Municipality of Anchorage
Ethan Berkowitz, Mayor

Monitoring, Evaluation, and Quality Assurance Plan

APDES Permit No. AKS-052558

Document No. WMP APd10016

MUNICIPALITY OF ANCHORAGE
WATERSHED MANAGEMENT PROGRAM

January 2016

WATERSHED MANAGEMENT

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WMS Project No. 99002

Prepared for: Alaska Department of Environmental Conservation
Division of Water

Prepared by HDR Alaska, Inc.
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and

Municipality of Anchorage
Project Management and Engineering Department
Watershed Management Services

A. Project Management Elements

A.1 Title and Approval Page

_____ **Date**_____
Kyle Cunningham
MOA Watershed Management Project
QA Officer

_____ **Date**_____
Kristi Bischofberger
MOA Watershed Management
Program Manager

_____ **Date**_____
William Ashton
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Richard Heffern
Alaska Department of Environmental Conservation
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Cindy Helmericks
HDR
Contractor Project Manager

_____ **Date**_____
Cindy Helmericks
HDR
Contractor QA Officer

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List of Acronyms

ADEC	Alaska Department of Environmental Conservation
ADOT&PF	Alaska Department of Transportation & Public Facilities
APDES	Alaska Pollutant Discharge Elimination System
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
C	Celsius
CoC	Chain of Custody
DO	Dissolved Oxygen
DMRQA	Discharge Monitoring Report-Quality Assurance
DQO	Data Quality Objective
LID	Low Impact Development
mg/L	milligrams per liter
µg/L	micrograms per liter
mS/cm	milli-Siemens/centimeter
µS/cm	micro-Siemens/centimeter
MOA	Municipality of Anchorage
MS4	Municipal Separate Storm Sewer System
NELAC`	National Environmental Laboratory Accreditation Conference
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OGS	Oil Grit Separator
QA	Quality Assurance
QAP	Quality Assurance Plan
QMP	Quality Management Plan
SOP	Standard Operating Procedure
TAH	Total Aromatic Hydrocarbons
TAqH	Total Aqueous Hydrocarbons
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WMS	Watershed Management Services

A.3 Distribution List

Signees shall receive a copy of this Quality Assurance Plan (QAP), all attachments, and all subsequent revisions. Offers of official copies of this QAP and any subsequent revisions will be extended to individuals on the Distribution List.

Table 1. Distribution List

Name, Title	Position	Agency	Division/ Branch	Contact Information
Kristi Bischofberger, Watershed Manager	Program/Project Manager	Municipality of Anchorage (MOA)	Watershed Mgmt. Services (WMS)	(907) 343-8057 BischofbergerKL@ci.anchorage.ak.us
Kyle Cunningham, Watershed Specialist	QA Officer	MOA	WMS	(907) 343-8026 CunninghamKB@muni.org
Cindy Helmericks	Contractor Project Manager	HDR Alaska	Water Business Group	(907) 644-2017 cindy.helmericks@hdrinc.com
Cindy Helmericks	Contractor QA Officer	HDR Alaska	Water Business Group	(907) 644-2017 cindy.helmericks@hdrinc.com
Alena Gerlek	Sampling and Analysis Manager	HDR Alaska	Water Business Group	(907) 644-2122 alena.gerlek@hdrinc.com
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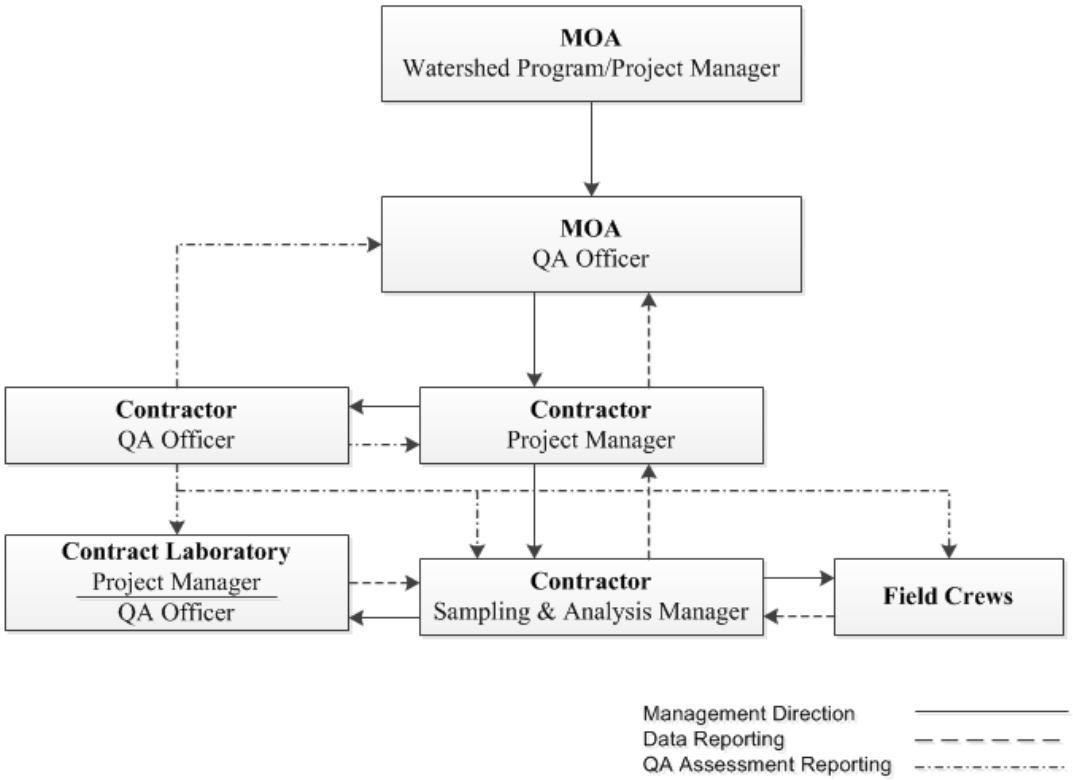
Record of Revisions

Table 2 provides a record of when and how this QAP has been revised.

Table 2. Record of Revisions

Date	Section	Description
June 4 2012	All, except App D	Updated for the 2012 season
Oct 2012	All, except App D	Final for 2012 season
Jan 2016	All, except App G and H	Updated to reflect new APDES Permit
Jan 2018	Main Body	Updated to reflect new personnel on the project

Figure 1.Project / Task Organization



A.4 Key Contacts and Responsibilities

The Watershed Management Services (WMS) will appoint a person to serve as the Municipality of Anchorage (MOA) Project Manager. This person will oversee the projects described in the monitoring plans appended to this QAP, provide technical support, QAP review, review of any modifications of the proposed sampling plans, and review all reports. She/he will appoint the sampling crews from MOA staff or develop a contract to perform the sampling and reporting tasks associated with this QAP. The person will also serve as the Quality Assurance (QA) Officer reviewing data validated by the Contract QA Officer to ensure quality objectives are met and data entry is conducted appropriately.

Kristi Bischofberger (WMS) will oversee the water quality monitoring program efforts and projects conducted to comply with Alaska Pollutant Discharge Elimination System (APDES) Municipal Separate Storm Sewer System (MS4) permit AKS-052558 and this QAP. She will provide or ensure adequate resources for the overall monitoring program, including direct contracting with a laboratory.

Monitoring Contractor MOA will hire a contractor to oversee and implement the monitoring plans. The Contractor will provide a Project Manager, a QA Officer, a Contract Sampling and Analysis Manager, and field crews.

> **Contract Project Manager** will ensure that all aspects of this QAP are implemented in conducting the monitoring projects; appoint a qualified QA officer (Contract QA Officer); assign qualified and trained field crews; and interface with the MOA Project Manger.
>
> **Contract QA Officer** will ensure or provide training to, examinations for, and oversight of the field crews; perform QA review and validation of the laboratory and field data; and provide QA review of the data entered into the spreadsheets and databases.
>
> **Contract Sampling and Analysis Manager** will provide direction to the field crews and will coordinate with the laboratory project manager. This person will receive direction from the Contract Project Manager and will receive feedback from the QA Officer. The Contract Sampling and Analysis Manager will: ensure that all equipment is functional prior to field sampling; ensure all supplies are available and that calibration chemicals have not exceeded their expiration dates; and assist in training field sampling crews, as needed.
>
> **Field Crews** will be either MOA staff or will be hired as contractors to conduct the work. Trained field crews will collect samples for the MOA APDES MS4 monitoring program in compliance with the permit and this QAP. If field crews are appointed by the MOA Project Manager, they will be integrated into the contractor field crews and receive the same training and oversight.

Laboratory – The Contract Project Manager will contract with a laboratory that will perform the chemical analyses and meet the precision, accuracy, and completeness requirements of this QAP. The contract laboratory must be currently certified for parameters of interest under the Alaska Department of Environmental Conservation's (ADEC) Drinking Water Program (http://dec.alaska.gov/eh/lab/index.htm) or be certified for water/wastewater analytes by a

National Environmental Laboratory Accreditation Conference (NELAC) accrediting body or the Washington State Department of Ecology Laboratory Accreditation program (http://www.ecy.wa.gov/programs/eap/labs/lab-accreditation.html) to perform the analyses required. The laboratory will deliver results to the Monitoring Contractor in an electronic format specified by WMS. The laboratory will provide a Project Manager and a QA Manager.

