Outfall Field Screening Manual

Prepared for

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Introduction

The Illicit Discharge Detection and Elimination (IDDE) Program was developed by CDOT to screen the MS4 for illicit discharges, illegal dumping, and illicit connections in response to citizen (members of the general public) complaints and CDOT staff observations. CDOT relies heavily on its maintenance staff to observe and scrutinize CDOT's MS4 outfalls for illicit discharges, illegal dumping and illicit connections, during their routine duties. In addition to reports from the general public and CDOT staff observations, the next field screening tool is the Outfall Reconnaissance Inventory (ORI). The ORI is used to develop a systematic attribute inventory of the physical conditions found at each outfall, resulting in a GIS based map of the CDOT MS4 infrastructure.

The primary field investigation methodology involves Dry Weather Screening. An important component of the storm sewer program, dry weather screening helps to ensure the integrity of the stormwater drainage system by detecting non-stormwater discharges during dry weather conditions.

Each illicit discharge is characterized by a unique frequency, composition, and mode of entry into the storm drainage system. For any IDDE program to be successful, it is important to clearly understand the variety of types of illicit discharges so that the appropriate steps toward elimination of the discharge can be taken.

Once implemented, this IDDE program establishes procedures and protocols to determine discharge frequency, composition, and identification of land use(s) associated with that particular class of discharge. Once this baseline information is obtained it is possible to trace the illicit discharge back to its source and take the necessary steps to eliminate it.

Illicit discharges can be generally classified into three (3) distinct categories based upon the frequency of the discharge:

1. **Transitory Illicit Discharge:** These are typically one-time events. They can result from spills, dumping, or line breaks. These types of discharges are often the most challenging to identify and eliminate. Methods for reducing the frequency of this type of discharge are to inform and educate the public on the importance of storm water management and the impacts of illicit discharges on stormwater quality. Establishment of a "Illicit Discharge Reporting Hotline" for the publics use when illicit discharges are observed, will facilitate the speed with which illicit discharges are removed.

2. **Intermittent Illicit Discharge:** These are typically discharges that occur periodically. They can occur several times per day, per week, or sporadically over the course of a year. They can occur as the result of sanitary sewer or water line breaks, or cross connections.

3. **Continuous Illicit Discharge:** Typically these are direct connections into the MS4 and can originate from sanitary sewers, cross connections, infrastructure problems with a sanitary sewer system, or malfunctioning household sewage treatment systems (HSTS). This type of discharge is the easiest to detect investigate, trace and eliminate from the MS4. These types of discharges also have the greatest impact on water quality due to constant pollutant loading into a water body.

Because field screening is only performed on a periodic basis, its usefulness in detecting transitory or intermittent discharges, or releases such as spills, is limited. However, the field screening procedure described in this manual can be expected to detect any ongoing illicit discharges and reveal potential signs of transitory and intermittent discharges. It can also be used during a response to a report of a potential illicit discharge.

Typical sources of illicit discharge include improper cross connections between sanitary or industrial sewers and storm sewers, spills that flow into the storm drainage system, and other non-stormwater sources that flow into the storm sewer system.

Illicit discharges can also be classified by how they enter the storm drain system. This entry can be direct or indirect.

- **Direct entry** is discharge that is directly conveyed to the storm drain pipe system via a pipe. This type of entry will produce discharges that are either

continuous or intermittent. Direct entry usually occurs when there are sewage cross-connections, or where there are industrial and commercial cross-connections.

- **Indirect entry** means that flows generated outside the storm drain system, enter through storm drain inlets or by infiltrating through the joints of the pipe. Generally, indirect modes of entry produce intermittent or transitory discharges. This type of entry can include groundwater seepage into the storm drain pipe, spills, dumping, outdoor washing activities, and irrigation from landscaping or lawns that reaches the storm drain system.

As part of the Illicit Discharge Management Program, field screening is generally implemented during dry weather periods when no stormwater flow is occurring. The premise behind screening is that any flows discharging from a storm sewer during dry weather are potentially an illicit discharge. However, such discharges can be related to approved non-stormwater discharges, including; landscape irrigation, diverted stream flows, rising groundwater, uncontaminated groundwater infiltration, uncontaminated pumped groundwater, discharges from potable water sources, foundation drains, air conditioning condensation, agricultural irrigation water, springs, water from crawl space pumps, footing drains, individual residential car washing, flows from riparian habitats and wetlands, street wash-water or a discharge permitted under the Colorado Discharge Permit System (CDPS). The analytical tests performed during screening will allow Colorado Department of Transportation (CDOT) personnel to determine if dry weather flows are an illicit discharge. The program is designed to target sources of illicit discharges and to provide corrective measures for illegal or poorly constructed connections.

The purpose of this manual is to provide guidance to CDOT field inspection teams when performing field screening. This manual includes direction on frequency with which field screening should be performed, discusses possible sources of potential pollutants, field procedures for performing field screening, guidelines for investigating an illicit discharge, procedures for sample collection, staffing and equipment requirements. The procedures described here were created for tracking, reporting, and follow-up activities conducted by CDOT. Tracking protocols include documenting field screening results using the Outfall Field Data Sheet contained in Appendix A. The tracking method includes an electronic format of the form for entering into a database and for yearly reporting to the Colorado Department of Public Health and Environment (CDPHE).

Outfall Reconnaissance Inventory (ORI)

The Outfall Reconnaissance Inventory (ORI) is used by CDOT to develop a systematic outfall inventory and map of its MS4. Field personnel will record the location of any outfall that they suspect is within the jurisdiction of CDOT. While performing this inventory, CDOT will field-screen outfalls for physical and visual observations such as deposits, staining, and presence of trash. If a dry weather flow is present, the flow rate will be estimated and the flow will be sampled and observed for visual and physical characteristics such as odor, color, clarity, and presence of floatables. The sample will then be analyzed for pH, conductivity, temperature, chlorine, copper and phenol. If deemed appropriate , or occasionally for verification of field analysis, a sample of the dry weather flow will be sent to a third-party analytical laboratory for analyses. This manual also includes the outfall data sheet that CDOT will use to record information gathered at each outfall during ongoing field screening visits.

Mapping Methodology

Mapping all storm outfalls within CDOT jurisdiction is resource intensive. In order to utilize CDOT resources effectively and target high-potential areas for illicit discharge, a list of conditions was established to identify priority areas for mapping. CDOT's mapping methodology for priority areas was developed following guidelines presented in the EPA webcast "Developing your IDDE program" and from the EPA document "Illicit Discharge Detection and Elimination: A Guidance Manual for Program Development and Technical Assessments." The following was used to develop priority areas:

1. Waters of the State - State Highway that crosses over waters of the state
2. Impaired stream segments (303d)- stream can parallel or intersect. Only streams with highway constituent impairments will be mapped. (refer to AASHTOs list of highway constituents)
3. Major CDOT highways and roads- 0.5 Miles of centerline
4. Industrial or Commercial Zoning

Phase II areas where the local agency has begun mapping will be given priority over areas where no mapping has been completed to compliment what has already been accomplished on the local level. In order to maximize efficiency, mapping of the CDOT system within a community should be complete before moving to the next community. When initiating mapping within a community, areas identified as high potential for illicit discharge should be mapped first.

Based on ongoing reconnaissance fieldwork, observations from CDOT employees, and the number of complaints received from the public regarding illicit discharges, some areas may need to be reprioritized.

After determining the high priority mapping areas, the following procedures were developed for field surveys:

Frequency of Screening

Outfalls will be inspected and sampled in response to complaints received by the CDOT Hotline (303-512-4426). Inspections will also be initiated in response to observation by CDOT Maintenance staff while in the field. Re-inspection will occur annually at high priority or high risk outfalls.

