STANDARD OPERATING PROCEDURES FOR CDOT WET WEATHER MONITORING PROGRAM

Colorado Department of Transportation

Environmental Programs Branch

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STANDARD OPERATING PROCEDURES FOR CDOT WET WEATHER MONITORING PROGRAM

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1.0 SITE SELECTION REQUIREMENTS

Purpose:
The purpose of this document is to provide documentation that references the specific site location requirements for the Colorado Department of Transportation's (CDOT) Wet Weather Monitoring (WWM) Program. General site criteria and supplemental information are available to prioritize potential sites, provide a naming convention, and procedure for adding/removing site locations for monitoring.

Date of Last Review:
November 29, 2017

Sampling Program:
WWM Program

Sampling Task:
CDOT Permanent Control Measure(s)

1.1 INTRODUCTION

The Colorado Department of Public Health and Environment (CDPHE) Permit No. COS000005 requires CDOT to implement a WWM program to assess wet weather impacts from highways, Permanent Water Quality (PWQ) Control Measures (CMs) and maintenance facilities, and the effectiveness of control measures by determining the excess loading of pollutants of concern. This supplemental Standard Operating Procedure (SOP) for the CDOT Sampling Program, is focused on the site selection process for assessing the effectiveness of point source, permanent CMs. Although the permit only requires monitoring the outfall of CMs, both pollutant concentration and stormwater runoff flow rate need to be monitored from the inlet and outlet of the control structure. Data obtained from selected inlet and outlet locations will assess the effectiveness of PWQ CMs by calculating the mass load difference between the inlet and outlet of the control measure.

1.2 PROCEDURE

Site selection should be considered annually, before the end of each fiscal year. The selection process should begin with a review of the previous monitoring season's sites and data collected and cover successes and challenges encountered from each location. In CDPHE Permit No. COS000005, Part 1.F.6.a.i requires sampling locations to include the following:

- Six site locations/sample points should be monitored each calendar year.
- Site locations should include at least one complex highway-maintenance facility, one priority development highway road surfaces with CMs, and one priority development highway road surfaces without CMs.
- Three samples must be collected from each monitored location/sample point each calendar year.
- Each sample for roadways with and without a CM will be analyzed, at a minimum, for all roadway pollutants of concern as well as for conductivity and hardness.
- Each sample from facilities will be analyzed for the respective pollutants of concern as well as other parameters that have the potential to impact the beneficial uses of receiving waters.

- All samples must be taken during a measureable storm event, as defined below:
  - An event that results in measureable discharge from the facility/site
  - A rain event that follows the preceding measureable storm event by at least 72 hours
  - A snow event where a measurable discharge occurs from the facility and results from melting snow
- Locations must have at least one rainfall event and one snowmelt event occur during the year.

CDOT also specify general criteria for site selection, specifically for automatic samplers for highways to include the following:

- **Average Daily Traffic (ADT):** Pollutant concentrations in highway stormwater runoff increase as traffic volumes increase.
- **Percentage of Impervious Surface:** The correlation between ADT and pollutant concentrations is stronger in drainage areas with higher percentages of impervious surface area.
- **Drainage Area Size:** The basin or receiving drainage area from which runoff will be collected must be of sufficient size to generate appreciable flow at the point of discharge so, at a minimum, the automated samplers will be triggered during low to moderate precipitation events.
- **Minimal Comingling With Stormwater That Originates Outside of the CDOT Right-of-Way:** Monitoring locations should be situated such that stormwater runoff from CDOT's area of jurisdiction is isolated and sampled. In cases where comingling with runoff generated outside CDOT's ROW is unavoidable, additional samplers shall be placed such that differentiating between the multiple sources is possible by performing a chemical mass balance once data are received.
- **Reasonable Degree of Protection of Sampling Equipment:** Sampling equipment will be housed in a locked steel box and situated such that it can be secured to a permanent object with a chain and lock. To avoid vandalism, the location should not be in an area that is easily accessed by foot traffic.

CDOT's Program Description Document (PDD) provides additional factors to consider when selecting and prioritizing site locations/sample points for roadways and maintenance facilities:

- Does the location or sample site drain to a 303(d) impaired stream?
- Is the location/sample site within the Cherry Creek Watershed?
- Does the site represent characteristics of discharge from a combination of highway-maintenance facilities or priority development highway road surface with and without CMs?
- Has the site been previously monitored?
- Is the site easily accessible and safe?
- Does the site reside in the Municipal Separate Storm Sewer System (MS4) permitted area?

Monitoring locations will collect data within the MS4 permit area, including a range of geographic and climatic zones. These data can be used for future water quality planning and impact assessments purposes. Figure 1-1 displays the previously monitored sites under the CDOT Sampling Program.

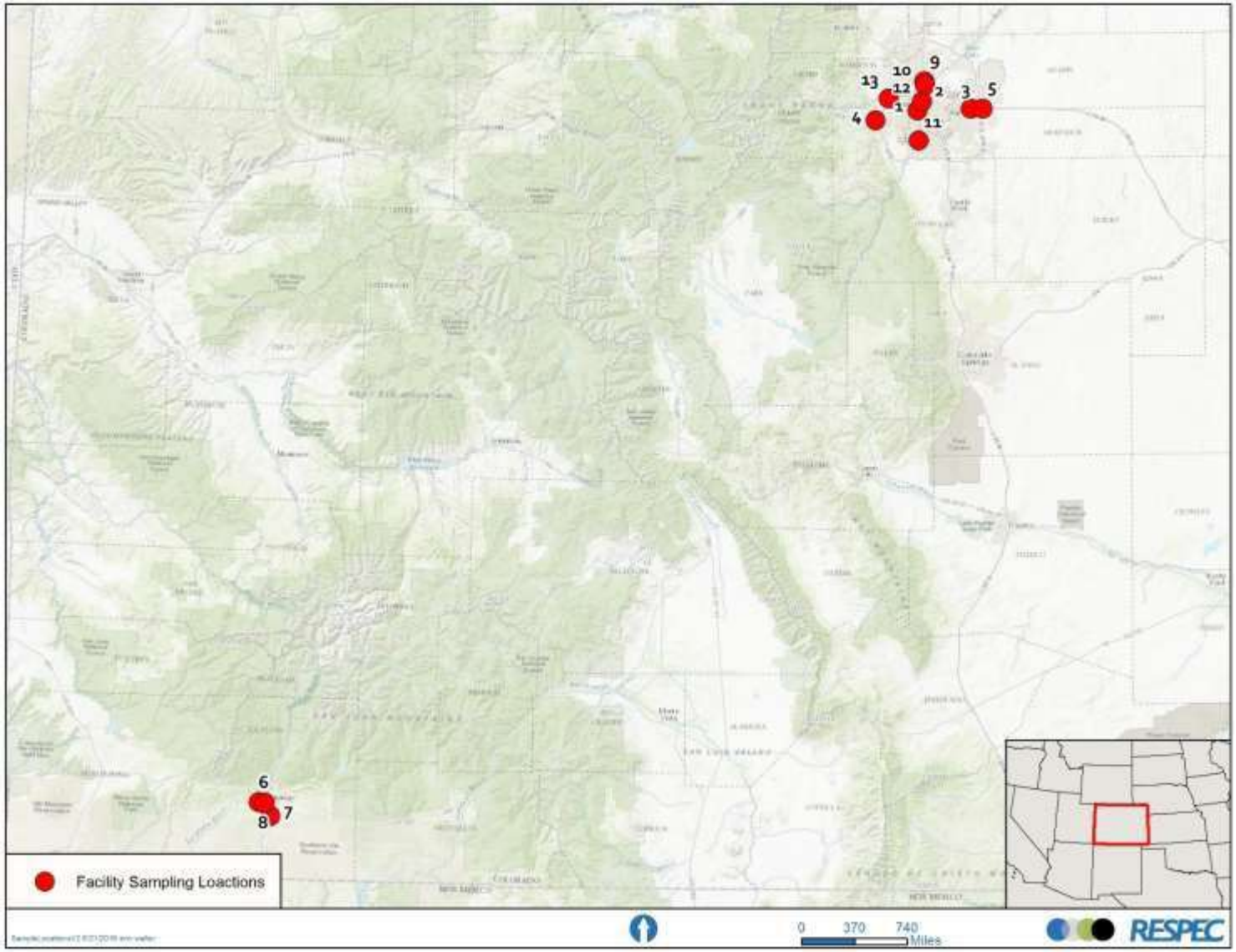

Figure 1-1. Map of Colorado Department of Transportation Facility Locations.

1.3 DOCUMENTATION FILING

All site locations and sample points need to have a consistent naming and ID convention. The Site Name should include a short description of the location (i.e. relation to a highway corridor or major intersection, etc.) as well as the facility SAP number (i.e., Maintenance Facility). Each ID should include the following information:

- PWQ CM ID Number (i.e., CO-025A-RS0251-EN001)
- The type of sampling point (I for an Inlet or O for Outlet)
- If a location has multiple inlet or outlet points:
  - Number each control point
  - Begin number sequence with the northernmost location
  - Increase the count in a clockwise method.

A possible Site Name and ID for an outlet sample point from the maintenance facility off Zang Street is Zang Facility CO-025A-RS0251-EN001Outlet 1 or CO-025A-RS0251-EN001-01.

For a table of all CDOT facilities and their associated SAP number, contact the WWM Manager or CDOT SAP Department.

1.4 QUALITY ASSURANCE/QUALITY CONTROL

When adding a new site, use the permit requirements listed in Part 1.F.6.a.i and the additional criteria discussed above as a checklist to prioritize potential site locations/sample points. All new site locations/sample points must be reviewed and require an approval signature by the WWM Manager. Additionally, photographic documentation of each site must be submitted to complete the site selection process.

If a site location/sample point is unable to meet one of the requirements from Permit No. COS000005 Part1.F.6.a.i, consider removing or relocating the sample equipment.

1.5 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005," *codot.gov*, retrieved September 25, 2017, from *https://www.codot.gov/programs/environmental/water-quality/documents/cdot-ms4-permit*

Colorado Department of Transportation, 2013. *Wet Weather Monitoring Program CDOT MS4 Areas*, prepared by the Colorado Department of Transportation, Water Quality Division Environmental Programs Branch, Denver, CO.

2.0 DATA REQUIREMENTS

Purpose:
Provides documentation on data requirements for the sampling program, including a sampling procedure overview; field parameters required to be collected and equipment and/or other sources to be used; specific water chemistry parameters required to be sampled and the US Environmental Protection Agency's (EPA's) analytical methods to be used (including information in the sample container and preservation requirements, as well as holding time).

Date of Last Review:
November 29, 2017

Sampling Program:
Wet Weather Monitoring (WWM) Program

Sampling Task:
Colorado Department of Transportation (CDOT) Permanent Control Measure(s)

2.1 SAMPLING PROCEDURE OVERVIEW

A primary objective of the CDOT Permanent Control Measure(s) Sampling Program is to provide the data needed to assess the effectiveness of water quality control measures on storm runoff from CDOT's highway surfaces and facilities. CDOT's municipal separate storm sewer system (MS4) Permit No. COS000005 requires the loading of chemicals of concern to be determined at the outlet of each selected water quality control structure. To quantify the reductions in pollutant loading, both the concentration of the chemical of concern and flow rate of stormwater runoff from the inlet(s) and outlet of the control structure (mass loading) are necessary, and their collection is required by CDOT's WWM program. Information about antecedent conditions (number of dry days before a storm event) and rainfall intensity and duration also provide insight into the effectiveness of the control measures (CMs). CDOT's MS4 permit requires 72 dry hours between sample events, and the WWMP requires that precipitation data be collected.

Water samples are to be obtained using a Sigma 900 Max portable auto-sampler, ISCO 3700 portable auto-sampler, or by grab sample. Grab samples are required for oil and grease per 40 CFR Part 136 because oil and grease have a tendency to adhere to the surface that contains them. However, given the flashy nature of storm runoff from impervious surfaces, this process is not always feasible. Per CDOT communications with the EPA-certified laboratory, oil and grease measurements can be obtained from the composite sample as long as it has been properly preserved. All other parameters will be collected by an automated sampler. The auto-samplers are equipped with area velocity meters that measure storm runoff, and a tipping bucket rain gauge is secured to each sampler's housing to measure rainfall intensity and duration. These data are stored in the sampler's computer and are downloaded by CDOT staff when samples are retrieved after a storm event. More information on downloading flow and rainfall data from the auto-sampler's computer can be found in the **"Field Documentation and Supporting Documents" SOP**.

The auto-samplers are programed to begin drawing samples when storm-event flow threshold criteria are met. When a predetermined flow rate is sensed by the velocity meter, a high-speed peristaltic dual roller pump is triggered to discharge a discrete sample into 1 of 24 1-liter polyethylene bottles. Hydrologic time intervals for sampling are site-specific and determined by travel time estimates per basin response. The discrete samples are obtained by site-specific intervals until each of the 24 bottles are filled. To ensure a representative sample once the auto-sampler has been triggered and before pulling the first sample, the auto-sampler will run through one purge and flush cycle. More information on auto-sampler operation can be found in the **"Operational Guidelines for Conducting Field Monitoring Activities" SOP**.

CDOT does not maintain and operate an analytical laboratory. Instead, sample analysis is performed by a contracted laboratory who must be EPA-certified. Before an anticipated runoff sampling event, the contracted laboratory will be contacted to prepare them for sample delivery.

Immediately following the runoff event, CDOT staff will retrieve samples from the auto-samplers, CDOT staff will then composite the samples into laboratory-supplied bottles that are of appropriate material and contain the required preservatives for the preferred analysis. The samples will then be transported to the laboratory for analysis using EPA-approved methods. Laboratories will provide all of the necessary materials for transporting samples to the laboratory (e.g., bottles, labels, coolers, and Chain-of-Custody forms). More information on sample retrieval, grab sample collection, and sample compositing procedures can be found in the **"Sampling Procedures for Surface Water Point Source Collection" SOP.**

2.2 REQUIRED FIELD MEASUREMENTS

Once samples have been composited, as described in the **"Sampling Procedures for Surface Water Point Source Collection" SOP**, pH will be measured using either an approved meter or pH strips.

2.3 REQUIRED WATER CHEMISTRY PARAMETERS

As stated in CDOT's MS4 Permit No. COS000005, "Each sample for roadways with and without a control measure shall be analyzed, at a minimum, for all roadway pollutants of concern, conductivity, and hardness. Each sample from (maintenance) facilities shall be analyzed for chloride, sodium, magnesium, total suspended soils, oil and grease, and any other parameters that the permittee determines have a reasonable potential to be present and cause impacts to beneficial uses of receiving waters. This determination shall be based on a review of pollutant sources at the (maintenance) facility."

Parameters that are required by Permit No. COS000005 are compared to pollutants listed by CDOT's WWM Program Description Document (PDD) as illustrated in Table 2-1. In addition to the required parameters, CDOT has determined other parameters to have a reasonable potential to be present and affect beneficial uses of receiving waters. Inorganic nitrogen species were analyzed and reported separately to gain more information from the measurement required by Permit No. COS000005.

Water chemistry parameters to be sampled, as required by both CDOT's MS4 Permit No. COS000005 and WWMP, are summarized in Table 2-1.

Table 2-1. Comparison of Parameters Required by Permit No. COS000005 to the Colorado Department of Transportation's Wet Weather Monitoring Program Description Document

Parameter	Required by MS4 Permit	Required by CDOT's WWMP
Ammonia Nitrogen		X
Arsenic/Arsenic Dissolved		X
Cadmium/Cadmium Dissolved	X	X
Calcium Dissolved		X
Chloride	X	X
Chromium/Chromium Dissolved	X	X
Conductivity/Specific Conductance	X	X
Copper/Copper Dissolved	X	X
Hardness	X	X
Iron/Iron Dissolved	X	X
Lead Dissolved	X	X
Magnesium/Magnesium Dissolved	X	X
Manganese/Manganese Dissolved	X	X
Nickel/Nickel Dissolved	X	X
Nitrate-Nitrite		X
Oil and Grease (hexane)	X	X
pH		X
Phosphorus	X	X
Selenium/Selenium Dissolved	X	X
Sodium	X	X
Total Inorganic Nitrogen	X	X[(a)]
Total Kjeldahl Nitrogen (TKN)		X
Total Suspended Solids	X	X
Zinc/Zinc Dissolved	X	X

(a) Note that inorganic nitrogen is composed of nitrate (NO_3), nitrite (NO_2), and ammonia (NH_3). By analyzing for ammonia, nitrogen, and nitrate-nitrite, as recommended in the WWM PDD, CDOT is meeting the MS4 permit requirements to measure inorganic nitrogen.

2.3.1 Analytical Methods, Sample Container, and Preservation

The EPA-approved standard methods (SM) employed by ESC Laboratories, along with the method detection limits (MDL) and reporting units, sample container and preservation requirements, and sample hold times are shown in Table 2-2. The table is organized to show the overall test category (gray rows) and the associated container material and volume, required preservative, and maximum hold time. Listed under each category is the individual water quality parameter to be measured, the EPA-approved analytical method, reporting unit, MDL, and practical quantification limit (PQL). Note that the hold time refers to laboratory hold time (where the samples are stored at 4 degrees Celsius [°C]), and that all water samples should be transported to the lab within 48 hours of the sample event initiation.