Laboratory Project Manager is responsible for the overall technical and contractual management of this project. This person will receive day to day direction from the Contract Sampling and Analysis Manager concerning the day to day arrival of samples, turnaround times, reporting of deliverables, and will receive feedback from the Laboratory and Contract QA Officers. This person will oversee and coordinate analyses within the laboratory and provide results to both the Contract Sampling and Analysis Manager and the Contract Project Manager.

Laboratory QA Manager is responsible for the QA/QC of the water quality laboratory analyses as specified in the QAP. Along with the Laboratory Project Manager, the Laboratory QA Officer reviews and verifies the validity of the sample data results as specified in the QAP and appropriate EPA-approved methods.

A.5 Problem Definition / Background and Project Objectives

Urban stormwater can contribute to the degradation of the quality of water bodies. Runoff from precipitation and snowmelt events can transport contaminants from impervious surfaces, such as driveways, sidewalks, and roads and semi-pervious surfaces, such as lawns, into the local water bodies. Most stormwater runoff flows into a storm sewer system or directly to a water body, often without receiving treatment to remove the pollutants.

The U.S. Environmental Protection Agency (EPA) has recognized urban stormwater as a major contributor to pollution of the nation's streams, rivers, and lakes. EPA and delegated states are using the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit to control pollutants from urban stormwater to the maximum extent practicable. EPA re-issued the MS4 permit in 2009 to co-permittees: the Municipality of Anchorage (MOA) and the Alaska Department of Transportation and Public Facilities (ADOT&PF). Figure 2 depicts the area regulated by the MS4 permit. The MOA has taken the lead role in implementing the monitoring requirements of the permit. Since permit issuance, EPA has delegated the NPDES stormwater program to the ADEC who now oversees its implementation. The permit is administered by ADEC as an Alaska Pollutant Discharge Elimination System (APDES) permit. The ADEC re-issued the MS4 permit with revisions, effective August 1, 2015.

The APDES MS4 permit establishes minimum control measures requiring the co-permittees to develop programs and policies, and implement actions designed to prevent and control contaminants entering publicly-owned storm sewer systems.

Figure 2. Municipality of Anchorage Watersheds

In issuing the Anchorage MS4 permit, EPA recognized that a number of water bodies in the greater Anchorage watershed have been categorized as impaired under section 303(d) of the Clean Water Act. For 12 of the water bodies impaired for elevated concentrations of fecal coliform and one water body impaired for petroleum hydrocarbons, ADEC has developed (and EPA has approved) Total Maximum Daily Loads (TMDL) plans to improve water quality to the extent that the waters will meet the current standards. The TMDLs identify stormwater runoff as a contributor of fecal coliform and petroleum hydrocarbon contamination to the water bodies; and the TMDLs establish reduction goals for concentrations of these pollutants in stormwater.

The monitoring elements of the MS4 permit are designed to identify sources of stormwater pollution, such as fecal coliform and petroleum hydrocarbons, monitor the effectiveness of best management practices (BMPs), and monitor the status of stormwater outfalls and receiving waters. The permit describes six specific monitoring projects.

This QAP describes common elements across the six monitoring projects and provides direction and QA/QC procedures for all the monitoring projects. Detailed, project-specific monitoring plans are provided in the following appendices to this QAP:

- Pesticide Screening Plan – Appendix A
- Stormwater Outfall Monitoring Plan – Appendix B
- Snow Storage Site Retrofit Monitoring Plan – Appendix C
- Low Impact Development Pilot Project Monitoring Plan – Appendix D
- Dry Weather Screening Monitoring Plan – Appendix E
- Standard Operating Procedures - Appendix F
- Maintenance and Calibration of Equipment - Appendix G
- Street Sweeping – Appendix H

A.6 Project / Task Description and Schedules

Each monitoring plan provided in the appendices includes descriptions of the specific tasks to be implemented to meet the objectives of the permit, and the associated schedules.

A.7 Quality Objective and Criteria for Measurement of Data

Data Quality Objectives (DQOs) for this program have been established to ensure that the data acquired meet the goals described in each of the monitoring plans – identifying illicit discharges by water quality screening, determining structural controls' effectiveness, and detecting changes and trends in stormwater quality. In preparing the NPDES permit, EPA identified the following monitoring objectives in the NPDES MS4 Fact Sheet:

- Assess compliance with this permit;
- Measure the effectiveness of the permittee's SWMP;

- Measure the chemical, physical, and biological impacts to the receiving waters resulting from
- storm water discharges;
- Characterize storm water discharges;
- Identify sources of specific pollutants; and
- Detect and eliminate illicit discharges and illegal connections to the MS4.

Stormwater monitoring is designed to provide a feedback loop for the permittees to improve the stormwater management program and best management practices, rather than to assess compliance with effluent limits or water quality standards.

Measurement Quality Objectives (MQOs) are a subset of DQOs and are derived from the monitoring project's DQOs. MQOs are designed to evaluate and control various phases (sampling, preparation, and analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the project's DQOs. MQOs are defined in terms of the following data quality indicators: detectability, precision, bias/accuracy, completeness, representativeness, and comparability. Tables 3 through 5 define the objectives of detectability, precision, and accuracy for each parameter tested by the methods and field probes MOA anticipates using. For all monitoring plans, the sampling matrix is water. Table 6 provides similar information for precipitation and discharge monitoring methods. MQOs for detectability, precision, accuracy, representativeness, comparability, and completeness are discussed below.

Project DQOs may be revised in the future if the MOA Project Manager determines that different objectives would be more effective in meeting program goals. Any changes in DQOs will require this QAP to be revised and submitted to ADEC for approval prior to implementation.

A.7.1 Detectability

Detectability is the ability of an analytical method to reliably measure a pollutant concentration above background concentrations. Two components define detectability: the Method Detection Limit (MDL) and the Practical Quantification Limit (PQL), also known as the Reporting Limit (RL).

- The MDL is the minimum value at which the instrument can discern presence of the parameter apart from background noise, without certainty as to the accuracy of the measured value. For field measurements, the manufacturer's listed instrument detection limit (IDL) is used.
- The PQL or RL is the minimum value that can be reported with confidence (usually a multiple of the MDL).

Sample data measured below the MDL will be reported as a non-detected value (ND). A sample measured above the MDL but below the PQL will be reported as the value with an estimated qualification flag. Results reported above the PQL will be reported as reliable, unless otherwise qualified based on the specific sample analyses.

Table 3. Measurement Quality Objectives for Field Instruments

Parameter	Method/Range	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
pH	EPA 150.2 YSI 556 hand-held/ 0-14 pH units	0.01 units	NA	± 0.2 units	± 0.2 units	Standard solutions at pH 4, 7, and 10
Turbidity	EPA 180.1 Rev 2.0 M Hach 2100P Turbidimeter/ 0 – 1,000 NTU	0.01 for 0 - 9.99 NTU 0.1 for 1 - 10 NTU 1 for 100 -1000 NTU	NA	±1 NTU	± 2% 0-500 NTU ±3% 500-1000 NTU	Primary standards, 0, 20, 100, 800 NTU (Hach method 8195)
Turbidity	EPA 180.1 Rev 2.0 M YSI 600 OMS V2 data logger/ 0 – 1,000 NTU	0.1 NTU	NA	±1 NTU	± 2% or 0.3 NTU, whichever is greater	Standard Solutions 0, 12.7, 126, and 1,000 NTU
Conductance	EPA 120.1 YSI 556 hand-held probe / 0.001 - 200 mS/cm	0.001 – 0.1 mS/cm range dependent	NA	± 0.001	± 5% of reading or 0.001 mS/cm, whichever is greater	Standard solution 3 pt cal (0 – 100, 100 – 1000, > 1000 µS/cm)
Conductance	EPA 120.1 YSI 600 OMS V2 data logger/ 0.001 - 200 uS/cm	0.001 – 0.1 mS/cm range dependent	NA	± 0.001	± 5% of reading or 0.001 mS/cm, whichever is greater	Standard solution 3 pt cal (0 – 100, 100 – 1000, > 1000 µS/cm)
Temperature	SM 2550 B YSI 556 hand-held probe/ -5 – 45°C	0.01 °C	NA	0.4 °C	± 0.15 °C	Comparison with a NIST-certified thermometer [a] at 0°C and 20°C
Temperature	SM 2550 B YSI 600 OMS V2 data logger/ -5 – 70°C	0.01 °C	NA	0.4 °C	± 0.15 °C	Comparison with a NIST-certified thermometer [a] at 0°C and 20°C
Dissolved Oxygen (DO)	EPA 360.1 YSI 556 hand-held probe/ 0 - 50 mg/L	0.01 mg/L	NA	± 10%	± 0.2 mg/L	100% air saturation (refer to YSI 556 Manual)

[a] NIST-certified thermometer will have a greater resolution than the probe it will be used to calibrate

M = Modified per manufactures' recommendations

Table 4. Measurement Quality Objectives for Illicit Discharge Screening (Field Test Kits)