Sources of Potential Pollutants

During field screening, the presence of a dry weather flow alone is not conclusive evidence of an illicit discharge. The presence of one or more indicator parameters is needed to verify an potential illicit storm sewer discharge. Observations for color, oil sheen, surface scum (floatables), odor, clarity, and sanitary sewer evidence etc. are made of any dry weather discharge. Field or laboratory analyses are used to quantify turbidity, pH, total chorine, total copper, total phenol, and detergents (surfactants). The significance and potential source contributors of the analytes listed above are summarized in this section.

Description of Pollutants

Color, odor, clarity, and the presence of an oil sheen, surface scum, and sanitary sewage are difficult to quantify and are a subjective opinion of the observer. Some of these constituents are common in stormwater discharges and should not be the sole basis for concluding that a storm sewer discharge is illicit. In some dry weather discharge these constituents could be the result of street cleaning operations, car washing, and general water sources (some of these sources are classified as non-illicit discharges). The observed presence of these constituents might be used in supporting field and laboratory assessment results. However, the observed presence of sanitary sewage such as feces, toilet paper, corn, eggshells, and coffee grounds is a very reliable indicator of the presence of illicit stormwater discharge. The presence of sanitary sewage would indicate the presence of an unapproved sanitary sewer connection to the storm sewer system.

Ammonia
Elevated levels of ammonia is an indicator of sewage. High ammonia concentrations may also indicate liquid wastes from some industrial sites. Ammonia is relatively simple and safe to analyze. Some challenges include the tendency for ammonia to volatilize and its potential generation from non-human sources, such as pets or wildlife.

Chlorine
Chlorine is widely used as an oxidizing agent and as a disinfectant in the control of waterborne diseases. Chlorine is also used in the water and wastewater treatment process for disinfection of drinking water, and removal of ammonia from wastewater. Industrial uses for chlorine include controlling biological growth in cooling towers, condensers, and other process equipment. Chlorine also is used as a disinfectant in swimming pools, both municipal and private. While the release of any of these sources into the storm sewer may be considered an illicit discharge, the presence of chlorine alone is not a good indicator. Since potable water is used for irrigation, detectable levels could occur in runoff to the storm sewer. The presence of chlorine is not necessarily indicative of an illicit discharge. However, if chlorine concentrations are similar to those found in the local municipal drinking water supply, it can be an important indicator as to the source of the discharge.

Color
Color is a numeric computation of color observed in a water quality sample. Both industrial liquid wastes and sewage tend to have elevated color values. Color occurs in natural surface waters and groundwater. Color generally results from metallic salts, organic matter, or other dissolved or suspended solids. Industrial wastes generate specific colors which vary with pH levels. For example, the observance of a green to strong yellow color would be a likely indicator of the presence of chromate or chromium. Color may be a good first screen for problem outfalls, but needs to be supplemented with other indicator parameters.

Conductivity
Conductivity is an indirect indicator of dissolved solids. Conductivity is often strongly correlated with the total amount of dissolved material in water, commonly known as Total Dissolved Solids. The utility of conductivity as an indicator depends upon whether concentrations are elevated in "natural" or clean waters. Variations between wastewater and surface water can be substantial enough to indicate the source of the dry weather flow. Observed conductivity levels in water range from 25 to 100,000 uS/cm. Determining the conductivity of a discharge is easy and inexpensive, which is useful in tracking the source of the discharge.

Copper
In most areas, the occurrence of copper in stormwater would most likely be caused by a industry which either uses or manufactures copper-based products. However, in areas of the West and Southwest such as Colorado, copper is often found naturally in low concentrations in soils and groundwater. In addition, tap water and potable water supplies used for irrigation may have copper present in the range of 1-2mg/L due to the corrosion of copper piping.

Industrial sources of copper include:

- Copper manufacturing (smelting)
- Copper metal processing/scrap re-melting
- Circuit board manufacturing
- Metal plating
- Chemicals manufacturing
- Analytical laboratories
- Power plants
- Electronics
- Wood preserving
- Copper wire production

In each of these industries, copper-containing wastes normally would be discharged to a treatment facility. Sludge from the waste treatment facility, whether treated onsite (including wastewater lagoons) or in publicly operated treatment facilities, would contain significant levels of copper. If the sludges were not disposed of or stored properly, or if partially processed wastewater tanks were illegally discharged, copper could enter the storm sewer system and would be detected in a dry weather discharge.

Detergents
Most illicit discharges from anthropogenic sources have elevated concentration of detergents. Detergents, soaps, and surfactants can be found in a multitude of forms and may come from many sources. Typical industrial sources would include:

- Soap and detergent manufacturing
- Chemical manufacturing
- Cleaning supplies manufacturing/repackaging
- Commercial laundries
- Textile manufacturing
- Aircraft, automobile, and truck washing
- Garment manufacturing and finishing
- Petroleum production

The nearly universal presence of detergents in illicit discharges, combined with their absence in natural waters makes them an excellent indicator. Research has revealed three indicator parameters that measure the level of detergent or its components—surfactants, fluorescence, and surface tension. Surfactants have been the most widely applied of the three indicators. Fluorescence and surface tension show promise, but only limited field testing has been performed on these more experimental parameters.

E. coli, enterococci and Total Coliform

Each of these bacteria is found at very high concentrations in sewage and is a good indicator of sewage or septage discharges, unless concentrated areas of pet or wildlife exist within the subwatershed. Overall, bacteria are good supplemental indicators and can be used to identify streams or outfalls that exceed public health standards. Relatively simple analytical methods are available to test for bacteria indicators, although they still suffer from two monitoring constraints. The first is the relatively long analysis time (18-24 hours) to get results, and the second is that the waste produced by the tests may be classified as a biohazard and require special disposal techniques. Since E.coli is not considered a highway runoff constituent, CDOT will engage the local municipality and/or CDPHE to obtain these samples and assist in any additional investigation that may follow.

Odor

The odor of a discharge can vary widely and may directly reflect the source of contamination. Strong odors, gasoline, oils, and solvents facilitate a rapid response by field personnel because the odor assists in tracking down the source. Obvious odors emanate from gasoline, oil, sanitary wastewater, industrial chemicals, and decomposing organic wastes. Examples include:

- Sewer (outhouse smell): associated with stale (septic) sanitary wastewater.
- Sulfide (rotten eggs smell): meat packers, canneries, dairies, and stale sanitary wastewater.
- Oil and gas (gasoline or asphalt smell): petroleum refineries and facilities associated with vehicles, discharges from Leaky Underground Storage Tank (LUST) sites.
- Rancid sour (spoiled food smell): food preparation facilities.

pH

A typical range for pH in natural waters is between 6.0 and 8.5. In most carbonate water systems, the pH is buffered to around 6.0 to 6.6. Low values of pH indicate the possible presence of acidic compounds in the water, and high pH values indicate the possible presence of alkaline compounds. The presence of acidic or alkaline compounds in water can be the result of many types of municipal and industrial uses.

Lime used in water softening and other water treatment processes raises the pH to as high as 11.0. The wastes from many industries, such as pharmaceuticals, are strongly acidic. Wastes associated with concrete are strongly alkaline. The pH of residential wash water tends to be rather basic (pH of 8). Discharges from any of these sources can affect the pH of naturally well-buffered waters. The pH of a discharge is very simple to monitor in the field with low cost test strips or probes. Although pH data is often not conclusive by itself, it can identify problem outfalls that merit follow-up investigations using more effective indicators.

Phenol

Total phenol would normally include phenol and the ortho-/meta-substituted phenols. Phenol is a very commonly occurring chemical and can be found in foods, medicines, petroleum products, and cleaning products, as well as industrial products and byproducts. Generally, the appearance of phenols in dry weather discharge would indicate an improper industrial sewer connection to a storm drain or ditch. Runoff from treated wood storage yards (treated lumber, telephone poles, etc.) and improper disposal of cleaning products would also contain phenols.