Table 2-2. Water Chemistry Parameters; Analytical Method Information; and Container, Preservative, and Hold Time Requirements (Page 1 of 2)

Water Chemistry Parameter	Analytical Method	MDL	PQL	Unit	Container	Preservative	Hold Time
Total Recoverable Metals					**500 ml HDPE**	**HNO_3**	**6 months**
Arsenic	EPA 200.7	6.5	10	µg/l			
Cadmium	EPA 200.7	0.7	2.0	µg/l			
Chromium	EPA 200.7	1.4	10	µg/l			
Copper	EPA 200.7	5.3	10	µg/l			
Iron	EPA 200.7	14.1	100	µg/l			
Lead	EPA 200.7	1.9	5	µg/l			
Magnesium	EPA 200.7	11.1	1,000	µg/l			
Manganese	EPA 200.7	1.2	10	µg/l			
Nickel	EPA 200.7	4.9	10	µg/l			
Selenium	EPA 200.7	7.4	10	µg/l			
Zinc	EPA 200.7	5.9	50	µg/l			
Dissolved Metals					**500 ml HDPE**	**N/A**	**6 months**
Arsenic	EPA 200.7	6.5	10	µg/l			
Cadmium	EPA 200.7	0.70	2.0	µg/l			
Calcium	EPA 200.7	46.3	1,000	µg/l			
Chromium	EPA 200.7	1.4	10	µg/l			
Copper	EPA 200.7	5.3	10	µg/l			
Iron	EPA 200.7			µg/l			
Lead	EPA 200.7	1.9	5	µg/l			
Magnesium	EPA 200.7	11.1	1,000	µg/l			
Manganese	EPA 200.7	1.2	10	µg/l			
Nickel	EPA 200.7	4.9	10	µg/l			
Selenium	EPA 200.7	7.4	10	µg/l			
Sodium	EPA 200.7	98.8	1,000	µg/l			
Zinc	EPA 200.7	5.9	50	µg/l			

Table 2-2. Water Chemistry Parameters; Analytical Method Information; and Container, Preservative, and Hold Time Requirements (Page 1 of 2)

Water Chemistry Parameter	Analytical Method	MDL	PQL	Unit	Container	Preservative	Hold Time
Total Phosphorus					**250 ml HDPE**	**H_2SO_4**	**28 days**
Total Phosphorus	EPA 365.1/ SM4500PE	0.035	0.10	mg/l			
Ammonia, NO_2/NO_3, TKN					**500 ml HDPE**	**H_2SO_4**	**28 days**
Ammonia Nitrogen	EPA 350.1	0.0317	0.10	mg/l			
Nitrite-Nitrate (NO_2/NO_3)	EPA 353.2	0.0197	0.10	mg/l			
Total Kjeldahl Nitrogen (TKN)	EPA 351.2/ SM4500NH3C	0.0350	0.25	mg/l			
Chloride, SPCON					**250 ml HDPE**	**N/A**	**48 hours**
Chloride – Dissolved	EPA 300.0 (Ion Chromatography)	0.051	1.0	mg/l			
Specific Conductance (SPCON)	EPA 120.1/ SM 2510 B	10	10	µmhos/cm			
Hardness	SM2340B	0.50	1.0				
TSS					**1,000 ml HDPE**	**N/A**	**48 hours**
Total Suspended Solids	SM 2540 D	0.35	2.5	mg/l			
OGHEX					**1,000 ml Glass**	**HCl**	**28 days**
Oil and Grease	EPA 1664 A	1.16	5.0	mg/l			
pH	Measure in field with pH strip/approved meter	**N/A**	**N/A**		**N/A**	**N/A**	**N/A**

2.4 REQUIRED FLOW MEASUREMENTS

To determine pollutant loading, each water chemistry sample must be accompanied by a flow measurement. This process is achieved by using the flow measurement equipment that is used to trigger the auto-samplers. Methods to measure flow differ based on site-specific conditions and the type of equipment employed. For the Permanent Control Measure(s) Sampling Program where flow is flashy by nature and volumes are relatively small (in comparison to streamflow), CDOT measures flow either using an area/velocity sensor or the combination of a level logger and a Modified Parshall Flume.

2.4.1 Area Velocity Sensor

A Hach AV9000 area velocity sensor is used to trigger the Sigma 900 Max portable auto-sampler, and flow measurements are recorded concurrently with sample collection. The sensor is secured within the channel or structure and uses a 1-megahertz (MHz) Acoustic Doppler flow sensor to detect the wetted perimeter (area) and the velocity of the flowing water. This method uses two ultrasonic transducers: a transmitter and a receiver. The 1-MHz signal is transmitted and reflected off of particles in the flow stream. The reflected signal is received and its frequency is offset by the Doppler shift proportional to the velocity of the particles in the flow stream. The flow logger converts the Doppler shift in the returned ultrasound signals to a velocity measurement. Flow is then determined as: flow rate = wetted area × average velocity. The flow data (wetted area, velocity, and flow rate) are stored within the auto-sampler's computer and should be retrieved when samples are collected.

2.4.2 Level Logger/Modified Parshall Flume Combination

The Hack AV900 can also be used as a level logger by using a pressure transducer in the sensor and converting the pressure of the water to a level measurement. Because the level logger determines water level based on the pressure of the water above, it must be secured to the bottom of the channel or structure. The level measurement provides the stage reading necessary to determine flow using a Cutthroat flume.

Flumes are structures that force water through a narrow channel. These structures consist of a converging section, a throat, and a diverging section. The flow rate through a flume is calculated from the depth of flow measured in the converging section of the flume, and equations that take into account the flume's specific dimensions. The Permanent Control Measure(s) Sampling Program uses a Cutthroat flume.

Because the rating curve is specific to a flume's dimensions, the flume must be cleared of debris. The flume's dimensions can be entered into the auto-sampler's computer, which will automatically calculate the flow rate. As with the area velocity sensor, the flow data (level, channel dimensions, and flow rate) is stored within the auto-sampler's computer and should be retrieved when samples are collected, as described in the **"Operational Guidelines for Conducting Field Monitoring Activities" SOP**.

2.5 QUALITY ASSURANCE/QUALITY CONTROL

Quality assurance (QA) of the sample starts when the sample is initially collected and requires some basic handling procedures, as described below:

1. Automated equipment should be properly cleaned and a new intake hose used if appropriate.
2. The sample container must be appropriate to the sampled parameter. Use special cleaning procedures if necessary.
3. A regular schedule for calibrating field instrumentation must be followed, as described previously. The calibration process is necessary to ensure that the instrument(s) is working properly and within the range of acceptability as determined by the manufacturer's specifications. All instrumentation used in field activities must be calibrated before field use and periodically thereafter, according to the manufacturer's instructions. Where required, field instrumentation must be calibrated before each sampling event. All calibrations must be recorded in a logbook.
4. Continuous sampling devices must be calibrated according to manufacturer specifications and checked as often as necessary. Sample lines for continuous devices must be clean or new before each installation. All maintenance and calibration will be recorded in a logbook.
5. In those instances where field equipment cannot be calibrated, the personnel will attempt a field repair of the affected equipment. The field coordinator is responsible for providing information on ordering new parts if equipment is in need of repair.

One set of QA/quality control (QC) samples will be collected for a minimum of 10 percent of samples collected per year. One set of QA/QC samples consists of a field replicate and blank.

2.5.1 Field Replicates

Field replicate samples are independent samples collected in such a manner that they are equally representative of the parameter(s) of interest at a given point in space and time. In short, a second sample is collected in the same way with the same equipment as close in time and space to the previous sample as practicable.

Field replicate samples should be collected from each location. The permit requires three events per year at six outfalls. Based on the CDOT sampling regime, two locations are monitored with three outfalls per location. With the requirement to sample three events per year, each location would yield nine samples per year. Ten percent of this sampling would yield 0.9 or 1 duplicate sample at each location for a total of two duplicates each year.

2.5.2 Field Blanks

Field blanks are defined as samples that are obtained by running analyte-free, deionized water through sample collection equipment (pump, filter, or churn-splitter) after decontamination and placing the water in the appropriate sample containers for analysis. These samples will be used to determine if decontamination procedures have been sufficient.

At least two equipment blanks per sample location should be collected and analyzed per year. This method would entail pulling deionized water through the tubing and into the automated sampler bottles, then composting the sample in the same manner as storm-event composite sampling. This process should be done once at the beginning and once midway through the sampling season.

2.6 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005," *codot.gov*, retrieved September 25, 2017, from *https://www.codot.gov/programs/environmental/water-quality/documents/cdot-ms4-permit*

Colorado Department of Transportation, 2013. *Wet Weather Monitoring Program CDOT MS4 Areas*, prepared by the Colorado Department of Transportation, Water Quality Division Environmental Programs Branch, Denver, CO.

3.0 EQUIPMENT LISTS, CLEANING, CONFIGURATION, AND CALIBRATIONS

Purpose:
The purpose of this document is to provide documentation of all of the equipment necessary to monitor and assess the Colorado Department of Transportation's (CDOT's) water quality control measures from stormwater runoff. Equipment will require routine cleaning procedures and calibration before each sampling event to validate equipment accuracy and avoid contamination.

Date of Last Review:
November 29, 2017

Sampling Program:
Wet Weather Monitoring (WWM) Program

Sampling Task:
CDOT Permanent Control Measure(s)

Supplemental Material:
This Standard Operating Procedure (SOP) should be accompanied by manuals, including but not limited to the following:

- ISCO 3700 Manual
- Sigma 900 Max Manual
- 1640 Liquid Level Actuator Manual
- Submerged Area/Velocity Sensor and AV9000 Manual
- SteamScrubber & FlaskScrubber Glassware Washers User's Manual
- Hach Flow Rain Gauge, Product Number 2149, Manual

3.1 INTRODUCTION

The CDOT is required under MS4 Stormwater Permit No. COS000005, Part 1.F.6 to assess the wet weather impacts from highways and facilities and the performance of permanent water quality control measures (CMs) used to control discharges. To meet the permit's requirements, sample locations at the inlet and outfall of CMs are selected to collect samples from three rainfall and snowmelt events annually. Stormwater runoff volume and pollutant concentrations from composited samples are applied to mass load calculations for the inlet and outfall structures to determine the control measure efficiency.

This SOP provides a list of all of the monitoring and sampling equipment necessary to monitor, collect, and composite samples to calculate pollutant loads. Equipment will require frequent cleaning and calibration practices to maintain accurate monitoring results and avoid sample contamination. This SOP will provide step-by-step procedures for completing the necessary equipment maintenance.

3.2 FIELD EQUIPMENT

The following list includes all of the specific equipment for sampling wet weather events:

- Sigma 900 Max sampler
  - 24-1000 mL bottle set
- ISCO sampler
  - 24-500 mL bottle set
- Submerged area/velocity Sensor
- Submerged pressure transducer
- Rain gauge
- Cutthroat flume
- ISCO 581 Rapid Transfer Device (RTD)
- Sigma 900 DTU-II and RS232 Cable
- Security enclosure

Note, the following equipment items generally need to be routinely replaced or may result in instrumentation malfunction:

- 12 V battery
- Connection cables
- Spare tubing
- Desiccant

Supplemental items must be carried in the vehicle when a measurable runoff event occurs:

- Field Laptop:
  - Teledyne ISCO Flowlink software
  - Hach InSight data-management software
  - Cables for ISCO RTD and Sigma 900
- Enclosure Keys
- Sample collection material
  - Sample bottle set (from respective labs)
  - Sample preservatives
  - pH strips or pH meter
  - Shipping coolers
  - Ice/ice packs if required as per lab
  - Extra disposable sample bags
  - Clean bucket (to perform composite sampling) –

    - Deionized water (-6 gallons)
    - Clean 1L polyurethane bottle
    - Two replacement bottle sets (one for Sigma and one for ISCO)
    - Disposable powder-free nitrile or latex gloves
- Papers and Documents
    - This SOP
    - Log book with waterproof pen
    - Chain-of-Custody forms
    - Field data forms
    - Storm Sampling Checklist and Record Forms
        - Auto-Sampler Station Field Inspection Record (FIR)
    - Sample bottle labels
- Safety
    - Rain gear
    - Steel-toed boats
    - First aid kit
    - Fire extinguisher
    - Hardhat
    - Headlamp
    - Waders if necessary
    - Reflective vests
    - Eye protection

3.3 EQUIPMENT CLEANING AND DECONTAMINATION

3.3.1 Sample Bottles and Containers

The US Environmental Protection Agency (EPA) requires all Sigma and ISCO bottle sets to be cleaned and prepared for field sampling according to 40 CFR Part 136 procedures. Monitoring staff are required to follow EPA procedures for all plastic containers. The CDOT WWM program uses an Auto-Clave Glassware Washer to clean and decontaminate all sample bottles. The following are basic instructions to program and start a wash cycle. For more detailed guidelines and modifications, refer to the Glassware Washer's User Manual.

1. Load the Sample Bottles, load the soap dispenser with approved soap, close the washer door, and slide the latch to the right to energize the electronic control.
2. A display will show the last program that was run. Press RUN to select this program.
3. To change the program, press DISPLAY.

4. Use the UP and DOWN arrows to select the PLASTIC program. Press RUN if no modifications to the program are necessary.
5. To modify the program, press DISPLAY to see the parameters entered.
6. Use the UP and DOWN arrows to choose parameters that need to be altered.
7. Use the LEFT and RIGHT arrows to select the appropriate settings.
8. Press RUN when the parameters are satisfactory.

Once all of the containers are decontaminated, they can be placed in the sampler housing or capped and placed in plastic trash bag for storage. These procedures should also be applied to the containers that are used for compiling composite samples. Larger containers must be sealed with foil to keep the sampling devices clean. Monitoring staff are required to document in their field logbook the date and time that the bottles and containers were decontaminated as well as when a bottle set is placed in the field. Bottle sets should be labeled as "clean" after decontamination.

3.3.2 Rain Gauge

A tipping bucket rain gauge is required for each control measure location to track rainfall intensity, storm total, and duration. The gauge installation must be level and kept clean from debris. Monitoring staff should clean the rain gauge weekly or every time data are collected to ensure that an entire event is measured as accurately as possible. When cleaning the rain gauge, be sure to closely examine and clean the following areas:

- Make sure that the tipping bucket can still tip on its axis and is free from debris.
- Be sure that the funnel is not clogged, and thoroughly clean the screen.
- Verify that all connections from the rain gauge to the sampler have no signs of damage or interference that may cause inaccurate readings.

3.3.3 Flume Maintenance

Regular cleaning and maintenance is recommended to ensure that flumes and channels are clear for accurate measurements. Water must enter the flume with minimal turbulence and uniform velocity across the width of the channel. The downstream channel must also be kept clear to avoid backwater submergence from affecting the flow measurement.

Stormwater typically carries sediment and debris. When water accelerates through a flume, deposition of sediment and debris that clogs the flume is possible and must be cleared. Flumes should be checked weekly and cleared before every storm event to ensure that they are clean and have no signs of damage that could affect the flow measurements.

3.4 EQUIPMENT CALIBRATION

3.4.1 Automated Sampler

Automated samplers will need to be calibrated annually to verify that the equipment is pumping an accurate amount of volume per sample. Calibration will require a graduated cylinder and a bucket of

water. Program the sampler to take a grab sample volume (i.e., 500 milliliters [mL]). If the volume collected is within 15 mL of the target volume, no calibration is necessary. Otherwise, a manual calibration will need to be completed to complete volume calibrations. Manual calibrations follow this basic procedure:

- Select Manual Calibration from Options – Volume Calibration.
- Select START PUMPING. Allow the sampler to pump into a graduated cylinder.
- Select DONE to stop pumping.
- Enter the volume measured from the graduated cylinder.
- Record the target volume and the actual volume.
- Select ACCEPT.

Recheck the sampler grab sample volume to verify that the calibrations were successful. If the sampler is having difficulty calibrating, field personnel who are performing the calibration will need to document the reoccurring issue and whether or not the calibration was successful. Refer to the manufacturer's directions for detailed instructions on sampler calibration procedures.

3.4.2 Submerged Area Velocity Sensor

A Submerged Area/Velocity (AV) Sensor can measure water level and velocity simultaneously and are recommended to be placed in a pipe or culvert. The Sigma and ISCO Samplers have programmable functions to use AV records to calculate flow; however, readings of level and velocity can also be recorded manually to calculate flow based on the channel beds' or structures' cross-sectional area. Calibrating the AV sensor will require a bucket that is filled with at least 6 inches of water. The manufacturer recommends calibrating the AV sensor under the following conditions:

- When the sensor is first used
- When installing a new or different sensor on a flow meter
- When the difference between the level reading of the flow meter and an independent verification (i.e., staff gauge or ruler) is increasing.

To calibrate, using the Sigma sampler:

- Select OPTION > ADVANCED OPTIONS > CALIBRATION > SUBMERGED PROBE.
- Set the sensor on a flat surface with the sensor facing down.
- Press any key to continue.
- Place the sensor face up in the bucket.
  - Lightly tap to remove any air bubbles.

    NOTE: If air bubbles are not removed, the sensor may record false readings during calibration.
- Submerge the sensor under at least 6 inches of water and wait 20 seconds. Make sure that the water surface is calm and the sensor is stable.
- Press any key to continue.

- Measure the depth of water from the bottom of the bucket to the surface and enter the value.
- Press ACCEPT.

Manual adjustments to calibrate the sensor's level recording should be checked weekly. The sensors are often placed in a dry control measure structure or channel bed and only have measurable flow during an event. Sensors may record false readings under dry conditions and will need to be routinely checked and calibrated.

- From the Main Menu, select **OPTION MENU > Level Adjust.**
- Enter the actual level (0.000" for dry channel beds) into **Enter New Level.**

3.4.3 Submerged Pressure Sensor

A submerged pressure sensor includes a pressure transducer that measures depth in an open channel. This sensor is ideally placed in a control structure, such as a flume. The flow rate in a flume is calculated from the depth of water measured in the converging section of the flume by using equations that are specific to the flume's dimensions. The pressure transducer must be routinely calibrated to verify that the depth recorded is accurate and that the flow calculated is based on dependable variables.
Initial calibration instructions are listed below:

- From the Main Menu of a Sigma sampler, select OPTIONS > ADVANCED OPTIONS > CALIBRATION > SUMERGED PROBE.
- Choose a horizontal orientation for the direction the sensors will be mounted in the stream or structure.
- Press ACCEPT.
- Place the sensor in a bucket, under at least six inches of water. Make sure that the sensor is stable and not moving.
- Press ACCEPT.
- Measure the depth from the bottom of the bucket to the surface and enter the value by using the numeric keypad.
- Press ACCEPT.

The pressure transducer can also be manually adjusted by using the Sigma sampler **Level Adjust** function.

3.5 INSPECTION DOCUMENTATION

Field personnel must document all maintenance procedures in their log field book and the Auto-Sampler Station FIR. When calibrating instruments, monitoring staff must record the reading before calibration in addition to the calibrated value. The records should include the following:

- Time and date of calibration
- Value pre- and post-calibration
- Calibration standard value
- Name, initials, and signature of staff who performed the calibration.

3.6 QUALTY ASSURANCE/QUALITY CONTROL

The WWM Manager should verify that the calibrations are completed routinely and correctly. Once the calibrations and maintenance tasks have been thoroughly reviewed and checked for quality control, data from the resulting sampling event can be loaded into the project final database: Ambient Water Quality Monitoring System (AWQMS). Periodic inspection audits should be conducted at least annually by the Water Quality Section Manager to ensure compliance to these SOP elements.

3.7 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005," *codot.gov*, retrieved September 25, 2017, from *https://www.codot.gov/programs/environmental/water-quality/documents/cdot-ms4-permit*

US Environmental Protection Agency, 1992. *NPDES Storm Water Sampling Guidance Document*, EPA 833-B-92-001, prepared by the US Environmental Protection Agency, Office of Water, Washington, DC.