Parameter	Method[a]/Range	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
Total Chlorine	LaMott Chlorine Octaslide Bar colorimetric (EPA Method 330.5)/ 0.1 - 6.0 mg/L	0.1 mg/L	NA	± 30%	± 0.5 mg/L	NA
Total Copper	Lamotte Total Copper EC-70 Cuprizone Color Chart	0.05 mg/L	NA	± 30%	± 0.5 mg/L	NA
Detergents	Hach model DE-1 Toluidine blue colorimetric (Analytical Chemistry #38-791)/ 0.05 - 1 mg/L	0.05 mg/L	NA	± 30%	± 0.5 mg/L	NA
Total Phenols	4 Amino Anti-Pyrine (4AAP) colorimetric (SM 5530C)/ 0.1 - 1 mg/L	0.1 mg/L	NA	± 30%	±0.5 mg/L	NA

[a] Field screening parameters are recommended by CWP and Pitt (2004) for illicit discharge detection

Table 5. Measurement Quality Objectives for Laboratory Methods

Parameter	Method	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
Fecal Coliform	SM 9222D	1 cfu/100 mL	1 cfu/100 mL	60 RPD	NA	Control checks for sterility and temperature
Chloride	EPA 300.0 Rev 2.1	0.031mg/L	0.10 mg/L	20 RPD	90-110%	5-point curve
Total Copper	EPA 200.8 Rev 5.4	0.034 µg/L	0.1 µg/L	20 RPD	85-115%	5-point curve
Dissolved Copper	EPA 200.8 Rev 5.4	0.034 µg/L	0.1 µg/L	20 RPD	85-115%	5-point curve
Hardness	SM 2340B	1.0 mg/L	1.0 mg/L	20 RPD	85-115%	5-point curve
BOD	SM 5210 B	2 mg/L	2 mg/L	NA	84-115%	DO meter calibration
TSS	SM 2540D	0.15 mg/l[a]	0.5 mg/l	25 RPD	75-125%	Standard balance calibration
2,4-D	EPA 515.4	1 µg/L	5 µg/L	30 RPD	70-130%	6-point curve
Carbaryl	EPA 531.2	2 µg/L	10 µg/L	30 RPD	65-135%	6-point curve
Total Organic Carbon	SM 5310B					
SpG	ASTM D854					
Passive Collection Device	EPA 8260/8270		0.02 µg/L	25 RPD	< 10% RSD	5-point external
TPH		0.006 µg/L				
BTEX						
Benzene		0.003 µg/L				
Toluene		0.003 µg/L				
Ethylbenzene		0.007 µg/L				
m-, p-xylene		0.007 µg/L				
o-xylene		0.003 µg/L				
Diesel Range Alkanes						
Undecane		0.003 µg/L				
Tridecane		0.003 µg/L				
Pentadecane		0.003 µg/L				
TMB						
1,3,5-trimethylbenzene		0.007 µg/L				
1,2,4-trimethylebenzene		0.003 µg/L				
PAH						
Naphthalene		0.003 µg/L				
2-methyl naphthalene		0.003 µg/L				
acenaphthene		0.01 µg/L				
acenaphthylene		0.02 µg/L				
fluorene		0.01 µg/L				

Parameter	Method	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
phenanthrene		0.02 µg/L				
anthracene		0.02 µg/L				
fluoranthene		0.02 µg/L				
pyrene		0.02 µg/L				
Methyl t-butyl ether		0.021 µg/L				
octane		0.007 µg/L				
Parameter	**Method**	**Sensitivity (MDL)**	**PQL**	**Precision**	**Accuracy**	**Calibration Method**
TAH	EPA 624					
Benzene		0.12 µg/L	0.4 µg/L	20 RPD	80-120%	Internal standard analysis
Toluene		0.31 µg/L	1 µg/L	20 RPD	77-120%	Internal standard analysis
Chlorobenzene		0.15 µg/L	0.5 µg/L	20 RPD	80-120%	Internal standard analysis
Ethylbenzene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
p & m Xylene		0.62 µg/L	2 µg/L	20 RPD	80-120%	Internal standard analysis
o-Xylene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
1,3-Dichlorobenzene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
1,4-Dichlorobenzene		0.15 µg/L	0.5 µg/L	20 RPD	80-120%	Internal standard analysis
1,2-Dichlorobenzene		0.31 µg/L	1 µg/L	20 RPD	80-120%	Internal standard analysis
TAqH	EPA 625					
Acenaphthylene		0.015 µg/L	0.05 µg/L	30 RPD	58-105%	Internal Standard analysis
Acenaphthene		0.015 µg/L	0.05 µg/L	30 RPD	57-110%	Internal Standard analysis
Fluorene		0.015 µg/L	0.05 µg/L	30 RPD	59-120%	Internal Standard analysis
Phenanthrene		0.015 µg/L	0.05 µg/L	30 RPD	60-115%	Internal Standard analysis
Anthracene		0.015 µg/L	0.05 µg/L	30 RPD	63-120%	Internal Standard analysis

Parameter	Method	Sensitivity (MDL)	PQL	Precision	Accuracy	Calibration Method
Fluoranthene		0.015 µg/L	0.05 µg/L	30 RPD	63-125%	Internal Standard analysis
Pyrene		0.015 µg/L	0.05 µg/L	30 RPD	62-130%	Internal Standard analysis
Benzo(a)anthracene		0.015 µg/L	0.05 µg/L	30 RPD	61-120%	Internal Standard analysis
Chrysene		0.015 µg/L	0.05 µg/L	30 RPD	71-120%	Internal Standard analysis
Benzo(b) fluoranthene		0.015 µg/L	0.05 µg/L	30 RPD	66-130%	Internal Standard analysis
Benzo(k)fluoranthene		0.015 µg/L	0.05 µg/L	30 RPD	67-120%	Internal Standard analysis
Benzo(a)pyrene		0.015 µg/L	0.05 µg/L	30 RPD	57-120%	Internal Standard analysis
Indeno(1,2,3-cd) pyrene		0.015 µg/L	0.05 µg/L	30 RPD	59-125%	Internal Standard analysis
Dibenzo (a,h) anthracene		0.015 µg/L	0.05 µg/L	30 RPD	56-125%	Internal Standard analysis
Benzo(g,h,i)perylene		0.015 µg/L	0.05 µg/L	30 RPD	60-125%	Internal Standard analysis
Naphthalene		0.031 µg/L	0.1 µg/L	30 RPD	56-108%	Internal Standard analysis

Table 6. Measurement Quality Objectives for Precipitation and Discharge Monitoring Methods

Parameter	Method/Range	Sensitivity	PQL	Precision	Accuracy	Calibration Method
Precipitation	Tipping Bucket Model TB3/Minilog digital data logger 0-700 mm/hr	1 tip	NA	0.2 mm/0.01 in	± 2% for intensities from 25 to 500 mm/hr	Factory calibration
Discharge	V-notch weir with 45, 60, 120 degree notches /0.02-2 cfs	0.01 inch stage height	NA	0.01 in	± 3%	Factory calibration and field calibration at deployment
	Volumetric Method[a]	NA [b]	NA [b]	[b]	[b]	Factory calibration of bucket and stopwatch
	KPSI 720 with Hobo U30 datalogger	0.00001 psi	NA	0.00001 psi	±0.25% at full scale	Factory calibration
	YSI 600 OMS V2	0.001 ft	NA	0.001 ft	± 0.06ft	Factory Calibration

[a] For small flows that can be concentrated into a single calibrated container
[b] Per USGS WSP 2175 because the measurement is taken 3 to 4 times the results are consistent and have no errors

A.7.2 Precision

Precision is the degree of agreement among repeated measurements of the same parameter and gives information about the consistency of methods. It applies to all analytical techniques and field replicates. Precision is expressed in terms of the relative percent difference (RPD) between two measurements (A and B).

For field measurements, precision is assessed by measuring replicate (paired) samples at the same locations as soon as possible to limit temporal variance in sample results. Field and laboratory precision are measured by collecting blind (to the laboratory) duplicate samples. For paired and small data sets, project precision is calculated using the following formula:

$$RPD = \frac{(A - B) \times 100}{(A+B)/2}$$

For larger sets of paired precision data (e.g., overall project precision) or multiple replicate precision data, the following formula is used:

RSD = 100* (standard deviation/mean)

Duplicate samples will be taken a described in Section B.5. Goals for precision are described for each element of the monitoring effort in Tables 3 through 5.

A.7.3 Bias (Accuracy)

Bias/Accuracy is a measure of confidence that describes how close a measurement is to its "true value." Methods to determine and assess accuracy of field and laboratory measurements include: instrument calibrations, various types of QC checks (e.g., sample split measurements, sample spike recoveries, matrix spike duplicates, continuing calibration verification checks, internal standards, field and laboratory blanks, external standards), and performance audit samples. Accuracy is usually assessed using the following formula:

$$Accuracy = \frac{\text{Measured value}}{\text{True value}} \times 100$$

Accuracy will be estimated by re-analyzing a sample to which a material of known concentration or amount of pollutant has been added, and results will be expressed as percent recovery. Matrix spikes and matrix spike duplicates will be collected for this purpose. Accuracy DQOs are provided in Tables 3 through 5.