Industrial sources of phenol include:

- Chemical manufacturing (organic)
- Textile manufacturing
- Paint and coatings manufacturing
- Metal coating
- Resin manufacturing
- Tire manufacturing
- Plastics fabricating
- Electronics
- Oil refining and re-refining
- Naval stores (manufacture of turpentine and other wood chemicals)
- Pharmaceutical manufacturing
- Paint stripping (automotive, aircraft, etc.)
- Military installations (rework and repair facilities)
- Coke manufacturing
- Iron production
- Ferro-alloy manufacturing

Other sources would include improper handling and disposal of cleaning compounds by institutions such as hospitals and nursing homes, and discharge from areas containing improperly stored drums of phenolic products.

Surface Scum/Floatable Matter
Dry weather flows that contain floatable matter may indicate an illicit discharge. This matter includes both floating liquids and solids. Evaluation of floatables can lead to identification of potential pollution sources because such substances are usually direct products or byproducts of the process. Examples include:

- Soap Suds: associated with the washing of an object such as a vehicle.
- Oil Sheen: petroleum refineries, storage facilities, and vehicle service facilities, and
- LUST sites.
- Fecal Matter and sanitary discharge: sanitary wastewater.
- Trash: associated with stormwater or with washing down areas (such as parking lots) into the storm sewer.

Surfactants
Surfactants are the active ingredient in most commercial detergents, and are typically measured as Methyl Blue Active Substances (or MBAS). They are a synthetic replacement for soap, which builds up deposits on clothing over time. Since surfactants are not found in nature, but are always present in detergents, they are excellent indicators of sewage and wash waters. The presence of surfactants in cleansers, emulsifiers and lubricants also makes them an excellent indicator of industrial or commercial liquid wastes. The most common analysis method uses chloroform as a reagent, and is recommended because it is relatively safer when compared to other reagents. Be sure to read and understand the test procedure and MSDS for chloroform before testing in the field.

Temperature
An elevated temperature can indicate an illicit discharge, particularly in cold weather. Sanitary wastewater and cooling water discharges are examples of sources that cause elevated water temperature.

Turbidity
Turbidity is a quantitative measure of cloudiness in water and is normally measured with a simple field probe. Turbidity occurs naturally in most surface waters and groundwater. Turbidity is generally the result of suspended clay, silt, organic, and inorganic matter in the water. If the dry weather discharge turbidity measurements significantly exceed typical values of local surface waters, one might conclude the presence of an illicit discharge. But as with oil sheen, surface scum, and odor, this should be used only in support of field and laboratory results.

Dry Weather Screening Procedures

It is important when screening for dry weather discharges to ensure that any discharge found is not commingled with stormwater runoff. To insure an accurate characterization of the discharge all outfall sampling and inspections will be conducted 48 hours or more after the end of a precipitation or snowmelt event. CDOT will utilize field inspection teams consisting of a minimum of two people to ensure safety, efficiency, proper documentation, and quality testing. Inspection teams will consist of one team leader and at least one sampler/technician.

CDOT will document dry weather field screening activities with the Outfall Field Data Sheet (Appendix A). This form will be used for initial site inspections and to document follow-up activities should a potential illicit discharge be detected. This form includes data fields such as color, odor, and floatable material. For tracking purposes, the information collected in the field and from follow-up laboratory work will be entered into a CDOT database.

The field inspection team leader is responsible for documenting the field inspections and the follow-up activities in the database. The database will be updated after each field screening activity. If the outfall inspection requires follow-up, the inspection team will document the follow-up activities in the Outfall Field Data Sheet. The team leader is responsible supplying the Water Quality Program Manager with an electronic version of the field screening activities for reporting purposes.

Data Collection

If the outfall has a discharge at the time of the dry weather screening site visit, and meets the screening criteria in Table 1, the field inspection team will collect a minimum of three l-liter well-mixed samples and perform the visual observations and field analyses outlined in this section with 1-liter of the collected sample. The remaining two 1-liters of the discharge sample are reserved for potential laboratory analyses.

The following paragraphs describe the information to be recorded in each section of the Outfall Field Data Sheet, visual observations to look for, how to estimate flow, the parameters to measure, and methods of field analyses to use. This information is organized according to the sections of the Outfall Field Data Sheet. Standard procedures for sample collection and handling are provided later in this manual and should be referenced prior to performing a dry weather field screening visit.

Table 1 - Screening Criteria for Outfalls

Outfalls that Require Screening

- Both large and small diameter pipes that appear to be part of the storm drain infrastructure
- Outfalls that appear to be piped headwater streams
- Field connections to culverts
- Submerged or partially submerged outfalls
- Outfalls that are blocked with debris or sediment deposits
- Pipes that appear to be outfalls from stormwater treatment practices
- Drop inlets from roads in culverts
- Pipes that appear to only drain roof downspouts but that are subsurface, preventing definitive confirmation

Outfalls that Do Not Require Screening

- Cross-drainage culverts in transportation right-of-way (can see daylight at other end)
- Parking lot drains to curbs
- Weep holes
- Flexible HDPE pipes that are known to serve as slope drains
- Pipes that are clearly connected to roof downspouts via above-ground connections

Outfall Field Data Sheet

The Outfall Field Data Sheet is located in Appendix A. The outline below provides descriptions of the various data fields. Appendix F contains the Illicit Discharge Detection and Elimination (IDDE) Field Pocket Guide which contains photo examples and other useful information while in the field.

General and Section 1: Background Information

1) Outfall Identification Number -If the outfall identification number is known it should be entered on the form. If it is not known, a detailed location description, or GPS location, should be attached to the Outfall Field Data Sheet.
2) GPS Unit – Identify the GPS unit being used
3) Date -Enter date of visit in MM/DD/YY format,
4) Time -Enter time of visit in 24 hour HH:MM format.
5) Inspection Team -Identify the team leader who will be responsible for completing the questions on the Data Sheet.
6) Reason for Visit -Check the reason for the visit, either routine monitoring, repeat/follow-up visit, hotline call, special investigation, or other. If "other," specify reason for visit. Photo Taken? -Take a picture of the sample site to document discharge and condition. Record the Photo ID Number on the form for all pictures taken of the sampling site and dry weather screening.
7) Location -The location description should include the CDOT highway, mile post, and/or distance and direction from the nearest cross streets or specified landmarks. GPS coordinates may also be entered.
8) Drains To – Indicate where the outfall drains to (ditch, gulch, manhole, stream or other). This location could be adjacent to the outfall or further away.
9) Precipitation Within Last 24-48 hours -The exact time and date of previous precipitation is NOT required. Enter approximate amount of precipitation in the last 24/48 hours. Data can be found at http://www.wunderground.com/ or from NOAA at http://www.weather.gov/climate/index.php?wfo=bou on the "NOW Data" tab
10) Land Use - Indicate if the dominant land use of the drainage area is highway, industrial, commercial, residential, unknown, or other. If "other," describe in the space provided.
11) Notes - Enter any other identifying information about the outfall including origin of outfall, permit number, outfall owner, etc. This space should also be used to add additional information if "other" was checked in any part of the section.

