specific analytical method. Sample container, required sample volume, storage and preservation, and holding time requirements are provided in Table 10. The analytical laboratories will supply sample containers that already contain, including ultra pure acids, where applicable. After collection, samples will be stored at 4°C until arrival at the contract laboratory.

Table 9. Sample Container, Volume, Initial Preservation, and Holding Time Requirements

Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time	Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time
Metals									
Antimony	P, G	500	HNO ₃	6 Months	Mercury	P, G	500	HNO ₃	28 days
Arsenic, Total	P, G	500	HNO ₃	6 Months	Nickel, Total	P, G	500	HNO ₃	6 Months
Arsenic, Dissolved	P, G	500	HNO ₃	6 Months	Nickel, Dissolved	P, G	500	HNO ₃	6 Months
Beryllium	P, G	500	HNO ₃	6 Months	Selenium, Total	P, G	500	HNO ₃	6 Months
Cadmium, Total	P, G	500	HNO ₃	6 Months	Selenium, Dissolved	P, G	500	HNO ₃	6 Months
Cadmium, Dissolved	P, G	500	HNO ₃	6 Months	Silver, Total	P, G	500	HNO ₃	6 Months
Chromium, Total	P, G	500	HNO ₃	6 Months	Silver, Dissolved	P, G	500	HNO ₃	6 Months
Chromium, VI	P, G	100	≤6°C, NH ₄ Buffer	28 Days	Thallium	P, G	500	HNO ₃	6 Months
Copper, Total	P, G	500	HNO ₃	6 Months	Zinc, Total	P, G	500	HNO ₃	6 Months
Copper, Dissolved	P, G	500	HNO ₃	6 Months	Zinc, Dissolved	P, G	500	HNO ₃	6 Months
Lead, Total	P, G	500	HNO ₃	6 Months	Cyanide	P, G	500	HNO ₃	28 Days
Lead, Dissolved	P, G	500	HNO ₃	6 Months					
Inorganic Substances									
Asbestos	P, G	2 X 1 L	≤6°C	48 Hours	2,3,7,8 Tetrachloro-dibenzo-p-dioxin (TCDD or Dioxin)	G-A	2 X 1 L	≤6°C	30/45 Days
Volatile Substances									
Acrolein	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Ethylbenzene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Acrylonitrile	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Methyl Bromide (Bromomethane)	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Benzene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Methyl Chloride (Chloromethane)	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Bromoform	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Methylene Chloride (Dichloromethane)	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Carbon Tetrachloride	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	1,1,2,2-Tetrachloroethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days

Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time	Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time
Chlorobenzene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Tetrachloroethylene (Tetrachloroethene)	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Chlorodibromomethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Toluene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Chloroethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	1,2-Trans-Dichloroethylene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Chloroform	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	1,1,1-Trichloroethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Dichlorobromomethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	1,1,2-Trichloroethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
1,1-Dichloroethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Trichloroethylene (Trichloroethene)	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
1,2-Dichloroethane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	Vinyl Chloride	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
1,1-Dichloroethylene (1,1-Dichloroethene)	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	1,2-Dichlorobenzene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
1,2-Dichloropropane	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	1,3-Dichlorobenzene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
1,3-Dichloropropylene (1,3-Dichloropropene)	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days	1,4-Dichlorobenzene	VOA-G	4 x 40 vials, TB	≤6°C, HCl	14 Days
Semi-Volatile Substances									
2-Chloroethylvinyl ether	G-TLC-A	1,000	≤6°C	7/40 Days	Chrysene	G-TLC-A	1,000	≤6°C	7/40 Days
2-Chlorophenol	G-TLC-A	1,000	≤6°C	7/40 Days	Dibenzo(a,h)Anthracene	G-TLC-A	1,000	≤6°C	7/40 Days
2,4-Dichlorophenol	G-TLC-A	1,000	≤6°C	7/40 Days	1,2-Dichlorobenzene	G-TLC-A	1,000	≤6°C	7/40 Days
2,4-Dimethylphenol	G-TLC-A	1,000	≤6°C	7/40 Days	1,3-Dichlorobenzene	G-TLC-A	1,000	≤6°C	7/40 Days
2-Methyl- 4,6-Dinitrophenol	G-TLC-A	1,000	≤6°C	7/40 Days	1,4-Dichlorobenzene	G-TLC-A	1,000	≤6°C	7/40 Days
2,4-Dinitrophenol	G-TLC-A	1,000	≤6°C	7/40 Days	3,3' Dichlorobenzidine	G-TLC-A	1,000	≤6°C	7/40 Days
2-Nitrophenol	G-TLC-A	1,000	≤6°C	7/40 Days	Diethyl Phthalate	G-TLC-A	1,000	≤6°C	7/40 Days
4-Nitrophenol	G-TLC-A	1,000	≤6°C	7/40 Days	Dimethyl Phthalate	G-TLC-A	1,000	≤6°C	7/40 Days
3-Methyl 4-Chlorophenol	G-TLC-A	1,000	≤6°C	7/40 Days	Di-n-Butyl Phthalate	G-TLC-A	1,000	≤6°C	7/40 Days
Pentachlorophenol	G-TLC-A	1,000	≤6°C	7/40 Days	2,4-Dinitrotoluene	G-TLC-A	1,000	≤6°C	7/40 Days
Phenol	G-TLC-A	1,000	≤6°C	7/40 Days	2,6-Dinitrotoluene	G-TLC-A	1,000	≤6°C	7/40 Days

Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time	Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time
2,4,6-Trichlorophenol	G-TLC-A	1,000	≤6°C	7/40 Days	Di-n-Octyl Phthalate	G-TLC-A	1,000	≤6°C	7/40 Days
Acenaphthene	G-TLC-A	1,000	≤6°C	7/40 Days	1,2-Diphenylhydrazine	G-TLC-A	1,000	≤6°C	7/40 Days
Acenaphthylene	G-TLC-A	1,000	≤6°C	7/40 Days	Fluoranthene	G-TLC-A	1,000	≤6°C	7/40 Days
Anthracene	G-TLC-A	1,000	≤6°C	7/40 Days	Fluorene	G-TLC-A	1,000	≤6°C	7/40 Days
Benzidine	G-TLC-A	1,000	≤6°C	7/40 Days	Hexachlorobenzene	G-TLC-A	1,000	≤6°C	7/40 Days
Benzo(a)Anthracene	G-TLC-A	1,000	≤6°C	7/40 Days	Hexachlorobutadiene	G-TLC-A	1,000	≤6°C	7/40 Days
Benzo(a)Pyrene	G-TLC-A	1,000	≤6°C	7/40 Days	Hexachlorocyclopentadiene	G-TLC-A	1,000	≤6°C	7/40 Days
Benzo(b)Fluoranthene	G-TLC-A	1,000	≤6°C	7/40 Days	Hexachloroethane	G-TLC-A	1,000	≤6°C	7/40 Days
Benzo(ghi)Perylene	G-TLC-A	1,000	≤6°C	7/40 Days	Indeno(1,2,3-cd)Pyrene	G-TLC-A	1,000	≤6°C	7/40 Days
Benzo(k)Fluoranthene	G-TLC-A	1,000	≤6°C	7/40 Days	Isophorone	G-TLC-A	1,000	≤6°C	7/40 Days
Bis(2-Chloroethoxy)Methane	G-TLC-A	1,000	≤6°C	7/40 Days	Naphthalene	G-TLC-A	1,000	≤6°C	7/40 Days
Bis(2-Chloroethyl)Ether	G-TLC-A	1,000	≤6°C	7/40 Days	Nitrobenzene	G-TLC-A	1,000	≤6°C	7/40 Days
Bis(2-Chloroisopropyl)Ether	G-TLC-A	1,000	≤6°C	7/40 Days	N-Nitroso-dimethyl amine	G-TLC-A	1,000	≤6°C	7/40 Days
Bis(2-Ethylhexyl)Phthalate	G-TLC-A	1,000	≤6°C	7/40 Days	N-Nitroso-di n-propyl amine	G-TLC-A	1,000	≤6°C	7/40 Days
4-Bromophenyl Phenyl Ether	G-TLC-A	1,000	≤6°C	7/40 Days	N-Nitroso diphenyl amine	G-TLC-A	1,000	≤6°C	7/40 Days
Butylbenzyl Phthalate	G-TLC-A	1,000	≤6°C	7/40 Days	Phenanthrene	G-TLC-A	1,000	≤6°C	7/40 Days
2-Chloronaphthalene	G-TLC-A	1,000	≤6°C	7/40 Days	Pyrene	G-TLC-A	1,000	≤6°C	7/40 Days
4-Chlorophenyl Phenyl Ether	G-TLC-A	1,000	≤6°C	7/40 Days	1,2,4-Trichlorobenzene	G-TLC-A	1,000	≤6°C	7/40 Days
Organo Chlorine Pesticides - PCBs									
Aldrin	G-TLC-A	1,000	≤6°C	7/40 Days	Endrin	G-TLC-A	1,000	≤6°C	7/40 Days
alpha-BHC	G-TLC-A	1,000	≤6°C	7/40 Days	Endrin Aldehyde	G-TLC-A	1,000	≤6°C	7/40 Days
beta-BHC	G-TLC-A	1,000	≤6°C	7/40 Days	Heptachlor	G-TLC-A	1,000	≤6°C	7/40 Days
gamma-BHC	G-TLC-A	1,000	≤6°C	7/40 Days	Heptachlor Epoxide	G-TLC-A	1,000	≤6°C	7/40 Days

Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time	Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time
delta-BHC	G-TLC-A	1,000	≤6°C	7/40 Days	Aroclor 1016	G-TLC-A	1,000	≤6°C	1year/1year
Chlordane	G-TLC-A	1,000	≤6°C	7/40 Days	Aroclor 1221	G-TLC-A	1,000	≤6°C	1year/1year
4,4'-DDT	G-TLC-A	1,000	≤6°C	7/40 Days	Aroclor 1232	G-TLC-A	1,000	≤6°C	1year/1year
4,4'-DDE	G-TLC-A	1,000	≤6°C	7/40 Days	Aroclor 1242	G-TLC-A	1,000	≤6°C	1year/1year
4,4'-DDD	G-TLC-A	1,000	≤6°C	7/40 Days	Aroclor 1248	G-TLC-A	1,000	≤6°C	1year/1year
Dieldrin	G-TLC-A	1,000	≤6°C	7/40 Days	Aroclor 1254	G-TLC-A	1,000	≤6°C	1year/1year
alpha-Endosulfan	G-TLC-A	1,000	≤6°C	7/40 Days	Aroclor 1260	G-TLC-A	1,000	≤6°C	1year/1year
beta-Endosulfan	G-TLC-A	1,000	≤6°C	7/40 Days	Toxaphene	G-TLC-A	1,000	≤6°C	7/40 Days
Endosulfan Sulfate	G-TLC-A	1,000	≤6°C	7/40 Days					
Conventional Substances					Bacteria				
Biological Oxygen Demand (BOD)	P, G	1,000	≤6°C	48 Hours	E. coli	P, G sterile	100	<10°C	6 Hours
Chemical Oxygen Demand (COD)	P, G	100	≤6°C, H ₂ SO ₄	28 Days	Fecal coliform	P, G sterile	100	<10°C	6 Hours
Total Dissolved Solids (TDS)	P, G	500	≤6°C	7 Days	Enterococcus	P, G sterile	100	<10°C	6 Hours
Total Suspended Solids (TSS)	P, G	500	≤6°C	7 Days	Total coliform	P, G sterile	100	<10°C	6 Hours
Total Organic Carbon	P, G	4 x 40 vials	≤6°C, H ₂ SO ₄	28 Days					
Other Minerals					Field Parameters				
Chloride	P, G	100	None	28 Days	Conductivity	P, G	100	≤6°C	28 Days
Fluoride	P	100	None	28 Days	Dissolved Oxygen	G	300	Fixed on site	8 Hours
Potassium	P, G	500	HNO ₃	6 Months	pH	P, G	100	None	15 Min.
Sodium	P, G	500	HNO ₃	6 Months	Temperature	N/A	N/A	N/A	N/A
Sulfate	P, G	100	≤6°C	28 Days	Turbidity	P, G	100	≤6°C	48 Hours
Nutrients					Hydrocarbons				

Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time	Constituent	Sample Container	Sample Volume (mL)	Immediate Processing and Storage	Holding Time
Ammonia-N	P, G	100	≤6°C, H ₂ SO ₄	28 Days	Oil and grease	G-A	500	≤6°C, H ₂ SO ₄	28 Days
Nitrate-N	P, G	100	≤6°C	48 Hours	Total Petroleum Hydrocarbons (TPH)	G-TLC-A	1,000	≤6°C, H ₂ SO ₄	28 Days
Nitrite-N	P, G	100	≤6°C	48 Hours	Organophosphorus Pesticides				
Ortho-Phosphorus	P, G	100	≤6°C	48 Hours	Atrazine	G-TLC-A	1,000	≤6°C	7/40 Days
Phosphorus, Total	P, G	100	≤6°C, H ₂ SO ₄	28 Days	Chlorpyrifos	G-TLC-A	1,000	≤6°C	7/40 Days
Phosphorus, Dissolved	P, G	100	≤6°C, H ₂ SO ₄	28 Days	Diazinon	G-TLC-A	1,000	≤6°C	7/40 Days
Total Kjeldahl Nitrogen	P, G	500	≤6°C, H ₂ SO ₄	28 Days					

G = Glass, P = Polyethylene (plastic), G-A = Amber Glass, VOA = Vial with Teflon-lined septum – zero head space, G-TLC-A = Amber Glass with Teflon-lined cap, TB = Travel Blank,

Sample Handling and Shipment

The field crews will have custody of samples during each monitoring event. COC forms will accompany all samples during shipment or delivery to contract laboratories to identify the shipment contents. All water quality samples will be transported to the analytical laboratory by the field crew or by shipment. The original COC form will accompany the shipment, and a signed copy of the COC form will be sent, typically via fax, by the laboratory to the field crew to be retained in the project file.

While in the field, samples will be stored on ice in an insulated container, so that they will be kept at approximately 4°C. Samples must have lids securely tightened and must be placed on ice to maintain the temperature at approximately 4°C. The original COC form(s) will be bagged in re-sealable plastic bags and either taped to the outside of the cooler or to the inside lid. Samples will be hand delivered or shipped to the laboratory according to Department of Transportation standards.

If shipped, coolers will be sealed with packing tape before shipping and must not leak. It is assumed that samples in tape-sealed ice chests are secure whether being transported by field staff vehicle, by common carrier, or by commercial package delivery. The laboratory's sample receiving department will examine the shipment of samples for correct documentation, proper preservation, and compliance with holding times.

The following procedures are used to prevent bottle breakage and cross-contamination:

- Bubble wrap or foam pouches are used to keep glass bottles from contacting one another to prevent breakage;
- All samples are transported inside hard plastic coolers or other contamination-free shipping containers;
- The coolers are taped shut to prevent accidental opening; and
- Arrangements must be made in advance to notify the laboratory's sample receiving department prior to sample shipment.

All samples remaining after successful completion of analyses will be disposed of properly. It is the responsibility of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or related chemicals.

Chain-of-Custody Form

Sample custody procedures provide a mechanism for documenting information related to sample collection and handling. Sample custody must be traceable from the time of sample collection until results are reported. A sample is considered under custody if:

- It is in actual possession.
- It is in view after in physical possession.
- It is placed in a secure area (accessible by or under the scrutiny of authorized personnel only after in possession).

A COC form will be completed after sample collection and prior to sample shipment or release. The COC form, sample labels, and field documentation will be cross-checked to verify sample identification, type of analyses, number of containers, sample volume, preservatives, and type of

containers. A complete COC form will accompany the transfer of samples to the analyzing laboratory.

Laboratory Custody Procedures

Contract laboratories will follow sample custody procedures as outlined in the laboratory's Quality Assurance (QA) Manual. A copy of each contract laboratory's QA Manual will be retained in the project file. Laboratories shall maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times. The following sample control activities must be conducted at the laboratory:

- Initial sample login and verification of samples received with the COC form;
- Document any discrepancies noted during login on the COC;
- Initiate internal laboratory custody procedures;
- Verify sample preservation (*e.g.*, temperature);
- Notify the Project Manager if any problems or discrepancies are identified; and
- Perform proper sample storage protocols, including daily refrigerator temperature monitoring and sample security.

Laboratories shall maintain records to document that the above procedures are followed. Once samples have been analyzed, samples will be stored at the laboratory for at least 30 days. After this period, samples may be disposed of properly.

13. ANALYTICAL METHODS

Table 10 lists the constituents for which samples will be analyzed for and the analytical methods, project method detection limits, and project reporting limits for each constituent. Additionally, field measurements will be collected for the parameters listed in Table 11 during each event. MDLs and RLs are discussed in more detail in this Element. Environmentally relevant detection limits will be used to the extent practicable for all monitored constituents. However, numeric criteria for some monitored constituents are lower than common reporting limits achievable in most commercial laboratories. Efforts will be made to achieve reporting limits that are sufficient for Program needs

Table 10. Constituents, Analytical Methods, and Quantitation Limits

Constituent	Method	Detection Limit	Reporting Limit	Units	Constituent	Method	Detection Limit	Reporting Limit	Units
Metals									
Antimony	EPA 200.8	0.1841	6	µg/L	Mercury	SM3112B	0.0551	0.5	µg/L
Arsenic, Total	EPA 200.8	1.1586	2	µg/L	Nickel, Total	EPA 200.8	0.1974	20	µg/L
Arsenic, Dissolved	EPA 200.8	1.1586	2	µg/L	Nickel, Dissolved	EPA 200.8	0.1974	20	µg/L
Beryllium	EPA 200.8	0.2604	1	µg/L	Selenium, Total	EPA 200.8	1.3857	5	µg/L
Cadmium, Total	EPA 200.8	0.2556	1	µg/L	Selenium, Dissolved	EPA 200.8	1.3857	5	µg/L
Cadmium, Dissolved	EPA 200.8	0.2556	1	µg/L	Silver, Total	EPA 200.8	0.2244	10	µg/L
Chromium, Total	EPA 200.8	1.9177	10	µg/L	Silver, Dissolved	EPA 200.8	0.2244	10	µg/L
Chromium, VI	EPA 200.8	0.1074	1	µg/L	Thallium	EPA 200.8	0.1976	200	µg/L
Copper, Total	EPA 200.8	0.2898	10	mg/L	Zinc, Total	EPA 200.8	1.5118	10	µg/L
Copper, Dissolved	EPA 200.8	0.2898	10	mg/L	Zinc, Dissolved	EPA 200.8	1.5118	10	µg/L
Lead, Total	EPA 200.8	0.1942	5	µg/L	Cyanide	SM4500-SNE	4.9	5	µg/L
Lead, Dissolved	EPA 200.8	0.1942	5	µg/L					
Inorganic Substances									
Asbestos	TBD	TBD	TBD	TBD	2,3,7,8 Tetrachloro-dibenzo-p-dioxin (TCDD or Dioxin)	TBD	TBD	TBD	TBD
Volatile Substances									
Acrolein	EPA 624	3.737	10	µg/L	Ethylbenzene	EPA 624	0.263	0.5	µg/L
Acrylonitrile	EPA 624	3.339	10	µg/L	Methyl Bromide (Bromomethane)	EPA 624	0.476	0.5	µg/L
Benzene	EPA 624	0.142	0.5	µg/L	Methyl Chloride (Chloromethane)	EPA 624	0.359	0.5	µg/L
Bromoform	EPA 624	0.129	0.5	µg/L	Methylene Chloride (Dichloromethane)	EPA 624	0.154	3	µg/L
Carbon Tetrachloride	EPA 624	0.149	0.5	µg/L	1,1,2,2-Tetrachloroethane	EPA 624	0.137	0.5	µg/L
Chlorobenzene	EPA 624	0.229	0.5	µg/L	Tetrachloroethylene (Tetrachloroethene)	EPA 624	0.168	0.5	µg/L
Chlorodibromomethane	EPA 624	0.367	0.5	µg/L	Toluene	EPA 624	0.223	0.5	µg/L
Chloroethane	EPA 624	0.352	0.5	µg/L	1,2-Trans-Dichloroethylene	EPA 624	0.185	0.5	µg/L
Chloroform	EPA 624	0.167	0.5	µg/L	1,1,1-Trichloroethane	EPA 624	0.117	0.5	µg/L
Dichlorobromomethane	EPA 624	0.1055	0.5	µg/L	1,1,2-Trichloroethane	EPA 624	0.117	0.5	µg/L
1,1-Dichloroethane	EPA 624	0.098	0.5	µg/L	Trichloroethylene (Trichloroethene)	EPA 624	0.1669	0.5	µg/L
1,2-Dichloroethane	EPA 624	0.206	0.5	µg/L	Vinyl Chloride	EPA 624	0.131	0.5	µg/L
1,1-Dichloroethylene (1,1-Dichloroethene)	EPA 624	0.117	0.5	µg/L	1,2-Dichlorobenzene	EPA 624	1.774	10	µg/L
1,2-Dichloropropane	EPA 624	0.1879	0.5	µg/L	1,3-Dichlorobenzene	EPA 624	1.741	10	µg/L
1,3-Dichloropropylene (1,3-Dichloropropene)	EPA 624	0.298	0.5	µg/L	1,4-Dichlorobenzene	EPA 624	1.713	10	µg/L