4.0 SAMPLING PROCEDURES FOR SURFACE-WATER POINT SOURCE COLLECTION

Purpose:
The purpose of this document is to provide a documentation of sampling procedures to assess the performance of control measures (CMs) from wet weather impacts for highways and facilities, including sample types and calculations that are necessary to assess control measure efficiencies.

Date of Last Review:
November 29, 2017

Sampling Program:
Wet Weather Monitoring (WWM) Program

Sampling Task:
Colorado Department of Transportation (CDOT) Permanent Control Measure(s)

4.1 INTRODUCTION

CDOT is authorized under Permit No. COS000005 to perform WWM to assess the performance of permanent water quality CMs used to control discharge from wet weather impacts. The permit requires CDOT to monitor outfalls from highways and facilities to assess their response to measurable storm events from rain and snowmelt. Control measure performance is determined by composite sampling collected during a measurable storm event at the control measure's inlet and outfall.

This Standard Operating Procedure (SOP) discusses the type of sampling required under Permit No. COS000005 and additional processes necessary to calculate control measure efficiencies. This document includes a step-by-step procedure on how to perform grab and composite samples, as well as the methodology for calculating pollutant loads from event mean concentrations, and the overall pollutant load reduction from a control measure.

4.2 GRAB SAMPLING

CDOT Stormwater Permit No. COS000005 requires all sampling to be performed in accordance with the specific methods in 40 C.F.R. Part 136 and requires all storm samples to be collect as composite samples, with the exception of certain pollutants, including oil and grease. The US Environmental Protection Agency's (EPA's) Stormwater Sampling Guidance reiterates that grab sampling is required for specific parameters (including pH, temperature, and oil and grease) because they have a tendency to transform into different substances or change in concentration after a short period of time. Oil and grease, in particular, tend to adhere to the surface that contains them. Therefore, samples should not be transferred from one container to another. Oil and grease must be collected in a glass container and stored at 39 degrees Fahrenheit (˚F) (or 4 degrees Celsius [˚C]). However, given the flashy nature of storm runoff from impervious surfaces, this method is not always feasible. Per CDOT communications with the EPA-certified laboratory, oil and grease measurements can be obtained from the composite sample as long as the sample has been properly preserved.

A grab sample is a discrete, individual sample taken in a short period of time and preferably collected during the first 30 minutes of discharge to capture the first-flush period (or as soon thereafter as practicable). The sample represents the quality of storm water discharge at a given time of the discharge. Oil and grease samples must be collected as a grab sample by using the glass container provided by the laboratory. When feasible, the following procedure shall be used to collect oil and grease grab samples:

- Label the bottles appropriately (project, site ID, sample date, and time collected)
- Wear powder-free latex gloves when collecting grab samples
- Do not rinse oil and grease bottles that contain a preservative (sulfuric acid or hydrochloric acid) with sampling site water
- Position the open end of the bottle toward the current flow and away from the hand of the collector
- Grasp the bottle securely at the base with one hand and plunge the bottle down into the water to avoid introducing surface scum
- If possible, sample at a depth of two-thirds below the water surface
- Tip the bottle slightly upward to allow air to escape and the bottle to fill
- Add the preservative as instructed by the laboratory
- Fill the sample bottle completely, then cap.
- DO NOT re-immerse the original bottle to add more sample volume
- Place the sample container on ice in a cooler to store at 39°F (4°C)
- Record the sample collection as per the Chain-of-Custody form

4.3 COMPOSITE SAMPLING

All roadway features and facilities, with or without CMs, are required to collect a composite sample of all pollutants of concern during both rain and snow events (with the exception of oil and grease). 40 C.F.R Part 122.26 requires all MS4 stormwater discharge samples to estimate the pollutant load and the event mean concentration from the cumulative discharge for three representative storms. Composite samples can be either flow-proportioned or time-proportioned. A flow-proportioned sample is the EPA-recommended standard to composite because each portion of the hydrograph is sampled proportionally to flow volume, which results in a more representative sample of the entire discharge volume than a grab sample or time-proportioned composite sample. Flow-weighted composite sampling will allow for the determination of event mean concentrations and pollutant mass load calculations; this method is preferred. When loading from the first flush needs to be understood, sampling will be composited from the first portion of the storm event.

Multiple methods can be used to collect a flow-weighted composite sample by varying either the time interval between aliquots or the volume collected. The standard flow-proportioned composite varies the time interval between aliquots, while the volume of the aliquots collected are equal. The intervals between collected aliquots depend on the flow volume that passes through the monitoring station. This automated

method requires the following information to determine the correct sequence of sampler programming settings:

- A detailed hydrologic study of the drainage area to each site (determine the expected runoff volume and hydrologic response time for various storm events [intensities and duration])
- Minimum required composite sample volume to fill analytical sample bottles
- Determine the time that corresponds to the set volume of flow. Time will vary proportionally to measured flow; aliquots are sampled more frequently during high flow and less frequently during periods of lower flow.

An additional method calculates the flow-weighted composite manually, while the sampler collects aliquot in a time-proportioned manner. Equal volume aliquots are collected at equal intervals. The time between samples will be site-specific and likely require shorter intervals for sampling CDOT's urban runoff at facility outfalls to capture the first flush and enough storm water volume to fill sample bottles. Aliquots are flow-weighted by using data collected from an automated flow meter and measured proportionally to their corresponding volume of flow during the sample collection period. This method is limited by the total composite volume, which may not be sufficient to fill analytical sample bottles.

Regardless of the flow-weight composite sampling method, monitoring staff must be familiar with the drainage area to each sample site, as well as the amount of impervious area that drains to the outfall. These characteristics will greatly influence the hydrologic response time and amount of discharge that is likely during an event. Sample intervals are also limited by the sampler's duration of the sample cycle. Intervals must be longer than the duration of sample cycle; otherwise, some sample events will occur at improper times. Sample times will be used to create flow-weighted composites; therefore, correct timing of sample collection is essential when identifying representative flow.

4.3.1 Manual Flow-Weighted Sample Compositing Procedure

The following is a step-by-step procedure for manual flow-weighted compositing after samples have been collected:

- Collect all ISCO or Sigma 900 Max sample bottles
- Transfer data from ISCO or Sigma 900 Max Samplers (manually or by direct downloads):
  - Sample bottle number and collection date/times
  - Stage, velocity, and/or flow data
  - Rainfall total
- Export data as a comma-delimited file or text file so it can easily be imported into Excel
- In Excel, plot the flow data to identify timing of the storm hydrograph
  - Select data within this period (include a few time periods before and after the hydrograph, if available)
  - Make sure that the samples collected were collected during this hydrograph
  - Copy these data into a new tab

- If flow data are not provided by the sampler, convert the stage data to flow (i.e., apply a rating curve, area * velocity, or Parshall Flume equation)
- Use the time from each collected aliquot and interpolate its corresponding flow value. Use a linear trend if the aliquot was collected between flow recordings.
- Take the average flow from the current aliquot and previous sample, then multiply by the sample interval to get an incremental volume (cubic feet)
- Calculate the incremental volume for each aliquot and its percentage of total volume
- Multiply the percentage by the total volume needed to fill laboratory bottles
  - This total represents the Bottle Volume that will be measured from the aliquot and added to the composite bucket
  - Make sure that the volume percentage never exceeds what is actually in the aliquot (i.e., 950 mL for the Sigma sampler, and 450 mL for the ISCO sampler)
- Combine all of the Bottle Volumes in a decontaminated bucket for composite mixing:
  - Read the volume necessary from the composite calculation
  - Shake the aliquot to mix homogenously, uncap, and immediately pour the required amount into the decontaminated bucket
  - Combine all of the appropriate sample volumes together in a decontaminated bucket and mix thoroughly
- Fill the sample collection bottles that were provided by the laboratory
- Add the preservative as instructed by the laboratory
- Cap and label the sample bottles and fill out the Chain-of-Custody form

  NOTE: For composite samples, the EPA Stormwater Guidance recommends using the sequence of date and times of samples collected by the sampler to be recorded on laboratory bottles and Chain-of-Custody
- Place the sample bottles on ice to store at 39°F (4°C) if required by laboratory in a cooler for delivery to the laboratory

4.3.2 First-Flush Sample Compositing Procedure

In situations where flow-weighted composting is not feasible, a first-flush composite method can be implemented to collect samples. This procedure is detailed below:

- Collect all of the ISCO or Sigma 900 Max sample bottles
- Transfer data from the ISCO or Sigma 900 Max Samplers (manually or by direct downloads):
  - Sample bottle number and collection date/times
  - Stage, velocity, and/or flow data
  - Rainfall total

- Combine approximately 8000m/l of stormwater (9 bottles from Sigma or 18 bottles from ISCO) into decontaminated bucket (churn-splitter) for composite mixing
- Fill the sample collection bottles that were provided by the laboratory
- Cap and label the sample bottles and fill out the Chain-of-Custody form
  - **NOTE**: For composite samples, the EPA Stormwater Guidance recommends using the sequence of date and times of samples collected by the sampler to be recorded on laboratory bottles and Chain-of-Custody form
- Place the sample bottles on ice (4°C) if parameters require in a cooler for delivery to the laboratory

4.4 MASS LOADING CALCULATIONS

The WWM program is required to assess the performance of CMs that are used to control discharges. Composite samples must be collected at the inlet and outlet of CMs to calculate a mass loading balance to evaluate the efficiency of the monitored CMs. To calculate mass loading for each parameter, the following equation can be applied to each pollutant event mean concentration (results received from the laboratory):

Pollutant Mass Loading = Pollutant Event Mean Concentration × Storm Volume

Table 4-1 provides a list of unit conversions that are applicable to mass loading calculations. The efficiency of a control measure can be evaluated by taking the difference between the inlet and outlet pollutant loads:

Load Reduction = Inlet Pollutant Load – Outlet Pollutant Load

Table 4-1. Pollutant Load Unit Conversion Table

Water Chemistry Parameter	Concentration	Mass Conversion	Storm Volume	Volume Conversion	Pollutant Load
Total Recoverable Metals Dissolved Metals	µg/l	2.20 x 10^–9 {lbs/µg}	{ft^3}	28.32 {L/ft^3}	{lbs}
Ammonia Nitrogen Nitrite-Nitrate (NO_2/NO_3) Total Kjeldahl Nitrogen (TKN) Chloride – Dissolved Total Suspended Solids Oil and Grease	mg/l	2.20 x 10^–6 {lbs/mg}	{ft^3}	28.32 {L/ft^3}	{lbs}
For example: Total Suspended Solids Load: 100 mg/l **×** 2.20 × 10^–6 {lbs/mg} **×** 1,000 {ft^3} **×** 28.32 {L/ft^3} = **6.24 lbs**					

Note: highlighted columns will include data that were entered by field personnel.

4.5 DOCUMENTATION AND FILING

Documentation of all samples is required by monitoring staff after every storm event. Field personnel will need to retrieve data from the sampler, collecting aliquot numbers, date, and times collected. Staff must also keep records of how composite samples were compiled. The monitoring program should use a flow-

weighted composite template to ensure that calculations are consistent and correct for every site and event. All data must be saved and stored for record keeping.

Pollutant concentrations that are received from the laboratory will be recorded into the database and used for pollutant load calculations. Load calculations, concentrations, and control measure efficiency results should be entered into the database for reference while writing an event summary and annual report.

4.6 QUALITY ASSURANCE/QUALITY CONTROL

The Water Quality Manager must review and check load calculations for quality control after a storm event. The manager must verify that the control measure efficiencies are documented and summarized in an event summary report, including a summary of the processes and procedures used to conduct monitoring and analyses. Annual reports are required by CDOT Stormwater Permit No. COS000005, which will include a discussion on the resultant pollutant concentrations, loads calculated by flow-weighted composites, and load reduction for monitored CMs.

Field duplicates must be collected for 10 percent of the composited samples. Six site locations require sample collection from three storm events each year, per CDOT Stormwater Permit No. COS000005. A minimum of 18 storms will need to be sampled per year, which would yield two duplicate samples each year. Duplicates will need to be collected from the same composite bucket used to fill the first set of analytical sample bottles.

4.7 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005" *codot.gov*, retrieved September 25, 2017, from *https://www.codot.gov/programs/environmental/water-quality/documents/cdot-ms4-permit*

US Environmental Protection Agency, 1992. *NPDES Storm Water Sampling Guidance Document*, EPA 833-B-92-001, prepared by the US Environmental Protection Agency, Office of Water, Washington, DC.

5.0 OPERATIONAL GUIDELINES FOR CONDUCTING FIELD MONITORING ACTIVITIES

Purpose:
The purpose of this document is to provide documentation of all equipment configuration guidelines to monitor and assess the Colorado Department of Transportation's (CDOT's) Permanent Water Quality (PWQ) control measures (CMs) from stormwater runoff. Specific operational guidelines are necessary for conducting field monitoring activities. Equipment and instrumentation will require detailed programming to capture each sampling event.

Date of Last Review:
November 29, 2017

Sampling Program:
Wet Weather Monitoring (WWM) Program

Sampling Task:
CDOT Permanent Control Measure(s)

Supplemental Documentation:
This Standard Operating Procedure (SOP) should be accompanied by manuals, including but not limited to the following:

- ISCO 3700 Manual
- Sigma 900 Max Manual
- 1640 Liquid Level Actuator Manual
- Submerged Area/Velocity Sensor and AV9000 Manual
- Hach Flow Rain Gauge, Product Number 2149

5.1 INTRODUCTION

The CDOT is required under the MS4 Stormwater Permit No. COS000005 to monitor and assess the wet weather impacts from highways and facilities. CDOT is responsible for monitoring the performance of permanent water quality CMs from three wet weather events, annually. A measurable storm event is defined in the Permit, Part 1.F.6.a. as a rain event that results in actual discharge from the facility and follows the preceding measurable storm event by 72 hours or a snowmelt event where a measurable discharge occurs from the facility and results from melting snow. Measurable storm events from a facility will result in a quick flush of discharge, which will require more frequent samples collected in a short period of time to capture the event. Measurable discharge that leaves the outlet of a control measure is likely to have a slower response and can follow the US Environmental Protection Agency's (EPA's) stormwater guidance recommendations of a minimum of 15-minute intervals between samples collected for the first 3 hours or the entire duration of the storm, whichever is less.

Monitoring staff need to have a full understanding of the drainage area to each sample location and the hydrologic response for various storm intensities and durations. For each sample site, EPA guidance suggests providing an estimate of the drainage area that is covered by impervious areas. Impervious surfaces are surfaces such as building roofs, parking lots, and roadways where storm water runs off at significantly higher rates than undeveloped areas.

This SOP discusses the different methods necessary to program equipment specific to site location and methodology for capturing various storm events. These methods include programming instructions for two different samplers: a Sigma 900 Max and an ISCO 3700. Additionally, this SOP includes recommendations for local weather forecasting to prevent monitoring staff from missing any of the required measurable events per site location.

5.2 EQUIPMENT CALIBRATION

When calibrating instruments and equipment, use the time displayed on your cellphone to ensure that all instrumentation are set to the same time.

5.2.1 ISCO 3700 Sampler

ISCO samplers will be programmed and configured before field installation. Some changes can be adjusted in the field to tailor settings to specific sites, including the following:

- Suction Line length and head
- Liquid Detector
- Sample start time delay
- Sample interval
- Purge counts
- Run Diagnostics.

Basic programming instructions for an ISCO 3700 for composite sampling are as follows:

1. Turn on the Sampler with the **ON/OFF** key.
2. Press **ENTER/Program** and arrow over to **CONFIGURE.**
3. Arrow over to the **SELECT OPTION** to access **Set Clock.** The clock must be set in military time.
4. From **SELECT OPTION,** select **Bottles and Sizes.**
    a. Select **Portable** Sampler.
    b. Set the number of bottles to **24.**
    c. Set the bottle volume as **500 ml.**
5. Enter type and length of suction line.
    a. $^{3}/_{8}$ inch or ¼ inch
    b. Vinyl or Teflon
    c. Enter the length in nearest foot

TIP: Enter a length 1–2 feet greater than the actual length

Note: Intake tube length affects sample volume accuracy; cut the tubing to the nearest whole foot. Avoid excessively long tubing runs. Doubling the intake tubing length can quadruple the pump tubing wear if intake rinses or sample retries are enabled. Always locate the sampler close to the sample liquid source to minimize tubing, pump, motor, and gearbox maintenance.

6. ENABLE the LIQUID DETECTOR.
   a. Select **1** rinse.
   b. Select **NO** for **Enter Head Manually.**
   c. Enter **3** for **Number of Retries.**
7. From SELECT OPTION, select Start Time Delay.
   a. Enter the amount of time in minutes between the time that the sampler is enabled and the time that the sampling routine is initiated.
   b. Typically, use the same interval as sampling interval (e.g., 15 minutes for PWQ Outfall).
8. From SELECT OPTION, select Enable Pin.
   a. Select the 1640 Liquid Level Actuator and SAMPLE UPON ENABLE.
   b. Select YES for Reset Sample Interval, which allows a full sample interval to begin when pin F is enabled (by the Level Actuator).
9. Press Enter/Program key and select PROGRAM.
10. Enter the Sample Pace as **Time.**
    a. Enter the sampling interval.

       Note: Sample interval will depend on the hydrologic response time that is specific to each site. Facility outfall site locations will need to have a shorter time interval to capture the first flush and entire storm event. However, sample intervals must be longer than the duration of the sampling cycle. If the intervals are too short, all of the samples will be collected but will occur at improper times. Control measure outfall locations will need to follow the EPA's recommended 15-minute interval for the first 3 hours or the entire duration of the storm event.
11. Select **NO** to Multiplex Samples.
    a. **No** will automatically use **Simple Sequential Sampling** (one sample per bottle).
12. Enter sample volume of: **450 ml.**
13. Select **NO** for Start Time.
14. The sampler returns to Standby. Press the **START SAMPLING** key to run the program.

5.2.2 Sigma 900 Max Sampler

The following steps outline the Sigma 900 Max Sampler programming procedure and are general guidelines for programming the Sigma sampler; for more information and detailed instructions, use the Sigma 900 Max Manual provided by Hach.

Navigating through a Sigma 900 sampler: Press the **ON** key to display the **Main Menu** (Figure 5-1):

1. **Setup**: Basic and Advanced Sampling programming
2. **Status**: Lists all of the current sampling status, power supply voltage, and values of any data channels that are enabled
3. **Display Data**: Shows graphs and tables of logged data
4. **Options**: Optional Device Programming.

Figure 5-1. Sigma 900 max Sample Main Menu.