Section 2: Outfall Description

12) Outfall Type – Indicate the configuration of the outfall (closed pipe, manhole, open channel or other).
13) Outfall Diameter/Dimensions – Measure the diameter if circular, measure both horizontal and vertical diameter if elliptical, measure vertical and horizontal distances if box, and measure both width and depth indicating shape (Trapezoidal or Parabolic) for a chute.
14) Submerged in Water – Indicate whether the outfall is submerged in water. Partially submerged is defined as less than half the pipe diameter or equivalent. Fully submerged is defined as greater than half the pipe diameter or equivalent.
15) Material – Identify whether outfall is predominantly concrete, CMP, PVC, grass channel, or other. If "other," describe in the space provided. Note that apron material may be different than that of the outfall itself.
16) Shape – Indicate the shape of the outfall based on its configuration of an open or closed system.
17) Structure – Indicate the condition of the drainage structure, such as concrete cracking/spauling, metal corrosion, or other. If "other," provide a description.
18) Vegetation - Indicate whether vegetation at the site is lacking (none), light, medium, heavy or excessive. If vegetation is blocking the outfall, indicate the percentage blocked.
19) Deposits - Document if there are any sediments, stains, oily residues, or other deposits at the sampling location. If "other," provide a description. If blocked, indicate the percentage blocked.
20) Notes/Sketches – sometimes it is useful to provide a sketch or other notes to better describe the outfall and its connections.
21) Benthic Growth – Document the presence of allege growth in pipe.
22) Pool Quality – Document pool quality indicators. If any of the pool quality parameters are observed, collect sample and complete Sections 3 and 4.
23) Misc. Dumping – Document the presence of illicit trash dumping, such as inorganics (cans, jars, etc.), organics (food wastes), chemicals, or other. If "other," provide a description. (Observe trash in and around the outfall. Look for trash that matches an upstream source, i.e., oil bottles from a gas station.)
24) Notes - This space should also be used to add additional information if “other “ was checked in any part of the section

Section 3: Flow Measurement and Water Quality

25) Flow Present? – Check Yes or No.
26) Evidence of Illicit Discharge in Pool? – Check Yes or No. If No, stop here and go to another site. If Yes, continue work at this site.
27) Field Meter Measurements – Record all field meter measurements including temperature, pH turbidity and conductivity

28) Stormwater Kit Measurements – Conduct field tests using the stormwater kit when appropriate. Note: Obtain three 1-liter well-mixed samples of the discharge water for use in the following tests before physically entering water for flow measurement tests. Be careful to obtain a representative sample with minimal bottom sediment/debris and an adequate volume for all tests. Test kit directions can be found in Appendix B and are also summarized in the field pocket guide (Appendix F).
29) Flow Dimensions – Enter measurement in feet. Flow rate will be estimated for channel flow (i.e., open channels or large pipes) and free-falling flow (i.e., free falling discharges). Suggested flow estimation procedures are outlined later in this section and in the field pocket guide.
30) Notes - This space should also be used to add additional information if "other " was checked in any part of the section.

Section 4: Physical Characterization

For the following tests, use one of the discharge samples collected before the discharge measurements were made. The suggested procedure is to grab a sample from the bank without disturbing the water and to use a clear glass or plastic bottle in order to observe the color and clarity of the sample.

31) Odor -Document the presence of observed odors, such as chlorine, gasoline, rotten eggs, septic odor, sour milk, or other. If "other," provide a description. Make sure the origin of an odor is the outfall. Sometimes shrubs, trash or carrion, or even the spray paint used to mark the outfall can mask the actual origin of the odor.
32) Color -Document the color of the discharge, whether it is clear, red, yellow, brown, green, grey, or another color. (Place a piece of white paper behind the glass sample bottle to aid in color determination.)
33) Turbidity/Clarity -Document if the discharge is clear, cloudy, opaque, or has suspended solids. (Place a piece of white paper behind the glass sample bottle to aid in clarity determination.)
34) Biological Waste - Document if there is algae, insects (including mosquito larvae), or other biological matter in the discharge. If "other," provide a description.
35) Floatables -Identify the presence of floating matter such as foam, oily sheen, trash, soap suds, or other uncharacteristic debris within the discharge.
36) Notes - This space should also be used to add additional information if "other " was checked in any part of the section.

Section 5: Data Collection

37) Sampled Collected for Lab? – Check Yes or No. If No, stop here and go to Section 6.
38) Collection Information – Record sample collection details as they are noted on sample label. Use an indelible ink pen such as a "Sharpie".
39) Collected From – Indicate where the sample(s) were collected in relation to the outfall.
40) Side of Stream – If collecting samples from the stream, indicate where the sample was collected looking downstream.

Section 6: Overall Outfall Characterization

41) Probability of Illicit Discharge – Indicate probability of an illicit discharge as unlikely, potential, suspect or obvious. If indicating anything of unlikely, coordinate with the CDOT Water Quality Program manager for follow-up actions and documentation.

Flow Estimation

Suggested Procedure for Channel Flow (including partial flow in pipe):

1. **Locate the hydraulic control for flow measurement**. The hydraulic control is defined as a location or point in a pipe or channel where dry weather flows can be measured with reasonable accuracy. In most cases, the hydraulic control also will be the sampling point. The optimal hydraulic control should consist of a 10-foot-long section of the channel or pipe where flow appears to be smooth and the cross section is as free from irregularities as possible. Do not enter pipes in order to measure flow as that may pose a possible health hazard.
2. **If possible, mark off a 10-ft longitudinal segment in the channel or pipe.**
3. **Clock the time required for a light-weight floatable object to travel the marked-off distance.** (Use corks, fishing bobbers, wood matches, sticks, or other floatable objects. Partial submergence is desired, especially in windy conditions.) Place the floating object in the water upstream of the starting point and begin timing as it passes the upstream mark.
4. **Repeat Step 3 three times and calculate the average velocity (v) of the floating object in feet per second (fps).**
5. **If a current meter is available, direct stream measurements should be taken at the point that the cross-sectional flow area is measured in lieu of steps 1-4.**

6. **Estimate cross-sectional flow area.**

For rectangular sections:

Area(A) = Average Width (W) x Average Depth (D)

For a trapezoidal section:

$$Area(A) = \frac{(TopofWater\,Width + BottomWidth)}{2} \times AverageDepth(D)$$

Compute flow rate:

Flowrate(Q) = Average Velocity(v) x Area(A)

Units:
Flow rate = cubic feet per second (cfs)
Velocity =feet per second (fps)
Area = square feet (ft^2)

Note: The flow rate (discharge) calculated by this method will be reasonably accurate (+ 25%) where very smooth, undisturbed flow exists in a concrete-lined channel with a consistent cross section for the 10-ft-long measuring section and at least 10 ft upstream and downstream of the section. However, where flow is not smooth or the cross section is irregular or has impediments to flow such as rocks in it, the accuracy of the method can be poor. If a reliable method is required in such a location, a current meter, weir, or other reliable method should be used.

Suggested Procedure for Free-Falling Flow:

1. **Place a container calibrated in gallon units beneath the free-falling discharge.** Carry several containers of different volumes and shapes so that you have one that best fits the site.
2. **Use a stop watch to clock the time required to fill a known volume in the container.**
3. **Repeat Steps 1 and 2 two or three times.** Calculate the average time required to fill the container**.**

Compute flow rate.

Flowrate(Q)=[Volume(V)] / [Time(t)]

Units:
Flow rate =gallons per minute(gpm)
Volume =gallons
Time = minutes

4. **Convert gallons per minute to cubic feet per second.** If the container is in other than gallon units, use an appropriate conversion factor (for example, 1liter equals 0.2642 gallons): Flow in cubic feet per second =Flow in gallons per minute x 0.0022
5. **Record the Calculated Flow on the Data sheet.** Enter to the nearest two significant figures only. (Examples: 0.024 cfs, or 2.1 cfs, or 15 cfs).

Field Water Analyses

Table 2 summarizes observations and/or tests that will be performed onsite (at the outfall) using the field test kits. Non-starred (*) analyses may be performed as long as the allowable holding times are not exceeded (see Table 5).