Constituent	Method	Detection Limit	Reporting Limit	Units	Constituent	Method	Detection Limit	Reporting Limit	Units
Semi-Volatile Substances									
2-Chloroethylvinyl ether	EPA 625	2.5	5	µg/L	Chrysene	EPA 625	1.59	10	µg/L
2-Chlorophenol	EPA 625	1.778	10	µg/L	Dibenzo(a,h)Anthracene	EPA 625	1.955	10	µg/L
2,4-Dichlorophenol	EPA 625	1.768	10	µg/L	1,2-Dichlorobenzene	EPA 625	1.774	10	µg/L
2,4-Dimethylphenol	EPA 625	1.682	10	µg/L	1,3-Dichlorobenzene	EPA 625	1.741	10	µg/L
2-Methyl- 4,6-Dinitrophenol	EPA 625	1.766	50	µg/L	1,4-Dichlorobenzene	EPA 625	1.713	10	µg/L
2,4-Dinitrophenol	EPA 625	1.59	50	µg/L	3,3' Dichlorobenzidine	EPA 625	2.064	20	µg/L
2-Nitrophenol	EPA 625	2.056	10	µg/L	Diethyl Phthalate	EPA 625	1.788	10	µg/L
4-Nitrophenol	EPA 625	1.129	50	µg/L	Dimethyl Phthalate	EPA 625	1.711	10	µg/L
3-Methyl 4-Chlorophenol	EPA 625	1.604	20	µg/L	Di-n-Butyl Phthalate	EPA 625	1.878	10	µg/L
Pentachlorophenol	EPA 625	1.635	50	µg/L	2,4-Dinitrotoluene	EPA 625	1.834	10	µg/L
Phenol	EPA 625	1.076	10	µg/L	2,6-Dinitrotoluene	EPA 625	1.886	10	µg/L
2,4,6-Trichlorophenol	EPA 625	1.923	10	µg/L	Di-n-Octyl Phthalate	EPA 625	2.611	10	µg/L
Acenaphthene	EPA 625	1.914	10	µg/L	1,2-Diphenylhydrazine	EPA 625	1.839	10	µg/L
Acenaphthylene	EPA 625	2.017	10	µg/L	Fluoranthene	EPA 625	2.022	10	µg/L
Anthracene	EPA 625	1.783	10	µg/L	Fluorene	EPA 625	1.98	10	µg/L
Benzidine	EPA 625	5.745	50	µg/L	Hexachlorobenzene	EPA 625	1.589	10	µg/L
Benzo(a)Anthracene	EPA 625	1.661	10	µg/L	Hexachlorobutadiene	EPA 625	1.847	10	µg/L
Benzo(a)Pyrene	EPA 625	1.971	10	µg/L	Hexachlorocyclopentadiene	EPA 625	1.733	50	µg/L
Benzo(b)Fluoranthene	EPA 625	1.542	10	µg/L	Hexachloroethane	EPA 625	1.617	10	µg/L
Benzo(ghi)Perylene	EPA 625	1.926	10	µg/L	Indeno(1,2,3-cd)Pyrene	EPA 625	2.031	10	µg/L
Benzo(k)Fluoranthene	EPA 625	2.178	10	µg/L	Isophorone	EPA 625	1.94	10	µg/L
Bis(2-Chloroethoxy)Methane	EPA 625	1.847	10	µg/L	Naphthalene	EPA 625	2.049	10	µg/L
Bis(2-Chloroethyl)Ether	EPA 625	1.792	10	µg/L	Nitrobenzene	EPA 625	2.045	10	µg/L
Bis(2-Chloroisopropyl)Ether	EPA 625	1.931	10	µg/L	N-Nitroso-dimethyl amine	EPA 625	1.447	10	µg/L
Bis(2-Ethylhexyl)Phthalate	EPA 625	2.337	3	µg/L	N-Nitroso-di n-propyl amine	EPA 625	1.708	10	µg/L
4-Bromophenyl Phenyl Ether	EPA 625	1.638	10	µg/L	N-Nitroso diphenyl amine	EPA 625	1.72	10	µg/L
Butyl Benzyl Phthalate	EPA 625	1.65	10	µg/L	Phenanthrene	EPA 625	1.873	10	µg/L
2-Chloronaphthalene	EPA 625	1.781	10	µg/L	Pyrene	EPA 625	1.716	10	µg/L
4-Chlorophenyl Phenyl Ether	EPA 625	1.828	10	µg/L	1,2,4-Trichlorobenzene	EPA 625	1.991	10	µg/L
Organochlorine Pesticides - PCBs									
Aldrin	EPA 608	0.0094	0.04	µg/L	Endrin	EPA 608	0.0103	0.06	µg/L
alpha-BHC	EPA 608	0.0153	0.03	µg/L	Endrin Aldehyde	EPA 608	0.07255	0.23	µg/L
beta-BHC	EPA 608	0.04991	0.06	µg/L	Heptachlor	EPA 608	0.01	0.01	µg/L

Constituent	Method	Detection Limit	Reporting Limit	Units	Constituent	Method	Detection Limit	Reporting Limit	Units
gamma-BHC	EPA 625	3.41	10	µg/L	Heptachlor Epoxide	EPA 608	0.01	0.01	µg/L
delta-BHC	EPA 608	0.0381	0.09	µg/L	Aroclor 1016	EPA 608	0.1736	1	µg/L
Chlordane	EPA 608	0.045	0.1	µg/L	Aroclor 1221	EPA 608	0.9997	1	µg/L
4,4'-DDT	EPA 608	0.0164	0.12	µg/L	Aroclor 1232	EPA 608	0.807	1	µg/L
4,4'-DDE	EPA 608	0.0102	0.04	µg/L	Aroclor 1242	EPA 608	0.6973	1	µg/L
4,4'-DDD	EPA 608	0.0161	0.11	µg/L	Aroclor 1248	EPA 608	0.7271	1	µg/L
Dieldrin	EPA 608	0.0114	0.02	µg/L	Aroclor 1254	EPA 608	50	50	µg/L
alpha-Endosulfan	EPA 608	0.0106	0.14	µg/L	Aroclor 1260	EPA 608	0.0634	1	µg/L
beta-Endosulfan	EPA 608	0.0166	0.04	µg/L	Toxaphene	EPA 608	0.8306	1	µg/L
Endosulfan Sulfate	EPA 608	0.4633	0.66	µg/L					
Conventional Substances					Bacteria				
Biological Oxygen Demand (BOD)	SM5210B	1.0163	2	mg/L	E. coli	SM9223B	1	1	MPN/100 mL
Chemical Oxygen Demand (COD)	SM5210B	6.28	10	mg/L	Fecal coliform	SM9221B,C,E	2	2	MPN/100 mL
Total Dissolved Solids (TDS)	SM2540C	5.4709	10	mg/L	Enterococcus	SM9230B	1	1	MPN/100 mL
Total Suspended Solids (TSS)	SM2540D	2.8	5	mg/L	Total coliform	SM9221 B,C,E	1	1	MPN/100 mL
Total Organic Carbon	SM5310B	0.362	0.7	mg/L					
Other Minerals					Hydrocarbons				
Chloride	EPA 300.0	0.5	1	mg/L	Oil and grease	EPA 1664A	0.9218	2.5	mg/L
Fluoride	SM4500F-C	0.05	0.1	mg/L	Total Petroleum Hydrocarbons (TPH)	EPA 418.1	0.5	1	mg/L
Potassium	EPA 200.7	0.22159	1	mg/L					
Sodium	EPA 200.7	0.05075	1	mg/L					
Sulfate	EPA 300.0	0.369	0.5	mg/L					
Nutrients					Organophosphorus Pesticides				
Ammonia-N	SM4500-NH ₃	0.0591	0.1	mg/L	Atrazine	EPA 8141	0.87	4	µg/L
Nitrate-N	EPA 300.0	0.4747	1	mg/L	Chlorpyrifos	EPA 8141	0.63	4	µg/L
Nitrite-N	SM4500-NO ₂	17	100	mg/L	Diazinon	EPA 8141	0.73	4	µg/L
Ortho-Phosphorus	SM4500-P E	0.0028	0.05	mg/L					
Phosphorus, Total	SM4500-P E	0.0142	0.05	mg/L					
Phosphorus, Dissolved	SM4500-P E	0.0142	0.05	mg/L					
Total Kjeldahl Nitrogen	EPA 351.2	0.063	.01	mg/L					

Table 11. Project Reporting Limits for Field Measurements

Parameter/Constituent	Range	Project RL
pH	0 – 14 pH units	NA
Temperature	-5 – 50 °C	NA
Dissolved oxygen	0 – 50 mg/L	0.1 mg/L
Turbidity	0 – 3000 NTU	5 NTU
Conductivity	0 – 10 mmhos/cm	2.5 umhos/cm

RL – Reporting Limit
NA – Not applicable

Detection and Reporting Limits

Method detection limits (MDL) and reporting limits (RLs) must be distinguished for proper understanding and data use. The MDL is the minimum analyte concentration that can be measured and reported with a 99% confidence that the concentration is greater than zero.

The RL represents the concentration of an analyte that can be routinely measured in the sampled matrix within stated limits and with confidence in both identification and quantitation.

For this program, RLs must be verifiable by having the lowest non-zero calibration standard or calibration check sample concentration at or less than the RL. RLs have been established in this QAPP based on the verifiable levels and general measurement capabilities demonstrated for each method. These RLs should be considered as maximum allowable reporting limits to be used for laboratory data reporting. Note that samples diluted for analysis may have sample-specific RLs that exceed these RLs. This will be unavoidable on occasion. However, if samples are consistently diluted to overcome matrix interferences, the analytical laboratory will be required to notify the Project Manager how the sample preparation or test procedure in question will be modified to reduce matrix interferences so that project RLs can be met consistently.