The following are basic programming instructions to set up a Sigma sampler for composite sampling:

1. Select SETUP > MODIFY ALL ITEMS.
2. Press ACCEPT to begin setting up the bottles.
3. Enter the number of sample bottles (24 bottles).
4. Enter the bottle volume.
5. Enter intake tube length (intake tubing attached to the sampler). Units can be adjusted using the CHANGE UNITS key.

   TIP: Enter a length that is 1–2 feet greater than the actual length.

   Note: Intake tube length affects sample volume accuracy; cut the tubing to the nearest whole foot. Avoid excessively long tubing runs. Doubling the intake tubing length can quadruple the pump tubing wear if intake rinses or sample retries are enabled. Always locate the sampler close to the sample liquid source to minimize tubing, pump, motor, and gearbox maintenance
6. Select the type of intake tube ($^3/_8$ in. Teflon, $^3/_8$ in. Vinyl, ¼ in. Vinyl).
7. **DISABLE** Program Delay under **CHANGE CHOICE** key.
8. Select the type of sampling collection: **Time proportional.**
   a. Press **CHANGE CHOICE** key until **Time Proportional** is displayed, then press **ACCEPT.**
   b. Enter the **Interval Between Samples.**

      Note: Sample interval will depend on the hydrologic time response that is specific to each site. Facility outfall site locations will need to have a shorter time interval to capture the first flush and entire storm event. However, sample intervals must be longer than the duration of the sampling cycle. If the intervals are too short, all of the samples will be collected but will occur at improper times. Control Measure outfall locations will need to follow the EPA's

recommended 15-minute interval for the first 3 hours or the entire duration of the storm event.

c. Select **After The First Interval.**

Note: A delay for the first sample is necessary for flow-weighted compositing to calculate the amount of volume to composite from the first sample bottle.

9. Sample Distribution
   a. Select Single Bottle and Stop After Last Bottle.
   b. Select NO for **Deliver Each Sample to All Bottles**.
   c. Select Samples per Bottle.
   d. Set Number of Samples Per Bottle to 1.
10. Enable or disable the liquid sensor by using the CHANGE CHOICE key.
11. For the Sample Volume, enter 950 mL for each sample by using the numeric keypad. Press ACCEPT to continue.
12. Intake Rinses - Enter 1 for number of rinses by using the numeric keypad.
13. Enter 3 for Sample Retries.

    Note: Sampling will cease and resume based on Deadband (low-flow) and High Trigger (high-flow) Point levels, which are measured by an Area/Velocity (AV) meter or pressure transducer.
14. **Site IDs** are limited to eight digits.
15. Select **YES** for **Advanced Sampling.**
16. **Setpoint Sampling** allows the control of an automatic liquid sampler from up to 14 sources. Setpoint sampling defines a set of limits that inhibits sampling until an upset condition occurs that causes the limits to exceed. Sampling is enabled only when the discharge falls outside of the setpoints.
    a. **Enable** Setpoint Sampling by using the **CHANGE CHOICE** key.
    b. Select **Start and Stop** on **Setpoint.**
    c. Enable the **trigger point.**
    d. SETPOINT SAMPLING:
    e. HIGH TRIGGER POINT:
    f. **1.5 inches**
    g. Enter the **Deadband value.**
    h. SETPOINT SAMPLING:
    i. DEADBAND:
    j. **½–¾ inch**
    k. Enter a delay when the input is active: **0.**
17. **Disable** Start/Stop Time.
18. **Disable** Timed Bottle Sets.

19. **Disable** Upset Sampling.
20. **Disable** Variable Intervals.
21. **Disable** Variable Volume.

NOTE: To **run** or **halt** a program, press the **RUN/STOP** key on the front pane.

A diagram of how to set up basic programming for a Sigma 900 sampler is displayed in Figure 5-2. Figure 5-3 illustrates the flow chart for advanced options in the Sigma sampler.

To set the Sigma sampler's date and time:

1. From the Main Menu, select **OPTION MENU > TIME / DATE** to adjust the internal real-time clock
2. Adjust the real-time clock and date setting by selecting **CHANGE AM/PM** and **CHANGE MONTH.**

To adjust the interval of data collection and storage method:

1. From the Main Menu, select OPTION MENU > ADVANCED OPTIONS > DATALOG.
   a. Select **Extended Power Mode** (with a 1-minute interval, the memory would become full after 12 days).

      Note: The Extended Power Mode will only store data for up to **12 days**. Data from a sampling event must be downloaded and logged within 12 days of the event. Data collection includes sample collection (date and time), rainfall, velocity, stage, and flow. Composite sampling will be impossible to calculate without these data. Monitoring staff must collect these data before they are overwritten.
2. From the Main Menu, select OPTION MENU > ADVANCED OPTIONS > DATALOG.
   a. Select MEMORY MODE.
   b. Press CHANGE CHOICE and pick WRAP, then press ACCEPT.

      Note: In wrap mode, when the memory becomes full, the oldest reading is discarded each time a new reading is taken.

For a Flume – Flow Meter Setup:

1. From the Main Menu, select OPTION MENU > ADVANCED OPTIONS > Flow Meter Setup.
2. Select the Flow Units (cfs).
3. Select the Level Units (in.).
4. Select the Primary Device (Flume) and type (Cutthroat flume).

To set up flow calculations by using an AV sensor:

1. From the Main Menu, select **OPTION MENU > LEVEL SENSOR.**
2. Select **Submerged Xducer** by using the **CHANGE CHOICE** key and press **ACCEPT.**
3. From the Main Menu, select **SETUP >MODIFY SELECTED ITEMS.**
4. Highlight **Velocity Directions** using the **UP** and **DOWN** keys; press **SELECT.**

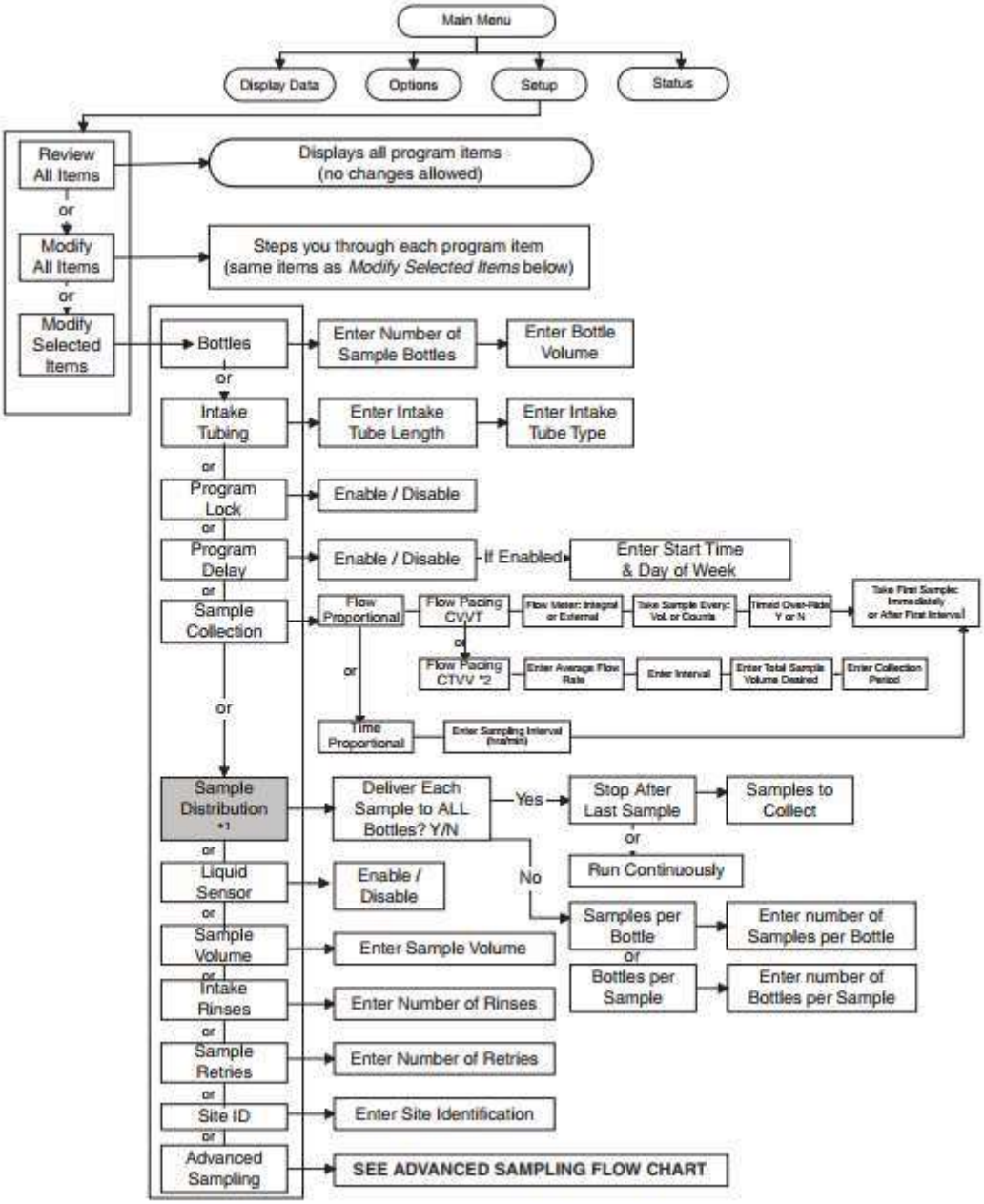

Figure 5-2. Basic Programming Setup Flow Chart for a Sigma 900 Max Sampler.

5. Set the velocity direction (upstream, downstream, or always positive) by using the **CHANGE CHOICE** key, then press **ACCEPT.**
6. Highlight **Velocity Units** and select **fps**; press **ACCEPT.**
7. Highlight **Velocity Cutoff** and set by using the numeric keypad.
8. Read the Velocity Cutoff information screen, and press any key to continue.

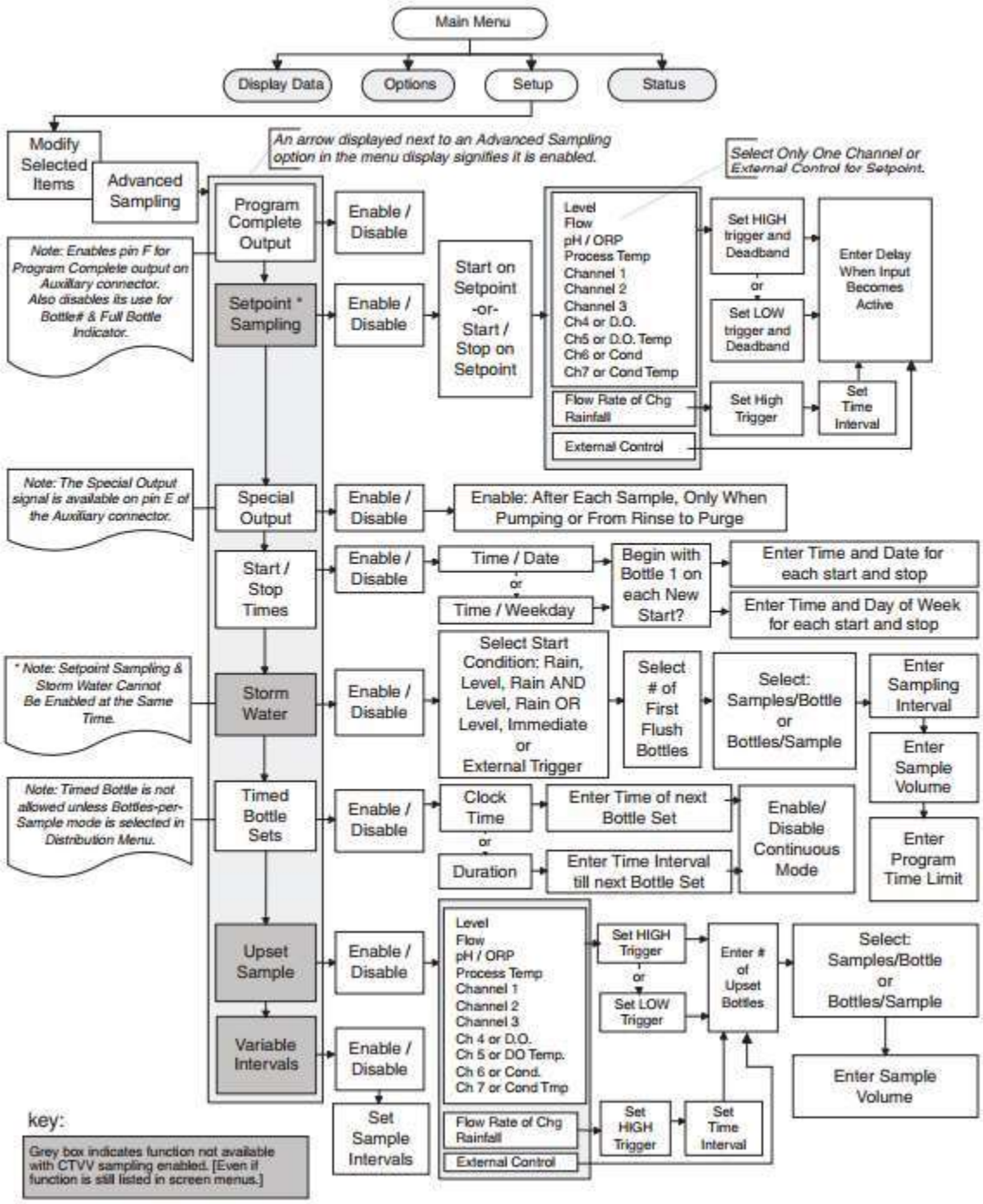

Figure 5-3. Advanced Sampling Flow Chart for the Sigma 900 Max Sampler.

9. Set the Velocity Cutoff by using the numeric keypad, then press **ACCEPT.**
10. Use the **Velocity Default** and press **ACCEPT.**

5.2.3 Rain Gauge (Tipping Bucket) Configuration

When selecting a site to install a rain gauge, identify a location in a clear area away from buildings and trees to avoid any obstacle that could block the natural fall of the rain. If possible, choose a level location that will also ensure a representative sample of rainfall for the area. The base of the rain gauge can be mounted onto a flat surface, or the mounting plate can be attached to the ground with small stakes or bolts.

The rain gauge must be level for accurate measurements. Internal bulls-eye levels are located inside the gauge for leveling the instrumentation. The following steps detail installation:

1. Remove the screen and rain gauge funnel.
    a. Make sure that all packing material/debris inside or under the gauge have been removed/ cleaned.
    b. Verify that the tipping buckets can move freely about the pivot point.
2. Use the three wing nuts, located on the base, to adjust the gauge. The gauge is level when the air bubble is centered in the circle of the bulls-eye level.

Each tip of the bucket will send a pulse into pin C of the Rain Gauge connector, which is plugged into the Sigma sampler and represents 0.01 inch of rain. To program a Hach Rain Gauge with the Sigma sampler, follow these steps:

1. From the Main Menu, select OPTION MENU > ADVANCED OPTIONS > DATALOG, then select Rainfall from Select Inputs.
2. Select CHANGE CHOICE to cycle between Logged and Not Logged, then press ACCEPT.
    a. Enter the logging interval (**05 Minute**).
    b. Select the Rainfall Units (**inches**).

5.3 WEATHER FORECASTING PROCEDURE

Monitoring staff are able to collect samples whenever there is a measurable runoff event from rainfall or discharged from melting snow. Samplers are programmed to automatically enable sampling when measurable discharge is detected. Monitoring staff must collect, composite, and ship sample containers to their EPA-certified laboratory within 48 hours of the event because of holding time limitations.

Storm events must follow the preceding measurable event by at least 72 hours as the permit requires. Monitoring staff must keep track of recent events and whether or not they produced measurable runoff. This can be accomplished by going to a number of weather tracking sites such as; Weather Underground, NOAA National Weather Service, USGS to name a few. If using an outside source for precipitation events. The data collection site must be within 1 mile of sampling site. The preferable method is using the sampling equipment tipping bucket to collect site specific precipitation amounts. Additionally, staff are responsible for following local forecasts for tracking current weather conditions and weather predictions over the next several hours to days in each watershed. Field personnel are required to check samplers and must be ready to composite samples immediately following an event.

Monitoring staff should verify data collected from the site's rain gauge with other, local precipitation tracking devices. The National Weather Service (NWS) and other websites (listed below) are resources that should be considered to obtain weather and precipitation information:

Instructions for using the NWS web site for weather forecasting in Colorado, as of 2017:

1. Go to www.weather.gov
2. Click on Colorado. For the Boulder/Denver area: http://www.weather.gov/bou/
3. Click on the map in the center of the page near the region of each site location for a 5-day forecast. A map on the new page (toward the bottom on the right) will have a zoom in and out feature to pinpoint exact locations.
4. This forecast page also has an hourly graph option on the right side of the web page (below the map) titled "Hourly Weather Forecast." A new page will open with hourly forecasts, including rain and snow probabilities (similar graphic as illustrated in Figure 5-4).