TABLE 2
Onsite Field Analysis

Parameter	**Method**	**Range**	**Detection Limit**
Ammonia	Test Strip	0-0.50 mg/L	
*Chlorine, Total Residual	DPD, Color Disc	0-3.5 mg/L	0.5 mg/L
Specific Conductance (Conductivity)	Field Meter	0-10,000 uS/cm	
Copper, Total	Bicinchoninate, Hydrosulfite, Color Disc	0-5 mg/L	0.5 mg/L
Detergents	Field Spectrophotometer	0-1 mg/L	0.05 mg/L
*pH	Platinum Electrode, Field Meter	0-14 pH	0.1 pH
Phenols, Total	Color Disc	0-0.200 mg/L	
Turbidity	Field Turbidimeter	0-1 000 NTU	0.01 NTU
*Temperature	Thermometer	NA	0.1^{0}C

* Test MUST be performed immediately at outfall site, upon sample collection (no allowable holding time-as shown in Table 5).
Chlorine, Total Residual -Use color wheel field test kit for chlorine to measure total residual chlorine.

Specific Conductance (Conductivity) -Use a field conductivity meter to measure the conductivity of the discharge.

Copper, Total -Use color wheel field test kit for copper to measure total copper.

Detergents (Surfactants) -Use detergents test kit to measure detergents.

pH-Use the field pH meter and probe to measure pH.

Phenols -Use color wheel field test kit for phenols to measure the total phenols of the sample.

Turbidity -Use a field turbidimeter to measure the turbidity of the sample.

Temperature-Use a thermometer to measure the temperature of the discharge.

Laboratory Analyses

Laboratory analyses will be performed for conductivity, copper, phenol, and surfactants, and turbidity if the field analyses detect concentrations greater than the trigger levels shown in Table 4. On the Outfall Field Data Sheet, the following information should be recorded when a sample is collected and sent for laboratory analysis. In addition, a copy of the chain-of-custody record should be attached to the form (see Appendix D).

Sample Identification -Assign a sample identification number to the sample and record on the sample bottle, Chain-of-Custody form, and on the Data Sheet.

Sample Type -Enter either A, B, C, or D to represent:

A -Grab Sample
B -Split Sample
C -Blank
D -Duplicate

Laboratory Sample Analysis -Table 3 summarizes parameters that may be measured in a laboratory if the field screening value listed in Table 4 is exceeded. The parameters listed in Table 3 will be analyzed by a commercial laboratory. Proper sample collection and handling procedures, including preservation methods and chain-of-custody documentation, need to be completed for laboratory samples. These procedures are described later in this manual.

TABLE 3
Laboratory Analysis

Parameters	Method	Units	Sample Container	Sample Size
Phenol, Total	EPA 420.1	mg/L	Glass with Preservative	500 mL
*pH	EPA 150.1	SU	Plastic	50 mL
Color, Apparent	EPA 11 0.1 - 3		Plastic	500 mL
Conductivity	EPA 120.1	uS/cm	Plastic	500 mL
*Chlorine. Total Residual	EPA 330.5	mg/L	Plastic	500 mL
Turbidity	EPA 180.1	NTU	Plastic	100 mL
Copper	EPA 220.1	mg/L	Plastic	500 mL
MBAS (Surfactants)	EPA 425.1	mg/L	Plastic	1000 mL

*Standard methods for these parameters require immediate analysis upon sample collection. This will be violated due to the time it takes to transport a sample from the outfall to the laboratory

Suspected Illicit Discharges

Upon completing the sampling and onsite field analysis, the field inspection team will interpret the data and decide if further investigation is required. If levels of tested pollutants exceed any of the trigger levels listed in Table 4, or if there are problems with odor, clarity, or floatables, CDOT will need to investigate further the suspected illicit discharge. Based on the judgment of the sampler, if a sample fails odor, color, or clarity tests, for safety reasons, the sample can be taken directly to the laboratory without field analysis. Table 4 lists the parameters and the values at which a field sampling and analysis must reoccur and an investigation may be initiated. In some instances, a sample may need to be obtained and analyzed in a laboratory.

TABLE 4
Trigger Levels

Parameter[1]	Trigger Levels	Basis	Action
Odor	Suspicious or Strong	Odors can vary widely and directly reflect the source of contamination. Sewage odors are associated with sanitary wastewater; rotten egg odors can indicate meat packers, canneries, dairies, and sanitary wastewater; oil and gas odors indicate petroleum refineries or facilities associated with vehicles; and spoiled food odors can indicate food preparation facilities.	Attempt to find source.
Clarity	Other than clear	Lack of clarity is generally the result of suspended clay, silt, organic, and inorganic matter. Natural waters have some degree of suspended solids that affect clarity. This is highly subjective.	Attempt to find source if CDOT has not permitted any large dewatering activities upstream.
Floatables	Foaming or oily sheen	Foam, soap suds, oil sheen, trash, and fecal matter are all considered floatables. Oily sheen reflects contamination from petroleum refineries and vehicle service facilities.	Attempt to find source.
pH	< 6.0 or > 8.5	Normal in-stream pH ranges from 6 to 8.5 pH values are outside this range indicate the introduction of waters that have been chemically adjusted.	Reanalyze. If confirmed, attempt to find source.[2]
Conductivity	>1,000 uS/cm	Rainwater and surface waters along the front range of Colorado are typically below 1,000pS/cm. Values greater than 1,000pS/cm in Denver or Colorado Springs, in combination with other constituents of concern, may indicate an illicit discharge.	Attempt to find source.
Total Chlorine	> 0.1 mg/L	Drinking water at the end of the distribution line will have chlorine levels greater than 0.1 mg/L. Thus, a value over this number could be an indication of the introduction of potable water into the storm sewer.	Reanalyze. If confirmed, attempt to find source.

TABLE 4 (continued)
Trigger Levels

Parameter	Trigger Levels	Basis	Action
Total Copper	> 0.1 mg/L	Copper does not occur in high levels in natural streams. Therefore, a measure that exceeds the detection limit could indicate an illicit discharge.	Reanalyze. If confirmed, attempt to find source. A lab analysis may be required. [3]
Turbidity	> 100 NTU	A high turbidity measurement of a dry weather flow could be an indication of a discharge of sediment or other material into the storm sewer.	Reanalyze. If confirmed, attempt to find source if CDOT has not permitted any large dewatering activities upstream.
Total Phenols	> 0.5 mg1L	Phenol can indicate the presence of a manufacturing discharge.	Reanalyze. If confirmed, attempt to find source. A lab analysis may be required.[3]
Detergents	> 0.5 mg/L	Natural waters usually have a surfactant level of <: 0.1 mg/L. A value above this could indicate another source. Sanitary systems usually have levels of 1 to 20 mg/L.	Reanalyze. If confirmed, attempt to find source. A lab analysis should be performed unless residential car washing is found to be the source.[3]

[1]Samples to be analyzed for stream pH and chlorine CANNOT be preserved for analysis at a later time. They must be analyzed onsite.

[2]Valuable time may be lost in finding the source of an illicit discharge if a second analysis is done every time a screening parameter level is exceeded. If the team leader feels the analytical value obtained is valid, an immediate attempt to find the source may be undertaken.

[3]Sample must be taken to the laboratory for analysis in accordance with 40 CFR Part 136 Methods. This includes proper sample preservation. The resulting analytical data may be used in Court. See "Standard Methods for the Examination of Water and Wastewater" published by the American Water Works Association for appropriate preservation method.

Identifying Sources of Illicit Discharges

When field screening reveals a suspected illicit discharge, it is the responsibility of CDOT's investigating team to report the suspected illicit discharge to the CDOT Water Quality Program Manager (303-512-4H20 or 303-512-4426). The investigating team then will perform a follow-up investigation to identify the source of the discharge within the drainage system and to determine if it is an ongoing discharge.

To identify the source and location of the suspected illicit discharge, the following procedures can be implemented in the follow-up investigation.