A.7.4 Representativeness

Representativeness is the extent to which measurements actually represent the true environmental condition. Representativeness will not be routinely monitored throughout the projects, but is incorporated as data are interpreted. Representativeness is particularly difficult to achieve for stormwater quality as it changes depending on the storm size, phase of the storm, antecedent conditions, land use, and the amount of impermeable surface contributing to the discharge. Routine sampling over multiple seasons as well as flow proportional composite sampling can aid in

understanding the variation associated with a particular outfall or subbasin. Sample locations, dates, times, sampling frequency, and environmental conditions will be selected for each of the monitoring plans to provide a framework for evaluating the representativeness of the data and meet the permit requirements.

A.7.5 Comparability

Comparability is the degree to which data can be compared directly to similar studies. Standardized sampling techniques, standard analytical methods, and units of reporting with comparable sensitivity will be used to ensure comparability. The MOA has selected EPA clean water act (CWA) approved field and analytical methods from Standard Methods for the Examination of Water and Wastewater and EPA-approved methods. All field crew members will be trained to follow the standard protocols for each parameter as described in this monitoring plan prior to conducting field work. Where possible, efforts to replicate conditions in previous studies have been made.

A.7.6 Completeness

Completeness is the comparison between the amount of useable data collected and the amount of data identified in the monitoring plan. Completeness is measured as the percentage of total samples collected and analyzed as a whole and for individual parameters and sites as compared to the goals established in the monitoring plan. Completeness will be measured as a percentage of useable samples of the total number of planned samples.

$$\text{Completeness} = \frac{\text{No. planned samples} - \text{No. unacceptable/incomplete samples}}{\text{No. planned samples}} \times 100$$

A completeness goal of 90% is established for hand-held field instruments, illicit discharge screening parameters, and for laboratory analyses. Thus, the lab will achieve 90% acceptable chemical and biological data under the QC conditions described in this QAP. However, holding time limitations for fecal coliform may have an effect on this completeness goal.

A.8 Training Requirements

A.8.1 Routine Monitoring

Training will be conducted by the Contract Project Manager, Contract QA Officer, Contract Sampling and Analysis Manager, the MOA QA Officer, and/or the laboratory staff depending on the type of training. The Contract QA Officer will ensure that field crews have or receive training on the following topics:

- General field safety
- Traffic safety
- Boat operation and safety (for pesticide screening field crew)
- Map reading

- Proper recording of data in field log books or data sheets including records of visual observations
- Flow measurements and data logger flow calibration

The Contract QA Officer, the Contract Sampling and Analysis Manager, the laboratory staff, and/or the MOA QA Officer will provide training on the following topics:

- Sampling protocols
- Field quality control samples
- Sample preservation and packaging
- Holding times
- Chain of custody completion and procedures
- Laboratory location

This training will include the pre-field checks for the proper number and types of bottles, proper handling and maintenance of sample bottles, field sample preservation, proper packing, and completion of the chain of custody forms.

As appropriate for the type of monitoring being conducted, field crew members will receive training in the use and calibration of the YSI 556 and Hach 2100P hand-held probes including procedures for calibration and measurement of pH, dissolved oxygen (DO), specific conductance, temperature, and turbidity. Field crews conducting the dry weather screening will have or receive training in monitoring, recording and reporting for data collected with the total phenols, detergents, total copper and total chlorine field test kits. Trainers will include those people listed above who are senior technical experts with no fewer than 100 hours of field experience performing water quality sampling.

A.8.2 Automated Probes Monitoring

Prior to entry into the field, training on both deployment, set up, and disassembly of all automated monitoring equipment and data loggers will be required for all field staff associated with projects requiring these specialized pieces of equipment. Training will be provided in the following areas:

- Tipping bucket rain gages
- Installation and use of pressure transducers
- Installation and use of temporary weirs
- Flow monitoring data loggers
- Automated probes that monitor temperature, specific conductance, pH, DO, temperature, and/or turbidity, such as the YSI 600 OMS V2 or equivalent

Equipment training may be offered by the equipment manufacturer, the rental company, or a senior technical expert who has at least 100 hours of field experience with the specific piece of equipment. Training will include operation and calibration of all hand-held and automated probes, and downloading data collected from these pieces of equipment. To participate in a field crew, staff who will use the equipment in the field will be required to score 80% or better on a written and practical exam covering the topics listed above.

A.9 Documentation and Records

All data gathered in the field will be recorded on-site in waterproof field log books or datasheets at the time of sampling. Each monitoring project will have a separate field log book that will be used throughout the duration of the monitoring project. Field crews will record instrument calibration data in the field log books, as well as other specific observations identified in each of the monitoring plans. Field log books and datasheets will become part of the record maintained by MOA. Recordings from the field instruments (i.e., pH, specific conductance, DO, temperature, and turbidity) and records of field test kit results will be made in the field log books or datasheets, then transferred to the database or spreadsheet for the specific monitoring project. A unique data file name will be assigned to each of the monitoring plans. The QA review process for field data is described in Section B.10, Data Management.

For data gathered via data logger, automated probe, or automated sampler, all data will be saved as raw data files before QA is performed. For each set of data gathered from these instruments, a unique data file name will be created each time the instrument is deployed and will include a root identifier specific to the monitoring plan. In addition to a project identifier that will link field data with automated data, the file name will contain the location and the date of deployment. Upon retrieval of the instrument, the data will be downloaded and saved as an Excel file. The QA review process is described in Section B.10, Data Management, and outlines how all data will be saved in the appropriate format and with the appropriate file names for easy retrieval.

Laboratory results associated with each of the monitoring plans will also be maintained electronically. The laboratory will provide results electronically in a format specified by the MOA. The laboratory data QA review process is described in Section B.10 and outlines how all data will be saved in the appropriate format and with the appropriate file names with a file identifier that links it to the specific monitoring plan for easy retrieval.

MOA will maintain records of all electronic data and field log books for a minimum of five years. Table 7 provides a list of the records and locations of their storage.

Table 7. Project Documents and Records

Category	Record/Document Type	Location
Site Information	Site maps in specific monitoring report	WMS
	Site Photographs in specific monitoring report	WMS
Environmental Data Operations	QAP	WMS
	Field SOPs – Appended to QAP	WMS
	Field log books and/or datasheets including sample handling, field observations, and field instrument calibration	WMS
	Chain of custody forms	WMS
	Equipment inspection and maintenance records	WMS
Data Reporting	Monitoring reports	WMS
	Project summary reports	WMS
	Lab analysis reports	Contract Laboratory
Data Management	Data algorithms appended to specific Monitoring reports	WMS
	Water quality data (field and laboratory results) in spreadsheets	WMS
	Flow and automatic field water quality electronic data	WMA
Quality Assurance	Field inspection reports	WMS
	Lab control charts	Contract Laboratory
	Performance evaluation samples	Contract Laboratory
	Lab audits	Contract Laboratory
	Lab QA reports/corrective action reports	Contract Laboratory
	Field equipment and field inspection reports/corrective action reports and response	WMS

B. Data Generation and Acquisition

B.1 Sampling Process Design

The design for each of the monitoring plans including monitoring objectives, sample locations, parameters, sampling frequencies, and site-specific procedures are described in the following appendices:

- Pesticide Screening Plan – Appendix A
- Stormwater Outfall Monitoring Plan – Appendix B
- Snow Storage Site Retrofit Monitoring Plan – Appendix C
- LID Pilot Project Monitoring Plan – Appendix D
- Dry Weather Screening Plan – Appendix E
- Street Sweeping Monitoring Plan – Appendix H

B.2 Sampling Methods Requirements

B.2.1 Sample Types

Grab samples or flow-weighted composite samples will be obtained depending on the monitoring plan. Continuous monitoring of some parameters will also be obtained. Sample types are discussed in each of the monitoring plans in the appendices.

B.2.2 Sample Containers and Equipment

All sampling equipment and sample containers will be cleaned according to the equipment specifications and/or the laboratory. Bottles supplied by the contract laboratory for sample analysis will be pre-cleaned. These will only be used for samples and will not be pre-rinsed. Sample equipment will be pre-cleaned and cleaned between sample locations as specified in Appendix F.

Samples collected in the field for laboratory analysis will be collected as described in Section B.2 and the SOPs in Appendix F, labeled as described below, and will be packed into insulated ice chests with either gel ice (freezable gel packs) or crushed ice that is double-bagged in zip-locked plastic bag. Samples will be maintained at temperatures listed in Table 8 (plus or minus 2^{o}C) until delivered to the laboratory. Temperature in transit will be monitored with a temperature blank provided by the laboratory. A chain of custody form will be completed by the field personnel for each packed ice chest, will be placed in a plastic zip-locked bag, and placed in the ice chest. All samples will be in control of the field crew until they are delivered to the laboratory, at which time the chain of custody form will be signed by the laboratory personnel indicating that they have assumed custodial responsibility. In the event that full sample coolers are removed from the direct control of the sampling team without being transferred to the laboratory, custody seals will be placed on the cooler from lid to base and taped in place with clear packing tape.