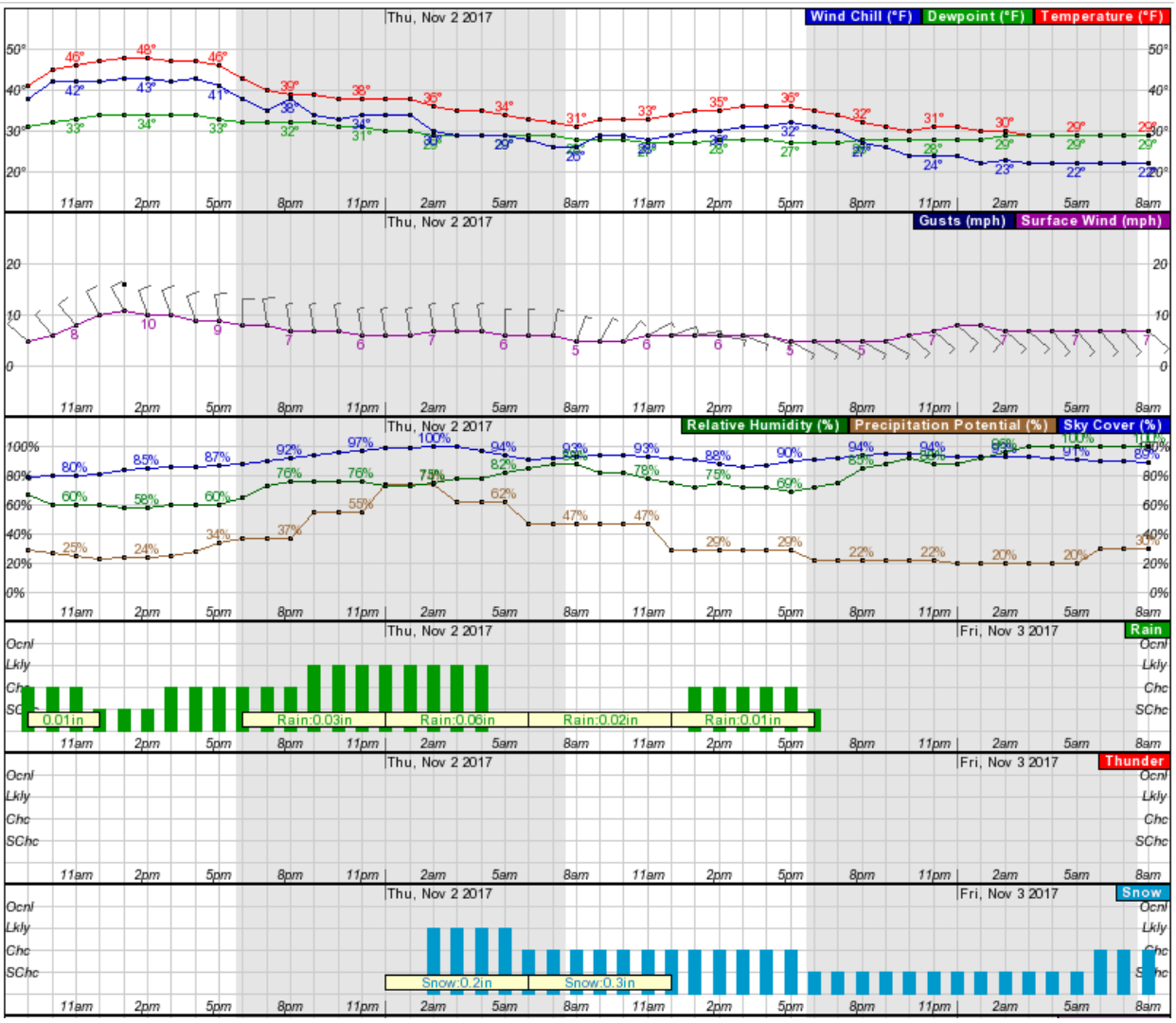

Figure 5-4. Example of Hourly Weather Forecasts From the National Weather Service.

Other websites:

- The Weather Channel, Hourly Forecasts (for the Denver area): https://weather.com/weather/hourbyhour/l/USCO0105:1:US
- The National Center for Atmospheric Research (NCAR) home web page: multiple links on the right side for local (Boulder) and Colorado's current weather and forecast pages
  - Access from: http://weather.rap.ucar.edu/
  - The CoCoRaHS tab opens a new window with current and past rain/snow data from measurements taken across the state of Colorado

To access hourly precipitation forecast maps, follow these steps:

1. Go to the College of DuPage NeXt Generation Weather Lab web page (http://weather.cod.edu/)
2. Click on the **Numerical Models** tab from the **Weather Analysis Tools** dropdown menu (or access from http://weather.cod.edu/forecast/)
3. For hourly rain/snowfall forecasts, click on the **HRRR** tab (up to 18-hour forecast)
   a. Click on Colorado
   b. The default product is **Sim. Reflectivity** (Simulated Reflectivity)
   c. To change products, select from **All Products** on the left side of the page (**Total Precip. Accum** and **Precipitation Type** are other recommended precipitation products)
4. Select the **NAM** or **GFS** tabs for a longer forecast range
   a. Click Colorado on the map
   b. Click **Precipitation Products** on the left side of the page
   c. From the dropdown menu, select either **SLP and Precipitation** (Surface pressure and precipitation), **Total Precip. Accum** (total accumulating precipitation), **Precipitation Type**, or **Sim. Reflectivity** (Simulated Reflectivity-not available for GFS).

Current radar images can be accessed from the following sources:

- The NWS, Colorado-Denver/Boulder web page (http://www.weather.gov/bou/). Click on the radar image below the map to loop through the most recent radar scans
- Use **NEXRAD** radar images:
  - From the College of DuPage, select **Satellite and Radar** from the **Weather Analysis Tool** dropdown menu
  - Click on **NEXRAD Sites** on the left side of the page
  - Click on one of the three radar points in Colorado, choosing the radar closest to the site's location
  - Loop through the most recent images by clicking the number of images to loop on the left side of the image (options are 6, 12, 24, 48, 96, or 200)

Recently archived radar images are available from NCAR (http://weather.rap.ucar.edu/)

1. Click on the **Radar** tab

2. Choose an **End Date** (will go back 5 days)
3. Choose an **End Time**
4. Time is in Coordinated Universal Time (UTC), Mountain Daylight Time (MTD) is six hours behind UTC (i.e., UTC – 6)
5. Choose the number of images to loop through from the **Loop Duration** dropdown menu
6. Click on **FTG** in Colorado to loop the image (radar for the Front Range and Denver, CO); **FTG** will open in a new window that displays the radar image.

5.4 DOCUMENTATION AND FILING

Monitoring staff are required to document when ISCO and Sigma equipment are initially configured and deployed in the field. Any changes to the program (updates for site-specific changes) must be well documented in the field logbook, including the time and date that the change was made and why the change was necessary. This process will be useful when setting up new site locations or when any equipment is replaced.

5.5 QUALITY ASSURANCE/QUALITY CONTROL

In instances where field equipment cannot be calibrated, the monitoring staff will need to attempt a field repair of the affected equipment or instrumentation. The WWM Manager or Water Quality Manager will be responsible for providing information and ordering new parts if equipment is in need of repair.

5.5.1 Auto-Sampler Troubleshooting

The ISCO and Sigma auto-sampler user's manuals both contain troubleshooting sections that include common errors and their solutions. Both manuals also provide contact information for technical support and repair services, as well as ordering information for replacement parts.

5.5.2 Rain Gauge Troubleshooting

Data from the rain gauge should be verified with local precipitation devices by analyzing archive radar or other precipitation data products. The rain gauge should be cleaned every time data is recorded. For each cleaning, make sure that the tipping bucket can still top on its axis, the funnel is not clogged, and the screen is clean. Also, routinely check the connections from the rain gauge to the sampler, and look for signs of damage or interference that may cause inaccurate readings.

Rain gauges are not required at every sample site if they are located within a 1-mile radius of another precipitation tracking device. Installed rain gauges will need to follow proper maintenance protocol to ensure a consistent level of accuracy of the device.

5.6 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005," *codot.gov*, retrieved September 25, 2017, from *https://www.codot.gov/programs/environmental/water-quality/documents/cdot-ms4-permit*

6.0 FIELD DOCUMENTATION AND SUPPORTING DOCUMENTS

Purpose:
The purpose of this Standard Operating Procedure (SOP) is to document how to maintain the integrity of all samples collected by documenting the control, transfer, and analysis of each sample in addition to data collected. The Wet Weather Monitoring (WWM) Program is required to deliver all samples to a US Environmental Protection Agency- (EPA-) approved laboratory for conducting analyses. Thus, a Chain-of-Custody must be completely filled out to document the handling history of samples, with appropriate sample bottle labeling. Copies of the Chain-of-Custody and documentation of field data from the Sigma 900 sampler and ISCO sampler (using direct data download methods or manually recorded) must be filed as supporting documents.

Date of Last Review:
November 29, 2017

Sampling Program:
WWM Program

Sampling Task:
Colorado Department of Transportation (CDOT) Permanent Control Measure(s)

6.1 INTRODUCTION

The Colorado Department of Public Health and Environment (CDPHE) requires the CDOT WWM program to use specific monitoring methods as described in 40 CFR Part 136. To ensure approved analytical methods are used, CDOT is required to use an EPA-certified laboratory to complete the analyses, requiring a completed COC form and labeled sample bottles. Additionally, field documentation of data collected during the WWM event is required to create composite samples delivered to the laboratory.

The COC form is a legal field document to be used by laboratories to record collected samples, transfer of samples, and analytical methods that were used. Sample bottle labels are supplemental documentation to the COC to verify that the correct analytical techniques are used by the laboratory.

This SOP provides a step-by-step process to collect and document data from the portable samplers, as well as instructions on how to input information into the COC and what information to include on sample bottle labels.

6.2 FIELD DOCUMENTATION

Data will be collected from each storm event directly from the Sigma 900 or ISCO 3700 portable samplers to complete composite samples. All of the data, including rain, flow, and sample bottle data, can be downloaded from each sampler or manually recorded in the format discussed below. The recommended methods for data collection are by a direct connection to the sampler using an RS232 cable to connect to a Data Transfer Unit (DTU-III) or directly to a computer for a Sigma 900 Max Sampler, or using a Rapid

Transfer Device (RTD) for an ISCO sampler. Manual documentation may substitute direct downloads in case the equipment fails or is missing the software/devices that are necessary to complete direct downloads. Data collection must be transferred to a computer in the office, regardless of the download method used.

6.2.1 Direct Download for Sigma 900 Sampler

An RS232 cable connector is a serial input/output port to communicate with the Sigma 900 sampler using a Data Transfer Unit (DTU-II) or directly to a laptop. The communication software InSight Gold is also required to complete the data transfer. InSight software is free to download from *www.hach.com*.

To set up RS232 programming on the Sigma 900, the following connection must be updated:

- From the Main Menu, select OPTION > ADVANCED OPTIONS > COMMUNICATIONS SETUP > RS232 SETUP
- Select 19200 for the Baud Rate.

To download data using the RS232:

1. Download data via a DTU-II.
    a. Transfer data from the Sampler to the DTU-II using PN 1726.
    b. Connect a DTU-II to the computer.
    c. Launch InSight and click on the 900 MAX icon.
    d. Click **Connect** via **RS232** and **DTU-II.**
    e. A new dialog box will open: **Connect to Logger**. Set the baud rate to **19200**, set the appropriate **port** number, and click **OK.**
    f. In the new window titled **DTU-II**, select one or more cells to download and click **OK.**
    g. Open to view/copy data into an Excel spreadsheet for appropriate formatting to calculate composite samples.
2. Download data via direct connection to the laptop.
    a. Launch InSight and click on the 900 MAX icon.
    b. Click **Connect** via **RS232** and **Sampler.**
    c. A new dialog box will open: **Connect to Logger**. Set the baud rate to **19200**, select the appropriate **port** number, and click **OK.**
    d. In the new window, titled **Connect to Sigma 900**, Click **Retrieve Logged Data**.
    e. Select to download all of or just the new data, then click **OK.**
    f. Open to view/copy the data into an Excel spreadsheet for appropriate formatting to calculate composite samples.

6.2.2 Direct Download for ISCO sampler

After a storm event, data can be downloaded via a RTD by following the provided steps:

1. Plug the RTD directly into the ISCO data transfer port.
   a. A green LED will start blinking during the data download.
   b. When the light turns solid green, the RTD can be removed.
2. A transfer cable and Flowlink software are necessary to upload data onto a computer. Open Flowlink and export all of the data as a comma-delimited file (csv) or text file.
3. Import data into Excel to format the data in a standard spreadsheet to calculate composite samples:
   a. Sample bottle (number and time collected)
   b. Rainfall
   c. Level and flow data.

6.2.3 Manual Documentation

When a direct connection to the sampler is unavailable, manual documentation must be tracked in the field logbook and data sheet after a sampling event. The following procedure will be used to document sample bottle data, rain, flow, and level data from a Sigma 900 sampler into a field sheet similar to Figure 6-1:

- Select Display Data from the Main Menu, then select Sample History.
  - Collect the times that each sample was pulled.
  - Sample history will assist you in retrieving rain and flow data.
- From **Display Data**, arrow down to **FLOW.**
  - Highlight **Display Data** and press **SELECT.**
  - Choose **View from time/date** under the **Display Data by Table** functions.

    Note: This function displays the data from the selected channel beginning from any preferred time and date. This function will allow the user to enter a desired time and date.
  - Enter the time that the first sample was pulled.
- From **Display Data**, arrow down to **RAINFALL.**
  - Highlight **Display Data** and press **SELECT.**
  - Choose **View from time/date** under the **Display Data by Table** functions.

    Note: This function displays the data from the selected channel beginning from any preferred time and date. This function will allow the user to enter a preferred time and date.
  - Enter the time that the first sample was pulled.

    Note: If this is for a snowfall event, rainfall data likely will not show. Document that no rainfall data are available and the type of event that triggered sampling. Use nearby weather station data to document snowfall amount.
- Record all of the data into a computer to begin calculating composite samples.

COLORADO
Department of Transportation

Print Form

SAMPLING LOCATION FIELD LOGBOOK DATA

SAMPLE/STATION ID_____DATE/TIME_____

OBSERVER(S)_____ TOTAL RAINFALL AMOUNT _____

#BOTTLES FILLED_____PROGRAM STATUS RUNNING____YES___NO BATTERY VOLT:_____

PROGRAM STARTED:_____PROGRAM ENDED:_____

PH:_____MISSED ANY SAMPLES:_____

DRAIN TYPE/SIZE _____

DRAINS TO _____

LATITUDE_____LONGITUDE_____

MAINTENANCE FACILITY_____

	SAMPLES		RAINFALL		FLOW_CFS	
DATE	TIME	BOTTLE#	TIME	AMOUNT	TIME	AMOUNT

Figure 6-1. Example Field Data Spreadsheet.

6.3 CHAIN-OF-CUSTODY

Once the sample collection process is complete and properly documented, a written record of the COC form must be completely filled out for each collected sample. **Each sample must be added to the form**

upon collection. Every laboratory has a unique COC form; however, the following information is always required:

- Name and signature of all personnel who collected and handled the samples
- Project Name (e.g., Highway Runoff Permanent Control Measure[s])
- Project Description (e.g., Highway Runoff or Highway Runoff Maintenance Facility)
- Site Name and Site ID
- Sample ID
- Date and time that the samples were collected
- Number of containers
- Sample analyses.

Military time must **ALWAYS** be used (i.e., "18:45" instead of "6:45 p.m."). Figure 6-2 displays an example COC with required fields specific to each sampling event highlighted in yellow. Each person who had control (custody) over the samples must sign and date the COC form upon receipt and surrender of samples. Monitoring staff must also ensure that laboratory personnel sign the COC form after receiving the samples and retain a copy of the signed and dated COC form. The laboratory is required to send their signed copy back to CDOT with the analytical results. CDOT must store all copies.

6.4 SAMPLE BOTTLE LABELING

Monitoring staff are required to contact the EPA-certified laboratory before the rain or snowmelt event. The necessary sampling equipment, including sample bottles, labels, preservation requirements, and the COC, will need to be retrieved from the contracted laboratory because individual parameters require specific sample containers (size and bottle type) and preservatives. Sample bottle labels must be filled out correctly and completely, according to the laboratory instructions, to ensure that the correct analytical test is performed on the appropriate bottle and to avoid sample analysis delay. The following information is required on every sample bottle:

- Name of sample collector
- Sample date
- Sample time (the time of collection is the time that the sampler collected the sample)
- Sample analysis type or method used
- Sample type (i.e., grab or composite, blank or duplicate)
- Sample identification number and exact sample location (use Site ID, i.e. CO-FCMC068-O1)
- Preservatives used.

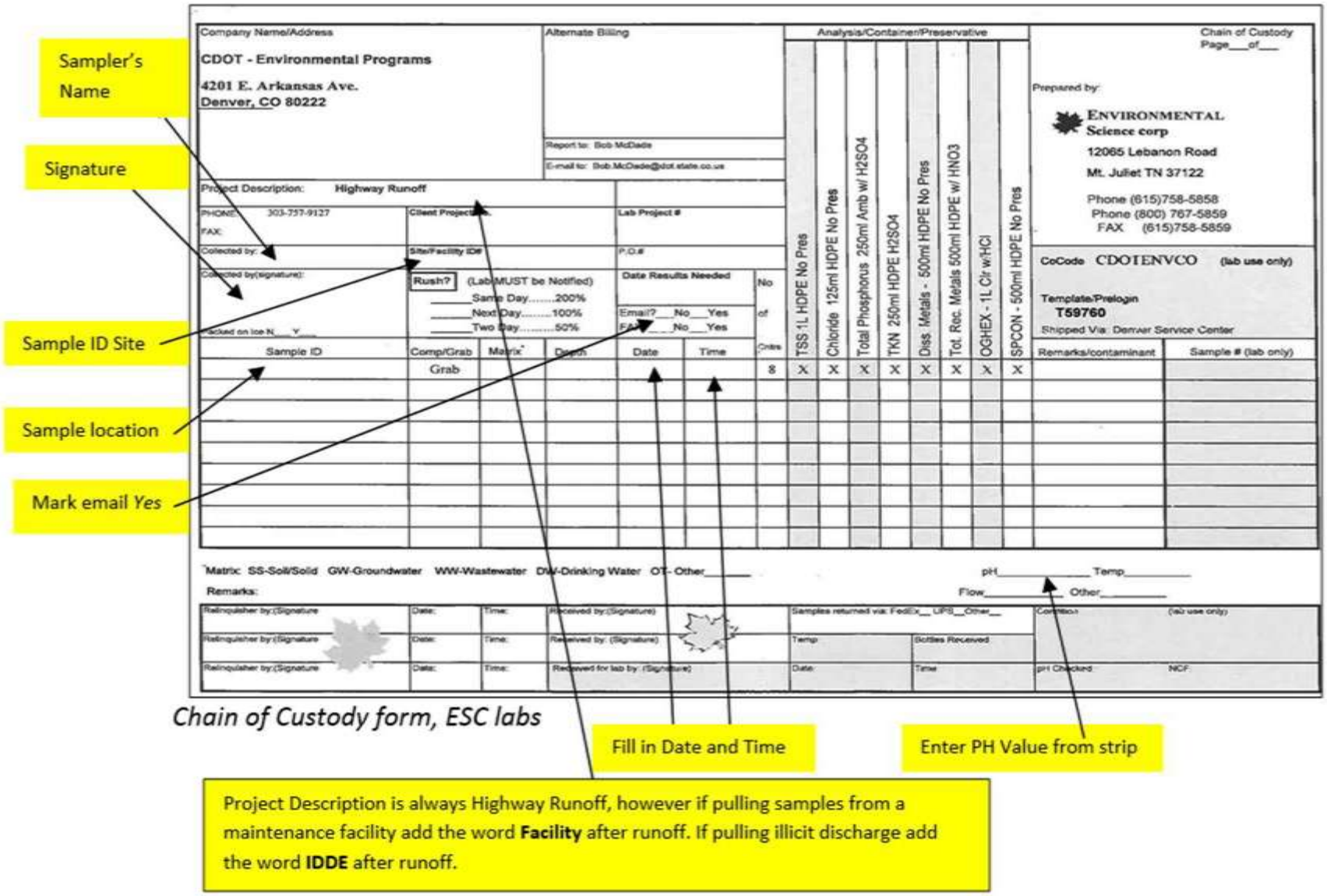

Figure 6-2. Sample Chain-of-Custody Form From Environmental Services Corporation. Field personnel must fill in the sections as noted.