- Perform a systematic sampling program of the upstream storm sewer system to identify the source of the suspected illicit discharge. This may require sampling from several manholes upstream of the outfall in order to isolate the area of potential contamination. A gas probe should be used to identify the presence of potentially hazardous gases inside a sewer line before a manhole cover is opened. For cost- effectiveness and efficiency, only a sub-sample of manholes located in a drainage area identified as having significant non-stormwater sources should be surveyed.
- Continue field and laboratory analyses of the suspected illicit discharge over a period of time to determine if it is an ongoing discharge, to evaluate the characteristics of the discharge, and to identify any variations in the discharge.
- Perform an in-depth watershed evaluation using aerial photography and/or zoning maps to determine the activities occurring within the catchment area of the outfall. By associating the water quality characteristics of the suspected illicit discharge with known activities occurring within the outfall's catchment area, potential sources can be identified.
- Employ drainage system survey techniques at several manhole points upstream from the outfall to identify the general location of the contaminating source. Survey techniques to be considered include visual inspections, tracer analyses, T.V. inspections, smoke tests, and dye tests. For cost-effectiveness and efficiency, only a sub-sample of manholes located in a drainage area identified as having significant non-stormwater sources should be surveyed.
- Distribute questionnaires to industries within the drainage area or perform industrial onsite studies to identify the source. This effort would require coordination with the CDPHE because CDOT does not have the authority or jurisdiction to initiate investigations on industrial premises.

Suspected Illicit Discharge Documentation and Reporting

Documentation of illicit discharge follow-up activities is a vital part of the program in order to pursue enforcement action, if needed, and to document illicit discharge program activities to the CDPHE. As a result, the inspecting team should document all field activities using the Outfall Field Data Sheet.

Once the source of an illicit discharge has been identified, steps should be taken to fix or eliminate the discharge. Four questions should be answered for each individual illicit discharge to determine how to proceed; the answers will usually vary depending on the source of the discharge.

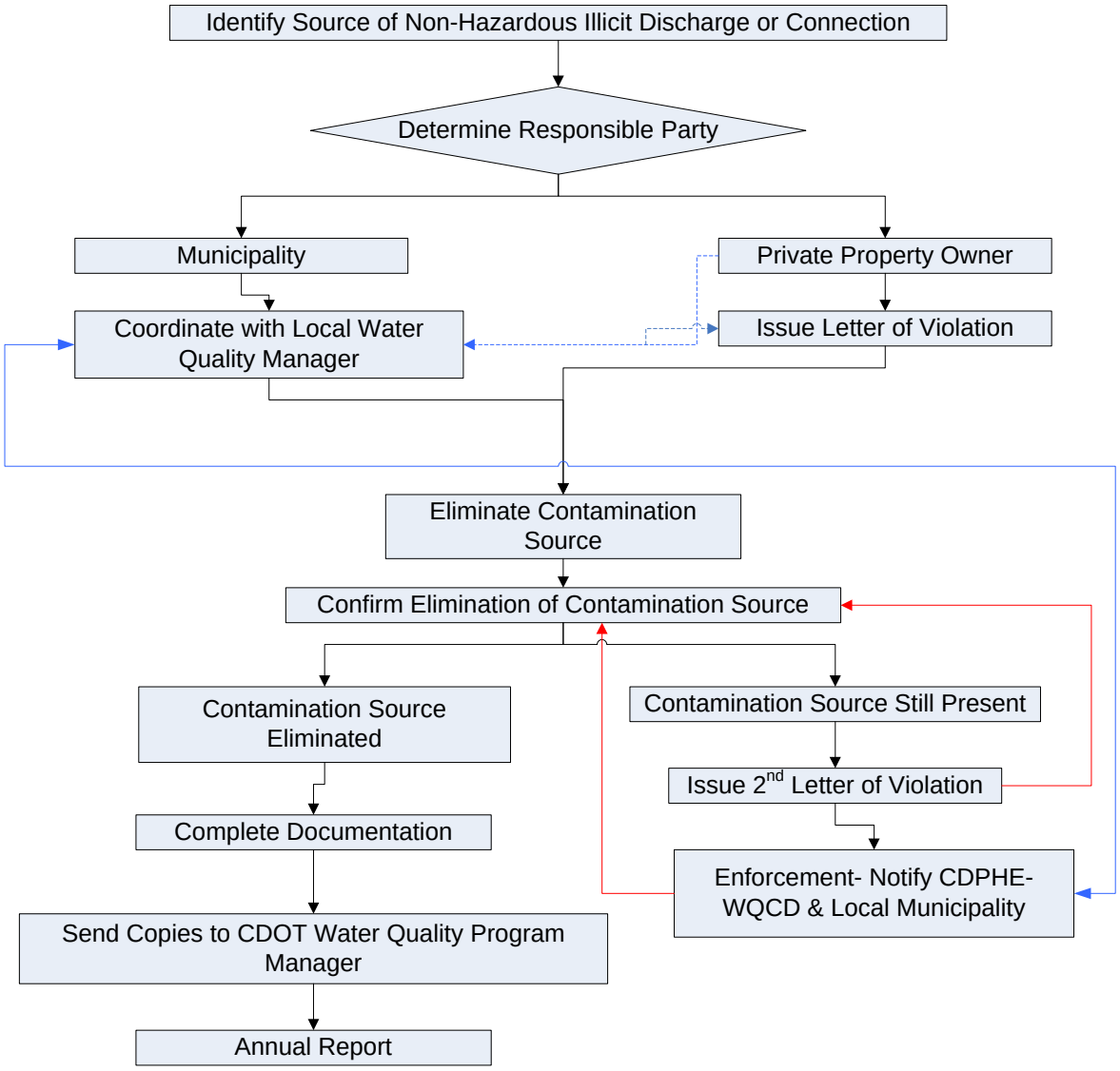
- Who is responsible?
- What methods will be used to repair?
- How long will the repair take?
- How will removal be confirmed?

Financial responsibility for source removal will typically fall on property owners, adjacent MS4 municipalities, or a combination of the two. Methods for removing illicit discharges usually involve a combination of education and enforcement. CDOT's procedures for fixing and eliminating illicit discharges and connections rely on an escalating enforcement approach.

If a determination is made identifying the source of the discharge, CDOT will issue a letter notifying the discharger of the violation. The letter should state what parameters were detected, the location, and date detected. If corrective actions were taken, CDOT should include the costs for the clean-up. If CDOT cannot resolve the matter with the discharger, then CDOT shall notify the CDPHE-WQCD, who has the enforcement capabilities of issuing a summons, fines, and prosecuting the offending discharger(s). Local municipalities may also have some enforcement capabilities and their Water Quality Manger should be cc'd on Letters of Violation and other pertinent correspondence. An example letter is presented in Appendix III.

FIGURE 1

Escalating Process for Removing or Correcting an Illicit Discharge



Sample Collection Operating Procedures

Sample collection for field or laboratory analyses is based on the assumption that the sample obtained is representative of the source being assessed. This idea is most important because if the sample is not truly representative, all subsequent conclusions, decisions, and actions may be affected by the errors in the sample. Samples must be collected so that nothing is added or lost and that no changes occur during the time between collection and examination of the sample.

The validity of the field or laboratory analyses will depend upon attention given to the following details:

- Sample and sampling point must be representative of the drainage basin for which information is desired.
- Correct sampling techniques must be used.
- Correct type of container and, if applicable, preservative must be used.

Sample Handling

A grab sample is a single sample taken at a particular place and time. A 1-liter grab sample will be collected for field testing of total chlorine, color, total copper, turbidity, pH, phenols, and other parameters. Two 1-liter grab samples will be collected at the same time for possible laboratory analysis of the same parameters.

Proper sample collection should reduce the potential for contamination and prevent the field crew from being exposed to harmful pollutants.

Sample Collection

- Select sampling points carefully to assure good mixing of the material to be sampled. Samples should be collected from the main body of flow where the velocity is high and will not be influenced by previous deposits or interfering side currents.
- Mark and reference sampling points well so that all samples are taken from the same place. In addition, proper sampling equipment should be available and adequate safety precautions must be observed.
- Use clean or new sample bottles for each sampling.
- Before sample collection, rinse the sampling container two or three times with the ambient water that is to be collected unless the sample bottle contains a preservative.