For samples that will be analyzed by the laboratory, the bottle requirements, sample volumes, preservatives, and holding times are described in Table 8. Because some of these samples will be

obtained in the afternoon or at times that are not normal operating times, special arrangements may need to be made to ensure that the laboratory is still able to process the samples within the specified holding times.

Table 8. Containers, Volumes, Preservation Methods, and Holding Times for Laboratory Analyzed Parameters

Parameter	Matrix	Container Type	Volume Required	Preservation	Holding Time
BOD	Stormwater	HDPE	1 Liter	Cool to ≤ 6 °C, keep in the dark, lab temp receipt must be recorded to 2 significant figures	48 hours
TSS	Stormwater	HDPE	1 Liter	Cool to ≤ 4 °C	7 days
Fecal Coliform	Stormwater	HDPE	125 mL sterile bottle	Cool to < 10 °C, do not freeze	< 6 hours to lab; < 2 hours from lab receipt to sample prep; Not additive
Total Copper	Stormwater	HDPE	250 mL	HNO_3 to pH< 2	6 months
2,4-D	Surface water	AG	2 - 1 Liter	Sodium sulfite Cool to ≤ 6°C, do not freeze	14 days until extraction, 40 days after extraction
Carbaryl	Surface water	AG	2 - 1 Liter	Potassium citrate, monobasic Cool to ≤ 4 °C, do not freeze,	7 days until extraction, 40 days after extraction
Chloride	Stormwater	HDPE	500 mL	NA	28 days
TAH	Stormwater	G, Teflon lined septum	3-40 mL vials, sample filled to meniscus	HCl pH <2, Cool to ≤ 6 °C, do not freeze, (0.0008% $Na_2S_2O_3$)[a]	14 days
TAqH	Stormwater	AG, Teflon-lined cap	2 - 1 Liter	Cool to ≤ 6 °C, (0.0008% $Na_2S_2O_3$)[a], do not freeze, store in dark	7 days until extraction, 40 days after extraction

G= glass; HDPE = high density polyethylene; AG = amber glass.

[a] Sodium thiosulfate required only if sample contains chlorine

B.2.3 Sampling Methods

Sampling methods are described in specific monitoring plan, Appendix F, and Section B.3.

B.3 Sampling Handling and Custody Requirements

B.3.1 Sampling Event Preparation

The Contract Sampling and Analysis Manager is responsible for ensuring the following has been completed prior to a field crew entering the field:

- Written instructions have been prepared and provided to each of the field crew
- Each field crew member has received the appropriate training to enter the field
- Each field crew has necessary field equipment and bottles from the laboratory
- Each field crew member has completed an in-office review of the anticipated conditions and sampling protocols

The field monitoring probes will be calibrated on the day of the sampling event prior to entry into the field or in the field. Calibration procedures will be documented in the field log book, including the expiration dates of the standards and the results from all calibration tests.

B.3.2 Sampling Procedures

Where stormwater grab samples will be collected from low flows for field parameters or laboratory analysis, the field crew will collect samples in accordance with the field sampling protocols described in Appendix F. Field sample crews will collect an adequate volume of sample for all sample bottles, replicates, and field monitoring analyses.

Where samples are to be collected from flow over a temporary or permanent weir or where water is free falling from a pipe, sample bottles will be held under the flow. For samples collected directly in laboratory analysis bottles that contain preservative, field crew should apply care not to overtop the sample bottles.

Where a stream is being sampled, the field crew will face up-stream and obtain a sample by inverting the clean sampling bottle below the water surface, righting the bottle, and drawing the bottle up through the water column. If the water is shallow, the field crew will use a shallower grab to ensure that no sediments are entrained in the sample.

Sample bottles for TAH must not contain any air bubbles. This is accomplished by pouring the sample from the sample collection bottle into the 40 mL bottle until there is a slight convex meniscus at the top of the bottle, placing and tightening the cap, and inverting the bottle to ensure no air bubbles are trapped. Standard Operation Procedures (SOPs) for sampling specific parameters are provided in Appendix F.

Field crew members will assign a unique sample number as described in Section B.3, label the bottles with indelible ink, add any preservative required (unless the laboratory has provided the preservative in the bottle already), prepare the chain of custody form, and pack the bottles as described in Section B.3.

The YSI 556 probe measurements will be collected from flowing water and probe measurements will be recorded in the field log book.

B.3.3 Unique Sample Identification Numbers

In 2011, each sample received a unique 13-digit, alpha-numeric sample number. The sample number included a station location identifier of five alpha-numeric characters, a 2-digit sample number, and a 6-digit date. The time of collection was recorded both on the sample label and in the field log book. For example, a sample collected January 15, 2011 at Lake Otis could have the following identifier: LOT01-01-01-15-11. However, this identification system was confusing for field staff and was not easily usable in the database created to store the information connected with each of these samples.

Starting in 2012, the sample identification will include the site name, a separate line for the date, and another line for the sample time. These three fields combined will create a unique identifier for each sample. For example, A sample taken at C St Up Station for the Sedimentation Basin Study on August 30th, 2012 at 4 pm will be labeled as follows:

Site Name: CSTUP

Date: 8/30/2012

Time: 1600

When field duplicates are collected along with primary samples the word “DUP” will be attached to the end of the site name.

All sample names, dates, times, and duplicate sample information will be filled in on each sample label and logged in the field book or on the associated datasheet.

B.3.4 Sample Labels

Each sample transported to the laboratory will have a label with the following information on it in indelible ink:

- Site Name
- Date sample collected
- Time sample collected (using 24-hour clock)
- Analyses required
- Preservation (if any)
- Initials of the field crew member who collected the sample

Sample Label Example

XXX Laboratory

Field Information:

Sample Name: _____

Date: _____

Time:_____

Preservation Method: _____

Name & Signature of Sample Collector:

_____

_____

Phone: _____

Comments: _____

B.3.5 Chain of Custody Forms

Chain of custody (CoC) forms provided by the laboratory will be used for samples submitted to the laboratory for analysis. An example CoC form is provided at the end of Appendix F. The chain of custody form must contain the following information for each sample:

- Unique sample number
- Type of sample (e.g., water)
- Sample location
- Date and time sample collected (time recorded on 24-hour clock)
- Analyses required by analyte name and method number
- Printed name of person collecting sample
- Printed name and signature of person with responsibility for custody of samples until receipt by the laboratory
- Time and date received at laboratory and
- Printed name and signature of laboratory person with responsibility for ensuring custody of samples

The completed chain of custody forms will be scanned and returned to the MOA with the data package.

B.3.6 Field Log Book

In addition to the information itemized in each of the monitoring plans, field crew members will record the following information in the log book at each sampling station:

- Weather conditions, time, date, and location of sample
- Unique sample identification numbers
- Other unusual conditions
- Photo numbers and explanation (e.g. upstream/downstream facing, control structure, waterbody, etc.)

Each page of the field log books will be numbered, signed, and dated by the sampling crew member who completed it. Where a page is left partially blank, a note should be made with a line through the clean portion of the page; and each page must be signed and dated.

B.3.7 Automated Multiprobes

The YSI 600 OMS V2 probes will be calibrated and calibration procedures recorded on calibration forms prior to deployment. The probes will be cleaned, recalibrated, redeployed, and documented on calibration forms on a consistent basis to prevent drift (approximately once every three weeks or more frequently if necessary). The calibrated probes will be programmed using a computer to begin sampling and recording at designated intervals of no less than 15 minutes throughout the storm or runoff event. Instruments will be placed in approximately mid-channel both vertically and horizontally in locations of moderate to slow velocity. Where instruments must remain submerged, a special device will be created to ensure continuous submersion.

Multiprobes and data loggers will be protected from vandalism.

A unique file name will be created each time a multiprobe is programmed and deployed with a route identifier unique to the monitoring project. The file name will contain the location and date of deployment. Upon retrieval, the data will be downloaded and saved as an Excel file using the unique file name.

Chain of custody forms will not be used for data obtained from automated data logging probes.

B.3.8 Flow Monitoring

Where flow monitoring is conducted manually, the field crew will accurately measure and record the staff gage level to the nearest 0.01 inch.

When flow will be recorded with data loggers, field crew will calibrate the data logger as described in the SOPs in Appendix F on a routine basis to ensure accuracy and record the calibration on the datalogger maintenance data form. During a storm event when they are obtaining samples, field crew will manually read and record staff gage measurements (and time), and compare the value to those recorded by the data logger, as described in Appendix F.

B.4 Analytical Methods Requirements

Tables 3, 4, and 5 provide the analytical methods, precision and accuracy requirements that apply to all of the Monitoring Plans (Appendices A through I). The contract laboratory will be provided a copy of this QAP to ensure that they can meet the measurement quality objectives for detectability, precision, accuracy, comparability, and completeness prior to being awarded the contract. Once a laboratory has been selected by the Contract Project Manager, the laboratory Quality Management Plan (QMP) will be appended to this QAP. QMPs for all local laboratories that have been approved under the Drinking Water Program are maintained on file at ADEC. Once selected, the Contract laboratory will provide their approved QMP to the ADEC Division of Water Quality Assurance Officer, if it has not already been approved.