6.5 DOCUMENTATION AND FILING

Data collection and filing are essential for accessing information to complete the annual report required by CDOT's MS4 permit. To track all of the procedures conducted during an event, monitoring staff are required to log all activities during and after a sampling event. CDOT monitoring staff will log all records in a field logbook. The Permit, in Part 1.F.6, requires the following information:

- The date, type, exact location, and time of sample collected/measurements
- Type of location being monitored (Permanent Control Measure(s), maintenance facility, or highway)
- Location information (i.e., inlet or outlet)
- All individual(s) who performed the sampling
- Dates that the sample analyses were performed
- All individual(s) who performed the analyses
- Analytical techniques or methods used
- Results of such analyses.

CDOT must also maintain all of the monitoring information, including the COC forms, original chart recordings or digitally logged flow data, and all equipment calibration/maintenance records. The CDOT's MS4 permit follows requirements under 40 CFR 122.41 (j)(2) for all data, metadata, and any reports generated from these records to be retained for at least 3 years from the date specific to when that item is no longer being used for stormwater management.

6.6 QUALITY ASSURANCE/QUALITY CONTROL

Documentation of sample events in the field data sheets, logbook, and COC forms should be quality-control checked by the WWM Manager. The WWM Manager should review monitoring staff's day-to-day field work. To ensure that the proper procedures were followed for sample collection and documentation, a brief summary of the event and information that was recorded in the field logbook should be written by monitoring staff and submitted to the WWM Manager. Once the laboratory data and procedures have been checked for quality control, data should be entered into the final project database: Ambient Water Quality Monitoring System (AWQMS). The monitoring results must be discussed, at least annually, with the Water Quality Section Manager for potential water quality management improvements.

6.7 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005," *codot.gov*, retrieved October 25, 2017, from *https://www.codot.gov/programs/environmental/water-quality/documents/cdot-ms4-permit*

7.0 DATABASE MANAGEMENT PROCEDURES FOR THE AMBIENT WATER QUALITY MONITORING DATABASE

Purpose:
The purpose of this Standard Operating Procedure (SOP) is to assist a first-time user in uploading data into AWQMS. The document also provides information to help ensure that data from field measurements and water quality laboratory data are complete and in a format that will easily integrate with AWQMS. The user should visit the AWQMS website (*https://awqms.goldsystems.com/Login.aspx*) and read the full SOP document before attempting to upload data to AWQMS.

Date of Last Review:
November 29, 2017

Sampling Program:
Wet Weather Monitoring (WWM) Program

Sampling Task:
Colorado Department of Transportation (CDOT) Permanent Control Measure(s)

7.1 INTRODUCTION

The Ambient Water Quality Management System (AWQMS; pronounced ah-kwums) is the water quality data-management system used by the Colorado Data Sharing Network (CDSN). AWQMS is a US Environmental Protection Agency (EPA) Water Quality Exchange- (WQX-) compatible database that allows users to manage various types of environmental data (e.g., surface-water, groundwater, and biological) with built-in analysis tools.

AWQMS is meant to provide a convenient location for various governmental and nongovernmental organizations to store, analyze, and share water quality data with each other and the public. CDOT intends to use AWQMS to store water data from various types of surface-water monitoring projects. These CDOT water quality monitoring projects are performed to monitor both surface-water and watershed impacts and restoration actions associated with CDOT.

This SOP provides an easy-to-use, step-by-step process to input water quality data into AWQMS for future analysis and public information. This SOP is envisioned to be used by both CDOT and their contractors for data management and database input throughout the state of Colorado.

7.2 LOGIN AND DATA SECURITY ISSUES

The login information that is necessary to access CDOT's AWQMS account can be obtained by contacting the CDOT WWM Manager or the Water Quality Programs Manager at 303.512.4053.

7.3 QUALITY ASSURANCE/QUALITY CONTROL

7.3.1 Introduction

Quality assurance (QA) and quality control (QC) are critical to ensure a high level of data collected from the field and laboratory and ultimately inputted into the database. The CDOT employee or contractor is responsible for ensuring that the water quality data is compliant to project QC field and laboratory acceptance criteria before data input. Additionally, the individual who collected the field data must have been qualified and trained in the skills of water quality sampling, testing, and sample management.

7.3.2 Water Quality Parameters and Standards

Water quality analysis typically requires both performing measurements in the field and sending samples to a third-party laboratory where additional analytical measurements are performed. Results from laboratories can be in a variety of formats and may or may not include CDOT-required information depending on the laboratory that performs the work. This SOP lists required information and recommended formats to ensure that both field and laboratory analysis meets CDOT standards and that data can easily be integrated into the AWQMS database.

7.3.3 Parameters and Practical Quantification Limits

The following sources have suggested parameters to be included in any CDOT water quality analysis:

- CDOT WWM program
- Permanent Water Quality Pollutants of Concern
- 303d Listing.

Any water quality analysis must use approved methodologies from the above sources and corresponding maximum practical quantification limits (PQLs). Higher sensitivity analysis methods with lower PQLs are permitted and acceptable to CDOT.

7.3.4 Required Parameter Metadata

In addition to parameter concentration, certain metadata are required for any water quality result. This additional information allows water quality researchers to understand exactly how a measurement was made and how the results can aid in reviewer interpretation. Required metadata and examples are presented in Table 7-1.

7.3.5 Water Quality Spreadsheet Templates

To simplify the process of uploading data to AWQMS, a template spreadsheet in Microsoft Excel format for CDOT projects is included in the appendix. This template should be provided to water quality laboratories before work begins, and analytical results should be stored in the spreadsheet. If the laboratory is unable or unwilling to use the template, copying data from the provided format to the template before uploading data to AWQMS is typically possible. Migrating data from another format to the template can also be useful when working with legacy water quality data. AWQMS can be “taught” to understand different spreadsheet formats; however, this process is typically more challenging than

migrating data to the template format and is discouraged. In general, to reduce possible errors and to save time and money, water quality laboratories should provide results using the template spreadsheet.

Table 7-1. Required Metadata

Metadata Type	Example
Activity Type	Field MSr/Obs, Field Msr/Obs-Habitat Assessment, Field Msr/Obs-Incidental, Field Msr/Obs-Portable Data Logger, Sample-Other, Sample-Routine
Activity Media Name	Air, Biological, Habitat, Other, Sediment, Soil, Tissue, Water
Activity Media Subdivision Name	Drinking Water, Finished Water, Groundwater, Industrial Effluent, Industrial Water, Lake Sediment, Mine Tailings Pond, Municipal Sewage Effluent, Rainwater, Septic Effluent, Snowmelt, Stormwater, Surface Water, Surface-Water Sediment, Unknown, Water-Vadose-Zone
Activity Start Date	2003/03/14
Activity Start Time	12:45:00 PM
Activity Start Time Zone	MDT, MST
Sample Collection Method ID	Field Meter, Meter or Flume, Grab, Secchi Disk, Staff Gauge, Mod Van Dorn, Benthic Scraping
Sample Collection Equipment Name	Water Sample (Other), Water Bottle, Probe/Sensor, Van Dorn Bottle, Miscellaneous (Other)
Parameter Name	pH, Chloride, Hardness, Phosphorus, Specific Conductance, Total Suspended Solids, Arsenic, Copper, Zinc
Method Speciation[(a)]	as As, as $CaCO_3$, as Cl, as CO_3, as H, as HCO_3, as N, as NH_3, as NO_2, as NO_3, as P, as PO_4, as Se
Result Unit	ug/L, mg/L, umho/cm, cfs, deg C, NTU, none
Result Qualifier[(a)]	A, U, K, J, D
Result Sample Fraction	Total, Dissolved, Total Recoverable, Bed Sediment, Bedload
Result Status ID	Accepted, Final, Preliminary, Rejected, Validated
Result Value Type	Actual, Blank Corrected Calc, Calculated, Control Adjusted, Estimated
Result Analytical Method ID	120.1, 130.1, 200.7, 300.0, 350.1, 351.2, 353.2, 365.4, 1664A, 2540, D-2011
Result Analytical Method Context	EPA, NIOSH, HACH, LACHAT, APHA, USDOC/NOAA, ASTM, IL/SWSD, SWQC
Result Detection/Quantitation Limit Type	Drinking Water Maximum, Estimated Detection Level, Instrument Detection Level, Interim Reporting Level, Long-Term Method Detection Level, Lower Quantitation Limit, Lower Reporting Limit, Method Detection Limit, Practical Quantitation Limit, Sample-Specific Min Detect Conc, Upper Quantitation Limit, Upper Reporting Limit, Water Quality Standard or Criteria
Result Detection/Quantitation Limit Measure	0.3, 100
Result Detection/Quantitation Limit Unit	uS/cm, mg/L, cfs, none, deg C, ug/L, NTU, mg/m^2
Lab Sample Preparation Method ID	HydroLab, EPA 200.7, Default Prep Alk, Filter Thru 0.45, Default Prep Ammonia, Default TDS SM2540-C, Default TSS SM2540 D
Laboratory Name	Field, EPA Region 8 Laboratory, LEWWTP Lab, TechLaw, Inc. - ESAT Region 8, CU Center for Limnology
Lab Sample ID	Varies

(a) May not apply to all results.

7.3.6 Global Positioning System Locations

AWQMS requires that GPS coordinates in file uploads of monitoring locations be in decimal degrees format (e.g., 39.692456°, –104.936684° = location of CDOT headquarters). A variety of resources are available to convert other formats to decimal degrees if necessary. All GPS locations should use the same

number of significant digits as provided by the GPS receiver and be checked for accuracy in GIS software or Google Earth before uploading to AWQMS.

7.4 AMBIENT WATER QUALITY MONITORING SYSTEM DATA INPUT PROCESS

7.4.1 Introduction

Uploading data into the AWQMS database is a relatively straightforward process but is sensitive to steps being performed in the proper order and data being in the correct format. If these instructions are read carefully and followed completely, one should encounter few if any errors during the uploading and migration process.

Before explaining the upload and migration procedure, the overarching data structure in the AWQMS database must be discussed. Projects, monitoring locations, and activities provide order and structure to what would otherwise be reams of disparate data. Projects allow related data to be grouped together. Monitoring locations represent the physical place where data were collected. Results are the measurements of physical and chemical data that were collected at monitoring locations.

Using a single device to measure one or more parameters is known as an activity. For example, measuring pH with a pH meter is an activity with a single result. Using a device that measures both pH and specific conductance is a single activity with two results (pH and specific conductance). Collecting water in a bottle to send off to a laboratory for the analysis of copper, magnesium, manganese, and zinc is a single activity with four results. Correctly organizing results into activities requires an understanding of how the analysis was performed in the field. Understanding the difference between activities and results in AWQMS is important. An activity means using a single device (e.g., pH meter, multi-meter, or water-collection bottle) to measure one or more parameters. A result is the measured concentration or value of a parameter.

Each result in AWQMS is associate with a project, monitoring location, and activity. To simplify this association, projects, monitoring locations, and activities each have an identification (ID) code. This code must be unique or loss of data within AWQMS may occur. Before assigning ID codes and uploading data, the user must check AWQMS to ensure that the IDs that they are using are not already being used. To keep entries in AWQMS consistent, a convention has been established for each type of ID and should be used for all CDOT water quality data. Monitoring location IDs should begin with the abbreviation of the drainageway/waterbody name followed by the number of the collection site. The Monitoring Location ID for site number 5 on Hoop Creek is HC-5. Because Colorado has many drainages that have duplicate names, check that monitoring location IDs do not overlap an existing ID in AWQMS. Some creativity may be needed to correct ID collisions, but IDs should be kept as short as possible because they are included in the activity ID. More exact information that defines monitoring locations should be included in the monitoring location name.

The Project ID should concisely list the name of the project. Please note that this number is not necessarily the CDOT project number; although, the CDOT project number may be appropriate to include in the project description. The date range should also be included in the Project ID for completed water quality

projects or projects with a fixed schedule (e.g., I-70 Mountain Corridor 2000–2013, or Hoop Creek 1997–2009).

The activity ID is limited to 35 characters and consists of the Monitoring Location ID, the date in yyyymmdd format, the time in h:mm:ss format, and an alphabetic activity descriptor; all of which are separated by hyphens. The alphabetic activity descriptors describe the type of measurement and are as follows: G for grab, F for flow (discharge), S for specific conductance, T for temperature, Y for turbidity, and P for pH. G represents the sample collection method that corresponds to a sample of water gathered via a bottle or syringe. The grab collection method is typically used when a sample is collected to send off to a laboratory. Example activity IDs are shown in Table 7-2. The first example represents a grab (water bottle) sample taken from monitoring location 2 on Gore Creek (GC-2) on September 27, 2009 at 2:40 PM. In the third example, note that the time is set to 0:00:00, which is the recommended time for activities with missing start times.

Table 7-2. Example Activity Identification Codes

Activity ID	Description
GC-2-20000927-14:40:00-G	Monitoring Location: GC-2
	Date: 9/27/2009
	Time: 2:40:00 PM
	Sample Collection: Grab
HC-5-19980724-7:00:00-F	Monitoring Location: HC-5
	Date: 07/24/1998
	Time: 7:00:00 AM
	Sample Collection: Flow Rate
CC-4-20030314-0:00:00-Y	Monitoring Location: CC-4
	Date: 03/14/2003
	Time: 0:00:00
	Sample Collection: Turbidity

Project, monitoring location, and activity IDs must be unique, otherwise data can be overwritten when new datasets are migrated into the database. The following procedures include directions on how to check existing project, monitoring location, and activity IDs and, thereby, allow the user to verify that their proposed IDs are not already in the system. The data entry procedure is outlined in Figure 7-1.

7.4.2 Ambient Water Quality Monitoring System Demo Account

New users should practice with the AWQMS demo account before attempting to upload data to the actual CDOT account. The demo account can be accessed at *http://awqmsdemo.goldsystems.com/Login.aspx*. The username and password for the demo account are both "demo". The demo account allows the user to practice uploading and modifying data in a "sandbox environment" without the risk of changing or overwriting existing CDOT water quality information.

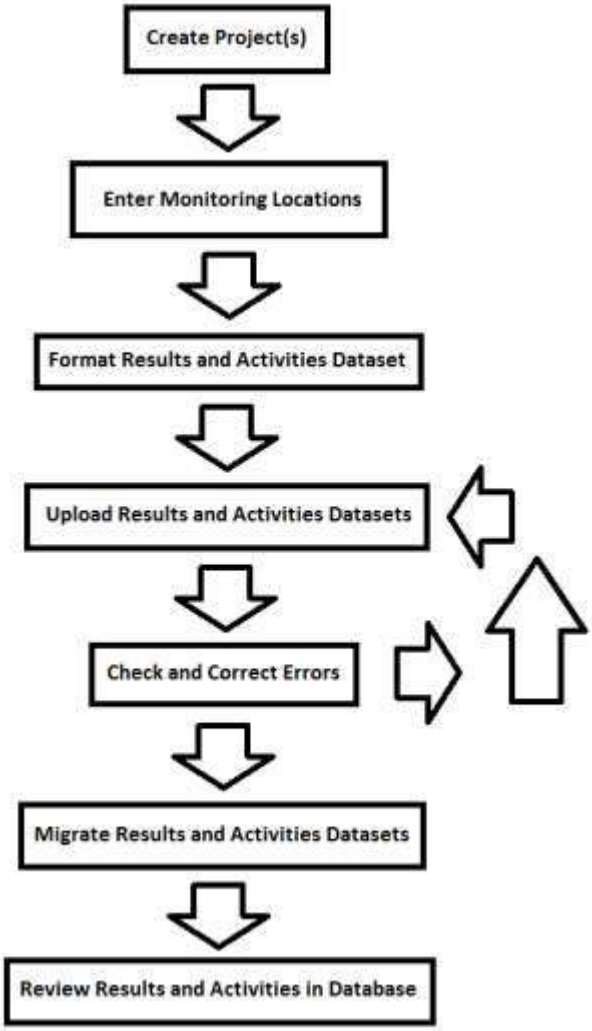

Figure 7-1. Order of Operations for Inputting Data Into the Ambient Water Quality Monitoring System.

7.4.3 Step 1 – Projects

1. Go to the AWQMS login page
2. Enter CDOT's username and password
3. Once on the AWQMS main page, find the Metadata tab in the top left corner
4. From the Metadata tab, navigate to Projects
5. On the Projects page, click Add New (see Figure 7-2).
6. Select CDOT from the Organization ID pull-down menu, and add a Project ID, Name, and Description.
7. For the description, include the project manager or the organization that collected the data (e.g., "Region 1 – Mad Hatter," "CEI WQ Joe Banks") in addition to any other pertinent information.

8. Once the Organization ID, Project ID, Name, and Description have been added, click Save (see Figure 7-3).
9. Add any reports that are pertinent to the project; under Attached Files > click Add.
10. Projects can be reviewed and project IDs checked by going to the Metadata tab, navigating to Projects, selecting CDOT from the Organization ID, and clicking Search.
11. Add more projects as needed, then proceed to Step 2.