Method Detection Limit Studies

Any laboratory performing analyses under this program must routinely conduct MDL studies to document that the MDLs are less than or equal to the project-specified RLs. If any analytes have MDLs that do not meet the project RLs, the following steps must be taken:

- Perform a new MDL study using concentrations sufficient to prove analyte quantitation at concentrations less than or equal to the project-specified RLs per the procedure for the Determination of the Method Detection Limit presented in Revision 1.1, 40 Code of Federal Regulations (CFR) 136, 1984.
- No samples may be analyzed until the issue has been resolved. MDL study results must be available for review during audits, data review, or as requested. Current MDL study results must be reported for review and inclusion in project files.

A MDL is developed from seven aliquots of a standard containing all analytes of interest spiked at five times the expected MDL. These aliquots are taken through the analytical method's sample processing steps. The data are then evaluated and used to calculate the MDL. If the

calculated MDL is less than 0.33 times the spiked concentration, another MDL study should be performed using lower spiked concentrations.

Project Reporting Limits

Laboratories generally establish RLs that are reported with the analytical results—these may be called *reporting limits*, *detection limits*, *reporting detection limits*, or several other terms by the analyzing laboratory. These laboratory limits must be less than or equal to the project RLs listed in **Table 5**. Environmentally relevant detection limits will be used to the extent practicable for all monitored constituents. However, numeric criteria for some monitored constituents are lower than common reporting limits achievable in most commercial laboratories. Efforts will be made to achieve reporting limits that are sufficient for Program needs. Laboratories performing analyses for this project must have documentation to support quantitation at the required levels.

Laboratory Standards and Reagents

All stock standards and reagents used for standard solutions and extractions must be tracked through the laboratory. The preparation and use of all working standards must be documented according to procedures outlined in each laboratory's Quality Assurance Manual; standards must be traceable according to U.S. EPA, A2LA or National Institute for Standards and Technology (NIST) criteria. Records must have sufficient detail to allow determination of the identity, concentration, and viability of the standards, including any dilutions performed to obtain the working standard. Date of preparation, analyte or mixture, concentration, name of preparer, lot or cylinder number, and expiration date, if applicable, must be recorded on each working standard.

Alternate Laboratories

In the event that the laboratories selected to perform analyses for the IWMP are unable to fulfill data quality requirements outlined herein (e.g., due to an instrument malfunction), alternate laboratories will be selected based on their ability to meet ELAP and/or NELAP certification and data quality requirements specified in this QAPP. The original laboratory selected may recommend a qualified laboratory to act as a substitute. However, the final decision regarding alternate laboratory selection rests with the Project Manager and Project QA Manager.

14. QUALITY CONTROL

QC procedures for field and laboratory activities are summarized in Table 12 and are discussed in more detail below. There are no SWAMP requirements for quality control for field analysis of general parameters (*i.e.*, flow, pH, temperature, dissolved oxygen, turbidity, and conductivity). However, field crews will be required to calibrate equipment as outlined in Element 16 (Instrument / Equipment Calibration).

Table 12. Quality Control Requirements – Field and Laboratory

Quality Control Sample Type	QA Parameter	Frequency ¹	Acceptance Limits	Corrective Action
Quality Control Requirements – Field				
Equipment Blanks	Contamination	Once per equipment batch cleaned ²	< MDL	Identify contamination source, re-clean equipment, and re-run equipment blank.
Field Blank	Contamination	5% of all samples	< MDL	Examine field log. Identify contamination source. Qualify data as needed.
Field Duplicate	Precision	5% of all samples	RPD ≤ 25% if Difference ≥ RL	If laboratory duplicate is within acceptance limits, no corrective action needed. Otherwise, reanalyze both samples if possible. Identify variability source. Qualify data as needed.
Quality Control Requirements – Chemistry Laboratory				
Method Blank	Contamination	1 per analytical batch	< MDL	Identify contamination source. Reanalyze method blank and all samples in batch. Qualify data as needed.
Lab Duplicate	Precision	1 per analytical batch	RPD < 25% if Difference > RL	Recalibrate and reanalyze.
Matrix Spike	Accuracy	1 per analytical batch	70-120% Recovery for GWQC 45-150% for Metals 50-150% for Pesticides	Check LCS/SRM recovery. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Matrix Spike Duplicate	Precision	1 per analytical batch	RPD ≤ 30% if Difference ≥ RL	Check lab duplicate RPD. Attempt to correct matrix problem and reanalyze samples. Qualify data as needed.
Laboratory Control Sample (or SRM)	Accuracy	1 per analytical batch	80-120% Recovery	Recalibrate and reanalyze LCS/SRM and samples.

MDL = Method Detection Limit RL = Reporting Limit RPD = Relative Percent Difference

LCS = Laboratory Control Sample/Standard SRM = Standard/Certified Reference Material

GWQC = General Water Quality Constituents

¹ “Analytical batch” refers to a number of samples (not to exceed 20 environmental samples plus the associated quality control samples) that are similar in matrix type and processed/prepared together under the same conditions and using the same reagents (equivalent to preparation batch).

² Equipment blanks will be collected by the analytical laboratory responsible for cleaning equipment, before returning equipment to the field crew for use.

Comparability

Comparability of the data can be defined as the similarity of data generated by different monitoring programs. For this monitoring program, this objective will be ensured mainly through use of standardized procedures for field measurements, sample collection, sample preparation, laboratory analysis, and site selection; adherence to quality assurance protocols and holding times; and reporting in standard units. If monitoring requires participation of several monitoring teams, data comparability will be ensured through regular group training sessions, as

well as adherence to standard sample collection procedures outlined in the IWMP. Additionally, comparability of analytical data will be addressed through the use of standard operating procedures and extensive analyst training at the analyzing laboratory.

Representativeness

Representativeness can be defined as the degree to which the environmental data generated by the monitoring program accurately and precisely represent actual environmental conditions. For the IWMP, this objective will be addressed by the overall design of the program.

Representativeness is attained through the selection of sampling locations, methods, and frequencies for each parameter of interest, and by maintaining the integrity of each sample after collection. Sampling locations were chosen that are representative of urban discharges/MS4s and major receiving waters, which will allow for the characterization of the impacts that such discharges may have on receiving water quality.

Completeness

Data completeness is a measure of the amount of successfully collected and validated data relative to the amount of data planned to be collected for the project. It is usually expressed as a percentage value. A project objective for percent completeness is typically based on the percentage of the data needed for the program or study to reach valid conclusions.

Because the IWMP is intended to be a long term monitoring program, data that are not successfully collected for a specific monitoring event will not be collected at a later date. Rather, subsequent events conducted over the course of the program will provide a data set of sufficient size to appropriately characterize conditions at individual sampling sites. Moreover, some monitoring sites will often be dry during the dry season, which is relevant information, identifying areas where discharge is not occurring. For these reasons, most of the data planned for collection cannot be considered absolutely critical. However, some reasonable objectives for data are desirable, if only to measure the effectiveness of the program. The program goals for data completeness shown in Table 13 and are based on the planned sampling frequency, SWAMP recommendations, and a subjective determination of the relative importance of the monitoring element the Program. All information collected as outlined in the QAPP will be reported.

Table 13. Required Data Completeness

Monitoring Element	Completeness Objective
Field Measurements	90%
General Water Quality Constituents	90%

Field Procedures

Field QA/QC for this project includes the following:

- Equipment Blanks
- Field Blanks
- Field Duplicates

Equipment Blanks

The purpose of analyzing equipment blanks is to demonstrate that sampling equipment is free from contamination. Equipment blanks will be collected by the analytical laboratory responsible for cleaning equipment, before sending cleaned equipment back to the field crew for use. Equipment blanks will consist of laboratory-prepared blank water (certified to be contaminant-free by the laboratory) processed through the sampling equipment that will be used to collect environmental samples.

It is unlikely that equipment blanks will be required for this monitoring program. However, if collected, the blanks will be analyzed using the same analytical methods specified for environmental samples. If any analytes of interest are detected at levels greater than the MDL, the source(s) of contamination will be identified and eliminated (if possible), the affected batch of equipment will be re-cleaned, and new equipment blanks will be prepared and analyzed before the equipment is returned to the field crew for use.

Field Blanks

The use of field blanks is intended to test whether contamination is introduced from sample collection and handling, sample processing, analytical procedures, or the sample containers. The field crew will use blank water provided by the laboratory to generate field blanks by pouring blank water directly into the appropriate sample containers. Field blanks will be identified with a unique Site ID prior to each monitoring event and submitted “blind” to the laboratory. If any analytes of interest are detected at levels greater than the MDL, the source(s) of contamination will be identified and eliminated, if possible. The sampling crew will be notified so that the source of contamination can be identified (if possible) and corrective measures implemented prior to the next sampling event. Field blanks will be collected for all constituents. If no contamination is detected for conventional constituents repeatedly following multiple events, field blanks may be discontinued for these constituents.

Field Duplicates

The purpose of analyzing field duplicates is to demonstrate the precision of sampling and analytical processes. Field duplicates will be analyzed along with the associated environmental samples. Field duplicates will consist of two aliquots from the same grab sample.

Laboratory Analyses

Laboratory QA/QC for this project includes the following:

- Use of the lowest available MDLs for trace elements.
- Analysis of method blanks and laboratory duplicates.
- Routine analysis of standard reference materials (SRMs) and method blanks.

Method Blanks

The purpose of analyzing method blanks is to demonstrate that sample preparation and analytical procedures do not result in sample contamination. Method blanks will be prepared and analyzed by the contract laboratory at a rate of at least one for each analytical batch. Method blanks will consist of laboratory-prepared blank water processed along with the batch of environmental samples. If the result for a single method blank is greater than the MDL, the source(s) of contamination should be corrected, and the associated samples should be reanalyzed.

Laboratory Duplicates

The purpose of analyzing laboratory duplicates is to demonstrate the precision of the sample preparation and analytical methods. Laboratory duplicates will be analyzed at the rate of one pair per sample batch. If the Relative Percent Difference (RPD) for any analyte is greater than 25% and the absolute difference between duplicates is greater than the RL, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and laboratory duplicates should be reanalyzed.

Matrix Spikes and Matrix Spike Duplicates

The purpose of analyzing matrix spikes and matrix spike duplicates is to demonstrate the performance of the sample preparation and analytical methods in a particular sample matrix. Matrix spikes and matrix spike duplicates will be analyzed at the rate of one pair per sample batch. Each matrix spike and matrix spike duplicate will consist of an aliquot of laboratory-fortified environmental sample. Spike concentrations should be added at five to ten times the reporting limit for the analyte of interest.

If the matrix spike recovery of any analyte is outside the acceptable range, the results for that analyte have failed to meet acceptance criteria. If recovery of laboratory control samples is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. An attempt will be made to correct the problem (*e.g.*, by dilution, concentration, etc.), and the samples and matrix spikes will be re-analyzed.

If the matrix spike duplicate RPD for any analyte is outside the acceptable range, the results for that analyte have failed to meet acceptance criteria. If the RPD for laboratory duplicates is acceptable, the analytical process is being performed adequately for that analyte, and the problem is attributable to the sample matrix. An attempt will be made to correct the problem (*e.g.*, by dilution, concentration, etc.), and the samples and matrix spikes will be re-analyzed.

Laboratory Control Samples

The purpose of analyzing laboratory control samples (or a standard reference material) is to demonstrate the accuracy of the sample preparation and analytical methods. Laboratory control samples will be analyzed at the rate of one per sample batch. Laboratory control samples will consist of laboratory fortified method blanks or a standard reference material. If recovery of any analyte is outside the acceptable range, the analytical process is not being performed adequately for that analyte. In this case, the sample batch should be prepared again, and the laboratory control sample should be reanalyzed.

15. INSTRUMENT/EQUIPMENT TESTING, INSPECTION AND MAINTENANCE

Sample Equipment Cleaning Procedures

If equipment is used for sample collection (*i.e.*, peristaltic pump tubing, sample containers and caps) it will be cleaned by the analytical laboratory prior to each monitoring event, according to procedures documented for each analytical method. After cleaning, sample containers will be stored with lids secured, and additional clean caps will be stored in clean re-sealable bags. Cleaned tubing will be stored in clean polyethylene bags.

Each batch of cleaned equipment will be used to generate an equipment blank as discussed in Element 14 (Quality Control).

Field Measurement Equipment

Each field crew will be responsible for testing, inspecting, and maintaining their field measurement equipment in accordance with the manufacturer's specifications. This includes battery checks, routine replacement of membranes, and cleaning of probes and electrodes.

Analytical Equipment Testing Procedures and Corrective Actions

Testing, inspection, and maintenance of analytical equipment used by the contract laboratory and corrective actions are documented in the QA Manual for each analyzing laboratory. Laboratory QA Manuals are available for review at the analyzing laboratory.

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Laboratory Analytical Equipment

Frequencies and procedures for calibration of analytical equipment used by each contract laboratory are documented in the QA Manual for each contract laboratory. Any deficiencies in analytical equipment calibration should be managed in accordance with the QA Manual for each contract laboratory. Any deficiencies that affect analysis of samples submitted through this program must be reported to the Project Manager or designee. Laboratory QA Manuals are available for review at the analyzing laboratory.

Field Measurement Equipment

Calibration of field measurement equipment is performed as described in the user manual for each individual instrument. Each field crew will be responsible for calibrating their field measurement equipment. Field monitoring equipment must meet the requirements outlined in Table 11 and be calibrated at a frequency recommended by the manufacturer, but at a minimum prior to each event. Each calibration will be documented on each event's calibration log.

If calibration results do not meet manufacturer specifications, the field crew should first try to recalibrate using fresh aliquots of calibration solution. If recalibration is unsuccessful, new calibration solution should be used and/or maintenance should be performed. Each attempt should be recorded on the equipment calibration log. If the calibration results cannot meet manufacturer's specifications, the field crew should use a spare field measuring device that can be successfully calibrated. Additionally, the Project Manager should be notified.

Calibration should be verified using at least one calibration fluid within the expected range of field measurements, both immediately following calibration and at the end of each monitoring day. Individual parameters should be recalibrated if results for the calibration check do not fall within the range of accuracy identified in Table 11. Table 14 outlines the typical field instrument calibration procedures for each field probe requiring calibration. Results of initial calibration checks will be recorded on the Field Measurement Equipment Calibration Log.

Table 14. Calibration of Field Measurement Equipment

Field Meter Parameter	Calibration and Verification Description	Frequency of Calibration	Frequency of Calibration Verification	Responsible Party
pH	Calibration for pH measurement is accomplished using standard buffer solutions. Analysis of a mid-range buffer will be performed to verify successful calibration.			
Temperature	Temperature calibration is factory-set and requires no subsequent calibration.			
Dissolved Oxygen	Calibration for dissolved oxygen measurements is accomplished using a water saturated air environment. Dissolved oxygen measurement of water-saturated air will be performed to verify successful calibration.	Prior to sampling event	After each day's calibration and at the end of the sampling day	Individual Sampling Crew
Conductivity	Conductivity calibration will follow manufacturer's specifications. A mid-range conductivity standard will be analyzed to verify successful calibration.			
Turbidity	Turbidity calibration will follow manufacturer's specifications. A mid-range turbidity standard will be analyzed to verify successful calibration.			

17. INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Inspection of gloves, sample containers, and any other consumable equipment used for sampling will be the responsibility of each individual sampling crew. Inspection should be conducted immediately upon receipt of equipment; equipment should be rejected/returned if any obvious signs of contamination (torn packages, etc.) are observed. Inspection protocols and acceptance criteria for laboratory analytical reagents and other consumables are documented in the QA Manual for each laboratory.

18. NON-DIRECT MEASUREMENTS

Water quality data collected through other monitoring programs may be used to augment data collected through the IWMP. Data reported by other entities will be evaluated for suitability for inclusion in the Program database. It is the responsibility of the Project QA Manager or designees to acquire, validate, and compile the necessary data from other programs. The data will be assessed against the data quality objectives stated in Element 7 of this QAPP (Quality Objectives and Criteria for Measurement Data).

19. DATA MANAGEMENT

The field crew or Project Manager shall retain the original field logs. The contract laboratory shall retain original COC forms. Concentrations of all parameters will be calculated as described in laboratory SOPs or referenced method document for each analyte or parameter. The various data and information generated through the IWMP will be stored and maintained as described in Element 9 (Documents and Records).

C. ASSESSMENT AND OVERSIGHT

20. ASSESSMENTS AND RESPONSE ACTIONS

Data will be evaluated and documented after each monitoring event to determine whether project quality assurance objectives have been met, to quantitatively assess data quality, and to identify potential limitations on data use. The following assessments of compliance with quality control procedures will be performed during the data collection phase of the project:

- Performance assessment of the sampling procedures will be performed by the field sampling crews. Corrective action shall be carried out by the field sampling crew and reported to the Project Manager.
- Field crews will be audited annually by the Project Manager or designee. Additional audits will occur as necessary to observe corrective actions taken to resolve errors identified during a previous audit.
- The laboratory is responsible for following established SOPs, including those for proper instrument maintenance, calibration of the instruments, and analytical methods used for samples submitted through the Program.
- Assessment of laboratory QC results and implementation of corrective actions will be the responsibility of the QA Officer at each laboratory and shall be reported to the Project QA Manager or designee as part of any data reports.
- Assessment of field QC results and implementation of corrective actions shall be the responsibility of the Project QA Manager or designee.

All project data must be reviewed as part of the data assessment. Review is conducted on a preparation batch basis by assessing QC samples and all associated environmental sample results. Project data review established for this project includes the following steps:

- Initial review of analytical and field data for complete and accurate documentation, chain-of-custody procedures, compliance with required holding times, and required frequency of field and laboratory QC samples;
- Evaluation of analytical and field blank results to identify random and systematic contamination;
- Comparison of all spike and duplicate results with data quality objectives for precision and accuracy;
- Assigning data qualifier flags to the data as necessary to reflect data use limitations identified by the assessment process; and
- Calculating completeness by analyte.

The Project QA Manager or designee is responsible for conducting the data assessment and for ensuring that data qualifier flags are assigned, as needed, based on the established quality control criteria. If an assessment or audit discovers any discrepancy, the Project QA Manager will address the observed discrepancy with the appropriate person responsible for the activity. Discussion points will include whether the information collected is accurate, identifying the cause(s) leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered. The Project QA Manager will maintain a QA Log of all communications and any specified corrective actions, and will make the QA Log available to the Project Manager upon request.

Routine procedures to assess the success of the data collection effort are discussed in Section D (Data Validation and Usability).

21. REPORTS TO MANAGEMENT

No additional documents, except those listed in Element 9 (Documents and Records), will be generated.

D. DATA VALIDATION AND USABILITY

22. DATA REVIEW, VERIFICATION AND VALIDATION REQUIREMENTS

The acceptability of data is determined through data verification and data validation. Both processes are discussed in detail below. In addition to the data quality objectives presented in Table 5, the standard data validation procedures documented in the contract laboratory's QA Manual will be used to accept, reject, or qualify the data generated by the laboratory. Each laboratory's QA Officer will be responsible for validating data generated by the laboratory.

Once analytical results are received from the analyzing laboratory, the Project QA Manager or designee will perform an independent review and validation of analytical results. Decisions to reject or qualify data will be made by the Project QA Manager or designee, based on the evaluation of field and laboratory quality control data according to procedures outlined in

Section 13 of Caltrans document No. CTSW-RT-00-005, *Guidance Manual: Stormwater Monitoring Protocols*, 2nd Edition (LWA, 2000), included in this QAPP as Appendix A.

23. DATA VERIFICATION

Data verification involves verifying that required methods and procedures have been followed at all stages of the data collection process, including sample collection, sample receipt, sample preparation, sample analysis, and documentation review for completeness. Verified data have been checked for a variety of factors, including transcription errors, correct application of dilution factors, and correct application of conversion factors. Verification of data may also include laboratory qualifiers, if assigned.

Data verification should occur in the field and the laboratory at each level (*i.e.*, all personnel should verify their own work) and as information is passed from one level to the next (*i.e.*, supervisors should verify the information produced by their staff). Records commonly examined during the verification process include field and sample collection logs, chain-of-custody forms, sample preparation logs, instrument logs, raw data, and calculation worksheets.

In addition, laboratory personnel will verify that the measurement process was "in control" (*i.e.*, all specified data quality objectives were met or acceptable deviations explained) for each batch of samples before proceeding with the analysis of a subsequent batch. Each laboratory will also establish a system for detecting and reducing transcription and/or calculation errors prior to reporting data.

24. DATA VALIDATION

In general, data validation involves identifying project requirements, obtaining the documents and records produced during data verification, evaluating the quality of the data generated, and determining whether project requirements were met. The main focus of data validation is determining data quality in terms of accomplishment of measurement quality objectives (*i.e.*, meeting QC acceptance criteria). Data quality indicators, such as precision, accuracy, sensitivity, representativeness, and completeness, are typically used as expressions of data quality. The Project QA Manager or designee will review verified sample results for the data set as a whole, including laboratory qualifiers, summarize data and QC deficiencies and evaluate the impact on overall data quality, assign data validation qualifiers as necessary, and include this information in a Quality Assurance Report. The validation process applies to both field and laboratory data.

In addition to the data quality objectives presented in Table 5. The standard data validation procedures documented in the analyzing laboratory's QA Manual will be used to accept, reject or qualify the data generated. The laboratory will submit only data that have met data quality objectives, or data that have acceptable deviations explained. When QC requirements have not been met, the samples will be reanalyzed when possible, and only the results of the reanalysis will be submitted, provided that they are acceptable. Each laboratory's QA Officer is responsible for validating the data it generates.

E. AMENDMENTS TO QAPP

The intent of this section is to provide a place within the QAPP to document significant additions, deletions and revisions to the approved QAPP and to provide the rationale for changes.

F. REFERENCES

California Regional Water Quality Control Board, Santa Ana Region, (SARWQCB). 1995. Water Quality Control Plan for the Santa Ana River Basin. January 1995.

Cleaner Rivers through Effective Stakeholder TMDLs (CREST), 2008. Los Angeles River Bacteria Source Identification Study: Final Report. November 2008.

Larry Walker Associates (LWA), 2000. Guidance Manual: Stormwater Monitoring Protocols, 2nd Edition. Caltrans document No. CTSW-RT-00-005.

Puckett, M., 2002. Quality Assurance Management Plan for the State of California's Surface Water Ambient Monitoring Program (SWAMP). California Department of Fish and Game, Monterey, CA. Prepared for the State Water Resources Control Board, Sacramento, CA. 145 pages plus Appendices.

San Bernardino County Stormwater Program, 2006. Report of Waste Discharge – Application for Renewal of the Municipal NPDES Stormwater Permit NPDES Permit No. CAS618036; 2007-2012. October 2006.

State Water Resources Control Board (SWRCB), 2004a. Surface Water Ambient Monitoring Program, SWAMP-Compatible Quality Assurance Project Plans. March 2004.

State Water Resources Control Board (SWRCB), 2004b. Surface Water Ambient Monitoring Program, Checklist. April 2004.

Chapter 13 QA/QC Data Evaluation from Caltrans Guidance
Manual: Stormwater Monitoring Protocols, 2nd Edition

SECTION 13

QA/QC DATA EVALUATION

All data reported by the analytical laboratory must be carefully reviewed to determine whether the project's data quality acceptability limits or objectives (DQOs) have been met. This section describes a process for evaluation of all laboratory data, including the results of all QA/QC sample analysis.

Before any results are reported by the laboratory, the deliverable requirements should be clearly communicated to the laboratory, as described in the "Laboratory Data Package Deliverables" discussion in *Section 12*.

The current section discusses QA/QC data evaluation in the following two parts:

KEY TOPICS

- **Initial Data Quality Screening**
- **Data Quality Evaluation**

The initial data quality screening identifies problems with laboratory reporting while they may still be corrected. When the data reports are received, they should be immediately checked for conformity to chain of custody requests to ensure that all requested analyses have been reported. The data are then evaluated for conformity to holding time requirements, conformity to reporting limit requests, analytical precision, analytical accuracy, and possible contamination during sampling and analysis. The data evaluation results in rejection, qualification, and narrative discussion of data points or the data as a whole. Qualification of data, other than rejection, does not necessary exclude use of the data for all applications. It is the decision of the data user, based on specifics of the data application, whether or not to include qualified data points.

➤ **INITIAL DATA QUALITY SCREENING**

The initial screening process identifies and corrects, when possible, inadvertent documentation or process errors introduced by the field crew or the laboratory. The initial data quality control screening should be applied using the following three-step process:

1. *Verification check between sampling and analysis plan (SAP), chain of custody forms, and laboratory data reports:* Chain of custody records should be compared with field logbooks and laboratory data reports to verify the accuracy of all sample identification and to ensure that all samples submitted for analysis have a value reported for each parameter requested. Any deviation from the SAP that has not yet

been documented in the field notes or project records should be recorded and corrected if possible.

Sample representativeness should also be assessed in this step. The minimum acceptable storm capture parameters (number of aliquots and percent storm capture) per amount of rainfall are specified in **Section 10**. Samples not meeting these criteria are generally not analyzed; however, selected analyses can be run at the Caltrans task manager's discretion. If samples not meeting the minimum sample representativeness criteria are analyzed, the resulting data should be rejected ("R") or qualified as estimated ("J"), depending upon whether the analyses were approved by Caltrans. Grab samples should be taken according to the timing protocols specified in the SAP. Deviations from the protocols will result in the rejection of the data for these samples or qualification of the data as estimated. The decision to reject a sample based on sample representativeness should be made prior to the submission of the sample to the laboratory, to avoid unnecessary analytical costs.

2. *Check of laboratory data report completeness:* As discussed in **Section 12**, the end product of the laboratory analysis is a data report that should include a number of QA/QC results along with the environmental results. QA/QC sample results reported by the lab should include both analyses requested by the field crew (field blanks, field duplicates, lab duplicates and MS/MSD analysis), as well as internal laboratory QA/QC results (method blanks and laboratory control samples).

There are often differences among laboratories in terms of style and format of reporting. Therefore, it is prudent to request in advance that the laboratory conform to the style and format approved by Caltrans as shown in **Section 14**. The Caltrans data reviewer should verify that the laboratory data package includes the following items:

- ✓ A narrative which outlines any problems, corrections, anomalies, and conclusions.
- ✓ Sample identification numbers.
- ✓ Sample extraction and analysis dates.
- ✓ Reporting limits for all analyses reported.
- ✓ Results of method blanks.
- ✓ Results of matrix spike and matrix spike duplicate analyses, including calculation of percent recovered and relative percent differences.
- ✓ Results of laboratory control sample analyses.
- ✓ Results of external reference standard analyses.
- ✓ Surrogate spike and blank spike analysis results for organic constituents.

- ✓ A summary of acceptable QA/QC criteria (RPD, spike recovery) used by the laboratory.

Items missing from this list should be requested from the laboratory.

3. *Check for typographical errors and apparent incongruities:* The laboratory reports should be reviewed to identify results that are outside the range of normally observed values. Any type of suspect result or apparent typographical error should be verified with the laboratory. An example of a unique value would be if a dissolved iron concentration has been reported lower than 500 µg/L for every storm event monitored at one location and then a value of 2500 µg/L is reported in a later event. This reported concentration of 2500 µg/L should be verified with the laboratory for correctness.

Besides apparent out-of-range values, the indicators of potential laboratory reporting problems include:

- Significant lack of agreement between analytical results reported for laboratory duplicates or field duplicates.
- Consistent reporting of dissolved metals results higher than total or total recoverable metals.
- Unusual numbers of detected values reported for blank sample analyses.
- Inconsistency in sample identification/labeling.

If the laboratory confirms a problem with the reported concentration, the corrected or recalculated result should be issued in an amended report, or if necessary the sample should be re-analyzed. If laboratory results are changed or other corrections are made by the laboratory, an amended laboratory report should be issued to update the project records.

➤ DATA QUALITY EVALUATION

The data quality evaluation process is structured to provide systematic checks to ensure that the reported data accurately represent the concentrations of constituents actually present in stormwater. Data evaluation can often identify sources of contamination in the sampling and analytical processes, as well as detect deficiencies in the laboratory analyses or errors in data reporting. Data quality evaluation allows monitoring data to be used in the proper context with the appropriate level of confidence.

QA/QC parameters that should be reviewed are classified into the following categories:

- ✓ Reporting limits

- ✓ Holding times
- ✓ Contamination check results (method, field, trip, and equipment blanks)
- ✓ Precision analysis results (laboratory, field, and matrix spike duplicates)
- ✓ Accuracy analysis results (matrix spikes, surrogate spikes, laboratory control samples, and external reference standards)

Each of these QA/QC parameters should be compared to data quality acceptability criteria, inalso known as the project’s data quality objectives (DQOs). The key steps that should be adhered to in the analysis of each of these QA/QC parameters are:

1. Compile a complete set of the QA/QC results for the parameter being analyzed.
2. Compare the laboratory QA/QC results to accepted criteria (DQOs).
3. Compile any out-of-range values and report them to the laboratory for verification.
4. Prepare a report that tabulates the success rate for each QA/QC parameter analyzed.

This process should be applied to each of the QA/QC parameters as discussed below.

Reporting Limits

Stormwater quality monitoring program DQOs should contain a list of acceptable reporting limits that the lab is contractually obligated to adhere to, except in special cases of insufficient sample volume or matrix interference problems. The reporting limits used should ensure a high probability of detection. , Table 12-1 provides recommended reporting limits for selected parameters.

Holding Times

Holding time represents the elapsed time between sample collection time and sample analysis time. Calculate the elapsed time between the sampling time and start of analysis, and compare this to the required holding time. For composite samples that are collected within 24-hours or less, the time of the final sample aliquot is considered the “sample collection time” for determining sample holding time. For analytes with critical holding times (48 hours), composite samples lasting longer than 24-hours require multiple bottle composite samples. Each of these composite samples should represent less than 24 hours of monitored flow, and subsamples from the composites should have been poured off and analyzed by the laboratory for those constituents with critical holding times (*see Section 12*). It is important to review sample holding times to ensure that analyses occurred within the time period that is generally accepted to maintain stable parameter concentrations. Table 12-1 contains the holding times for selected parameters. If holding times are exceeded, inaccurate concentrations or false negative results may be reported.

Samples that exceed their holding time prior to analysis are qualified as “estimated”, or may be rejected depending on the circumstances.

Contamination

Blank samples are used to identify the presence and potential source of sample contamination and are typically one of four types:

1. **Method blanks** are prepared and analyzed by the laboratory to identify laboratory contamination.
2. **Field blanks** are prepared by the field crew during sampling events and submitted to the laboratory to identify contamination occurring during the collection or the transport of environmental samples.
3. **Equipment blanks** are prepared by the field crew or laboratory prior to the monitoring season and used to identify contamination coming from sampling equipment (tubing, pumps, bailers, etc.).
4. **Trip blanks** are prepared by the laboratory, carried in the field, and then submitted to the laboratory to identify contamination in the transport and handling of volatile organics samples.
5. **Filter blanks** are prepared by field crew or lab technicians performing the sample filtration. Blank water is filtered in the same manner and at the same time as other environmental samples. Filter blanks are used to identify contamination from the filter or filtering process.

If no contamination is present, all blanks should be reported as “not detected” or “non-detect” (e.g., constituent concentrations should not be detected above the reporting limit). Blanks reporting detected concentrations (“hits”) should be noted in the written QA/QC data summary prepared by the data reviewer. In the case that the laboratory reports hits on method blanks, a detailed review of raw laboratory data and procedures should be requested from the laboratory to identify any data reporting errors or contamination sources. When other types of blanks are reported above the reporting limit, a similar review should be requested along with a complete review of field procedures and sample handling. Often times it will also be necessary to refer to historical equipment blank results, corresponding method blank results, and field notes to identify contamination sources. This is a corrective and documentative step that should be done as soon as the hits are reported.

If the blank concentration exceeds the laboratory reporting limit, values reported for each associated environmental sample must be evaluated according to USEPA guidelines for data evaluations of organics and metals (USEPA, 1991; USEPA, 1995) as indicated in Table 13-1.

Table 13-1. USEPA Guidelines for Data Evaluation

<i>Step</i>	<i>Environmental Sample</i>	<i>Phthalates and other common contaminants</i>	<i>Other Organics</i>	<i>Metals</i>
1.	Sample > 10X blank concentration	No action	No action	No action
2.	Sample < 10X blank concentration	Report associated environmental results as “non-detect” at the reported environmental concentration.	No action	Results considered an “upper limit” of the true concentration (note contamination in data quality evaluation narrative).
3.	Sample < 5X blank concentration	Report associated environmental results as “non-detect” at the reported environmental concentration.	Report associated environmental results as “non-detect” at the reported environmental concentration.	Report associated environmental results as “non-detect” at the reported environmental concentration.

Specifically, if the concentration in the environmental sample is less than five times the concentration in the associated blank, the environmental sample result is considered, for reporting purposes, “not-detected” *at the environmental sample result concentration* (phthalate and other common contaminant results are considered non-detect if the environmental sample result is less than ten times the blank concentration). The laboratory reports are not altered in any way. The qualifications resulting from the data evaluation are made to the evaluator’s data set for reporting and analysis purposes to account for the apparent contamination problem. For example, if dissolved copper is reported by the laboratory at 4 µg/L and an associated blank concentration for dissolved copper is reported at 1 µg/L, data qualification would be necessary. In the data reporting field of the database (see **Section 14**), the dissolved copper result would be reported as 4 µg/L, the numerical qualifier would be reported as “<”, the reporting limit would be left as reported by the laboratory, and the value qualifier would be reported as “U” (“not detected above the reported environmental concentration”).

When reported environmental concentrations are greater than five times (ten times for phthalates) the reported blank “hit” concentration, the environmental result is reported unqualified at the laboratory-reported concentration. For example, if dissolved copper is reported at 11 µg/L and an associated blank concentration for dissolved copper is reported at 1 µg/L, the dissolved copper result would still be reported as 11 µg/L.

Precision

Duplicate samples provide a measure of the data precision (reproducibility) attributable to sampling and analytical procedures. Precision can be calculated as the relative percent difference (RPD) in the following manner:

$$RPD_i = \frac{2 * |O_i - D_i|}{(O_i + D_i)} * 100\%$$

where:

RPD_i = Relative percent difference for compound i

O_i = Value of compound i in original sample

D_i = Value of compound i in duplicate sample

The resultant RPDs should be compared to the criteria specified in the project's DQOs. The DQO criteria shown in Table 13-2 below are based on the analytical method specifications and laboratory-supplied values. Project-specific DQOs should be developed with consideration to the analytical laboratory, the analytical method specifications, and the project objective. Table 13-2 should be used as a reference point as the least stringent set of DQO criteria for Caltrans monitoring projects.

Laboratory and Field Duplicates

Laboratory duplicates are samples that are split by the laboratory. Each half of the split sample is then analyzed and reported by the laboratory. A pair of field duplicates is two samples taken at the same time, in the same manner into two unique containers. Subsampling duplicates are two unique, ostensibly identical, samples taken from one composite bottle (see **Section 10**). Laboratory duplicate results provide information regarding the variability inherent in the analytical process, and the reproducibility of analytical results. Field duplicate analysis measures both field and laboratory precision, therefore, it is expected that field duplicate results would exhibit greater variability than lab duplicate results. Subsampling duplicates are used as a substitute for field duplicates in some situations and are also an indicator of the variability introduced by the splitting process.

The RPDs resulting from analysis of both laboratory and field duplicates should be reviewed during data evaluation. Deviations from the specified limits, and the effect on reported data, should be noted and commented upon by the data reviewer. Laboratories typically have their own set of maximum allowable RPDs for laboratory duplicates based on their analytical history. In most cases these values are more stringent than those listed in Table 13-2. Note that the laboratory will only apply these maximum allowable RPDs to laboratory duplicates. In most cases field duplicates are submitted "blind" (with pseudonyms) to the laboratory.

Environmental samples associated with laboratory duplicate results greater than the maximum allowable RPD (when the numerical difference is greater than the reporting limit) are qualified as “J” (estimated). When the numerical difference is less than the RL, no qualification is necessary. Field duplicate RPDs are compared against the maximum allowable RPDs used for laboratory duplicates to identify any pattern of problems with reproducibility of results. Any significant pattern of RPD exceedances for field duplicates should be noted in the data report narrative.

Corrective action should be taken to address field or laboratory procedures that are introducing the imprecision of results. The data reviewer can apply “J” (estimated) qualifiers to any data points if there is clear evidence of a field or laboratory bias issue that is not related to contamination. (Qualification based on contamination is assessed with blank samples.)

Laboratories should provide justification for any laboratory duplicate samples with RPDs greater than the maximum allowable value. In some cases, the laboratory will track and document such exceedances, however; in most cases it is the job of the data reviewer to locate these out-of-range RPDs. When asked to justify excessive RPD values for field duplicates, laboratories most often will cite sample splitting problems in the field. Irregularities should be included in the data reviewer’s summary, and the laboratory’s response should be retained to document laboratory performance, and to track potential chronic problems with laboratory analysis and reporting.

Accuracy

Accuracy is defined as the degree of agreement of a measurement to an accepted reference or true value. Accuracy is measured as the percent recovery (%R) of spike compound(s). Percent recovery of spikes is calculated in the following manner:

$$\%R = 100\% * [(C_s - C) / S]$$

where:

- %R = percent recovery
- C_s = spiked sample concentration
- C = sample concentration for spiked matrices
- S = concentration equivalent of spike added

Accuracy (%R) criteria for spike recoveries should be compared with the limits specified in the project DQOs. A list of typical acceptable recoveries is shown in Table 13-2. As in the case of maximum allowable RPDs, laboratories develop acceptable criteria for an allowable range of recovery percentages that may differ from the values listed in Table 13-2.

Percent recoveries should be reviewed during data evaluation, and deviations from the specified limits should be noted in the data reviewer's summary. Justification for out of range recoveries should be provided by the laboratory along with the laboratory reports, or in response to the data reviewer's summary.

Laboratory Matrix Spike and Matrix Spike Duplicate Samples

Evaluation of analytical accuracy and precision in environmental sample matrices is obtained through the analysis of laboratory matrix spike (MS) and matrix spike duplicate (MSD) samples. A matrix spike is an environmental sample that is spiked with a known amount of the constituent being analyzed. A percent recovery can be calculated from the results of the spike analysis. A MSD is a duplicate of this analysis that is performed as a check on matrix recovery precision. MS and MSD results are used together to calculate RPD as with the duplicate samples. When MS/MSD results (%R and RPD) are outside the project specifications, as listed in Table 13-2, the associated environmental samples are qualified as "estimates due to matrix interference". Surrogate standards are added to all environmental and QC samples tested by gas chromatography (GC) or gas chromatography-mass spectroscopy (GC-MS). Surrogates are non-target compounds that are analytically similar to the analytes of interest. The surrogate compounds are spiked into the sample prior to the extraction or analysis. Surrogate recoveries are evaluated with respect to the laboratory acceptance criteria to provide information on the extraction efficiency of every sample.

External Reference Standards

External reference standards (ERS) are artificial certified standards prepared by an external agency and added to a batch of samples. ERS's are not required for every batch of samples, and are often only run quarterly by laboratories. Some laboratories use ERS's in place of laboratory control spikes with every batch of samples. ERS results are assessed the same as laboratory control spikes for qualification purposes (see below). The external reference standards are evaluated in terms of accuracy, expressed as the percent recovery (comparison of the laboratory results with the certified concentrations). The laboratory should report all out-of-range values along with the environmental sample results. ERS values are qualified as "biased high" when the ERS recovery exceeds the acceptable recovery range and "biased low" when the ERS recovery is smaller than the recovery range.

Laboratory Control Samples

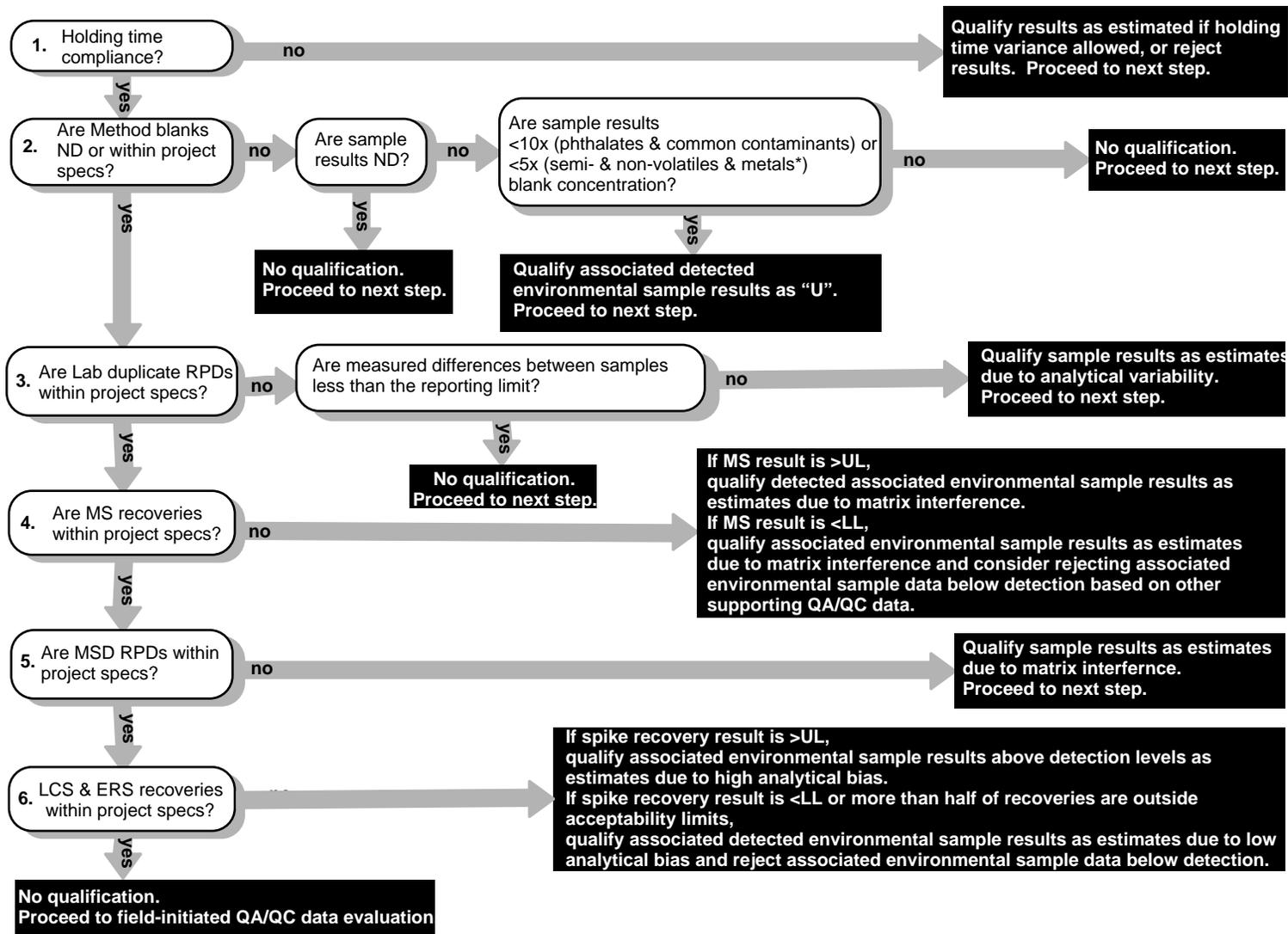
LCS analysis is another batch check of recovery of a known standard solution that is used to assess the accuracy of the entire recovery process. LCSs are much like ERS's except that a certified standard is not necessarily used with LCSs, and the sample is prepared internally by the laboratory so the cost associated with preparing a LCS sample is much lower than the cost of ERS preparation. LCSs are reviewed for percent recovery within

control limits provided by the laboratory. LCS out-of-range values are treated in the same manner as ERS out-of-range values. Because LCS and ERS analysis both check the entire recovery process, any irregularity in these results supersedes other accuracy-related qualification. Data are rejected due to low LCS recoveries when the associated environmental result is below the reporting limit.

A flow chart of the data evaluation process, presented on the following pages as Figures 13-1 (lab-initiated QA/QC samples) and 13-2 (field-initiated QA/QC), can be used as a general guideline for data evaluation. Boxes shaded black in Figures 13-1 and 13-2 designate final results of the QA/QC evaluation.

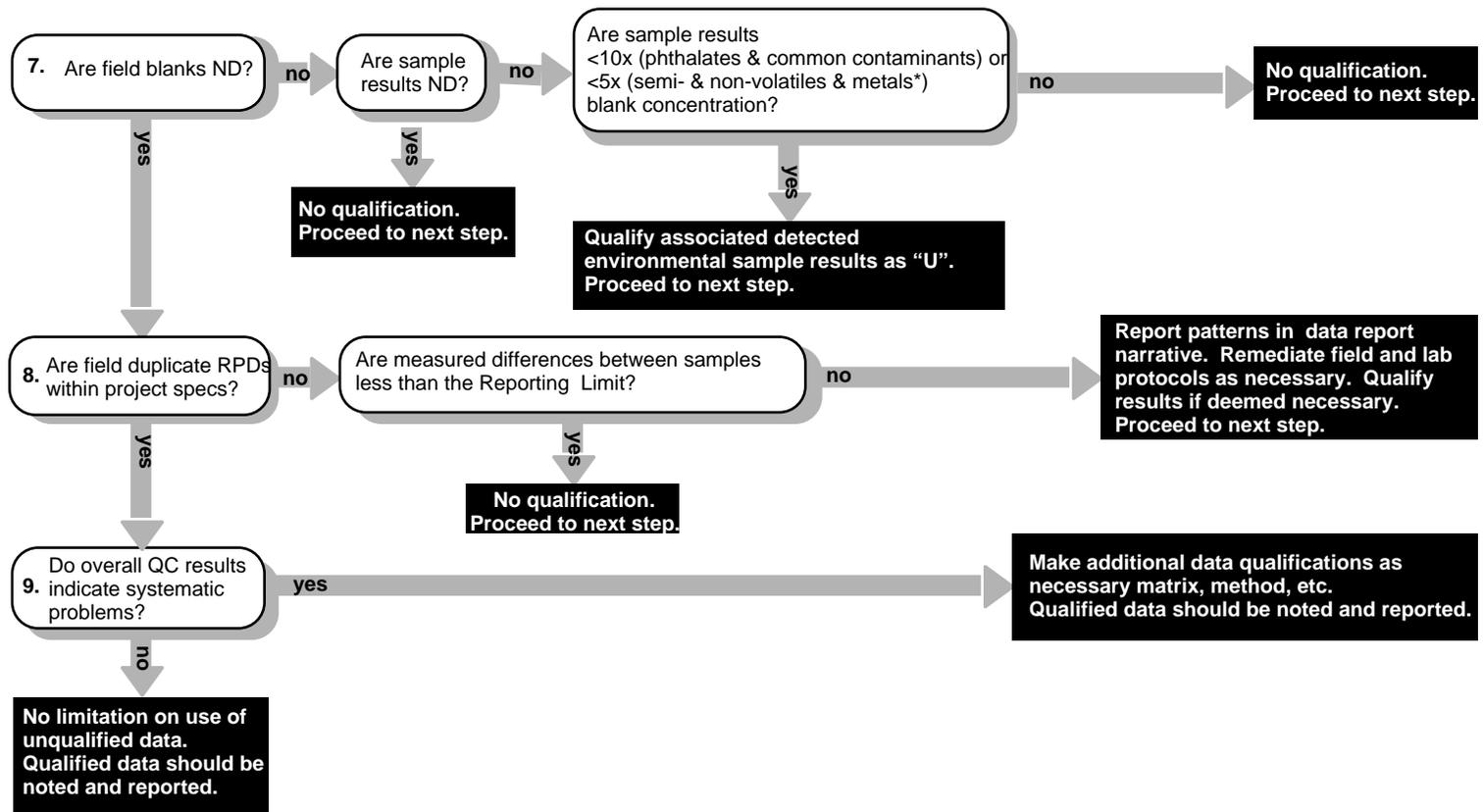
Table 13-2. Typical Control Limits for Precision and Accuracy for Analytical Constituents

Analyte	EPA Method Number or Standard Method	Maximum Allowable RPD	Recovery Upper Limit	Recovery Lower Limit
Conventionals				
BOD	405.1; SM 5210B	20%	80%	120%
COD	410.1; 410.4; SM 5220C; SM 5220D	20%	80%	120%
Hardness	130.2; 130.1; SM 2340B	20%	80%	120%
pH	150.1	20%	NA	NA
TOC/DOC	415.1	15%	85%	115%
TDS	160.1	20%	80%	120%
TSS	160.2	20%	80%	120%
Turbidity	180.1	20%	NA	NA
Nutrients				
NH3-N	350.2; 350.3	20%	80%	120%
NO3-N	300.0	20%	80%	120%
NO2-N	300.0	20%	80%	120%
NO3/NO2-N	353.2	20%	80%	120%
P	365.2	20%	80%	120%
Ortho-P	365.2; 365.3	20%	80%	120%
TKN	351.3	20%	80%	120%
Metals				
Ag	272.2; 200.8	20%	75%	125%
Al	200.9; 200.8	20%	75%	125%
Cd	213.2; 200.8	20%	75%	125%
Cr	218.2; 200.8	20%	75%	125%
Cu	220.2; 200.8	20%	75%	125%
Ni	249.2; 200.8	20%	75%	125%
Pb	239.2; 200.8	20%	75%	125%
Zn	289.2; 200.8	20%	75%	125%
As	206.3; 200.8	20%	75%	125%
Fe	200.9; SM 3500-Fe B	20%	75%	125%
Se	200.9; 270.3; 200.8	20%	75%	125%
Hg	1631	21%	79%	121%
Total Petroleum Hydrocarbons				
TPH (gasoline)	8015b	21%	45%	129%
TPH (diesel)		21%	45%	129%
TPH (motor oil)		21%	45%	129%
Oil & Grease	1664	18%	79%	114%
Pesticides and Herbicides				
Glyphosate	547	30%	70%	130%
OP Pesticides (esp. diazinon and chlorpyrifos)	8141; ELISA	25%	see method for constituent specific	
OC Pesticides	8081	25%		
Chlorinated Herbicides	8150; 8151	25%		
Carbamate Pesticides	8321	25%		
Miscellaneous Organic Constituents				
Base/Neutrals and Acids	625; 8270	30% to 50% (analyte dependent)		see method for constituent specific
PAHs	8310			
Purgeables	624; 8260	20%		
Purgeable Halocarbons	601	30%		see method, Table 2
Purgeable Aromatics	602	20%		see method for constituent specific
Miscellaneous Constituents				
Cyanide	335.2	20%	75	125
Bacteriological				
Fecal Coliform	SM 9221E	-	-	-
Total Coliform	SM 9221B	-	-	-



*Environmental results between 5x and 10x the blank concentration are qualified as “an upper limit on the true concentration” and the data user should be cautioned.

Figure 13-1. Technical Data Evaluation for Lab-Initiated QA/QC Samples



*Environmental results between 5x and 10x the blank concentration are qualified as "an upper limit on the true concentration" and the data user should be cautioned.

Figure 13-2. Technical Data Evaluation for Field-Initiated QA/QC Samples