B.5 Quality Control Requirements

Quality control begins with training the field staff. As described in Section A.8, training will be conducted by the Contract Project Manager, the Contract QA Officer, the Contract Sampling and Analysis Manager, the MOA QA Officer, and/or the laboratory staff depending on the type of training. The Contract QA Officer will ensure that field crews receive appropriate training for those facets of monitoring that they will conduct.

Quality control activities in the field will include adherence to documented SOPs, comprehensive documentation of sample collection information, and field instrument calibration data. A rigidly enforced chain of custody program will ensure sample integrity and identification. The chain of custody will document the handling of each sample from the time the sample was collected until its arrival and acceptance at the laboratory.

Table 9 lists the types of field QC samples that will be collected for samples to be analyzed in the laboratory.

Field replicates provide a way to estimate the variability of individual results. If conditions in the stormwater change faster than the procedure is repeated, the precision calculated from duplicate samples will also include that variability. Both field samples (kits and hand-held probes) and laboratory samples will be replicated at a rate of 15% or one per field day, whichever is greater.

Trip blanks are samples that are prepared in the laboratory and carried into the field to determine whether samples are exposed to contamination in transit from lab to field or field to lab, from sampling handling procedures, or from conditions in the field such as boat or vehicle exhaust.

Equipment rinse analyses (Equipment Blanks) will be conducted for all parameters, except pH and temperature, for each sampling event where a sampling device is used to collect the sample. This type of analysis ensures that sample equipment is clean and uncontaminated. After decontaminating the sampling equipment, deionized water will be poured through the equipment and samples will be collected for analyses.

Matrix spike/matrix spike duplicate samples provide an estimate of laboratory accuracy and precision and will be gathered for the relevant laboratory parameters listed in Table 9.

Table 9. Frequency of QC Samples to be Collected in the Field

Parameter	Field Replicate (15% or 1/day whichever is greater)	Trip Blank (one per day)	Equipment Rinse Blank (1/day or 15% whichever is greater)	MS/MSD (15% or 1/day whichever is greater)
Hand-Held Probes and Field Test Kit Methods				
pH	X			
Conductance	X			
Turbidity	X			
Temperature	X			
Total chlorine	X			
Detergents	X			
Phenols	X			
Laboratory Analyses				
Fecal Coliform	X			
Chloride	X		X	X
Total Copper	X			
BOD	X			
TSS	X			
2,4-D	X		X	X
Carbaryl	X		X	X
TAH	X	X	X	X
TAqH	X		X	X

QC acceptance criteria for trip blanks and equipment rinse blanks are equal the PQLs defined in Table 5. Replicate QC acceptance criteria for field replication and MS/MSDs are defined as precision and accuracy for the parameters in Tables 3 though 5.

Automated water quality instrument readings will be verified against calibrated hand-held probes for water quality parameters on a tri-weekly basis or more frequently if necessary. This level of replication will allow determination of whether or not the automated instruments are accurate, need recalibration, or data should be adjusted for drift.

Discharge measurements using the bucket method will be performed in quadruplicate to assure precision and accuracy. Field discharge monitoring using weirs and data loggers will be checked either on a monthly basis or when sampling, downloading of data, or maintenance is occurring by comparing a visual reading of the staff gage against the data logger. This level of replication for the hydrology (discharge measurements) will allow determination of whether or not the automated instrument is accurate, needs recalibration (by adjusting the reference level), or data should be adjusted for drift. Data loggers that do not meet the accuracy tests prior to deployment will be returned to the manufacturer. Comparison of visual or handheld instrument data sets will be appended to the monitoring report.

Laboratory QC sample frequencies and QC acceptance criteria are described in Tables 10 and 11. The laboratory will provide analytical results after verification and validation by the laboratory QA Officer. The laboratory will provide all relevant QC information with its summary of data results for each analytical batch. The Contract QA Officer will perform a review of the laboratory results to ensure that the required QC measurement criteria have been met. If a QC concern is identified in the review process, the Contract Project Manager and QA Officer will seek additional information from the laboratory to resolve the issue and take appropriate corrective action.

Table 10. Frequency of Laboratory QC Samples

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
Fecal Coliform	SM 9222D	1 per daily batch	NA	NA	NA	1 per daily batch	NA
Chloride	EPA 300.0 Rev 2.1	1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	1 per 10 samples and at end of run	1 MS and 1 duplicate per 10 samples	1 per analytical batch or daily	NA
Total Copper	EPA 200.8 Rev 5.4	1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	1 per 10 samples and at end of run	1 MS per 10 samples	After each calibration curve	NA
BOD	SM 5210 B	3 per batch of ≤ 20 samples	3 per batch of ≤ 20 samples	NA	NA	NA	NA
TSS	SM 2540D	1 per batch of ≤ 20 samples	NA	NA	1 duplicate per 10 samples	1 per batch of ≤ 20 samples	NA
2,4-D	EPA 515.4	1 per batch of ≤ 20 samples	NA	Beginning of each batch, after every 10 samples, and at end of batch	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard
Carbaryl	EPA 531.2	1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	Beginning of each batch, after every 10 samples, and at end of batch	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard
TAH	EPA 624						
Benzene		1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	Beginning of each 12-hour tune period	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard
Toluene							
Chlorobenzene							
Ethylbenzene							
m,p-Xylene							

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
o-Xylene							
1,3-Dichlorobenzene							
1,4-Dichlorobenzene							
1,2-Dichlorobenzene							
TAqH	EPA 625						
Acenaphthylene		1 per batch of ≤ 20 samples	1 per batch of ≤ 20 samples	Beginning of each 12-hour tune period	1 per batch of ≤ 20 samples	After each calibration curve	In each sample, prep QC sample, and instrument standard
Acenaphthene							
Fluorene							
Phenanthrene							
Anthracene							
Fluoranthene							
Pyrene							
Benzo(a)anthracene							
Chrysene							
Benzo(b)fluoranthene							
Benzo(k)fluoranthene							
Benzo(a)pyrene							
Indeno(1,2,3-cd) pyrene							
Dibenzo (a,h) anthracene							
Benzo(g,h,i)perylene							
Naphthalene							

Table 11. Laboratory QC Samples Acceptance Criteria

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
Fecal Coliform	SM 9222D	No growth	NA	NA	NA	Growth present	NA
Chloride	EPA 300.0 Rev 2.1	<PQL	±10%	±10%	MS = ±10% Dup. = RPD ≤ 20 or absolute difference < LOQ	±10%	NA
Total Copper	EPA 200.8 Rev 5.4	< PQL	±15%	±15%	70 – 130% if analyte concentrations are < 4 times the spike	±10%	NA
BOD	SM 5210 B	Maximum depletion of ± 0.2 mg/L	TV = 198 ± 30.5 mg/L	NA	NA	NA	NA
TSS	SM 2540D	< PQL	NA	NA	Duplicate RPD ≤ 25	75 – 125%	NA
2,4-D	EPA 515.4	< PQL	NA	70 – 130%	70 – 130%, RPD ≤ 30	70 – 130%	70 – 130%
Carbaryl	EPA 531.2	< PQL	70 – 130%	70 – 130%	70 – 130%, RPD ≤ 20	70 – 130%	70 – 130%
TAH	EPA 624						
Benzene		< PQL	80 – 120	% Difference ≤ 20%	80 – 120	80 – 120%	
Toluene			77 – 120		77 – 120		
Chlorobenzene			80 – 120		80 – 120		
Ethylbenzene			80 – 120		80 – 120		
m,p-Xylene			80 – 120		80 – 120		
o-Xylene			80 – 120		80 – 120		
1,3-Dichlorobenzene			80 – 120		80 – 120		
1,4-Dichlorobenzene			80 – 120		80 – 120		
1,2-Dichlorobenzene			80 - 120		80 - 120		
1,2-Dichloroethane-d_4 (surr.)		NA	73 - 120		73 - 120		73 - 120
Toluene-d_8 (surr.)		NA	80 - 120		80 - 120		80 - 120
4-Bromofluorobenzene (surr.)		NA	76 – 120		76 – 120		76 – 120

Parameter	Method	Lab Blank	Lab Fortified Blank	Calibration Verification Check Standard	MS/MSD	External QC Check Standard	Surrogate Standard
TAqH	EPA 625						
Acenaphthylene			53 - 105		53 - 105		
Acenaphthene			53 – 110		53 – 110		
Fluorene			56 - 110		56 - 110		
Phenanthrene			58 - 115		58 - 115		
Anthracene			59 - 110		59 - 110		
Fluoranthene			59 - 115		59 - 115		
Pyrene			62 - 128		62 - 128		
Benzo(a)anthracene			64 - 110		64 - 110		
Chrysene		< PQL	63 – 110		63 – 110		
Benzo(b) fluoranthene			57 - 120		57 - 120		
Benzo(k)fluoranthene			58 - 124		58 - 124		
Benzo(a)pyrene			58 – 110	% Difference ≤ 20%	58 – 110	70 – 130%	
Indeno(1,2,3-cd) pyrene			51 – 125		51 – 125		
Dibenzo (a,h) anthracene			53 - 125		53 - 125		
Benzo(g,h,i)perylene			48 - 123		48 - 123		
Naphthalene			45 - 100		45 - 100		
2-Fluorophenol (surr.)		NA	21 – 88		21 – 88		21 – 88
Phenol-d_6 (surr.)		NA	28 – 97		28 – 97		28 – 97
Nitrobenzene-d_5 (surr.)		NA	41 – 110		41 – 110		41 – 110
2-Fluorobiphenyl (surr.)		NA	50 – 110		50 – 110		50 – 110
2,4,6-Tribromophenol (surr.)		NA	45 – 124		45 – 124		45 – 124
Terphenyl-d_{14}		NA	52 - 135		52 - 135		52 - 135

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

The training described in Section A.8 includes expectations for proper field equipment handling and the inspection of field test kits, hand-held monitoring equipment, sampling equipment, and laboratory bottles prior to entering the field.