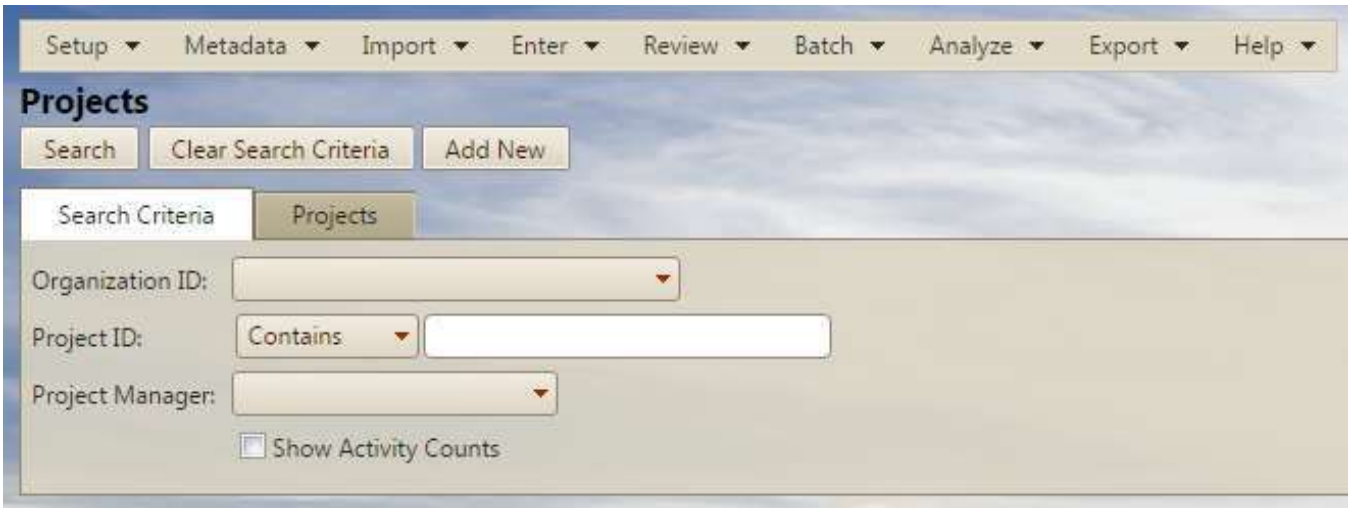

Figure 7-2. Metadata Projects Page.

7.4.4 Step 2 – Monitoring Locations

Monitoring locations can be added to the system individually using a dialog or as group by uploading a file. Some overhead and additional challenge are involved in uploading multiple locations at once. In general, upload a file if ten or more locations need to be added to AWQMS. If fewer than ten locations need to be added to the system, adding the locations individually is typically faster and easier. A monitoring location upload template in Microsoft Excel is available in the appendix. Regardless of the method used to add monitoring locations to the system, all locations should have values for the following fields: Monitoring Location ID, Monitoring Location Type, Monitoring Location Name, Latitude, Longitude, Horizontal Reference Datum, and Horizontal Collection

<u>Adding Monitoring Locations Individually</u>

1. On the AWQMS main page, click the **Metadata** tab in the top left corner.
2. From the **Metadata** tab, navigate to **Projects.**
3. On the Projects page, click **Add New**.
4. Fill out all of the required fields and click **Save.**

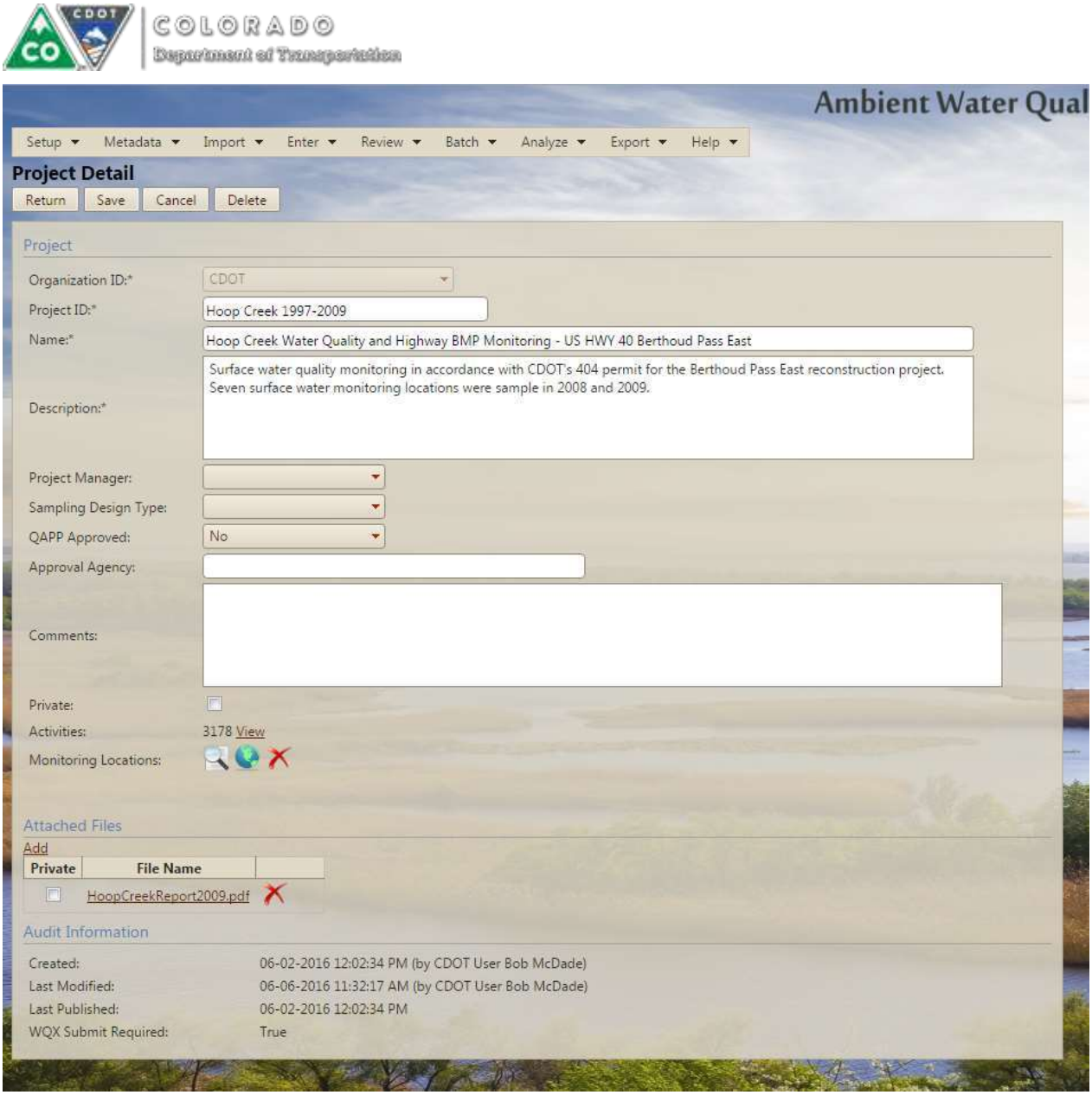

Figure 7-3. Page for Adding a Project.

<u>Uploading Multiple Monitoring Locations with a File</u>

1. Fill out all of the required columns in the monitoring location template located in the appendix.
2. The manual upload page (discussed above) can be checked for acceptable monitoring location types, horizontal reference datums, and horizontal collection methods.
3. Once the template is completely filled out, save as a comma separated values (csv) file. While AWQMS permits uploading xls and xlsx files, uploading a csv is significantly easier and more reliable.
4. To upload the completed template click **Import > Monitoring Locations, Assessment Units and Reaches**, which will open the dialog shown in Figure 7-4.

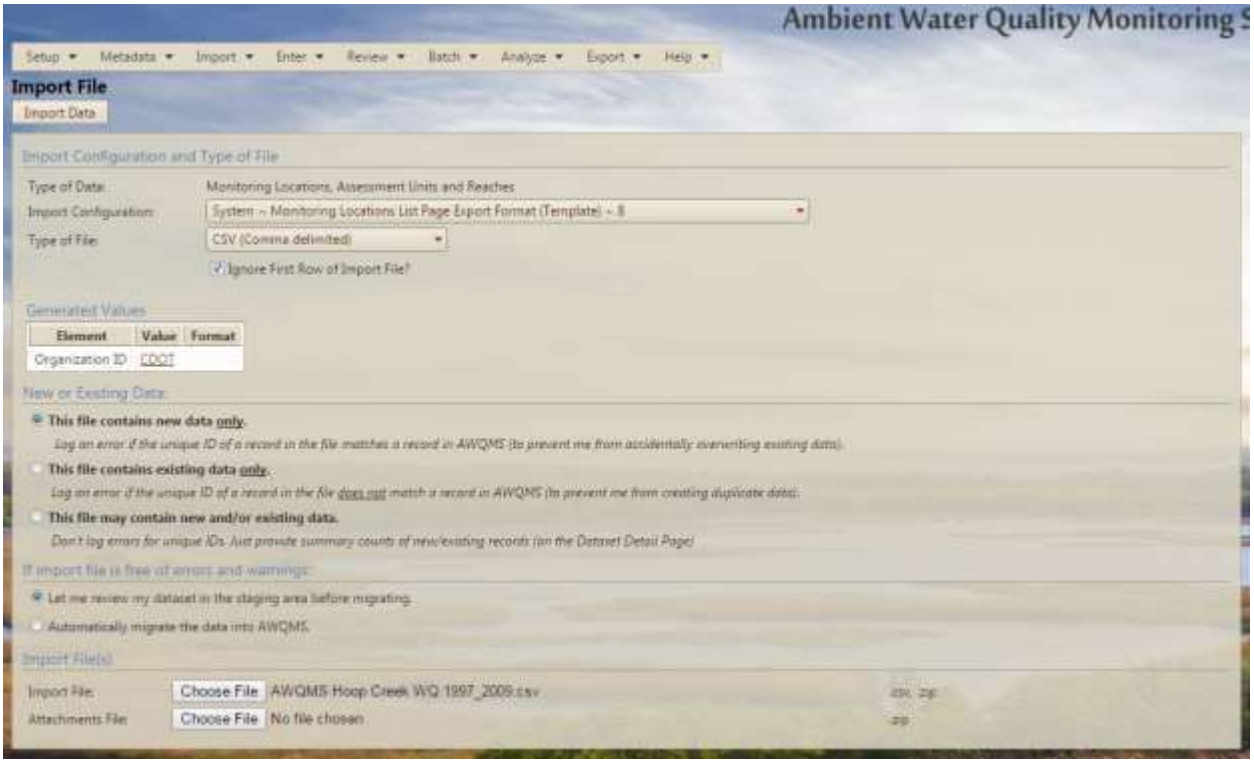

Figure 7-4. Page of Uploading Monitoring Locations.

5. From the **Import Configuration** pull-down menu, select **CDOT Monitoring Locations Template ~ 2531.**
6. Select **CSV (comma-delimited)** from the **Type of File** pull-down menu.
7. Under **Generated Values**, click on **{none}**. Select **CDOT** from the menu.
8. Under **New or Existing Data**, keep the default setting at **This file contains new data only.**
9. Keep the default setting for **If import file is free of errors and warnings**. Remember to review your dataset before migrating.
10. Click **Choose File** next to **Import File** under the **Import File(s)** heading. Select the csv version of the upload template that is filled out with the monitoring locations to be uploaded.
11. Additional files that are relevant to the monitoring location (site maps, etc.) can be uploaded by clicking Choose File next to **Attachments File:** (optional).
12. Click the **Import Data** button in the top left of the page.
13. A new page that displays the progress of the upload will appear.
14. If any errors are found during the upload, a red dialog box will appear as shown in Figure 7-5.
    a. The error types can be viewed under the **Import Event**.
    b. Click on **View Log** to be taken to a page that explains the errors.
    c. Use the explanation of errors in **View Log** to make corrections to the spreadsheet.

Figure 7-5. Result of Uploading a Dataset That Contained Errors.

15. Delete the dataset if it has errors by clicking **Delete** in the upper left corner. The user must correct errors in the template and re-upload rather than attempt to fix errors by clicking **Resolve Online.**
16. Repeat the upload process again and make sure to upload the updated spreadsheet.
17. Once the spreadsheet uploads successfully without errors, a yellow dialog box will appear that says that the dataset is ready to be migrated, as shown in Figure 7-6. Note that only valid monitoring locations will be migrated.

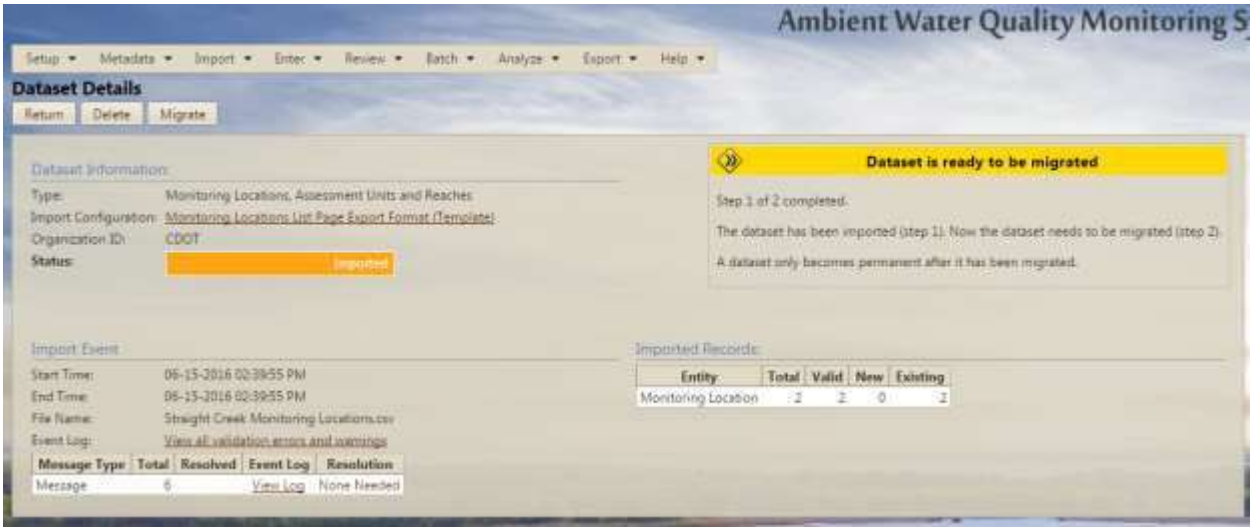

Figure 7-6. Result of Uploading a Dataset Without Errors.

18. Click **Migrate** in the upper left corner.
    a. Depending on the amount of data, and if results are being updated, this process can take 20 minutes or more.
    b. If a dataset has already been migrated, but the dataset needs to be changed, make the corrections in the spreadsheet, and follow the upload procedure but select **This file may contain new and/or existing data** in the **New or Existing Data** section.

19. Once the migration is complete, a green dialog box will appear that states that the migration was successfully completed, as shown in Figure 7-7.

Figure 7-7. Successful Migration of a Dataset.

7.4.5 Step 3 – Formatting Activities and Results

1. Input activities and results into the provided activities and results template (located in the appendix).
2. The following field must be filled out in the template for each result: Project ID (Project ID codes are described in Section 6.1), Monitoring Location ID, Activity ID, Activity Start Date, Activity Type, Activity Media Name, Activity Media Subdivision Name, Sample Collection Method ID, Sample Collection Equipment Name, Characteristic Name, Result Value, Result Unit, Result Sample Fraction, Result Value Type, Result Analytical Method ID, Result Analytical Method Context, Analysis Start Date, Analysis Start Time, Result Detection Type, Result Detection Measure, Result Detection Unit, Laboratory Sample Preparation Method ID, and Laboratory Name.
    a. Activity start date must be in yyyy/mm/dd format.
    b. Activity Start Time must be in h:mm:ss AM/PM format.
    c. Activity Start Time zone will typically be MST or MDT.
    d. If a result is described as Bicarbonate as $CaCO_3$, then the **Characteristic Name** is Bicarbonate and the **Method Speciation** is as $CaCO_3$.
    e. Check the units of pH; sometimes this is reported as su. None is an acceptable domain value for pH's **Result Unit.**

f. Referencing the CDSN Minimum Data Elements Upload Template (included in appendix) when formatting the results and activities data can be very beneficial because this method provides acceptable domain values for parameters and examples of formatting.

g. See Step 5 – Trouble Shooting if you experience any issues.

3. The other parameters are not required, but as many as possible should be provided.
4. Some data that are not initially required will become required depending on which fields are filled out.
   a. For instance, **Sample Collection Method ID** is required when **Activity Type** contains the word "sample."
   b. Figuring out secondary requirements is an iterative process and may take several cycles of uploading the dataset, reviewing, and correcting errors. Properly preparing data and selecting allowable values will reduce the number of iterations required.
5. Once all of the data have been added to the template, proceed to Step 4.

7.4.6 Step 4 – Uploading and Migrating Results and Activities Data

Uploading results is typically the most challenging aspect of adding data to AWQMS. This process is typically iterative and consists of attempting to upload data, analyzing error messages, modifying data in the template, and re-uploading data.

1. Go to the **Import** tab and select **Results & Activities**.
2. From the **Import Configuration** dropdown menu, select **CDOT Results & Activities Template ~ 2532.**
3. The **Type of File** should be **CSV (comma-delimited).**
4. Under **Generated Values,** click on **{none}**. Select **CDOT** from the menu**.**
5. Under **New or Existing Data,** use the default setting **This file contains new data only**.
6. Use the default option for **If import file is free of errors and warnings.** Remember to review your dataset before migrating.
7. Click **Choose File** next to **Import File** under the **Import File(s)** heading. Select the csv version of the upload template that is filled out with the results to be uploaded.
8. Click **Import Data** in the top left of the page.
9. A new page will appear that displays the progress of the upload.
10. If any errors are found during the upload, a red dialog box will appear.
    a. Error types are shown in the **Import Event** section.
    b. Click on **View Log** to open a new page that explains the errors.
11. Make corrections for any errors to the spreadsheet based on the import log. Note: warnings about Characteristics not being configured as valid parameters in the Quality Control Threshold table can be ignored.
12. Delete the unsuccessful upload by clicking **Delete** in the upper left corner.

13. Repeat the upload process again and make sure to upload the updated spreadsheet.
14. Once the spreadsheet uploads successfully without errors, a yellow dialog box will appear that says that the dataset is ready to be migrated.
15. Click **Migrate** in the upper left corner.
    a. Depending on the amount of data and if the dataset is being updated, this process can take 20 minutes or more.
    b. If a dataset has already been migrated but needs to be changed, make the corrections in the spreadsheet and follow the upload procedure but select **This file may contain new and/or existing data** in the **New or Existing Data** section.
16. Once the Migration is complete a green dialog box will appear stating the migration was completed successfully.

Check that the results and activities have migrated.

1. Go to the **Review** tab find and click on **Activities.**
2. Select **CDOT** from Organization ID.
3. Select a Project ID.
4. Click **Search** in the upper left corner.
5. A new page will appear that display all of the activities associated with the project, as shown in Figure 7-8.
6. To look for activities associated with another project click **Clear Search Criteria** in the upper left corner and once again select **Organization ID** and **Project ID** and click **Search.**
7. When finished, log out by clicking **Log Out** in the upper right corner of the page.

7.4.7 Step 5 – Troubleshooting

Formatting and uploading the datasets can go wrong in many places. The following is a discussion of common problems and solutions. If you cannot determine the appropriate value(s) or domain for a particular parameter, consult the following:

- CDSN Minimum Data Elements Fact Sheet (see Section 9).
- CDSN Minimum Data Elements Upload Template (see appendix). Some of the parameters have links to other sheets that provide details on acceptable values.
- Metadata pages on the AWQMS website associated with certain topics.
- Manual upload pages on the AWQMS website for monitoring locations, projects, results, and activities.