- Cover samples to prevent airborne contaminants from entering.
- If the sampler is required to enter the water course, samples must be collected upstream of the sampler to avoid collecting stirred-up bottom sediment.
- To avoid an excess of floating material, hold the mouth of the collecting container below the surface level when conditions allow.
- Take special care to not contaminate the sample container with the hands or by scooping up bottom deposits.
- Obtain an adequate volume of the sample to run all tests. This will ensure that all analyses are done on the same column of water.
- When performing analyses in the field, vigorously flush glassware or plastic used in the analysis three or more times with de-ionized water before and after each analysis. If sufficient sample water is available, use a small amount to rinse out the testing equipment prior to performing the analysis.
- For samples to be tested at a laboratory, use bottles and preservatives supplied by the laboratory. Use the appropriate container for the type of analysis to be run (see Table 5).
- Where samples are to be tested at a laboratory, label sample containers or tags with sample location, date, and time. Provide other information that may have an influence on the methods of analyses, results, or the interpretation of results, such as heavy pollution, high sediment loads, sediment discoloration, poor mixing, or other, and attach a copy of the Outfall Field Data Sheet.

TABLE 5
Required Containers, Preservation Techniques, and Holding Times

Parameter	**Container[1]**	**Volume**	**Preservation**	**Maximum Holding Time**
Ammonia	P		N/A (Field Analysis), H_2S0_4 to pH<2, Cool at 4°C	Analyze within 28 days[2]
Chlorine, Total Residual	P or G	500 mL	Analyze Immediately	Analyze within 15 min. [2]
Color, Apparent	P or G	500 mL	Cool at 4°C (39°F)	Analyze within 48 hours
Conductivity	P or G	500 mL	Refrigerate	Analyze within 28 days
Copper, Total	P or G	1000 mL	N/A (Field Analysis), Filter and add $HN0_3$ to pH<: 2 and Cool at 4°C (39°F) (Lab Analysis)	Analyze within 6 months[2]
Surfactants	P or G	250 mL	N/A (Field Analysis), Cool at 4°C (39°F) (Lab Analysis)	Analyze within 48 hours[2]
pH	P or G	50 mL	Analyze Immediately	Analyze within 15 min[2]
Phenol, Total	P or G (PTFE-lined cap)	500 mL	N/A (Field Analysis), Cool at 4°C (39°F)[3] and adjust pH < 2 with H_2S0_4 (Lab Analysis)	Analyze within 28 days[2]
Turbidity	P or G	100 mL	N/A (Field Analysis), Store in dark up to 24 h, refrigerate	Analyze within 48 hours[2]

Sources: Federal Register 40 CFR. PART 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants" September 16, 2002.
Standard Methods for the Examination of Water and Wastewater, 20th Ed., 1999. American Water Works Association.
[1] Polyethylene (P) or Glass (G).
[2]For field analysis, preserve at same temperature as outfall water by placing sample in outfall water until ready for testing.
[3]Or colder for testing.

Sample Preservation

Laboratory samples should be stored in a cooler with ice or cold packs as soon as possible. Refrigeration at temperatures near freezing is the best preservation technique available, but it is not applicable to all types of samples. Table 5 gives types of containers, preferred method of preservation, and holding times for various test parameters.

Complete preservation of any sample, regardless of the source, is almost impossible and can never be achieved for every constituent in the sample. At best, preservation techniques can only retard the biological and chemical processes that inevitably continue after the sample is removed from the source. The methods of preservation are limited and intended generally to retard biological action, retard hydrolysis of chemical compounds and complexes, and reduce volatility of constituents. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and/or freezing.

Quality Assurance Project Plan (QAPP)

Quality Assurance/Quality Control

Quality assurance/quality control (QA/QC) programs are extremely important. All results must be valid, representative, comparable, and of known precision and accuracy to be of value. A well-established and well-documented QA/QC program is necessary to provide defensible results.

Quality control is a planned system of activities designed to provide a quality product. This system of activities consists of training technicians and developing sample collection and testing protocols that will produce consistent, realistic results.

Quality assurance is the sum, of activities that document and maintain the quality of monitoring data. It is the means of assuring that only proven methods are used, instruments are properly calibrated and maintained, uniform operating procedures are established and followed, and performances are documented and audited.

Field Analysis QA/QC

Quality assurance in sample collection should be implemented to minimize such common errors as improper sampling methodology, poor sample preservation, and lack of adequate mixing during compositing and testing. The items listed below will help to ensure that the sample collection system is meeting project standards.

- Calibration of field equipment each day prior to sampling event
- Distilled water field blanks (one per analytical event)
- Duplicate samples (one in 10 samples)
- Distilled water trip blank (one per analytical event)
- Control charts (done by CDOT database manager and laboratory, see Appendix E)

Field blanks are de-ionized water samples prepared in the field at the time of sample collection. If the lab results for field banks have non-zero values, it indicates that impurities were introduced to the sample during collection or lab analysis. The distilled de-ionized water should be placed in whatever is used to collect samples (e.g., sample dipper) and then poured in the sample bottle, just as if it had been dipped as a real sample.

A **duplicate** (replicate) sample entails the collection of two or more samples from the same location and flow source during the same field visit. A discrepancy between the two sample measurements indicates a lack of precision or repeatability introduced during sample collection or lab analysis.

Glassware and Cleaning

Check cleanliness of swing sampler bottle and test kit tubes prior to each use. Carefully clean swing sampler bottle and test tubes used for field analyses after each use. Detergents are excellent cleansers for many purposes and can be used to clean most test tubes and plastic bottles. After the bottles have been cleaned, rinse them thoroughly with tap water and then with distilled water. When sampling for detergents, do not use detergents for cleaning, or be sure to very thoroughly rinse detergents from the sample container. New or pre-cleaned sample bottles to be used for laboratory analyses will be supplied by the laboratory.

Guidelines for Proper Sampling Procedures

- Check cleanliness of sampling equipment and containers before the sampling effort.
- Collect samples in the correct type of container (either glass or plastic).
- Properly label/identify samples with permanent markers and/or tags.
- Collect a substantial volume of the sample for analysis.
- Do not exceed holding times set for each sample (see Table 5).
- Properly preserve all samples after collection.

Contract Laboratory QA/QC

The labeling and integrity of each sample are important parts of the sampling protocol. The contract laboratory selected to perform the sample analyses will be responsible for its own quality assurance and quality control procedures. Certified analytical laboratories are required to have QA/QC procedures in place. However, the QA/QC tracking forms for laboratory data, found in Appendix E of this document, should be filled out to ensure all procedures and requirements were adhered. Additional procedures listed below should be followed to sustain the integrity of each sample:

Sample QA/QC element	Description
1. Sample Labels	Labels should include a unique ID, type of sample, name of collector, date and time of collection, and preservative

	used (if applicable).
2. Sample Seals	Seals the lid on the label to ensure they are not tampered with. Generally only necessary if using a third party for delivery to the laboratory.
3. Field Log Book	Includes basic information about sample collection, usually the ORI field form is used for this purpose.
4. Chain-of-Custody	See Appendix D or a sample COC.
5. Sample Delivery to the Laboratory	Ensure that sample delivery is timely. Include COC with the sample.
6. Receipt and Logging of Sample	The lab needs to document time of receipt of the sample.
7. Assignment of Sample for Analysis	The lab supervisor assigns an analyst to the sample. The lab supervisor or analyst is responsible at this point.
8. Disposal	Save samples until results are confirmed and finalized. Have the lab dispose of samples according to US EPA approved methods.

Staffing and Equipment Requirements

This section summarizes staffing and equipment requirements needed to complete dry weather sampling.

Staffing Requirements

Staffing requirements have been estimated for dry weather screening activities.

Field Teams

It is recommended for safety reasons that the size of a field team never be less than two people. This number shall be increased, as field activities and the site dictate, to ensure safety and an efficiently managed field investigation. Additional personnel will be required for sites requiring traffic control. All state and Occupational Safety Health Act (OSHA) safety requirements must be satisfied.

Primary assignments and responsibilities of the field teams are generally as follows:

- Locate outfall using GPS coordinates if necessary.
- Transport equipment to the outfall point.
- Collect and preserve (if necessary) field and laboratory samples.

- Perform onsite field analyses (chlorine, temperature, pH), visual observations, and flow estimations.
- Record the results of the field analyses, visual observations, and flow estimations on the Outfall Field Data Sheet. It is the team leader's responsibility to ensure that this is completed and entered into the database system.
- Report a suspected illicit discharge to the Illicit Discharge Hotline (Water Quality Program Manager).
- Manage and maintain field and laboratory equipment and supply inventories.

The time available to complete dry weather sampling is weather-dependent since it must be completed during dry weather (defined as less than 0.1 inch of precipitation during the prior 48 hours and no evidence of snowmelt).

Field Equipment Requirements

To collect samples and perform onsite analyses requires a significant amount of equipment. Table 6 lists suggested equipment needed to perform dry weather field screenings, including flow measuring tools, sample containers, safety equipment, and analytical equipment and accessories. This list is not inclusive of all the equipment needs for all field situations, and the list should be modified for special needs of each particular site visit. For example, sampling within manholes could require additional field safety equipment for entering a confined space. CDOT discourages sampling in confined spaces due to safety concerns.

TABLE 6
Recommended Dry Weather Sampling Equipment

Safety Equipment	**Flow Estimation Equipment**
First Aid Kit	Flow tape measure and floating object to measure velocity
Nitrile Gloves	Stop Watches
Safety Goggles	Spray Paint / Chalk / Nylon Marking Ribbon
Orange Traffic Safety Vests	Flow Containers / Buckets – Graduated in L or Gal
Emergency Telephone Numbers	Calculator
Cell phone or Communication Device	Velocity Meter (Optional)
Traffic Cones for Parking	
Mace (for self defense only)	**Analytical Equipment**
Maps / Aerial Photos	Conductivity Probe, Meter, and Calibration Standards
Dry Weather Screening Manual	Turbidity Meter
	pH Probe, Meter, and Calibration Standards Thermometer
Sample Collection Equipment	Total Chlorine Test Kit and Reagents
Sample Pole (Swing Sampler) and Accessories	Copper Test Kit and Reagents
Manhole Cover Pick (optional)	Phenols Test Kit and Reagent
Sample Bottles – 500 mL (plastic and glass)	Detergents Test Kit
Sample Bottles – 1000 mL (plastic)	De-ionized Water – to rinse analytical equipment
Sample Bottles – 125 mL (plastic)	Wash Bottles
Beakers – 50 mL (plastic)	Pipets AND Other Measuring Devices
Sharpie Markers/Label Tags for Sampling Labeling	Replacement Batteries
Blue Ice Packs or Ice Cubes (Care must be taken to ensure that sufficient ice is maintained in the cooler to keep samples cool during transport to the laboratory	Pipettes and Bulb
Cooler Chests	Clipboard
Filter Funnels	Bound Field Notebook
Filter Paper – for turbid samples	Kimwipes
Outfall Field Data Sheets	Paper Towels
MSDS for all Chemicals / Reagents	Scissors
	Other Equipment
	Digital camera
	GPS unit
	Field notebook
	Tape measure

Safety

There is a safe way to perform all field work. Advance planning and knowledge can prevent injury in the field. A convenient common sense question to ask before performing a procedure is "what would happen if...?" Answers to this question require an understanding of the hazards associated with site access, sampling conditions, chemicals, and equipment involved. Safety concerns are even more important when sampling is being conducted in urban stream environments where there is potential for contact with contaminated water, sharp debris and objects, and threatening individuals (both animals and humans). A health and safety plan was developed to address the particular hazards of dry weather screening and suspected illicit discharge investigations, see Appendix C. This section is intended to identify areas of potential concern that may be addressed in the safety program.

Site Safety

Site safety, as a minimum, should include considerations of site access and sampling conditions, specifically:

- Implementing traffic control measures
- Wearing appropriate clothing and footwear when working in densely vegetated areas
- and near waterways
- Wearing bright colored vests or clothing when working near traffic
- Having an emergency plan
- Having a minimum of a two-person field team
- Carrying a well-stocked first-aid kit
- Carrying a cell phone or other means of contacting emergency personnel
- Carrying a list of the following emergency phone numbers: physician and ambulance service, fire department, and police department

Private properties should not be accessed unless proper notification has been provided, preferable in advance and in writing.

Safety During Sample Analysis

The following are suggested rules applicable to field analysis:

- Gloves and eye protection are required at all times. Mouth suction is never to be used to fill pipettes, to start siphons, or for any other purpose.
- All solutions must be labeled with descriptive labels and the appropriate warnings.
- Remember the ABC's of safety: *Always Be Careful*

Emergency Action

An emergency action plan will be developed and administered by the CDOT program coordinator for each region. At a minimum, the following should be included:

- Names and phone numbers of emergency personnel to contact (i.e., fire, rescue, or medical facility)
- Procedures to follow while waiting for assistance
- First aid training
- CPR training

Handling Chemicals and Samples

- Keep your hands and face clean. Wash thoroughly with soap and warm water whenever a chemical contacts your skin. Always wash face, hands, and arms after handling samples or chemical reagents. Use a liquid hand sanitizer or disinfectant wipes if soap and water is not available.
- Most chemicals are harmful to some degree. Avoid direct contact with any chemical or sample. Some substances considered "safe" today may be found to cause unsuspected long-term disorders in the future. It is especially important to keep chemicals from hands, face, and clothing, including shoes or other foot covering. Many substances are readily absorbed into your body through the skin and through inhalation. Chemicals may also enter you body through your mouth and eyes by contamination from the hands.
- Never taste or smell a chemical. Smoking, drinking, or eating is forbidden during analysis. Smoking is an obvious fire hazard. Extreme caution should be observed. Smoking is not permitted around flammable chemicals.

- Should anyone ingest a chemical the Material Safety Data Sheet (MSDS) should be consulted before encouraging anyone to drink large amounts of water while seeking immediate medical assistance. Be certain to find out exactly which substance(s) was ingested and designate someone to inform the emergency room of the chemicals involved while the injured person is being assisted or transported to medical aid.
- The MSDS should be accessible to all members of the field inspection team for all chemicals used and in addition, copies should be kept on file with the Water Quality Program Manager.
- All containers with chemicals or samples in them must be clearly labeled. Do not use any substance that is in an unlabeled or improperly labeled container. Unlabeled containers should be promptly disposed of and handled with care to avoid bodily harm.
- Read the label carefully before removing a reagent from its container. Read it again as you promptly recap the container and return it to its proper location. Names of distinctly different substances are sometimes very similar. Using the wrong substances can lead to accidents.
- Do not use more material than directed. Remove what is needed from the container and discard any excess. Never return a chemical to its original container.
- Always add a reagent slowly; never "dump" it in. Observe the reaction when the first small amount is added, and wait a few moments before adding more; some reactions do not occur immediately. If an expected reaction does not initiate, ask your supervisor for advice before adding more reagent.
- Never look down the openings of a vessel unless it is empty.
- Never use mouth suction to fill a pipette. Use an aspirator bulb or a loose-fitting hose attached to a water aspirator. Constantly watch the tip of the pipette and do not allow it to draw air.

Appendix C provides an example of Field Safety Instructions that can be used for dry weather screening fieldwork. CDOT will need to either prepare an individualized safety plan or adopt the one provided for its employees' use.