All equipment and field test kits are checked upon receipt from the manufacture by the Contract Sampling and Analysis Manager to ensure that equipment is properly operating and the kits are complete. Before a sampling event, the field crew will inspect all kits for completeness. Equipment that is not operating properly or cannot be calibrated will not be used in the field. Field equipment and test kits will also be inspected when the field crew returns from the field by the Contract Sampling and Analysis Manager.

Automated probes will be inspected prior to their deployment into the field. Instruments that fail to calibrate appropriately or fail to function (i.e., automatic samplers) will be sent to the manufacturer for repair. Data logged from the automatic instruments will be graphed when they are returned from the field or in the field if possible to detect erratic measurements. All instrument maintenance, testing, and storage will follow the manufacturer's recommendations.

B.7 Instrument Calibration and Frequency Procedures

Instrument calibration will follow the manufacturer's recommendation.

Hand-held water quality monitoring instruments will be calibrated daily before use. Tables 3 through 5 list the calibration standards for each type of hand-held and automated device. Calibration procedures for the YSI 556 and the Hach 2100P are provided in Appendix G. Water temperatures will be calibrated against a NIST-certified thermometer accurate to 0.01^{o}C. Calibration checks for water temperature will be conducted at 0^{o}C and 20^{o}C. A record of equipment calibration and calibration standards will be maintained in the field log books, which will be maintained for 5 years.

When MOA has purchased the automated water quality multiprobes (e.g., YSI 600 OMS V-2 or equivalent) the manufacturer's instrument calibration instructions will be added to Appendix G. When the YSI 600 OMS V-2 is deployed, the water quality parameters it records will be checked against a hand-held YSI 556 and/or Hach 2100P turbidimeter on a tri-weekly basis or more frequently if necessary as described in Section B.5.

For those projects where precipitation will be recorded, a tipping bucket rain gage and data logger that records in 0.01 inch increments will be used. These instruments are calibrated by the manufacturer prior to field deployment and require no additional calibration.

Weirs and installed staff gages will be calibrated at installation. The field crew will check calibration prior to a predicted storm event, during event grab sampling, and following the event.

B.8 Inspection and Acceptance Requirements for Supplies

Monitoring supplies such as sample bottles, preservatives, sample labels, ice, coolers, and chain of custody forms will be provided by the contract laboratory. Calibration solutions and deionized

water, and other supplies will be maintained at the field office. The Contract Sampling and Analysis Manager is responsible for ordering supplies and equipment and ensuring adequate supplies are available for use at the time of sampling. It is also the responsibility of the Contract Sampling and Analysis Manager to ensure that the calibration chemicals and supplies have not past their expiration date.

Automated multiprobes and data loggers will be checked for proper operation upon receipt from the manufacturer and prior to each deployment. Multiprobes will be calibrated prior to deployment. It is the responsibility of the Contract Sampling and Analysis Manager to ensure that the calibration chemicals and supplies are not expired. All equipment will be inspected upon retrieval from the sites. Any problems or concerns resulting from inspections will be documented and brought to the attention of the Contract Project Manager, and if necessary, to the MOA Project Manager.

B.9 Data Acquisition Requirements for Non-Direct Measurements

Weather data such as antecedent precipitation is readily available and can be downloaded from the National Oceanic and Atmospheric Administration web site (http:://www.ncdc.noaa.gov/oa/ncdc.html) for a small fee. These data are assumed to be accurate and usable.

B.10 Data Management

Data review and management are also part of the QC process. The description below identifies three levels of QC review, and the data review process is depicted in Figure 3.

As previously discussed, field log books and/or data sheets will be used to record instrument calibration data, locations of the sampling station, date and time of sample collection, recorded measurements, deviations from the sampling protocols, and observations as described in each of the monitoring plans. Field staff will document records in waterproof ink or pencil. At the end of each day's sampling event, the field log books will be reviewed and initialed by the Field Staff Lead for the project. Corrections will be made by drawing a single line through the corrected entry and will be initialed and dated.

Proper data management is necessary to effectively collect, display, and evaluate data. Data from filed log books and continuously recorded data will be compiled to produce discharge and water quality data. Field data (both manual and electronic) will be stored with spatial coordinates in a database that interfaces with GIS for management, storage, and analysis. Manual data refer to data that are recorded in the field log books. Electronic data include pressure transducer records, discharge meter measurements, GPS files, continuously recording YSI meters, and tipping bucket rain gages. Data management includes processes that range from pre-field activities through compilation and export of data; it includes the following activities:

- Database file creation and organization
- Electronic scanning and organization of field log books
- Uploading raw manual field data into the project database
- Uploading, adjusting, and organizing flow and continuously recording water quality data
- Compiling and organizing GIS data

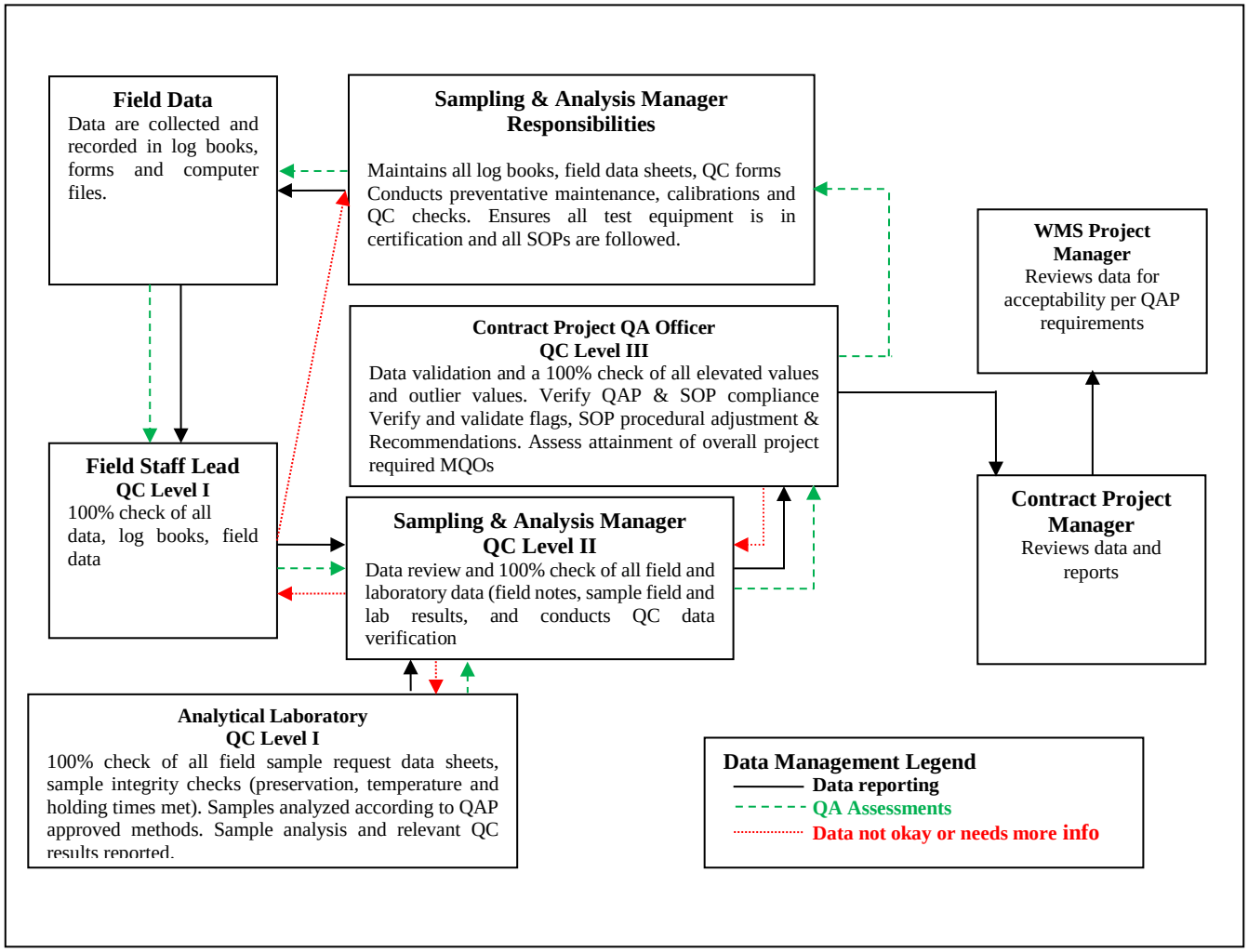
- Compiling surveyed gage elevations
- Periodic data exportation to WMS

The QC program for each monitoring project's field data is designed to meet the data quality objectives at three levels. A QC Level I review includes a daily review of field log books to assure data integrity and completeness. This will be conducted by the Field Staff Lead, who will initial the logbooks at the end of each field day to document that QC Level I has been completed. Data transfers of electronically collected data (e.g., stream gage, YSI continuously recording meters, and GPS data) will also be reviewed and documented using a datalogger download form (Appendix G) to ensure data integrity and completeness. Data are typically transferred to the database in the office, and 100% of these data will be reviewed weekly.

Once the data are stored in the database, the Contract Sampling and Analysis Manager will conduct a QC Level II review to check for data entry errors. Corrections for data entry errors are implemented as warranted. For spatial data, QC Level II review confirms that the data set was downloaded and projected properly and that the spatial locations are plotted correctly. For water quality data, the QC Level II is performed after uploading the laboratory-validated files. Data downloaded from data loggers will be imported into Excel files.

For all data types, the Contractor QA Officer, or her/his designee, conducts a QC Level III review using queries and professional judgment to find identifiable errors, outliers, missing data, and data that do not meet the MQOs. Suspect data are investigated further and, if technically appropriate, they are corrected or flagged. Data will also be reviewed for indications of water quality concerns such as erratic or unexpectedly high or low results based on professional judgment. All data files will be backed up on the MOA server, and data will be stored for no less than 5 years

Figure 3. Data Flow and QC Responsibilities



C. Assessment and Oversight

C.1 Assessment / Oversight

As described in Section B.10, once data are reviewed by the Contract QA Officer data are submitted to the database. If problems are discovered with data quality or management, it is the responsibility of the Contract QA Officer to address them in a timely manner.

Procedures for inspection, acceptance, calibration and maintenance of equipment and supplies are described in detail in Sections B.6, B.7, and B.8. If problems with data quality are traceable to equipment failure, inspection, calibration and maintenance will be scheduled more frequently.

The Contract QA Officer or the Sampling and Analysis Manager will spot check field crews at 10% of the sampling locations/events to observe sample collection. If sampling technique problems are observed, corrective action will be taken immediately to resolve the problem. Observations of problems and corrective actions will be included in a corrective action report (reporting errors observed and actions taken to correct the errors). The Contract QA Officer will submit corrective action reports to the MOA Project Manager/QA Officer within two business days of the identification of the need for corrective action. Corrective action reports will also be appended to each of the monitoring reports, as appropriate. Data quality assessment for completeness, bias, and precision will be included in each of the monitoring reports submitted to ADEC.

The contractor laboratory selected for the analyses will be certified in the DMRQA program for water/wastewater annually, the Contractor laboratory will participate in the DMRQA for water/wastewater samples from a 3rd party certified vendor.

C.2 Revisions to QAP

The MOA Project Manager and Contract Project Manager will review this QAP and overall design of the monitoring plans annually and may suggest procedural refinements or additional testing procedures. This may include changes to procedures in use or new parameters to be measured. Minor revisions such as identified project staff, QAP distribution list, and minor editorial changes, will be made without formal review by ADEC. Other changes will be subject to ADEC review and approval.

C.3 QA Reports to Management

Table 12 provides the QA assessment reports, frequencies, and responsible individuals.

Table 12. QA Reports to Management

QA Report	Description	Presentation Method	Report Issued by	Report As Needed
Field Inspection Report	Description of field inspection results, audit methods, standards/equipment used, and any recommendations	Written text/tables	Contract QA Officer	Each field audit/inspection
Threshold Exceedance Report	If a threshold is exceeded, field work results and any recommendations	Email/telephone call	Contract Sampling and Analysis Manager	Each field inspection, as required
Corrective Action Recommendation	Description of problem(s), recommended action(s) required, time frame for feedback on resolution of problem(s)	Written text/table	QA Officer/auditor	As required
Response to Corrective Action Report	Description of problem(s), description/date corrective action(s) implemented and/or scheduled to be implemented	Written text/table	Project Manager overseeing sampling and analysis	As required
3rd Party PT Sample (DMRQA, etc.) Audit Report	Description of audit results, methods of analysis, and any recommendations	Written text and charts, graphs displaying results	3rd Party PT provider report issued to: • Lab QA Officer/Manager • Project QA Officer • ADEC DOW Compliance • ADEC DOW QA Officer Note: responsibility of lab to self-enroll and ensure reports are issued to ADEC	Annually and as required by APDES permit
Data Validation	Data validation in comparison to MQOs	Data spreadsheet with data qualifiers; written text (as needed)	Contract QA Officer provides to Project QA Officer for review	With completion of each monitoring project or season
QA Report to Management	Summary assessment of whether QC measures are effectively meeting DQOs and corrective actions taken	Written text/tables	Contract QA Officer provides to Project QA Officer for review, ADEC Project Manager and ADEC Water QA Officer receive with NPDES annual report	Annually

D. Data Validation and Usability

D.1 Data Review, Verification, and Validation Requirements

The purpose of this section is to state the criteria used to review and validate—that is, accept, reject or qualify data in an objective and consistent manner. It is a way to decide the degree to which each data item has met its quality specifications as described in B above.

Data Validation means determining if data satisfy QAP-defined user requirements; that is, that the data refer back to the overall data quality objectives. Data validation is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set to ensure that the reported data values meet the quality goals of the environmental data operations (method specific data validation criteria).

Data Verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. The primary goal of verification is to document that applicable method, procedural, and contractual requirements were met in field sampling and laboratory analysis. Verification checks to see if the data were complete, if sampling and analysis matched QAP requirements, and if SOPs were followed.

Data review is the process that evaluates the overall data package to ensure procedures were followed and that reported data is reasonable and consistent with associated QA/QC results.

The Contract QA Officer will be assigned to conduct data review and validation as described in Sections B.10 and A.7. In addition, the MOA Project Manager/QA Officer will conduct data review following validation. Data that are obtained using equipment that has been stored and calibrated correctly and that meets the precision and accuracy data quality objectives will be used. Data that do not meet these objectives will be flagged.

D.2 Validation and Verification Methods

As described in Section B.10, the data verification and validation process includes three levels of QC with responsibilities for QC Level I identified for both field staff lead and analytical laboratory reviews; QC Level II is the responsibility of the Contract Sampling and Analysis Manager. The Contract Sampling and Analysis Manger will correct errors in data entry and will flag inconsistencies for further review. The Contract QA Officer will review data and flag any values that are outside of the MQOs range for each parameter. QC Level III review, including final data validation and verification will be conducted by the Contract QA Officer. The MOA Project Manager/QA Officer will review the validated data after entry into the database/spreadsheet.

The summary of all laboratory analytical results will be reported to the Contract Sampling and Analysis Manager. Data validation will be performed by the laboratory for all analyses prior to the release of data. All laboratory data will be validated according to the laboratory's QAP and SOPs and as specified in the Monitoring Project's QAP. Lab reports will include the results of all QC data and their acceptance/rejection criteria used to validate/invalidate sample report data. The

rationale for any anomalies in the QA/QC of the laboratory data will be provided to the Contract Sampling and Analysis Manager with the data results. Completed Chain-of-Custody or Transmission forms (if required) will be sent back from the laboratory to the Contract Project Manager.

The laboratory will calculate and report the Relative Percent Difference (RPD) and percent analyte recovery of analytical duplicate samples and MS/MSD samples. RPDs greater than the project requirements will be noted. The Contract Project Manager, and the Contract QA Officer, will decide if any QA/QC corrective action will be taken if the precision, accuracy (bias), and data completeness values exceed the project's MQO goals.

D.3.1 Practical Quantitation Limits

The practical quantitation limits (PQLs) are the lowest concentration that can be reliably achieved within specified limits of precision and accuracy for field and lab measurement methods. Estimated PQLs should be equal to or below the RL but above the MDL and are provided in Table 5 in Section A.7.

The Contract QA Officer or his/her designee will calculate the RPD between field replicate samples.

The Contract QA Officer will also be responsible for reviewing the maintenance and calibration records show all monitoring equipment in use to be in compliance with this QAP (Sections B.6, B.7, and B.8). If data quality questions cannot be adequately resolved, data will not be entered into the database without being flagged as questionable. The Contract QA Officer will arrange for corrective measures (e.g., re-training, equipment recalibration).

D.3 Reconciliation with Data Quality Objectives

The Contract QA Officer will compare the results and associated variability, precision, accuracy and completeness with project objectives. If data quality indicators do not meet the program specifications established in Tables 3 through 5, data will not be entered into the database system, unless flagged. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration, and maintenance procedures will be reassessed and improved. In some cases, accuracy MQOs may be modified; when this occurs, strong rational justification for modification, problems associated with collecting and analyzing data, and potential solutions will be reported.

If failure to meet program specifications is found to be unrelated to equipment methods or crew error, specifications may be revised. Revisions to this QAP will be submitted to ADEC for approval.