Sometimes the values in the domain of a parameter are not defined in any of the above locations. However, domain values for certain parameters can be added. For instance, if the Result Analytical Method ID and the Result Analytical Method Context are unknown, a domain value of Unknown can be added. Go to the

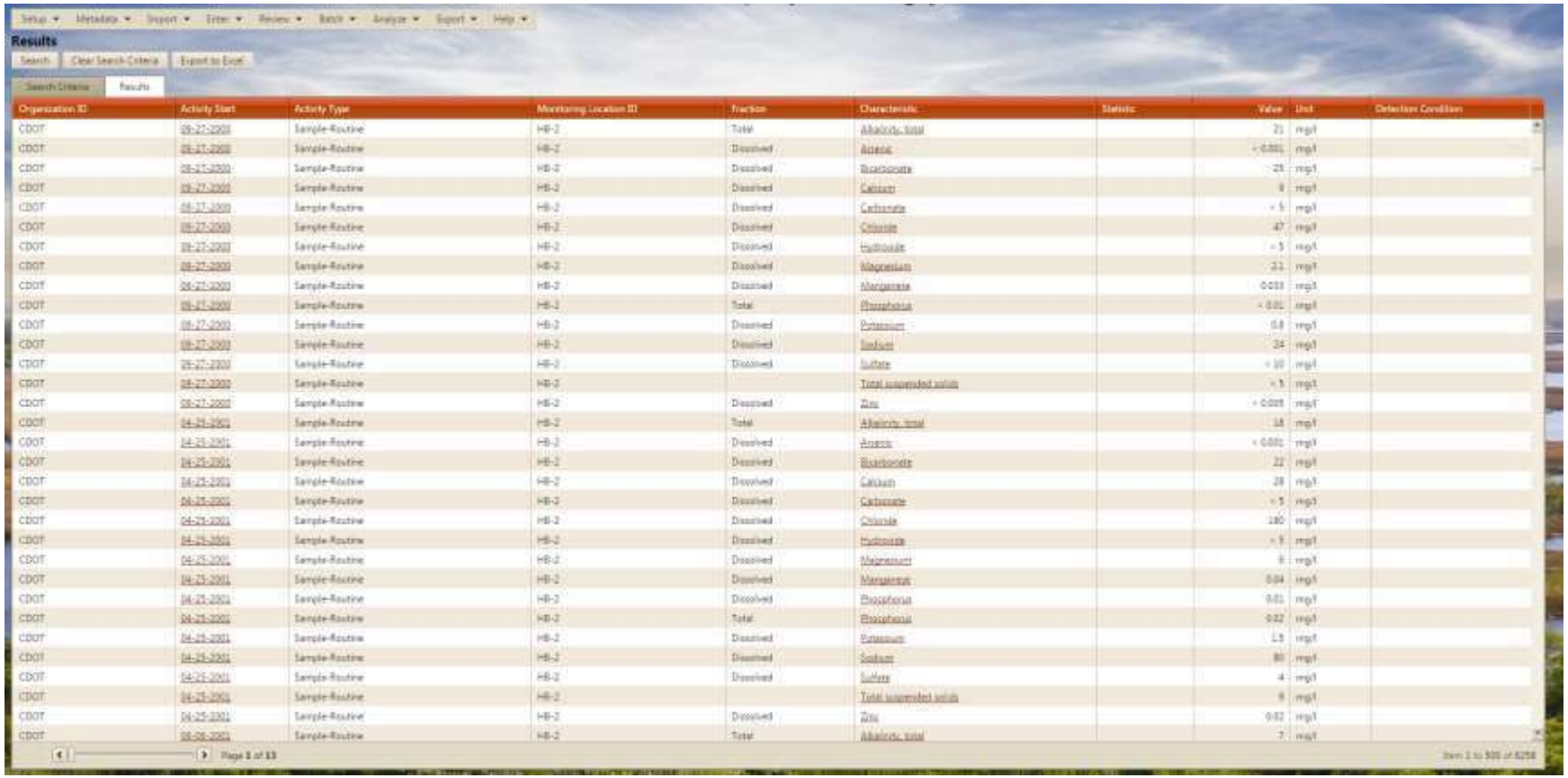

Figure 7-8. Reviewing Successfully Migrated Results.

Metadata tab > **Analytical Methods**, from the **Context** dropdown menu select **CDOT**. Click **Add New**, in the dialog box for **ID** type Unknown, in the **Name** dialog box type Unknown. After click **Save**, Unknown will now be a Result Analytical Method ID and CDOT will be the Result Analytical Method Context.

Always use the CSV format. The xls and xlsx spreadsheet formats can cause uploading issues even when the spreadsheets are otherwise identical. If a dataset was uploaded and migrate, and the results are not appearing when reviewed, the Result Analytical Method ID and the Result Analytical Method Context likely were not provided.

Results and activities cannot be uploaded and migrated into the database if the associated monitoring location has not already been uploaded and migrated into the database.

The CDSN project coordinator can also be contacted for further assistance as described in Section 8.

7.5 REPORTING REQUIREMENTS

CDOT is required to report submit electronic Discharge Monitoring Reports (DMR) to NetDMR. Once data are fully loaded to AWQMS, the appropriate fields can be automatically pushed to other database entities, such as NetDMR.

7.6 DATA INPUT QUALITY CONTROL

Before final quality data are inputted into AWQMS, an independent QC check should be performed by checking for correct data entry at a 10 percent frequency or at a level consistent with the project QA Plan. As previously mentioned, the quality of the data from the field and laboratory must be reviewed and deemed acceptable before AWQMS entry.

7.7 PROCESS CONTACTS

DTD Environmental Programs Branch
Water Quality Section (WQS)
WQS Programs Manager
Phone: 303-512-4053
Further technical assistance can be obtained by contacting the CDSN coordinator at *cdsn@coloradowaterdata.org*
Link to PDD, SAPP, SOP's, and all templates:
https://www.codot.gov/programs/environmental/water-quality/stormwater-programs.html

7.8 REFERENCES

Ambient Water Quality Monitoring system, 2017. "AWQMS-Cloud," *goldsystems.com,* retrieved Nov 28, 2017, from http://awqms.goldsystems.com/Login.aspx

Colorado Data Sharing Network, 2017. "Colorado Water Data," *coloradowaterdata.org,* retrieved Nov 28, 2017, from http://www.coloradowaterdata.org/cdsnawqms_cdsn.html

Colorado Data Sharing Network, 2016. "CDSN Minimum Data Elements Fact Sheet," *coloradowaterdata.org,* retrieved June 11, 2016, from *http://www.coloradowaterdata.org/cdsnawqms_cdsn.html*

8.0 PERSONNEL AUTHORIZATIONS AND OVERSIGHT

Purpose:
The purpose of this Standard Operating Procedure (SOP) is to provide documentation to identify the personnel responsible for quality assurance/quality control (QA/QC) of all of the data that result from a sampling event; verify that all of the appropriate steps were taken before, during, and after the event; and verify that field personnel have completed all of the necessary training requirements.

Date of Last Review:
November 29, 2017

Sampling Program:
Wet Weather Monitoring (WWM) Program

Sampling Task:
Colorado Department of Transportation (CDOT) Permanent Control Measure(s)

8.1 INTRODUCTION

CDOT's WWM program is required to follow US Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) WWM regulations. To ensure that sampling procedures, safety requirements, and reporting protocols are followed, the program has an organizational structure that assigns specific responsibilities to each personnel. CDOT's Program Description Document (PDD) divides the management responsibilities between the CDOT WWM Manager and the Water Quality Section Manager. This SOP will focus on responsibilities of each tier.

8.2 PROGRAM ORGANIZATIONAL STRUCTURE

8.2.1 Colorado Department of Transportation Wet Weather Monitoring Manager

The CDOT WWM Manager is responsible for supervising the day-to-day operations of the program and all monitoring staff. These operations include tasks during the planning and implementation stage, data collection and data entry, and reporting. A list of responsibilities for the WWM Manager include but are not limited to the following:

- Oversee permit compliance
- Complete the annual data report and data storage
- Maintain the Sampling and Analysis Plan
- Develop and authorize QA/QC procedures
- Ensure that all monitoring staff are properly trained
- Collect field data.

The WWM Manager must verify that monitoring staff complete all of the steps thoroughly during sampling preparation (i.e., instrumentation maintenance, cleaning, and calibration) and the sampling procedure as well as conduct proper clean-up after every event. Monitoring staff should provide the WWM Manager

with a report of the sample procedures followed, monitoring results, and list of documentations made for each sample. Data and results must have approval from the WWM Manager before data are formally submitted into the Final Project's Database, the Ambient Water Quality Monitoring Database (AWQMS).

New monitoring staff must complete all of the training requirements under the WWM program and can only be authorized to sample by the WWM Manager. Generally, new staff should shadow a trained staff member for their first sampling event and have one trained staff member monitor their first event before sampling on their own. The same requirements also apply to any subcontractors or other external entities.

8.2.2 Water Quality Manager

The Water Quality Section Manager is tasked with ensuring that reporting requirements and permit compliance are being followed by the WWM Manager. The Water Quality Section Manager has the following responsibilities:

- Review the annual report
- Ensure that the final annual report is submitted
- Evaluate compliance to the CDOT Environmental Management System (EMS) Program
- Ensure that all QA/QC procedures are adhered to
- Review the annual report
- Ensure that the final report is submitted.

Figure 8-1 exemplifies the work flow for the WWM program, which contains three phases: planning, data collection/entry, and reporting. The data collection and data entry phase will be a continuous loop until all of the required samples are collected in a given year to meet permit requirements.

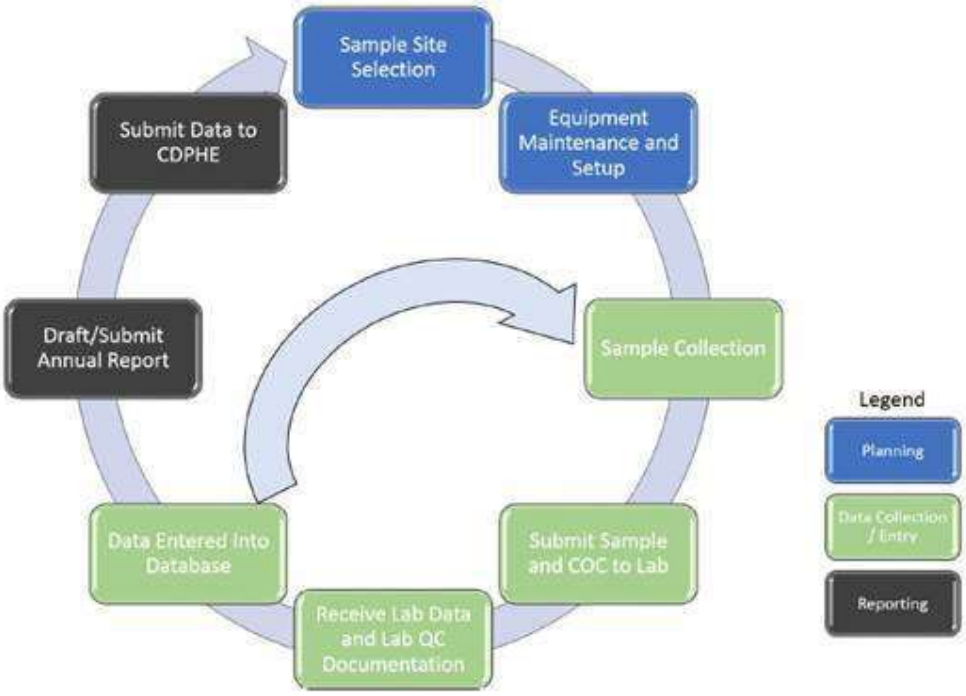

Figure 8-1. Annual Workflow for the Wet Weather Monitoring Program.

8.3 DOCUMENTATION FILING

Monitoring staff are required to file the field logbook, legal records (i.e. Chain-of-Custody), sample results, photographic documentation of the storm sampling event, and summarized report for every event. The WWM Manager is expected to oversee the monitoring staff's work and ensure that all procedures were filed appropriately.

8.4 QUALITY ASSURANCE/QUALITY CONTROL

The WWM Manager is responsible for reviewing the planning procedures and data collection and for ensuring that data entries are correctly filed into the File Project Database. The Water Quality Section Manager is then responsible for ensuring that the final phase of the WWM program work flow is complete, which includes submitting an annual report and data that have been QC checked to the CDPHE. All data must be submitted to the CDPHE via the AWQMS database.

8.5 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005," *codot.gov*, retrieved October 25, 2017, from *https://www.codot.gov/programs/environmental/water-quality/documents/cdot-ms4-permit*

Oswald, J. K., 2016. *Wet Weather Monitoring Program Description Document,* RSI-2641, prepared by RESPEC, Rapid City, SD, for the Colorado Department of Transportation, Denver, CO.

9.0 STANDARD PROCEDURES FOR FIELD SAFETY

Purpose:
The purpose of this document is to provide documentation of field personnel safety procedures and safety checklists for all of the equipment required for Wet Weather Monitoring (WWM).

Date of Last Review:
November 29, 2017

Sampling Program:
WWM Program

Sampling Task:
Colorado Department of Transportation (CDOT) Permanent Control Measure(s)

9.1 INTRODUCTION

The Colorado Department of Public Health and Environment (CDPHE) in compliance with the Colorado Water Quality Control Act have authorized CDOT to discharge from its municipal separate storm sewer system (MS4) in accordance with the effluent limitations, monitoring requirements, and other conditions set forth in Parts I and II of Permit No. COS000005. The permit requires a WWM program to be implemented to assess wet weather impacts from highways and facilities. CDOT will monitor and assess the performance of permanent water quality control measures that are used to control discharge from measurable storm events.

By permit requirements, CDOT staff must collect composite samples from the outfalls of control measures. Inlet structures will also be assessed to calculate a load reduction from the monitored control measures. To complete these tasks, monitoring staff will be required to conduct sampling requirements during and after storm events. Measurable storm events often create an environment with dangerous conditions. Monitoring personnel must be aware of the hazards associated with WWM and follow safety protocol to avoid accidents and injuries.

This Standard Operating Procedure (SOP) will discuss the standard safety equipment required to conduct sampling. Additionally, safety protocols must be followed when accessing a sample site location during or after a storm event. This document forms a safety checklist that all personnel should be familiar with.

9.2 HEALTH AND SAFETY

Stormwater sampling a facility or highway control measure during a storm event is an inherently dangerous activity. Monitoring staff must be aware of the following hazardous conditions:

- Hazardous weather conditions (i.e., lightning, wind, flooding, hail, etc.)
- Confined spaces
- Chemical hazards

- Biological hazards (i.e., rodents and snakes)
- Physical hazards (i.e., traffic, falling objects, sharp edges, and slippery footing)

Monitoring staff must always follow safety protocol when approaching or entering a site location while collecting samples. A safety checklist to avoid hazardous conditions while accessing a sample site follows:

- Be prepared for unpredictable weather
- Wear CDOT-approved safety vest and hard hat
- Wear CDOT-approved steel toed
- During warm seasons or summer conditions wear snake gators
- Other protected equipment such as waders are advisable.
- Maintain access to cell phone for emergency calls
- Never enter confined spaces at any time without following Confined Space Procedures
- Note locations of hospitals
- Wear disposable gloves if there is potential for contact with sample water
- Assume that any sample represents a potential biohazard
- Keep first aid kits on hand, in every vehicle
- Maintain updated tetanus, hepatitis B, and typhoid immunizations
- Be aware of and avoid garbage bags that may contain hazardous waste
- Be aware of surroundings and/or the homeless population. If not secure, leave and contact the WWM Manager for assistance.

Even shallow streams can be dangerous because of high velocities, slippery beds, or murky water. Movements while near the storm discharge and while approaching a sampler enclosure should be slow and careful, and foot placement should be sure and solid. Often, field personnel slipping or tripping can be the cause of injury or death, even in very shallow water (less than 4 inches) because of being submerged after being knocked unconscious.

Field personnel need to use good judgment before entering a site location. No sampling personnel should place themselves in danger during adverse weather conditions, such as high winds, lightning storms, or flooding conditions, which might be unsafe. A less hazardous event should be sampled under extreme conditions.

9.3 DOCUMENTATION

Any safety training or emergency programs that are completed by monitoring staff must be documented with the sampler's name, date of completion, and signature. Documentation that contains the safety items discussed above should be kept on file to reference for renewals.

9.4 QUALITY ASSURANCE/QUALITY CONTROL

The Water Quality Manager is responsible for ensuring that all monitoring staff complete the necessary training to conduct sampling procedures. Any safety, field training, and emergency programs will be overseen by the WWM and/or the Water Quality Manager before staff enter the field. All field personnel should use the lists provided in this SOP as a safety checklist to ensure that appropriate equipment are available and easily accessible for each monitoring event. The Water Quality Manager should perform spot checks to determine if safety meetings are conducted and documented in the project file.

9.5 REFERENCES

Colorado Department of Public Health and Environment, 2015. "Authorization to Discharge Under the Colorado Discharge Permit System, Permit Number COS000005,"

US Environmental Protection Agency, 1992. *NPDES Storm Water Sampling Guidance Document*, EPA 833-B-92-001, prepared by the US Environmental Protection Agency, Office of Water, Washington, DC.

Colorado Department of Transportation, 2017 Policy Directive, Employee Safety Program-Excellence in Safety 80.0 Effective 5/16/2016

APPENDIX A
CALIBRATION WORKSHEETS

AUTOMATIC SAMPLER/ATTACHMENTS CALIBRATION

CDOT Site ID/Name			
DATE:	**TIME:**	**Personnel:**	
Latitude:		**Longitude:**	
Sampler Reading before Calibration From the status menu			
Battery:	A/V Level:	Flow:	Precipitation amount:
Previous Program Start Date:		Time:	
Sampler Calibration including Area Velocity Meter, Pump Operations, Distributor Arm, and Solar Panel			
Review all Set-up information:	Good		Reset
Check Distributor Arm:	Good	Bad	Fixed
Check Pump Operations:	Good	Bad	Fixed
Check Solar Panel & Clean:	Good	Bad	Fixed
Check Tipping Bucket:	Good	Bad	N/A
A/V Level:	Flow:	Battery:	
Calibration Successful:	YES	NO	
DATE:	**TIME:**	**Program Running:**	**YES NO N/A**
Collected By:		Signature:	

Comments: