Illicit Discharge Detection & Elimination Program Manual
(IDD&E)

Pennsylvania Turnpike

June 29, 2018

Updated: September 4, 2020

Updated: February 11, 2021

Updated: October 18, 2021

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A. BASIS FOR THE PROGRAM

The Pennsylvania Turnpike Commission (PTC) is undertaking the Illicit Discharge Detection and Elimination (IDD&E Program) for the Municipal Separate Storm Sewer System (MS4) as part of coverage under its National Pollutant Discharge Elimination System (NPDES) permit. The PTC MS4 is the portion of the PTC property within and receiving runoff from the Urbanized Area as defined by the 2010 U.S. Census. The MS4 system consists of a series of stormwater management facilities, inlets, pipes, swales, and outfalls; collecting and conveying stormwater from impervious areas and discharging them into various locations.

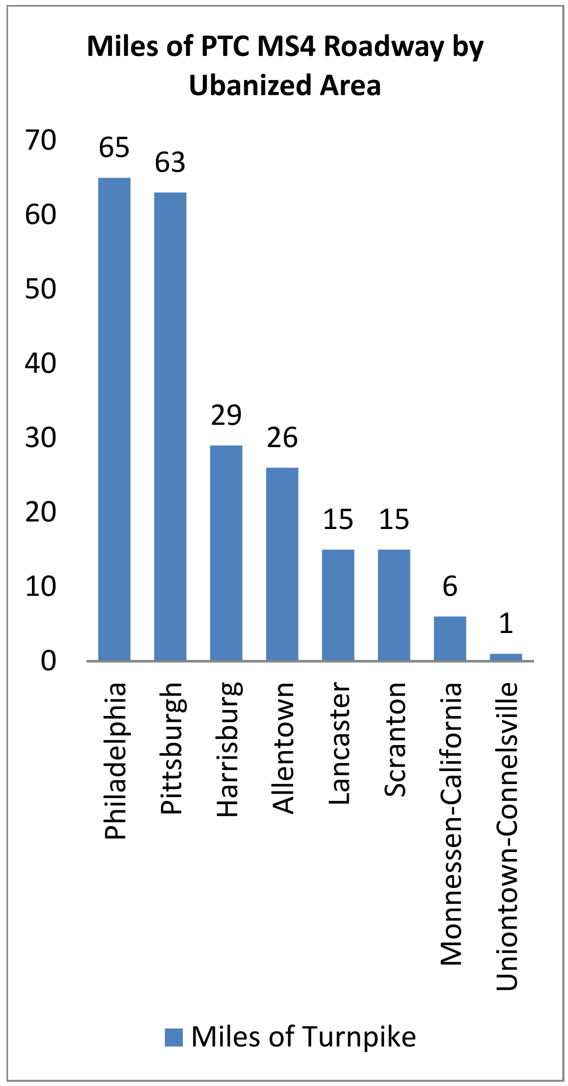
The Pennsylvania Turnpike is comprised 556 miles of toll roads:

- East-West Mainline (I-76, I-276)
- Beaver Valley Expressway (I-376)
- Southern Beltway (Turnpike 576)
- Mon/Fayette Expressway (Turnpike 43)
- Greensburg Bypass (a.k.a. Amos K. Hutchinson Turnpike 66)
- Northeast Extension (I-476)

The PTC also includes a number of properties and facilities that support the transit corridor, including service plazas, maintenance facilities, stand-alone storage facilities, communication tower properties, administration and operations centers as well as surplus properties.

The Turnpike and its facilities span the east-west axis of the Commonwealth, with north-south extensions from Philadelphia and Pittsburgh. The PTC MS4 is defined by the eight urbanized areas that the Turnpike traverses that are listed below.

- Philadelphia (PA-NJ-DE-MD)
- Pittsburgh
- Harrisburg
- Allentown (PA-NJ)
- Lancaster
- Scranton
- Monessen-California
- Uniontown-Connellsville



Approximately 40% of the Turnpike (220 miles) is in the PTC MS4. The PTC MS4 is subject to the IDD&E procedures outlined in this manual.

The various components include impervious surfaces that produce increased runoff. In turn the runoff is collected and conveyed through the MS4 and ultimately makes its way to surface waterways. It is protection and enhancement of the quality of that water that is the focus of this program; The IDD&E program is the strategies to find, correct, and prevent contaminated stormwater discharges to the waters of the U.S./Commonwealth from the MS4.

The PTC regulated storm sewer system area is currently defined by the U.S. Census Bureau's 2010 Urbanized Area. This Program applies to monitoring discharges within the current MS4 area to comply with Pennsylvania's Chapter 92a *National Pollutant Discharge Elimination System (NPDES) Permitting, Monitoring and Compliance*, specifically with regard to compliance with stormwater discharges (25 Pa. Code § 92a.32) and *U.S. Code of Federal Regulations* (CFR). Title 40: Protection of Environment. Minimum Control Measure (MCM) #3 (40 CFR§ 122.34(b)(3)) explains the federal requirement for MS4 permit holders to identify and eradicate sources of stormwater-borne pollutants to U.S. surface waters as part of the permittee's Stormwater Management (SWM) Program.

Essentially illicit discharges are any flows from the stormwater system that are non-stormwater. However, there are a few exceptions. The PTC MS4 Permit identifies the following categories of non-stormwater discharges that do not require elimination unless the PTC designates them as significant contributors of pollutants. The categories include:

- Discharges or flows from firefighting activities.
- Discharges from potable water sources including water line flushing and fire hydrant flushing if such discharges do not contain detectable concentrations of Total Residual Chlorine (TRC).
- Non-contaminated Irrigation water.
- Water from lawn maintenance.
- Flows from riparian habitats and wetlands.
- Diverted stream flows.
- Springs
- Non-contaminated groundwater
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and where detergents are not used.
- Water from foundation and footing drains.
- Water from crawl space pumps.
- Air conditioning condensation.
- Individual residential car washing where cleaning agents are not used.
- Routine external building wash down which does not use detergents or other compounds.

Required Program Components:

Best Management Practice #1 under Minimum Control Measure #3 requires the following be accomplished by the PTC Stormwater Management Program:

> *BMP #1: The PTC shall continue to implement its* <u>*written*</u> *program for the detection, elimination, and prevention of illicit discharges into the PTC's regulated small MS4 as documented in the PTC's Illicit Discharge Detection and Elimination (IDD&E) Program Manual. The Manual shall, at all times during the term of the permit, contain the following, at a minimum:*
>
> - *Procedures for employee reporting of illicit discharges.*
> - *Procedures for identifying priority areas. These are areas with a higher likelihood of illicit discharges, illicit connections or illegal dumping. Priority areas may include areas with older infrastructure, a concentration of high-risk activities, or past history of water pollution problems.*
> - *Procedures for screening at outfalls and observation points in priority areas.*
> - *Procedures for identifying the source of an illicit discharge when a contaminated flow is detected at a PTC's regulated small MS4 outfall or observation point.*
> - *Procedures for eliminating an illicit discharge.*
> - *Procedures for assessing the potential for illicit discharges caused by the interaction of sewage disposal systems (e.g., on-lot septic systems, sanitary piping) with storm drain systems within the regulated MS4 and reporting discharges detected to the municipality.*
> - *Procedures for program documentation, evaluation and assessment.*
> - *Procedures for addressing information or complaints received from the public.*

The IDD&E program shall be implemented, evaluated each year, and revised as necessary.

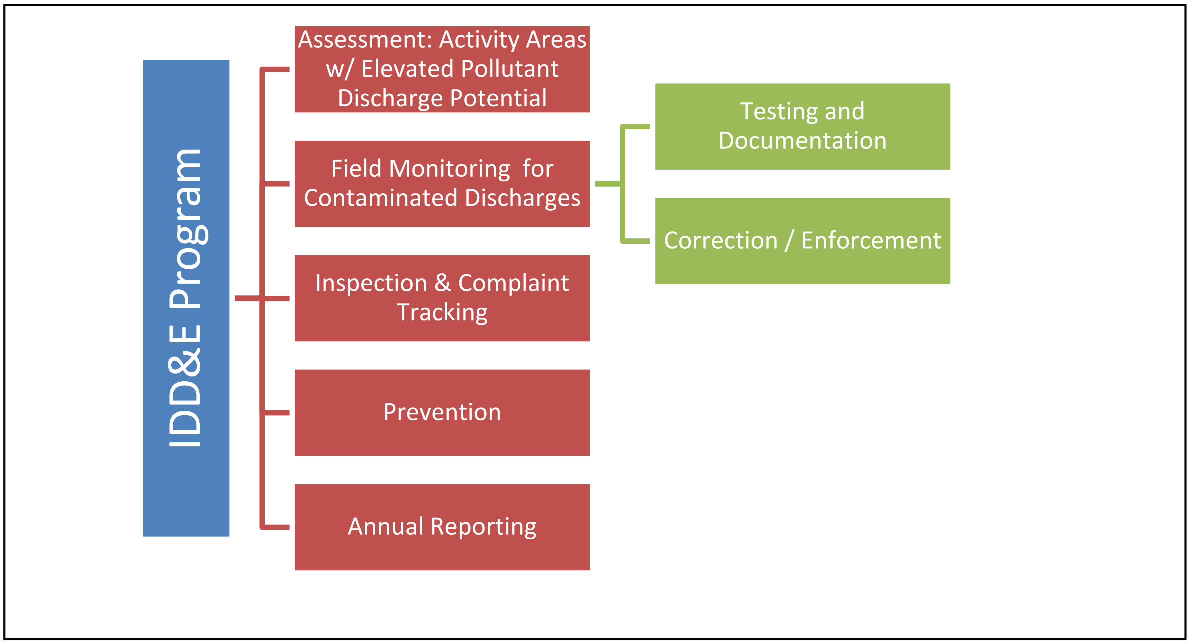
PTC Authority to Prohibit Illicit connection and Dumping into the MS4

The PTC *Maintenance Manual* addresses issues related to runoff including critical IDD&E factors. The statutes and policy provide the PTC with the enforcement capability to eliminate illicit discharges from the PTC's storm sewer system. Specifically, Section 7.4 Drainage Discharge prohibits specified discharges of sewage or drainage within the Turnpike Property. See below:

> *Section 420(e) of the State Highway Law of 1945 and, as amended, March 7, 1982 and Pennsylvania Code title 67, Chapter 441 supports the Commission's position in this matter.*
>
> *Section 420 (e) makes it a summary offense for any person to:*
>
> *(a) Violate any rule or regulation promulgated under authority of Section 420.*
>
> *(b) Willfully destroy, injure or damage any highway by any method or device.*
>
> *It is unlawful for any person or entity to discharge sewage or drainage on or within Turnpike property. Any such discharge should be considered an unlawful trespass and should be reported immediately to the Engineering and Legal departments. In the event the discharge presents an imminent danger to the health and safety of traveling public, actions should be taken immediately to block or remove the drainage and protect the traveling public. The Engineering and Legal departments should be promptly advised of any such actions to be taken by maintenance personnel***.**

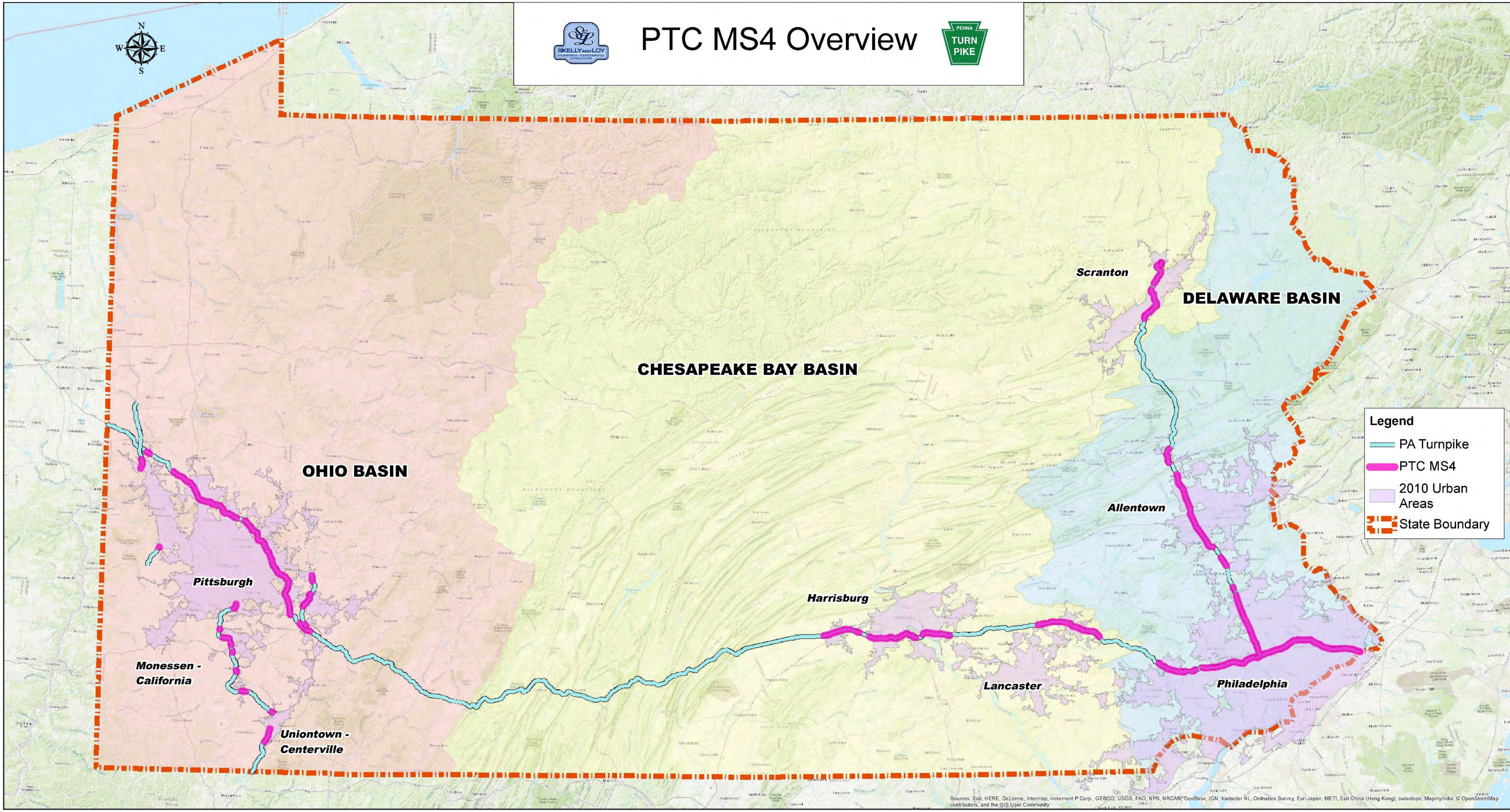
B. PROGRAM FUNDAMENTALS

Although the PTC is a non-traditional (non-municipal) MS4, the PTC's IDD&E Program contains the same fundamental components practiced by MS4's nationwide. The primary elements of the Program were originally outlined by the Center for Watershed Protection (CWP) in its publication, *Illicit Discharge Detection and Elimination – A Guidance Manual for Program Development and Technical Assessments* (*IDD&E Guidance*) and are diagrammed below.
(https://www3.epa.gov/npdes/pubs/idde_manualwithappendices.pdf)



The PTC IDD&E Program utilizes the CWP *IDD&E Guidance* to the extent practical because it is featured by the U.S. Environmental Protection Agency (EPA) (and provided on the PADEP MCM #3 webpage as the IDD&E Manual) as a primary resource for developing an IDD&E Program and is an agency-accepted methodology for recognizing and eliminating potential stormwater-borne pollution. However, since the *IDD&E Guidance* was specifically tailored for a municipal audience, some of the information is not directly transferrable to a transportation network. The Turnpike is a linear land use with a singular purpose, facilitation of automotive travel within its system. The Turnpike crosses dozens of municipalities and hundreds of watercourses. The PTC is not a government and has no ability to legislate. While the PTC provides user services and roadway maintenance, it is limited to the Turnpike corridor and infrastructure such as sewer, water and emergency services are usually coordinated with non-Turnpike entities such as adjacent municipalities or state agencies.

The map on the following page 6 shows the considerable land area included in PTC's regulated MS4 area. Due to the size and expanse of the regulated area, the IDD&E Program combines a field monitoring program supplemented by Turnpike motorists' observations of suspicious-looking fluids entering the storm sewer system and waterways.


PTC MS4 Overview
OHIO BASIN
CHESAPEAKE BAY BASIN
DELAWARE BASIN
Scranton
Allentown
Harrisburg
Lancaster
Philadelphia
Pittsburgh
Monessen - California
Uniontown - Centerville
Legend
PA Turnpike
PTC MS4
2010 Urban Areas
State Boundary

C. PROCEDURES FOR EMPLOYEE REPORTING OF ILLICIT DISCHARGES

The PTC has implemented MS4 Illicit Discharge Detection and Elimination (IDD&E) Awareness Training for PTC staff. The awareness training incorporates instruction for PTC staff and construction contractors in observing and reporting potential illicit discharges. PTC Maintenance staff and construction contractors are given more specific IDD&E Training that covers their responsibility in reporting potential illicit discharges.

The reporting process is documented in the IDD&E Field Guide (Appendix C). PTC Staff are provided with an email (PIDReport@paturnpike.com) for reporting potential illicit discharges or may report observations to their immediate supervisor. The observations are reported to the designated PTC Environmental Staff via the provided email and the staff member or supervisor making the report provides pertinent information as requested on the Potential Illicit Discharge Report form (Appendix D). The Potential Illicit Discharge Report provides a section for PTC Environmental Staff (or 3rd Party Contractor) to document follow-up observations and findings.

D. PROCEDURES FOR IDENTIFYING PRIORITY AREAS

An Illicit Discharge Potential (IDP) desktop assessment helps target areas with high potential for illicit discharges and aids in planning the field monitoring program. These are referred to as IDP Priority Areas. The goal of the Desktop Assessment is to identify areas within the PTC MS4 with the strongest potential to release illicit discharges. The assessment also takes into account urban sites beyond PTC-owned property with the high potential to have illicit discharges to the PTC MS4.

<u>Factors For Elevated IDP</u>

The PTC referenced the Center for Watershed Protection's *IDD&E Guidance, which discusses* discharge screening factors that can be indicators of IDP during the screening process. In determining the Priority Areas for illicit discharge detection, the PTC uses the following factors:

- Frequency of past discharge complaints, hotline reports, and spill responses per sewershed.
- Outfalls with a history of illicit discharges or where collected samples of dry weather water exceed pre-determined indicators (See Appendices B and C) two or more times in a single permit period.
- Facilities that store, manage, and utilize potentially polluting materials, otherwise known as Common Generating Sites.
    - PTC Maintenance Yards
    - PTC Stand-alone Storage Facilities
    - PTC Service Plazas
    - Adjacent Dense Residential, Commercial or Industrial Land Use
    - Adjacent Expansive Parking
    - Adjacent Recyclers and Scrap Yards
    - Adjacent Nurseries and Garden Centers
- Facilities that possess Industrial NPDES Stormwater Permits.
- Adjacent municipal land uses with potential to convey stormwater flows to the PTC MS4:
    - Dense Industrialized Uses
    - Dense Commercialized Uses
    - Dense Urbanized Uses

Priority Areas

The PTC maintains a GIS mapping system for further reference of the MS4 boundaries, urbanized areas, and the storm sewer collection system.

E. PROCEDURES FOR SCREENING OUTFALLS IN PRIORITY AREAS

Overview

All stormwater outfalls regulated by the PTC's MS4 NPDES permit must be inspected at least once during the five-year permit term. An outfall located in an area that is dangerous or infeasible to access via the PTC right-of-way will be screened at the closest identified observation point within the common drainage conveyance of the outfall. IDD&E screening for an outfall located outside of the PTC property, where stormwater from the PTC property comingles with municipal MS4 flow, falls under the responsibility of the local Municipal MS4 permit holder. Additionally, in compliance with PTC's MS4 permit conditions, mapping showing the location of observation points associated with these Municipal outfalls will be provided to the respective municipality. PTC will not be performing any IDD&E screening at observation points where this mapping has been provided unless requested by the municipality as part of an illicit discharge investigation.

The outfall numbers correspond to PTC's storm sewer system maps, which are maintained in the PTC GIS database and are subject to periodic updates as necessary. Outfalls within IDP Priority Areas are identified as such within the database.

The numbering code has five digits. The first digit refers to the major drainage basin in which the outfall is located. The next number refers to the outfall's Urbanized Area (UA). The final three digits are the outfall identification (ID) number. (See PTC Outfall Numbering Code Table below.)

OUTFALL NUMBERING CODE

DIGIT 1	MAJOR DRAINAGE BASIN	DIGIT 2	URBANIZED AREA	DIGITS 3 THROUGH 5 (SEQUENTIAL OUTFALL ID)
1	Ohio River Basin	1	Pittsburgh	001 to 999
		2	Uniontown-Connellsville	
		3	California-Monessen	
2	Chesapeake Bay Basin	1	Harrisburg	
		2	Lancaster	
		3	Wilkes Barre-Scranton	
3	Delaware River Basin	1	Philadelphia	
		2	Allentown	

Outfall Screening Prioritization

As of March 20, 2018, PTC has 887 regulated outfalls. The PTC intends to conduct prioritized outfall screenings in multiple Major Drainage Basins per year, broadening the geographic reach of the IDD&E Program rather than concentrating it in a singular Basin. Outfall screenings will be conducted in a two-group method during the permit period. The outfalls screened as part of Group 1 will consist of the IDP Priority Area outfalls and non-IDP Priority Area outfalls to equal approximately half of the total outfalls within the PTC MS4. Group 2 will consist of the balance of the regulated outfalls. Each group will be screened at least once during the 5-year permit period. Outfalls identified within IDP Priority Areas will be screened, at a minimum, twice during the permit period. It should be noted that cross-drainage culverts carrying blue-line waterways under PTC right-of-way will not be monitored as part of this program since they are streams and not outfalls.

Outfalls identified as having an illicit discharge will be monitored as described in **Section G. Procedure for Eliminating an Illicit Discharge**.

Outfall Field Screening (OFS) Protocol

Outfall Screening for the PTC will be performed by contractual personnel. The PA DEP MS4 Outfall Field Screening (OFS) Report (3800-FM-BCW0521), see Appendix A, will be used to record findings. This reporting form standardizes the PTC's field monitoring and reporting between seasons and from year to year for efficient recordkeeping. OFSs corresponding to outfalls scheduled for the current field screening season will be pre-populated with available data (e.g. subwatershed, outfall ID, latitude/longitude, land use, etc.), and accompanied by tailored maps or mobile GIS applications to guide personnel in the field.

At the outfall location, photo-documentation will take place and data collected as prompted by the OFS regardless of the presence or absence of flows. For flowing outfalls, the Dry Weather Flow Evaluation of the OFS will be completed based on observations and preliminary screening, as necessary.

To ensure that outfalls are properly maintained, the outfall screening process includes an evaluation of the functionality and structural stability of the outfall and appurtenant features that compose the stormwater system (i.e. swales, check-dams, end-walls, piping, blockages, general deterioration, etc.). This evaluation is recorded within the Mobile GIS Application and includes a description of the issue observed and photographic documentation. It should be noted that photographic documentation is included for all evaluations even if a functional or structural deficiency is not noted during the screening. This field documentation is intended to be used by PTC Maintenance/Roadway Department to coordinate and plan needed maintenance or repair during the current or next annual Capitol Budget planning work flow.

A Guide to Indicators and Monitoring Methods, downloaded from PA DEP's MS4 Resources webpage is provided in Appendix B. (The Guidance was excerpted by PA DEP from a publication entitled *Designing Your Monitoring Program-A Technical Handbook for Community-based Monitoring in Pennsylvania.)* PTC will contract consultants trained to conduct preliminary screening to determine if discharges are present, are illicit in nature, and conduct field parameter testing for determining if follow-up investigative measures are necessary to eliminate an illicit discharge.

Planning and Testing

For dry weather field screenings, the goal is to observe outfalls during dry conditions (48 consecutive hours of less than 0.1" of rainfall). It will be the responsibility of the field team to monitor weather reports and plan the field work accordingly.

Whether or not illicit discharges are detected from dry-weather field screenings, the MS4 Outfall Screening Report (PADEP Form 3800-FM-BCW0521) provided in Appendix A, or PTC equivalent form should be completed for each observed outfall. The following list identifies the critical data fields for reporting:

- Outfall identification number
- Date and Time of Screening
- Individual(s) performing the screening
- Approximate Date of Last Rain
- Land Use in Contributing Drainage Area
- Outfall Description (Type, Material, Shape, Dimensions, Submerged)
- Dry Weather Flow Presence
- Description of Flow Rate
- Dry Weather Flow Evaluation

- Field/Laboratory Analysis (Field Screening of pH, Temperature, Specific Conductance, Dissolved Oxygen)

If a discharge is observed from any outfall during dry weather screenings, the discharge shall be inspected for color, odor, floating solids, scum, sheen, substances that result in observed deposits in the surface waters. In addition, the discharge cannot contain substances that result in deposits in the receiving waters or produce an observable change in the color, odor, or turbidity of the receiving water. If the discharge exhibits any of the above characteristics or the field-testing parameters (pH, temperature, conductivity, dissolved oxygen) are abnormal to the local system and indicate that there is a possible illicit discharge, the screening personnel will report the outfall for follow-up investigation.

Dry-weather flows without any indicators of illicit discharge may be permissible. An unexhaustive list of EPA listed instances of non-illicit, permissible discharges are described previously in **Section A**. This in-field determination should be noted on the OFS, effectively ending the investigation.

All investigations of illicit discharges are to be thoroughly documented and centralized in the IDD&E Case Files at the PTC Office. These files are a repository for IDD&E cases triggered by scheduled outfall inspections as well as those initiated by PTC personnel or PTC Users' observations. All field work, communication documentation, and desktop analysis relating to a given case are maintained at this single location for quick reference. Copies of OFSs for outfalls containing dry-weather flows determined not to be illicit discharges in the field are also kept with the case files but are considered closed.

Safety Concerns

All Consultants/Contractors performing field observations for outfalls, illicit discharges, and other related work on PTC property must follow a Health and Safety Plan (HASP) prepared in accordance with applicable OSHA and current industry guidelines and may be subject to PTC review. Typical safety concerns include, but are not limited to confined spaces, unstable embankments/slopes, slip/trip hazards, fall hazards, drowning, heat/cold stress, biohazards, etc. Prior to any confined space entry, the Consultant/Contractor must provide the PTC a copy of their Confined Space Program and training certifications prior to conducting any field investigations.

F. PROCEDURES FOR IDENTIFYING THE SOURCE OF ILLICIT DISCHARGES

Where a violation constitutes an immediate danger to public health or safety, PTC personnel or first responders must act swiftly to cut off pollution to surface waterways and eliminate the source.

Illicit Discharge Notifications

If an Illicit discharge is identified at any time, including during a dry weather outfall screening meeting the criteria in the commentary below, the PTC must also take the action prescribed below to report the issue to PA DEP.

According to 25 PA Code §91.33 and §92a.41(b), the permittee shall immediately report <u>*any incident causing or threatening pollution*</u>. The following steps will be initiated by notification by the field personnel to the PTC's Traffic Engineering and Operations Center.

1. *If, because of an accident or other activity or incident a toxic substance which would endanger users downstream from the discharge or would otherwise result in pollution or create a danger of pollution or would damage property, the permittee shall immediately notify PA DEP by telephone of the location and nature of the danger. Oral notification to DEP is required as soon as possible, but no later than four (4) hours after the permittee becomes aware of the incident threatening pollution.*

2. *If reasonably possible to do so, the permittee shall immediately notify downstream users of the waters of the Commonwealth to which the substance was discharged. Such notice shall include the location and nature of the danger.* [Downstream users includes, but is not limited to the downstream Municipalities.]
3. *The PTC shall immediately take or cause to be taken steps necessary to prevent injury to property and downstream users of the waters from pollution or a danger of pollution and, in addition, within 15 days from the incident, shall remove the residual substances contained thereon or therein from the ground and from the affected waters of the Commonwealth to the extent required by applicable law.*

In the case of any unanticipated *non-compliance which may endanger health or the environment* the PTC shall follow the requirements according to 40 CFR §122.41(l)(6). The following requirements will be initiated by notification by field personnel to the PTC's Traffic Engineering and Operations Center. These requirements include the following obligations:

1. *24 Hour Reporting- The PTC shall orally report any non-compliance with this MS4 permit which may endanger health or the environment within 24 hours from the time PTC becomes aware of the circumstances.*
2. *Written Report – A written submission shall also be provided within 5 days of the time the PTC becomes aware of any non-compliance which may endanger the health or the environment. The written submission shall contain a description of the non-compliance and its cause; the period of non-compliance, including exact dates and times, and if the non-compliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate and prevent reoccurrence of the non-compliance.*
3. *Waiver of the Written Report – PA DEP may waive the written report on a case-by-case basis if the associated oral report has been received within 24 hours of the time the PTC becomes aware of the circumstances which may endanger health or the environment. Unless such a waiver is expressly granted by PA DEP, the PTC shall submit a written report in accordance with this paragraph. (25 PA Code §92. a.3(c) and 40 CFR § 122.41(l)(6)(iii)).*

Non- Emergency Illicit Discharge Response: **On PTC Property**

Discharges within the PTC's control will be traced upstream from the discharge to search for the source of the pollution. Pollutant source on PTC property will be eliminated through the combination of education and maintenance operations. The outfall will be revisited and retested, as appropriate, until the elimination of the pollution has been verified. Outfalls identified as having an illicit discharge shall be placed on an outfall screening priority list and the procedures detailed in **Section G: Procedure for Eliminating an Illicit Discharge** will be implemented.

Non-Emergency Illicit Discharge Response: **Off PTC Property**

Since the PTC has no legal authority beyond its property boundaries, it may not be possible to identify the source of an apparent illicit discharge (see **Section E**) without coordination with neighboring municipalities. . Using the PTC's storm sewer system map, the inspector should identify the name of the municipality from which the discharge is emanating. Notifications to the Pennsylvania Department of Environmental Protection (PADEP) should be made in conformance with the PTC's MS4 Permit as described above in **Illicit Discharge Notifications.** Due to the origin of the illicit discharge being located off PTC property, during the initial notification to PADEP, it is necessary to coordinate with PADEP for notification to the upstream Municipality of origin. Lacking specific directive in the Permit, after the initial notifications, the PTC will issue a follow up letter to the municipality and notification to PA DEP within 30 days of the observed and unresolved discharge. PTC Outfalls, observation points, and stormwater conveyances identified as receiving illicit discharges from off PTC property shall be placed on an outfall screening priority list and the procedures detailed in **Section G: Procedure for Eliminating an Illicit Discharge** will be implemented.

Procedures for Tracking Pollution Sources

There are several methods that may be employed to locate the source of an illicit discharge. The PTC will predominately rely on visual/sensory inspections but may use video inspection.

Visual/Sensory Inspections

Once an illicit discharge has been verified, the inspection team will refer to the stormwater network map to familiarize themselves with the contributing system and identify if there is a connection to an upstream MS4 (referred to as an Observation Point). Generally, any connection to an upstream MS4 will be inspected first to determine if the source of the discharge is within the jurisdiction of the PTC or if it is emanating from the upstream municipality. This inspection will rely on observations that the inspectors can make using sight and smell to observe color, odor, floating solids, scum, sheen, and substances that result in observed deposits in the surface waters indicating the presence of materials other than stormwater within the stormwater network that discharges to the polluted outfall. If the source is confirmed to be emanating from the upstream municipality, the PTC will notify the municipality and PA DEP as stated above in the **Non-Emergency Illicit Discharge Response**: **Off PTC Property** section.

If there is no evidence of the pollutant at an upstream Observation Point, the inspection team will systematically visually examine the flow path of the stormwater runoff beginning at the compromised outfall and working upstream along the conveyance system until the source of the illicit discharge is located. Observations for stormwater enclosed in pipes will be made at inlets and manholes. Only properly certified personnel for confined spaces will be permitted to enter stormwater pipes, inlets and manholes.

Video Inspection

While expensive and time consuming, remotely operated mobile video cameras can be used to examine storm sewer lines to observe possible illegal connections into the storm sewer system. The method allows definitive identification of unauthorized connection and video imaging provides reliable documentation.

G. PROCEDURE FOR ELIMINATING AN ILLICIT DISCHARGE

Illicit discharges within the Turnpike stormwater system is a straightforward endeavor. The PTC MS4 is owned and operated by the PTC. The PTC can therefore take direct corrective measures or require any utility or vendor with facilities located on PTC land to take corrective measures as required by their respective agreements. PTC utility and vendor agreements include required compliance with federal, state and local regulations and laws. PTC Staff (or 3rd Party Contractor) will perform screenings of the illicit discharge, as needed, to confirm presence of the illicit discharge and to confirm elimination of discharge has occurred; this does not limit the screening to two events, but allows for multiple screenings during the time period between discovery and elimination and is dependent on the complexity of the illicit discharge. Screening locations for identified illicit discharges may include the outfall, source, or along the path of the discharge within the PTC property.

Any illicit discharge emanating from outside the PTC property is under municipal jurisdiction and is their responsibility. As stated in **Section F. Procedures for Identifying the Source of Illicit Discharges**, the PTC will notify the upstream municipality and PA DEP of the illicit discharge so that corrective action can be pursued by the municipality and/or PA DEP. The confirmation of the elimination of an illicit discharge is limited to occurrences on PTC property. When an illicit discharge is determined to be emanating from outside the PTC property, as part of the notification to the upstream municipality and PA DEP, the PTC will request that the municipality and/or DEP provide confirmation of elimination and actions taken to eliminate the illicit discharge.

H. PROCEDURES FOR ASSESSING POTENTIAL ILLICIT DISCHARGE BY THE INTERACTION OF SEWAGE DISPOSAL SYSTEMS

Interactions between sewage disposal systems and stormwater systems located on PTC land are limited. There are five types of facilities within the PTC where such interaction is possible. The uses are listed below.

- Service Plazas
- Maintenance Facilities
- Toll Plazas
- Administration Buildings
- Tunnels

Once evidence of sanitary sewage is discovered at an outfall, the same discovery procedure described in **Procedures for Tracking Pollution Sources** will be followed. The First step will be to determine if the source is within PTC property or emanating from an upstream municipality. This will be accomplished through the inspection of observation point(s) where the upstream municipality's stormwater enters the PTC MS4.

The PTC will then examine potential sources on PTC property. To aid in identification of the source of the sanitary sewer interaction the PTC might rely on Dye or Smoke Testing or by use of a Video Inspection.

Dye Testing

Dye testing requires non-toxic dyes to be flushed down facility toilets and sinks. Pre-positioned observers watch for the passage of the dye at sanitary and storm manholes. The presence of the dye in the stormwater system would indicate an interconnection of the stormwater and sanitary system. The PTC is unlikely to use this method to identify connections from outside the PTC since the Commission has no jurisdiction beyond their property and cannot require private property owners to allow the injection of dye through their toilets and sinks.

Smoke Testing

Smoke testing is a relatively simple process that consists of blowing smoke mixed with large volumes of air into the sanitary sewer line usually induced through the manhole. The smoke travels the path of least resistance and quickly shows up at sites that allow surface water inflow. Where the PTC is served by public sewer, and smoke testing is selected as a means or determining infiltration and inflow, the PTC will coordinate with the local sanitary sewer provider.

Once sanitary sewer interaction is discovered it can be resolved directly by the PTC or by requiring a vendor or co-located sanitary sewer utility operator to take the required corrective actions.

Interaction between sewage systems located outside the PTC and the PTC MS4

Interaction of sewage systems located outside the PTC property is under municipal jurisdiction and is their responsibility. As stated in **Section F. Procedures for Identifying the Source of Illicit Discharges**, the PTC will notify the upstream municipality and PA DEP of the illicit discharge so that corrective action can be pursued by the municipality and/or PA DEP.

I. PROCEDURES FOR PROGRAM DOCUMENTATION, EVALUATION AND ASSESSMENT

All reporting shall be performed based on a reporting period of July 1 to June 30. At the conclusion of each reporting year, an activity report will be produced to detail that year's work under the IDD&E Program. PTC's overarching SWM Plan has established a process for logging annual reporting into that document, which encompasses this Program. The IDD&E work will be an integral part of the MS4 Annual Status Report (3800-FM-BCW0491) and will consist of the following elements, as applicable:

1. Written Program Review
2. MS4 Mapping Updates
3. Storm Sewer Collection System Mapping Updates
4. Outfall Screening Activities (including results from any lab testing)
5. Illicit Discharge Investigation Documentation
6. Employee Training & Public Outreach Activities

J. PROCEDURES FOR ADDRESSING INFORMATION OR COMPLAINTS RECEIVED FROM THE PUBLIC

The PTC's *Public Education and Outreach & Public Involvement and Participation Programs* are a way for Turnpike users to become involved with the IDD&E process. Part of the PTC's public awareness campaign is using Turnpike motorists to report any unusual fluids entering or discharging from the storm sewer system, especially during dry weather conditions.

The role of PTC staff is to investigate and pursue remedies for illicit discharges reported by Turnpike users or observed by PTC personnel. Public comments are recorded and tracked at the PTC Traffic Engineering and Operations Center. A prompt visual inspection of the site will take place, resulting in an assessment of the perceived illicit discharge through photo-documentation and tracking it back to a potential source or to the PTC's upstream MS4 boundary. If pollutants are suspected, the subsequent process will mirror that which is used in the PTC regularly scheduled field monitoring regimen.

The PTC receives complaints from the public via the incident reporting hotline. Calls are fielded by the Traffic Engineering and Operations (TE&O) Center, where it is determined if the complaint requires an emergency response or is a non-emergency issue. Emergency responses are managed by TE&O staff who notifies emergency responders, and federal, state, and local offices.

Non-emergency issues are forwarded to the PTC Public Relations office that assesses the nature of the issue and connects the caller to the appropriate PTC department for response.

Appendix A
PA DEP MS4 Outfall Field Screening Report (OFS)
[PADEP Form 3800-FM-BCW0521]

pennsylvania
DEPARTMENT OF ENVIRONMENTAL PROTECTION

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF CLEAN WATER

MS4 OUTFALL FIELD SCREENING REPORT

BACKGROUND INFORMATION

Permittee Name:	NPDES Permit No.: PA
Date of Inspection:	Outfall ID No.:
Land Uses in Outfall Drainage Area (Select All):	Latitude: _____° _____' _____"
☐ Industrial ☐ Urban Residential	Longitude: _____° _____' _____"
☐ Commercial ☐ Suburban Residential	Dry Weather Inspection? ☐ Yes ☐ No
☐ Open Space ☐ Other:	Date of Previous Precipitation:
	Amount of Previous Precipitation: in
Inspector Name(s):	Were Photographs Taken? ☐ Yes ☐ No
	Are Photographs Attached? ☐ Yes ☐ No

OUTFALL DESCRIPTION

TYPE	MATERIAL	SHAPE	DIMENSIONS	SUBMERGED
☐ Closed Pipe	☐ RCP ☐ CMP ☐ PVC ☐ HDPE ☐ Steel ☐ Other	☐ Circular ☐ Single ☐ Elliptical ☐ Double ☐ Box ☐ Triple ☐ Other ☐ Other	Diameter: _____ in	☐ In Water ☐ With Sediment
☐ Open Channel	☐ Concrete ☐ Earthen ☐ Rip-Rap ☐ Other	☐ Trapezoid ☐ Parabolic ☐ Other	Depth: _____ in Top Width: _____ in Bottom Width: _____	

Dry Weather Flow Present at Outfall During Inspection? ☐ Yes ☐ No *(If No, skip to Certification Section)*

Description of Flow Rate: ☐ Trickle ☐ Moderate ☐ Significant ☐ N/A

DRY WEATHER FLOW EVALUATION

Does the dry weather flow contain color? ☐ Yes ☐ No If Yes, provide a description below.

Does the dry weather flow contain an odor? ☐ Yes ☐ No If Yes, provide a description below.

Is there an observed change in the receiving waters as a result of the discharge? ☐ Yes ☐ No
If Yes, provide a description below.

Does the dry weather flow contain floating solids, scum, sheen or substances that result in deposits? ☐ Yes ☐ No
If Yes, provide a description below.

Were sample(s) collected of the dry weather flow? ☐ Yes ☐ No (If Yes, No. Samples: _____)

FIELD / LABORATORY ANALYSIS

PARAMETER	RESULTS	UNITS	PARAMETER	RESULTS	UNITS
Flow Rate		GPM	Fecal Coliform		No./100 mL
pH		S.U.	COD		mg/L
Total Residual Chlorine (TRC)		mg/L	BOD5		mg/L
Conductivity		µmhos/cm	TSS		mg/L
Ammonia-Nitrogen		mg/L	TDS		mg/L
Other: _____			Oil and Grease		mg/L
Other: _____			Other: _____		

Indicate the parameters above that were analyzed by a DEP-certified laboratory:

ILLICIT DISCHARGES

Is the dry weather flow an illicit discharge? ☐ Yes ☐ No

If Yes, describe efforts made to determine the source(s) of the illicit discharge.

Describe corrective actions taken by the permittee in response to the finding of an illicit discharge.

Inspector Comments:

RESPONSIBLE OFFICIAL CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowledge of violations. See 18 Pa. C.S. § 4904 (relating to unsworn falsification).

Responsible Official Name	Signature
Telephone No.	Date

Appendix B
Guide to Indicators and Monitoring Methods

[Adapted From: Illicit Discharge Detection and Elimination – A Guidance Manual for Program Development and Technical Assessments]

APPENDIX B

GUIDE TO INDICATORS AND MONITORING METHODS

This appendix contains general information about watershed indicators and methods.

Descriptions of Common Water Sampling and Analysis Indicators and Methods Used in this Handbook

General Terms Used In Water Sampling

- **Grab Sampling:** Samples are collected in some type of container by dipping the container in the water and filling it to some pre-determined level.
- **Integrated Sampling:** Samples are collected from various depths or locations across a transect that are combined into one sample for analysis.
- **Multiple Depth Sampling:** Individual samples are collected at various depths and analyzed separately.
- **Direct Measurement:** The indicator is measured directly from the water without collecting a sample.

Sample Handling Requirments

From Standard Methods				
Indicator	**Container Type**	**Minimum Size (mL)**	**Preservation**	**Max. Holding Time**
Alkalinity	P, G	200	Ref.	24 h
Bacteria	P, G (S)	200	Ref.	6 h
BOD	P, G	1000	Ref.	6 h
Chlorophyll	P, G	500	Dark	30 d
Conductivity	P, G	500	Ref.	28 d
N-Ammonia	P, G	500	ASAP or acidify	7 d
N-Nitrate	P, G	100	ASAP or ref.	48 h
N-Kjeldahl	P, G	500	Ref., acidify	7d
Oxygen	G-BOD	300	Fix	8 h
PH	P, G	-	ASAP	2h
Phosphate	G(A)	100	Ref.	48 h
Solids	P, G	-	Ref.	7 d
Turbidity	P, G	-	Ref., Dark	24 h

Abbreviations

P = Plastic, G = Glass
G(A) = acid-rinsed glass
(S) = sterile

Ref. = refrigerate
h = hours, d = days

General Terms Used In Water Analysis Methods

This section describes the basic laboratory methods used to analyze water samples. These methods are referred to in the next section on methods for each indicator.

- **Titration:** Determining the concentration of an indicator in a sample by adding to it a standard reagent of known concentration in carefully measured amounts until a color change or electrical measurement is achieved, and then calculating the unknown concentration. Common indicators measured this way are dissolved oxygen and alkalinity.
- **Colorimetric:** Determining the concentration of an indicator in a sample by adding to it a reagent that causes a color change in direct proportion to the concentration of the indicator being measured. The intensity of the color (as measured by the extent to which it absorbs or transmits light) is either read with a visual color comparator or measured using a meter and either read directly in appropriate reporting units or read in "% absorbance" or "% transmittance" units and converted to reporting units. Common indicators measured this way are nutrients.
- **Electrometric:** Determining the concentration of an indicator in a sample by using a meter with an attached electrode that measures the electric potential (millivolts) of the sample. This amount of electric potential is a function of the activity of ions or molecules in the sample and proportional to the concentration of the indicator being measured. The electrode is selected based on its response to specific ions (known as an "Ion Selective Electrode" (or ISE), general ionic activity (conductivity) or molecules (for example, a Membrane Electrode). The meters can either display results in millivolts (mV) or in appropriate reporting units. Common indicators measured this way are dissolved oxygen, pH, conductivity and nutrients.
- **Gravimetric:** Determining the concentration of an indicator in a sample by filtering a specified quantity of the sample and determining the weight of the material retained on the filter. Common indicators measured this way are total solids and total suspended solids.
- **Nephelometric:** Determining the clarity of a sample by measuring the intensity of light scattered by particles in the sample and comparing this with a known solution. The higher the intensity of the scattered light, the higher the turbidity reported in nephelometric turbidity units (NTU's).
- **Membrane Filtration and Incubation:** Determining the bacteria concentration of a water sample by filtering a specified quantity through a specified gridded membrane filter, which retains the bacteria and other particles larger than 0.45 microns. After filtration, the membrane containing the bacterial cells is placed on a specific nutrient medium and then incubated at a specified temperature for a specified length of time. Colonies of a specified color growing on the filter are then counted.

Acidity

Acidity is the water's ability to resist a change in pH when a base is added. This is largely caused by carbon dioxide, salts of strong acids and weak bases and other factors. Above a pH of 8.3, there is no measurable acidity. Acidity is the reverse of the alkalinity buffering effect. It is measured as the concentration of $CaCO_3$.

Analytical Methods

Acidity is measured by titrating a sample to either 3.7 (methyl orange acidity using bromphenol blue indicator) or 8.3 phenolpthalein acidity using penolpthalein indicator). Acidity (in mg/L as $CaCO_3$) is calculated from the amount of titrant (sodium hydroxide) needed to bring the sample to either pH.

Alkalinity, Total

This is a measure of the water's ability to neutralize acids -- the higher the alkalinity levels, the more acid-neutralizing capacity the water has. This is important for aquatic ecosystems because it protects against changes in pH, which can harm aquatic life.

Analytical Methods

Basic methods use titration. The advanced method uses a meter to measure the pH at two endpoints.

Basic Methods	**Advanced Methods**
Sulfuric Acid Titration w/ Bromcresol Green/Methyl Red 1) The sample is collected and treated with bromcresol green-methyl red. 2) It is then titrated with sulfuric acid until the solution turns pink. 3) The amount of acid added to reach this point is converted to total alkalinity.	*Double End Point Sulfuric Acid Titration w/ pH Meter* 1) The sample is collected and the pH measured 2) It is then titrated with sulfuric acid until the pH is 4.5 3) The amount of acid added to reach this point is converted to total alkalinity.

Biochemical Oxygen Demand (BOD)

BOD is a measurement of the amount of oxygen consumed by organic matter and associated microorganisms and through chemical oxidation in the water over a period of time, usually five days. Measuring the biochemical oxygen demand (BOD) of the water tells us whether oxygen demanding wastes might cause low dissolved oxygen (DO) levels at times.

Analytical Methods

Basic and advanced methods use a version of Winkler Titration. As with dissolved oxygen (DO), the main difference is the type of titrator or use of a meter.

Basic Methods	**Advanced Methods**
Modified BOD-5 Day Method (Hach via Mitchell & Stapp) 1) Two samples are collected in glass-stoppered BOD bottles (one clear and one black) as in the DO method. 2) The DO is determined for the clear bottle, using Modified Winkler Titration with a syringe or eyedropper. 3) The black bottle is placed in the dark and incubated for five days at 68°F. 4) The DO for this sample is then determined the same way. 5) BOD is determined by subtracting the DO level of the black bottle from the clear bottle.	*Modified BOD-5 Day Method w/ modified Winkler Titration or Meter (Standard Methods #521 O-B or equivalent)* 1) Two samples are collected in glass-stoppered BOD bottles (one clear and one black) as in the DO method. 2) The DO is determined for the clear bottle, using Modified Winkler Titration with a buret, syringe, digital titrator or meter 3) The black bottle is placed in the dark and incubated for five days at 68°F. 4) The DO for this sample is then determined the same way. 5) BOD is determined by subtracting the DO level of the black bottle from the clear bottle.

Chlorophyll *a*

Chlorophyll *a* is a green pigment found in all plants. It is used to quantify the abundance of algae in water. When chlorophyll *a* degrades, it converts to pheophytin. The ratio of chlorophyll *a* to pheophytin is used to determine the health of the algae sampled.

Analytical Methods

Measuring chlorophyll *a* involves a sophisticated process for which there are no simple methods.

Basic Methods	**Advanced Methods**
None	*Pigment extraction followed by spectrophotometry (Adapted by Paul Godfrey from Standard Methods #10200 H)* **1)** Collect an integrated water sample using a clean container (at least one quart). **2)** Filter subsample (quantity depends on a Secchi reading) using a glass fiber filter and vacuum pump. **3)** Analyze filters immediately, frozen or dried. **4)** Extract pigment by grinding the filter, steeping the ground mass in 90% acetone, and centrifuging in tubes to de-suspend fibers from the solution. **5)** Read color with a spectrophotometer and calculate concentration. **6)** Add hydrochloric acid to the sample to convert all chlorophyll *a* to pheophytin. **7)** Read color again with a spectrophotometer and calculate the concentration of pheophytin.

Chlorine, Total Residual

Chlorine is a gas in its natural state. It is toxic to microbes and animals and is widely used to disinfect drinking water and wastewater. It can also combine with a wide variety of organic and inorganic chemicals to produce toxic compounds. It does not appear to be toxic to humans, except when it combines with other compounds. Total Residual Chlorine consists of Free Chlorine (hypochlorite ion, hypochlorous acid – the disinfecting agent) and chloramines (formed when chlorine reacts with ammonia or nitrogen).

Analytical Methods

Amperometric Titration: Chlorine is tricky to sample because it is volatile (tends to convert to gas quickly) and has tricky flow patterns. We recommend consulting with your regional DEP biologist. The analytical method involves titrating a prepared sample with Phenylarsine Oxide with an Amperometric Titrator to an endpoint.

Conductivity

This is a measure of the water's ability to pass an electrical current. This ability depends on the presence of inorganic dissolved solids made up of ions (particles that carry a positive or negative electrical charge). Since it measures a wide range of materials, its primary importance is as an indicator of general pollution, rather than a specific pollutant.

Analytical Methods

Basic and advanced methods use a conductivity meter. This meter contains a probe with two electrodes. The probe is lowered into the water, voltage applied, and the drop in voltage caused by the resistance of the water is measured and converted to conductivity. The basic method uses a relatively inexpensive "pen." The advanced method uses a high-quality meter to measure the conductivity.

Basic Methods	**Advanced Methods**
Electrometric Using A Conductivity Pen 1) Collect water sample or measure directly with pen. 2) Measure collected sample with pen.	*Electrometric Using A Conductivity Meter (EPA Method 120.1)* 1) Collect water sample or measure directly with meter. 2) Measure collected sample with meter.

Dissolved Oxygen (DO)

DO is the presence of oxygen gas molecules in the water. Since it is critical to many biological and chemical processes in the water and essential for aquatic life, dissolved oxygen is an indicator of the capability of the aquatic ecosystem to support life.

Analytical Methods

Basic and advanced methods use a version of Winkler Titration. The main difference is the size of the increment of titrant added to the sample – smaller increments increase sensitivity.

Basic Methods	Advanced Methods
Modified Winkler Titration with a syringe or eyedropper (Hach via Mitchell & Stapp) This is essentially the Modified Winkler Titration described above, with some changes. The titrant is phenylarsine oxide solution and the titrator is an eyedropper. The eyedropper gives less accuracy and sensitivity than other titrators because it dispenses larger drops -- each drop equals 0.5 mg/l.	*Modified Winkler Titration with a buret, syringe or digital titrator: Standard Method #4500-OG (or equivalent)* **1)** Collect surface samples in 300 mL "BOD" bottles with glass stoppers so that no air bubbles are trapped. In lakes, an integrated sample is collected using a length of garden hose. **2)** Samples must be analyzed immediately or fixed and analyzed within eight hours. **3)** The level of oxygen in the sample is "fixed" by adding reagents which produce a chemical reaction producing iodine in direct proportion to the amount of oxygen in the water. **4)** Sodium thiosulfate is then added incrementally using a digital titrator (Hach) or syringe (Lamotte). The amount of sodium thiosulfate it takes to turn the solution clear is proportional to the amount of iodine (which has taken the place of the oxygen) in the sample.
	Meter (Membrane Electrode) Method: Standard Methods #4500-OG (or equivalent) 1) A membrane-covered electrode probe is lowered into the water. 2) The meter electronically measures the diffusion of oxygen from the water across a membrane-covered electrode, which is directly proportional to the DO concentration.

Notes On Methods

- Water samples for dissolved oxygen should be collected in glass-stoppered BOD bottles or other container designed so that no air is trapped in the sample.
- If you have a limited budget for this indicator (<$300), we recommend that you use the Hach or Lamotte Adaptation of Winkler Titration. The Hach digital titrator dispenses smaller increments of the sodium thiosulfate than the Lamotte syringe and therefore increases the sensitivity. But, it's more expensive.
- If you have the budget ($600-800) to purchase a meter and you need frequent (or continuous) measurements from a few sites, a meter will work best. However, if you have a large number of sites and can only use one meter, we recommend titration.

Fecal Coliform and *E. coli* Bacteria

Fecal coliforms and *E. coli* are bacteria that are common in the intestines and feces of warm-blooded animals. They are used both as an indicator of the presence of sewage or animal manure in the water and as an indicator of the health risk of swimming and other water contact recreation. Fecal coliforms are the indicator used in Pennsylvania's water quality standards. *E. coli* (a species of fecal coliforms) are used in other states, per their water quality standards.

Analytical Methods

The basic methods will either detect the presence of bacteria (but won't give you a count) or they give you an estimate of density (but not a reliable count). Advanced methods are EPA-approved and give reliable counts. The most reliable count is produced by the mTEC method. Note that the mColiBlue method does not identify fecal coliforms. *E. coli* colonies are used as the equivalent, but these counts will underestimate fecal coliforms.

Basic Methods	Advanced Methods
Estimates of Density These methods estimate the number of bacteria in a sample in various ways: 1) Easygel: Using one subsample size, usually 1-5 mL, bacteria are grown on nutrient medium without filtration. Colonies of specified color are counted. Estimates total coliforms and E. coli. Fecal coliforms are estimated using E. coli counts. 2) Colilert: A reagent is added to various subsample sizes, which turns yellow if coliforms are present and fluoresces if they are *E. coli*. A statistical table is used to estimate density based on which subsamples turn yellow and/or fluoresce.	*Fecal coliforms and E. coli: Membrane Filtration Using mTEC: EPA Method #1103.1* **1)** Collect water sample in sterile container. **2)** Filter several subsample sizes through 0.45 micron filters. **3)** Dry incubate on mTEC nutrient medium in petri plates at 35°C for two hours. **4)** Incubate at 44.5°C in a water bath for 22 hours. **5)** Count fecal coliforms after incubation. **6)** Incubate at room temperature for 20 minutes on a urea solution and count *E. coli*.
Presence-Absence These methods detect the presence of selected bacteria types by whether or not bacteria grows on the plate (as detected by a certain color) or whether a special broth turns color when exposed to sample water. These methods tell you bacteria is present, but do not indicate the number of bacteria	*Fecal Coliforms: Membrane Filtration Using mFC: Standard Methods #9222 D* **1)** Collect water sample in sterile container. **2)** Filter several subsample sizes through 0.45 micron filters. **3)** Incubate at 44.5°C in a water bath for 24 hours on mFC nutrient medium in petri plates. **4)** Count fecal coliforms after incubation.
	Fecal Coliforms: Membrane Filtration Using mColiBlue24 (Hach) **1)** Collect water sample in sterile container. **2)** Filter several subsample sizes through 0.45 micron filters. **3)** Incubate at 44.5°C in a water bath for 24 hours on mColiBlue nutrient medium in petri plates. **4)** Count *E. coli* colonies after incubation (use to estimate fecal coliforms).

Hardness

Hardness is a measure of the calcium and magnesium positively charged ions in the water. These ions reduce the surface tension of the water, and soap does not produce lather in hard water. When hardness is primarily calcium, it is closely related to alkalinity. Hardness frequently reduces the impacts of metals on aquatic life: the higher the hardness, the lower the toxicity. Hardness is reported as mg/l of $CaCO_3$ at a given pH.

Analytical Methods

There are no basic methods. The advanced method involves either a titration or calculating the hardness from previously-determined calcium and magnesium concentrations.

Basic Methods	Advanced Methods
None	*EDTA Titration Method (Standard Method 2340C, EPA Method 130.2)* 1) Collect water sample. 2) Add dye (EBT indicator) which turns sample purple. 3) Titrate with EDTA reagent until solution turns blue. 4) Calculate hardness from amount of titrant used as $CaCO_3$.

Nitrogen

Nitrogen is a gas in the atmosphere. It combines with oxygen or hydrogen to produce various compounds -- ammonia, nitrites and nitrates. It is an essential nutrient for plant growth and metabolic reactions in plants and animals. Together with phosphorus, it is the primary source of food energy in the aquatic ecosystem. Too much of certain forms of nitrogen can cause too much biological activity and cause undesirable effects. It is also toxic to babies in high concentrations. Nitrogen occurs in various forms, both organic and inorganic in the water, some of which are more available for plant growth than others. In some waters, nitrogen is the nutrient in short supply, so that relatively small amounts can cause impacts. Three forms of nitrogen are recommended as indicators in this handbook: ammonia, nitrates and total. Their descriptions and methods follow:

Nitrogen - Ammonia Nitrogen

Ammonia (NH_3) is produced when organic nitrogen and/or urea break down. It is a byproduct of sewage decomposition. It is naturally present in surface waters, and can be toxic to aquatic life at relatively low concentrations (<1.0 mg/l).

Analytical Methods

Measuring ammonia involves a sophisticated process for which there are no simple methods. The Hach adaptation is the easiest, though it uses the distillation step only if known interferences are present.

Basic Methods	Advanced Methods
None	*Distillation followed by Nesslerization (Standard Methods #4500-NH3 C or equivalent)* **1)** Add borate solution to sample for buffering. **2)** Distill[1] sample using a distillation apparatus. This removes certain interferences. **3)** Nesslerization. This involves pretreatment to remove turbidity-producing compounds and adding a Nessler reagent. **4)** This produces a yellow to brown color that is measured with a spectrophotometer. **5)** The reading is compared with a set of standard concentrations and reported as mg/l NH_3 -N.

Nitrogen - Nitrate Nitrogen

Nitrate (NO_3) is produced naturally by nitrogen-fixing plants and lightning acting on atmospheric nitrogen or ammonia. Nitrate is a form of nitrogen readily used by plants. In excess, it can cause excessive biological activity in surface waters and can be toxic to infants.

Analytical Methods

Basic and advanced methods use a variation on the same procedure, except that in the basic method the color is read using a visual color comparator. In the advanced method, the color is read using an electronic meter.

Basic Methods	Advanced Methods
Cadmium Reduction followed by Color Comparator (Hach via Mitchell & Stapp) *1)* A cadmium reduction reagent is added to a water sample. This causes a chemical reaction and turns the sample pink. *2)* The sample color is matched to colors labeled in pH units on a color comparator. *3)* The analyst determines the closest color match and records the nitrate concentration.	*Cadmium Reduction followed by spectrophotometry (Standard Methods #4500-NO_3- E or equivalent)* **1)** A cadmium reduction reagent is added to a water sample. This causes a chemical reaction and turns the sample pink. **2)** This color is measured with a spectrophotometer. **3)** The reading is compared with a set of standard concentrations and reported as mg/l NO_3 -N.

Notes on Methods

- The basic method should be considered an approximation only. This method is not acceptable for federal and state agency assessment, but is fine for education and awareness and some community assessments.

Nitrogen - Total Kjeldahl Nitrogen (TKN)

This refers to the total of organically bound nitrogen and ammonia. By analyzing samples for both ammonia and total Kjeldahl nitrogen, organic nitrogen can be calculated. This enables you to

[1] Distillation involves boiling the sample and collecting the steam.

estimate how much nitrogen in the system is in organic form, intermediate form (ammonia) and inorganic form (nitrate). It may tell you how much comes from sewage, versus fertilizer, for example.

Analytical Methods

Measuring TKN involves a sophisticated process for which there are no simple methods. The Hach adaptation is the easiest, though it uses the distillation step only if known interferences are present.

Basic Methods	**Advanced Methods**
None	*Digestion followed by Nesslerization followed by spectrophotometry (Standard Methods #4500-Norg B or equivalent)* **1)** Digest[2] water sample to convert organic and ammonia compounds to ammonia nitrogen. **2)** Ammonia is then measured using the Nesslerization Method (see ammonia methods). **3)** The reading is compared with a set of standard concentrations and reported as mg/l TKN.

pH

pH is a measure of the acidity of the water. Since pH affects many biological and chemical reactions in the water and most organisms have a preferred range, it is a good indicator of capability of the aquatic ecosystem to support life.

[2] The process of disintegration by means of chemical action, heat, and/or moisture.

Analytical Methods

Basic methods use colorimetry. The advanced method uses a meter.

Basic Methods	**Advanced Methods**
Colorimetric Method (Hach via Mitchell & Stapp) 1) This method involves the addition of pH indicator solution to a water sample which changes color according to the pH. 2) The sample color is matched to colors labeled in pH units in a color comparator. 3) The analyst determines the closest color match and records the pH. This should be considered an approximation only.	*Electrometric Method (EPA Method 050.1 or Equivalent)* **1)** Collect sample or measure directly with a meter. **2)** Measure on a collected sample using a laboratory-quality meter with an electrode suitable for ionic-strength of waters. **3)** There are less expensive pH pens or "pocket pals" on the market. These should be checked against a reliable, laboratory-quality meter to establish accuracy and precision.
pH Paper This is similar to the colorimetric method, except that a specially coated paper is dipped in the sample and turns color according to the pH. This should be considered an approximation only.	

Notes on Methods

- For waters that are low in ionic strength, accurate pH measurements require a probe that will respond in these types of waters.
- pH samples should be collected so that no air is trapped in the sample.
- The colorimetric method is subject to variation in the light source and the judgments of the analyst. It is inherently imprecise.

Phosphorus

Phosphorus is an essential nutrient for plant growth and metabolic reactions in plants and animals. Together with nitrogen, it is a key element in the aquatic ecosystem. Too much phosphorus can cause too much biological activity and cause undesirable effects. Phosphorus occurs in various forms in the water, some of which are more available for plant growth than others.

Phosphorus - Total Orthophosphates

This is primarily the dissolved and most available form. It is a good indicator of enrichment from various sources, such as sewage, manure or fertilizer.

Analytical Methods

Basic and advanced methods are basically the same colorimetric method. The main difference is that the advanced method measures the color of the treated sample using an electronic instrument.

Basic Methods	Advanced Methods
Ascorbic Acid Method 1) Collect a sample in a phosphorus-free container. 2) Analyze by adding ascorbic acid reagent which turns the sample blue (ascorbic acid method) in proportion to the amount of phosphorus in the sample. 3) Compare this blue color to various shades using a visual color comparator to get a concentration.	*Ascorbic Acid Method (EPA Method #365.2 or equivalent)* 1) Collect a sample in a phosphorus-free container. 2) Analyze by adding ascorbic acid reagent which turns the sample blue (ascorbic acid method) in proportion to the amount of phosphorus in the sample. 3) Measure the intensity of this blue color using a spectrophotometer or colorimeter and compare with results for a set of standard concentrations.

Notes on Methods

- ♦ The basic method should be considered an approximation only. This method is not acceptable for federal and state agency assessment, but is fine for education and awareness and some community assessments.

Phosphorus, Total

Total phosphorus includes all the forms. It is a good indicator of enrichment from various sources, such as sewage, manure, or fertilizer.

Analytical Methods

Basic and advanced methods are basically the same colorimetric method. The main difference is that the advanced method measures the color of the treated sample using an electronic instrument.

Basic Methods	Advanced Methods
Persulfate Digestion Followed by Ascorbic Acid Method 1) Collect a sample in a phosphorus-free container. 2) Boil, acidify and oxidize a sub-sample to convert all forms of phosphorus to orthophosphate (persulfate digestion). 3) Analyze Orthophosphate by adding ascorbic acid reagent which turns the sample blue (ascorbic acid method) in proportion to the amount of phosphorus in the sample. 4) Compare this blue color to various shades using a visual color comparator to get a concentration.	*Persulfate Digestion Followed by Ascorbic Acid Method (EPA Method #365.2 or equivalent)* 1) Collect a sample in a phosphorus-free container. 2) Boil, acidify and oxidize a sub-sample to convert all forms of phosphorus to orthophosphate (persulfate digestion). 3) Analyze Orthophosphate by adding ascorbic acid reagent which turns the sample blue (ascorbic acid method) in proportion to the amount of phosphorus in the sample. 4) Measure the intensity of this blue color using a spectrophotometer or colorimeter and compare with results for a set of standard concentrations.

Notes on Methods

- The basic method should be considered an approximation only. This method is not acceptable for federal and state agency assessment, but is fine for education and awareness and some community assessments.

Phosphorus, Total Dissolved

Total dissolved phosphorus includes all the forms after a sample is filtered. It is a good indicator of the available forms from various sources, such as sewage, manure or fertilizer.

Analytical Methods

Basic and advanced methods are basically the same as the method for total phosphorus, with the addition of filtering the sample before digestion and analysis.

Solids

Solids include materials that are dissolved, suspended or settled in the water column. *Total solids* include all of these.

Solids - Total Suspended

Total suspended solids consist of solids that are filtered out of a water sample. Suspended solids affect water clarity and can reduce photosynthesis and cause higher temperatures.

Analytical Methods

Measuring total suspended solids involves a sophisticated process for which there are no simple methods.

Basic Methods	**Advanced Methods**
None	*Gravimetric Method: Total Suspended Solids Dried at 103-105° C (Standard Methods #2540D)* **1)** Weigh a glass fiber filter. **2)** Filter a sample through the filter, and transfer it to a Gooch crucible. **3)** Dry filters and crucibles in an oven at 103-105°C for an hour. **4)** Weigh filters and crucibles again. **5)** Calculate total dissolved solids by subtracting the weight of the filter and crucible from the weight after filtering and drying. Results are reported as mg/l.

Solids - Total Dissolved

Dissolved *solids* include various ions of calcium, chlorides, nitrate, phosphate, iron, sulfur and others that will pass though a two-micron pore. These affect the water balance in the cells of aquatic organisms, making it difficult for them to maintain position in the water column.

Basic Methods	Advanced Methods
None	*Gravimetric Method: Total Dissolved Solids Dried at 180°C (Standard Methods #2540C)* **1)** Filter a sample through a glass fiber filter. **2)** Weigh a ceramic dish. **3)** Pour the filtered sample into the dish. **4)** Evaporate the water in an oven at 180°C, and weigh the dish plus residue. **5)** Calculate total dissolved solids by subtracting the weight of the dish from the weight of the dish with residue. Results are reported as mg/l.

Secchi Depth Transparency (for lakes only)

Transparency describes scattering and absorption of light by small particles and molecules in the water. This is most commonly expressed as the depth at which a black and white patterned device known as a *Secchi disk* disappears from sight. The more transparent the water, the lower the depth at which the disk disappears. Reduced transparency has the same effects as elevated turbidity.

Basic Methods	Advanced Methods
Secchi Disk *1)* Lower Secchi disk into the water until it disappears from sight. *2)* Bring disk up until it appears again. *3)* The average of these two depths is the Secchi depth transparency.	*Same as basic*

Temperature

Since temperature affects many biological and chemical reactions in the water and most organisms have a preferred range, it is a good indicator of capability of the aquatic ecosystem to support life. It is measured in degrees Fahrenheit (°F) or degrees Celsius (°C).

Analytical Methods

Basic Methods	Advanced Methods
Direct measurement with thermometer	*Direct measurement with thermometer, thermocouple, thermistor or a multi-use meter*

Turbidity (for streams only)

Turbidity describes how the particles suspended in the water affect its clarity by scattering light. It is an indicator of the presence of suspended sediment from erosion, which can decrease biological activity, raise water temperatures and clog fish gills and gravel spawning areas. Turbidity results are usually reported as nephelometric turbidity units (NTUs).

Analytical Methods

The basic methods involve measuring transparency, which includes both light scattering and absorption. The advanced method measures just light scattering. Thus, the results of basic and advanced methods are not comparable with each other. The "advanced" method is actually fairly simple, though it involves an expensive meter.

Basic Methods	**Advanced Methods**
Turbidity Tubes (Lamotte) 1) Two graduated cylinders with black dots on the bottom are filled to a specific volume -- one with sample water the other with turbidity-free water. 2) A reagent is added to the turbidity-free water cylinder, until the visibility of the dot on the bottom is equivalent to that of the cylinder with the sample. 3) The results are reported in unspecified units. 4) This method actually measures absorbance plus scattering, so the results are not actually NTUs.	*Nephelometric Method (Standard Methods #2130 or equivalent)* **1)** Turbidity is measured by collecting and analyzing a water sample using a nephelometer. **2)** A nephelometer consists of a light source that projects a beam of light through the water sample and a photo-electric cell that measures the intensity of light scattered by particles at a 90° angle from its original path. **3)** The results are reported as nephelometric turbidity units (NTUs).
Turbidity Tube (Tennessee Valley Authority) 1) These tubes are marked in increments of NTUs on the side and a wave pattern on the bottom. 2) The sample is poured into the tube until the wave pattern disappears. 3) The NTU increment level of the sample is reported. 4) This method actually measures absorbance plus scattering, so the results are not actually NTUs. In fact, they should be reported in centimeters or inches.	

Notes on Methods

- Measure turbidity in rivers.
- Make sure that the meter you purchase is a nephelometer that measures light scattered at a 90° angle.
- Turbidity tubes are not acceptable substitutes for a nephelometer, since they actually measure transparency (light scattering and absorption), rather than just light scattering. Because of this, they are unreliable in colored waters, which absorb light, though may not be turbid at all. They are really more analogous to Secchi disks, in that your eye responds to absorption. If you use these tubes, report your results as a depth (in centimeters or inches) rather than NTUs.

Water Column Metals and Other Elements Recommended for Sampling Only (Advanced Assessments)

Many naturally-occurring metals are toxic to aquatic life, when present in high enough concentrations. The most common process is when they bind to gill surfaces on fish and insects. The metals of concern are mostly those that are "available" as dissolved ions in the water column.

The following metals and other elements are recommended by several of the advanced assessments. However, the analysis methods require techniques and equipment beyond the means of community-based groups and schools (except universities). Therefore, we recommend sampling only. Even for sampling, we recommend consulting with your regional DEP biologist as to sampling procedure

Sampling (Standard Methods 3010B)

Because some metals are toxic in very small amounts (micrograms per liter), the methods must be able to detect very low concentrations. Contamination of sampling containers is a real concern. Samples for metals are usually collected in special acid-rinsed containers made of polypropylene, linear polyethylene or borosilicate glass. Samples to be analyzed for dissolved metals are immediately filtered through a 0.45 micron filter. Otherwise they are preserved by acidifying with concentrated nitric acid to a pH of <2.

Analytical Method (EPA Method 200.7)

Various forms of metals can be analyzed, depending on how the sample is treated:

- Dissolved Metals: The filtered sample is analyzed.
- Suspended Metals: Metals are trapped on the filter.
- Total Metals: Metals are detected in an unfiltered sample after digestion or the sum of dissolved and suspended metals are added together.
- Acid-extractable Metals: Metals in solution after treatment of the sample with hot mineral acid.

Metals are usually analyzed as a suite using *Inductively Coupled Plasma - Atomic Emission Spectrometry*. An inductively coupled plasma source (a machine) vaporizes the sample and heats it to about 6000-8000°C. Molecules separate and atoms become active and ionized (reactive). In this state, each element produces a unique spectral (colored) pattern which is read by a spectrometer.

Needless to say, this is an extremely technical and expensive method beyond the reach of volunteer monitoring programs.

Aluminum (sampling only)

Aluminum is a naturally occurring element in rocks, soils and the waters in contact with them. It occurs as a soluble salt, a colloid or an insoluble compound. Aluminum toxicity for aquatic life depends on pH.

Arsenic (sampling only)

Arsenic is a naturally occurring element in rocks, soils and the waters in contact with them. Recognized as a toxic element for centuries, arsenic today also is a human health concern because it can contribute to skin, bladder and other cancers (National Research Council, 1999).

Arsenic is widely distributed throughout the earth's crust and is used commercially, primarily in alloying agents. It is introduced into water through the dissolution of minerals and ores, from industrial effluents and from atmospheric deposition; concentrations in groundwater in some areas are elevated as a result of erosion from local rocks

Arsenic is highly toxic, though its toxicity is dependent on its form and environmental conditions.

Used in groundwater assessment only.

Barium (sampling only)

Barium is a lustrous, machinable metal that exists in nature only in ores containing mixtures of elements. It is used in making a wide variety of electronic components, in metal alloys, bleaches, dyes, fireworks, ceramics and glass. In particular, it is used in well drilling operations where it is directly released into the ground.

EPA has found barium to potentially cause gastrointestinal disturbances and muscular weakness when people are exposed to it at unsafe levels for relatively short periods of time

In water, the more toxic soluble barium salts are likely to be converted to insoluble salts that precipitate. Barium does not bind to most soils and may migrate to groundwater. It has a low tendency to accumulate in aquatic life and does not seem to be an aquatic life health concern.

Used in groundwater assessment only.

Cadmium (sampling only)

Cadmium is a metal found in natural deposits as ores containing other elements. The greatest use of cadmium is primarily for metal plating and coating operations, including transportation equipment, machinery and baking enamels, photography and television phosphors. It is also used in nickel-cadmium and solar batteries and in pigments.

EPA has found cadmium to potentially cause vomiting, diarrhea, muscle cramps, nausea, salivation, sensory disturbances, liver injury, convulsions, shock and renal failure when people are exposed to it at unsafe levels for relatively short periods of time. Cadmium has the potential to cause kidney, liver, bone and blood damage from a lifetime exposure at unsafe levels.

Cadmium occurs naturally in zinc, lead, copper and other ores that can serve as sources to ground and surface waters, especially when in contact with soft, acidic waters. Major industrial releases of cadmium are due to waste streams and leaching of landfills, and from a variety of operations that involve cadmium or zinc. In particular, cadmium can be released to drinking water from the corrosion of some galvanized plumbing and water main pipe materials.

Some cadmium compounds are able to leach through soils to groundwater. When cadmium compounds do bind to the sediments of rivers, they can be more easily bioaccumulated or re-dissolved when sediments are disturbed, such as during flooding. Its tendency to accumulate in aquatic life is great in some species, low in others. Toxicity increases as hardness decreases.

Calcium (sampling only)

Calcium is a naturally-occurring element that enters surface water from surrounding rocks. It is a vital micro-nutrient for both plants and animals. In various compounds, calcium is an important part of the water's buffering system (see alkalinity, acidity, hardness). Used in groundwater assessment only.

Chromium (sampling only)

Chromium is a metal found in natural deposits as ores containing other elements. Though chromium occurs in nature mostly as chrome iron ore and is widely found in soils and plants, it is rare in natural waters. The greatest use of chromium is in metal alloys such as stainless steel; protective coatings on metal; magnetic tapes; and pigments for paints, cement, paper, rubber, composition floor covering and other materials. Its soluble forms are used in wood preservatives.

Short-term: EPA has found chromium to potentially cause skin irritation or ulceration when people are exposed to it at unsafe levels for relatively short periods of time. Chromium has the potential to cause damage to liver, kidney, circulatory and nerve tissues; and cause skin irritation from a lifetime exposure at unsafe levels.

When released to land, chromium compounds bind to soil and are not likely to migrate to groundwater. They are very persistent in water as sediments. There is a high potential for accumulation of chromium in aquatic life.

Copper (sampling only)

Copper is a metal found in natural deposits as ores containing other elements. It is widely used in household plumbing materials.

Copper is an essential nutrient, required by the body in very small amounts. However, EPA has found copper to potentially cause stomach and intestinal distress, liver and kidney damage, and anemia when people are exposed to it at high levels for relatively short periods of time.

Copper may occur in drinking water either by contamination of the source water used by the water system, or by corrosion of copper plumbing. Corrosion of plumbing is by far the greatest cause for concern. Copper is rarely found in source water, but copper mining and smelting operations and municipal incineration may be sources of contamination.

All water is corrosive toward copper to some degree, even water termed non-corrosive or water treated to make it less corrosive. Corrosivity toward copper is greatest in very acidic water. Many of the other factors that affect the corrosivity of water toward lead can also be expected to affect the corrosion of copper.

Copper is toxic to aquatic life at high levels, though it does not appear to accumulate in the edible portions of freshwater fish. Toxicity increases as hardness decreases.

Iron, Total (sampling only)

Iron is a metal common in rocks and soils and in varying quantities in surface water. It is an essential trace element required by both plants and animals. Iron is not considered a problem for aquatic life, except for physical effects from iron precipitate.

Lead (sampling only)

Lead is a metal found in natural deposits as ores containing other elements. It is sometimes used in household plumbing materials or in water service lines used to bring water from the main to the home.

Lead can cause a variety of adverse health effects when people are exposed to it at usafe levels for relatively short periods of time. These effects may include interference with red blood cell chemistry, delays in normal physical and mental development in babies and young children, slight deficits in the attention span, hearing and learning abilities of children, and slight increases in the blood pressure of some adults. Lead has the potential to cause stroke, cancer and kidney disease from a lifetime exposure at unsafe levels.

Lead may occur in drinking water either by contamination of the source water used by the water system, or by corrosion of lead plumbing or fixtures. Lead is rarely found in source water, but lead mining and smelting operations may be sources of contamination. Corrosion of plumbing is by far the greatest cause for concern.

When released to land, lead binds to soils and does not migrate to groundwater. In water, it binds to sediments. It does not accumulate in fish, but does in some shellfish, such as mussels. Toxicity increases as hardness decreases.

Used in groundwater assessment only.

Manganese (sampling only)

Manganese does not occur naturally as a metal. It is frequently found in various salts and minerals, frequently with iron. It is a vital micro-nutrient for both plants and animals. It occurs in surface waters in soluble or suspended form, but rarely in concentrations considered toxic to aquatic life.

Potassium (sampling only)

Potassium is an abundant element found in many minerals. It is an essential plant and animal nutrient and is also common in fertilizers. Used in groundwater assessment only.

Silica (sampling only)

Silicon is an abundant element and most waters contain it in the form of silica (SiO_2) and silicates. The chief concern is deposits on industrial equipment. Used in groundwater assessment only.

Sulfate (sampling only)

Sulfate occurs in natural waters in a wide variety of concentrations. It can occur in high concentrations in mine drainage from the oxidation of pyrite and the use of sulfuric acid.

Zinc (sampling only)

Zinc is common in natural waters, but is increased by the deterioration of galvanized pipes. It is essential to human metabolism, but can be toxic to aquatic life.

Descriptions of Common Physical and Stream Channel Indicators and Methods Used in this Handbook

Lake Level

Lake level is the elevation of the water surface elevation relative to a fixed elevation. This is typically done by fixing a staff gauge (a stick marked in inch or centimeter increments) to an object anchored to the lake bottom, such as a dock or pier support. Levels are read directly off the gauge. Frequently, lake level gauges are located at lake outlet dams.

Rainfall

Rainfall amounts can be measured using a rain gauge, or received from the National Oceanic and Atmospheric Administration (NOAA). Rain gauges are essentially collection devices marked in inches. The amount collected in the gauge is read and recorded at the time interval of interest (daily, hourly, etc.). NOAA data is collected at various locations throughout the country. If one of these stations is in your watershed, this data may serve your needs. This information is available from the National Climatic Data Center: http://cdo.ncdc.noaa.gov/plclimprod/plsql/poemain.poe. This will take you to a page where you can begin your search for data. There is a charge for this data. The National Climatic Data Center (NCDC) is part of the Department of Commerce, National Oceanic and Atmospheric Administration (NOAA). However, since rainfall patterns can vary over a region, you may need to set up your own gauges that more accurately reflect conditions in your areas of interest.

River Channel Characteristics (wadeable waters only)

River channel characteristics are the various physical features of the river channel that reflect geological and hydrological changes over time. The river channel is a dynamic land form that is constantly moving as water erodes the land surface. It also responds to human-caused changes in watershed land use and alterations of the river channel. These characteristics form the physical foundation of the river system and provide habitat for aquatic life. Monitoring these characteristics must be a long term, on-going effort. Characteristics recommended in this guide are Bottom Composition, Embeddedness, Channel Cross Section and Longitudinal Profile. These characteristics should be surveyed at both pool (low energy) and riffles (high energy) habitats. These measurements can be done only in wadeable waters.

Bottom Composition (Wolman Pebble Count, US Forest Service Stream Channel Reference Sites Guide)

Bottom composition is the percent of the bottom in various size classes: sand, gravel, cobble and boulder. It is measured using the pebble count procedure. This involves measuring the intermediate axis (neither the shortest nor the longest of the sides) of randomly selected particles on the stream bottom along transects where cross sections are measured. Each particle is placed in a size class, from sand (<2mm) to very large boulders (2048-4096 mm). This data can be plotted in various ways to represent bottom composition. The USFS recommends plotting cumulative percent (cumulatively adding the percent of the total count in each size class percent from smallest to largest) versus particle size. The changes in particle size over time will reflect the effects of erosion and deposition.

Embeddedness (EPA Environmental Monitoring and Assessment Program)

Embeddedness is the extent to which larger particles (especially cobbles) are surrounded by sand and silt. It is measured by estimating the percentage of the particle surface (the same particle used in the pebble count) that is surrounded by sediment. The area that was buried is typically lighter in color than that which was exposed. Changes in embeddedness can indicate scouring and deposition.

Channel Cross Section (US Forest Service Stream Channel Reference Sites Guide)

A channel cross section is the shape of a "slice" of the channel -- its width and depth. It is also the location where flow and bottom composition are measured. A channel cross section is measured at locations that represent typical channel form, clear channel features, clear indicators of bankfull (top of the bank flow) and active floodplain, clear terraces and a straight reach. It is measured by locating and determining the elevations of endpoints on either side of the channel, measuring the depths (using a surveyor's level and rod) from a line stretched across the endpoints to the channel bottom and water surface. The measurements are plotted as distance versus elevation to depict the cross-section. Changes in channel cross-section will reflect scouring, deposition and channel movement.

Longitudinal Profile (US Forest Service Stream Channel Reference Sites Guide)

A longitudinal profile measures and plots the slope of a 300-500 foot reach of the river. It is measured by first locating and marking important channel and related features (such as terraces, riffles, pools, vegetation changes, etc.). Elevations at the marked features are measured using a surveyor's level and rod. Elevations of the channel bottom, water surface, terraces and floodplains can all be gathered. The data are plotted as elevation versus distance. Changes in channel cross-section will reflect scouring and deposition.

Stream Flow

This is the volume of water passing a point expressed in cubic feet or meters per second. Flow affects the river physical characteristics, such as erosion and sedimentation, bottom composition, amount of the bottom covered with water, etc. Historical and current flow data can be found at the USGS' Pennsylvania Web Site: http://pa.water.usgs.gov/. If no data are available for your waters, you may have to collect your own.

Embody Float Method (EPA Volunteer Stream Monitoring Method Manual/Pa. Senior Environment Corps)

Flow is measured by first calculating cross-sectional areas (width times average depth) of two transects in a 20-foot section of stream. Then current velocity is measured by how long it takes a float (typically an orange) to travel the length of the 20-foot segment. Flow is calculated by multiplying the average cross sectional area times a constant (for rocky or muddy stream bottoms) times the length (20 ft.) and dividing by how long it takes a float (typically an orange) to travel the length of the 20-foot segment. Flow is reported in cubic feet per second.

Visual Field Surveys

Visual surveys involve observations, inventories and estimates of river, riparian, lakeshore and watershed characteristics, uses, values and threats:

- A pollution source inventory.
- Water color, odor and appearance.
- Corridor land uses.
- Evidence of pollution.
- Habitat types.
- Pipe Survey.
- Channel and shoreline vegetation.
- Bottom composition.
- Condition of shorelines.
- Water uses.
- In-stream or in-lake plant growth.

The area surveyed should include the watershed zones of interest -- the water column, river banks, riparian areas or upland areas. Typically, the presence or absence of these characteristics is noted, the quantity or extent visually estimated, and location mapped.

Methods Options

There are a variety of visual survey methods available. Sources of these methods include:

- DEP
- Pennsylvania Senior Environment Corps
- ALLARM
- Alliance for Chesapeake Bay
- Pennsylvania Bureau of State Parks
- River Network
- EPA
- Adopt-A-Stream Foundation

These agencies and organizations have methods that have been field tested and found to produce useful information and can be taught to and carried out by volunteers and schools. Select a method that will provide information useful to your data users and meets your data quality goals.

Descriptions of Common Aquatic Life and Habitat Indicators and Methods Used in this Handbook

Benthic Macroinvertebrates

These are organisms without backbones that live on the river bottom. They include aquatic insects (such as mayflies), mollusks, crustaceans and worms. They are good indicators of ecological conditions and human impacts, since they are integral to the river's food web. The community present reflects both water and habitat quality.

Terms Used In Benthic Macroinvertebrate Sampling

- Qualitative Net Collection: A sample is collected directly off the bottom using a net. The level of effort is not standardized.
- Semi-Quantitative Net Collection: A sample is collected directly off the bottom using a net. The level of effort is standardized by collecting from a specified area in front of the net. Since the area is not precisely delineated, the method is not strictly quantitative.
- Quantitative Surber or Hess Sampler: A sample is collected directly off the bottom using a sampler which delineates the area from which samples will be collected. The level of effort is standardized by collecting from this delineated area
- Rock Basket or Multi-Plate Samplers: A sample is collected by placing rock-filled baskets or stacked tiles on the bottom or in the water column and allowing them to be colonized. The time they are left out is standardized at six weeks and the colonization area in each basket is roughly the same. This is the most quantitative collection method.

Note that there are many variations on the sampling methods. The ones listed below should be considered basic templates that can be modified to fit different conditions.

Methods for each are described below.

Basic Methods	Advanced Method
Streamside Benthic Macroinvertebrate Assessment (Pa. Senior Environment Corps, River Network or equivalent) **1)** This assessment is carried out entirely in the field. **2)** It involves the qualitative collection of one composite sample from three spots in riffle habitats with a seine or net with a 0.6 mm mesh. **3)** Organisms are identified to major group and the relative abundance estimated in the field. **4)** Three primary habitat characteristics are estimated or measured. This survey produces a quick estimate of conditions, based on the presence and relative abundance of key indicator organisms. This method is not acceptable for federal and state agency assessment, but is fine for education and awareness and some community assessments.	*Intensive Benthic Macroinvertebrate Assessment: Net Collection (River Network, Stroud Water Research Center)* **1)** This method is carried out in the field and lab. **2)** Semi-quantitative samples are collected with a metal frame net with an opening of 18” wide by 8” high with 0.6 mm nylon mesh[3] OR **3)** Quantitative collection with a Surber or Hess sampler. **4)** Collection with the specified device of three composite samples from two fast and two slow spots in riffle habitats. **5)** This sample is preserved in alcohol for later lab identification. **6)** Twenty-two habitat characteristics are estimated or measured in the field. **7)** Critters are identified to family and counted in the lab. This survey produces a fairly sensitive assessment of conditions based on a number of numerical analyses of community composition, functional feeding groups, pollution tolerance of families, and allows numerical site to site comparisons. It can detect shifts in families within major groups that might result from pollution or habitat alteration.

[3] This mesh size is the standard recommended by the U.S. EPA. This size catches the smaller critters (like midges) but does not quickly plug up with sediment.

<table>
<tr><th>Basic Methods</th><th>Advanced Method</th></tr>
<tr><td>Basic Benthic Macroinvertebrate Assessment (River Network)
1) This assessment is carried out in the field and lab.
2) It involves the semi-quantitative collection with a specified seine or net (0.6 mm mesh) of one composite sample from one fast and one slow spot in riffle habitats.
3) This sample is preserved in alcohol for later lab identification.
4) Twenty-two habitat characteristics are estimated or measured in the field.
5) Organisms are identified to major group and counted in the lab.
This survey produces a somewhat sensitive assessment of conditions based on a number of numerical analyses of community composition, gross pollution tolerance of major groups and allows site to site comparisons (if the communities are different enough to produce dramatically different results).</td><td>Intensive Benthic Macroinvertebrate Assessment: Rock Basket Collection (River Network)
1) This assessment is carried out in the field and lab.
2) Quantitative samples are collected with rock baskets consisting of a coated wire mesh basket filled with similar sized rocks (4 to 12 cm in diameter). Organisms colonize the rock basket over a period of five weeks. Two or three samples are collected from riffle and run habitats.
3) Samples are preserved in alcohol for later lab identification.
4) Twenty-two habitat characteristics are estimated or measured in the field.
5) Organisms are identified to family and counted in the lab.
This survey produces a fairly sensitive and more quantitative assessment of conditions based on a number of numerical analyses of community composition, functional feeding groups, pollution tolerance of families, and allows more precise numerical site to site comparisons. It can detect shifts in families within major groups that might result from pollution or habitat alteration.</td></tr>
</table>

Benthic Macroinvertebrate Habitat

Benthic macroinvertebrates exist in a wide range of locations in the river:

- Shallow, fast moving rocky bottom areas known as *riffles;*
- Deeper, slower moving sandy and gravely bottom areas known as *runs;* and
- Slow moving muddy-bottom areas known as *pools.*

However, the number and diversity of organisms present is greatest in riffles. Habitat quality must be assessed in order to separate the influence of water column chemistry and biology from habitat on the community. While all of these are affected by human activities, natural variations in habitat might produce changes that might be mistaken for human-caused changes. So, a habitat assessment is a critical part of a benthic macroinvertebrate assessment.

Habitat Assessment (River Network Adaptation of EPA Rapid Bioassessment Protocol II)

A habitat assessment is the estimate and measurement of 10 selected physical characteristics of the river in order to determine the overall quality of the habitat for benthic macroinvertebrates. Examples of these characteristics include the velocity of the current; the composition of the river bottom; depth; and the nature and extent of riffles. Together with water quality, these characteristics determine the kinds and numbers of macroinvertebrates that can live there. Both habitat, quality and water quality are affected by human activities in the river or on lands in the watershed. This includes physical characteristics of the river that provide habitat for the invertebrates such as bottom composition, sedimentation, current velocity, shading, extent of riffle habitat, and others. Results for each site from the "Benthic Macroinvertebrate Habitat Assessment Field Sheet" are scored, totaled and compared with the total score from the reference site (least impaired upstream conditions).

Aquatic Vegetation (lakes)

Aquatic vegetation is an important part of a lake ecosystem, especially in near-shore areas. They provide habitat for aquatic animals and are an important source of oxygen. Some are nuisance plants that cause dramatic habitat alterations and interfere with recreational uses. The plant types, density, diversity and growth patterns are important characteristics to assess.

Aquatic Vegetation Mapping/ Identification

Aquatic vegetation mapping and identification involves visual observation and mapping and collection of specimens for identification. For mapping, monitors take a tour of the lake shoreline and observe areas of the lake where aquatic vegetation is at or near the surface. The location and extent of vegetation beds is drawn onto a map. For identification, vegetation samples are collected along a transect using a weighted rake. The samples are sorted, a qualitative estimate is made of the percentage and density of each type of plant, and specimens of each type are bagged for shipment to a botanist for identification.

Appendix C
IDD&E Field Guide

ILLICIT DISCHARGE DETECTION AND ELIMINATION

November 2021

Field Guide

PENNA TURN PIKE

Illicit Discharge of Sewage near Mile Post 51.0 @ Outfall 11611
Observed November 11, 2018

Pennsylvania Turnpike Commission
PO Box 67676
Harrisburg, PA 17106-7676

ILLICIT DISCHARGE DETECTION AND ELIMINATION

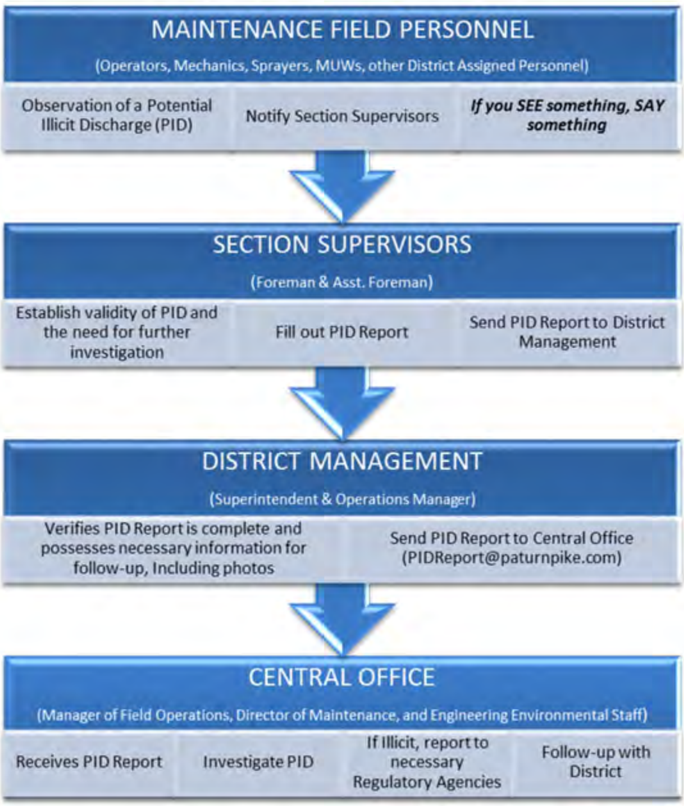
November 2, 2021

Field Guide

Pennsylvania Turnpike Commission
PO Box 67676
Harrisburg, PA 17106-7676

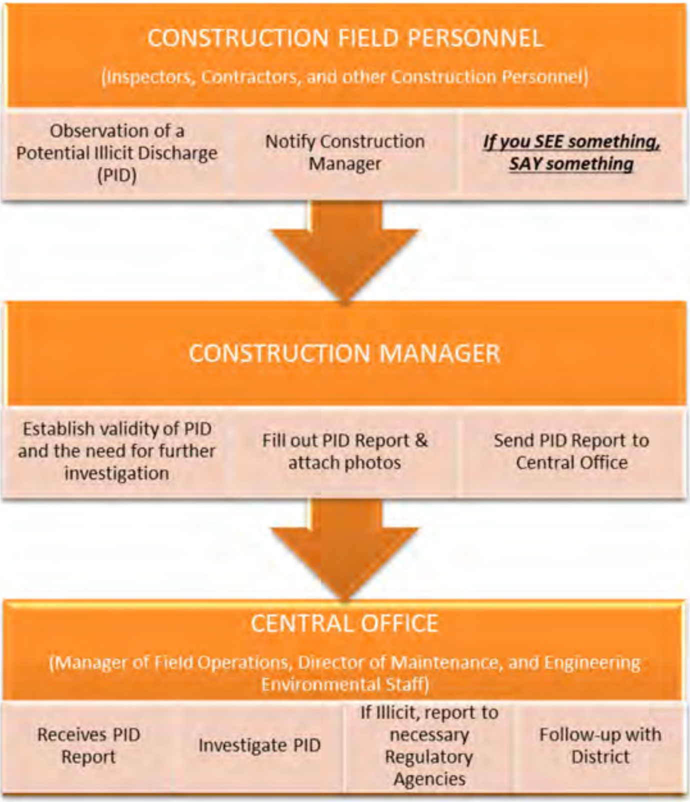
Maintenance Reporting Reference

The Maintenance Field Personnel will report the initial observation of the potential illicit discharge. A Potential Illicit Discharge Report Form (PID), which is covered in detail starting on Page 31, will be compiled and transmitted according to the following reporting sequence.



Construction Reporting Reference

The Construction Field Personnel will report the initial observation of the potential illicit discharge. A Potential Illicit Discharge Report Form (PID), which is covered in detail starting on Page 31, will be compiled and transmitted according to the following reporting sequence.



Acronyms and Abbreviations

BMP	**Best Management Practice**
IDD&E	**Illicit Discharge Detection and Elimination**
GPS	**Geographic Positioning System**
MS4	**Municipal Separate Storm Sewer System**
NPDES	**National Pollution Discharge Elimination System**
PID	**Potential Illicit Discharge**
PTC	**Pennsylvania Turnpike Commission**

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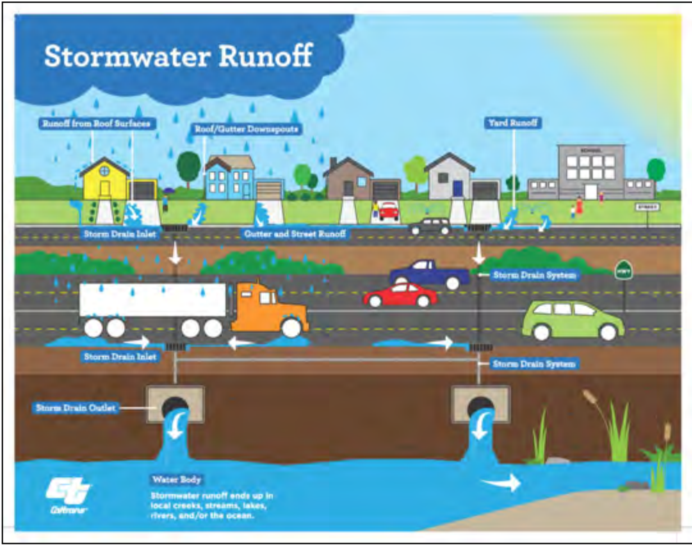
1 - Introduction

CONTEXT AND BACKGROUND

The Pennsylvania Turnpike Commission (PTC) is undertaking the Illicit Discharge Detection and Elimination (IDD&E Program) for the Municipal Separate Storm Sewer System (MS4) as part of coverage under its National Pollutant Discharge Elimination System (NPDES) permit. The PTC MS4 is the portion of the PTC property within and receiving runoff from the Urbanized Area as defined by the 2010 U.S. Census. The MS4 system consists of a series of stormwater management facilities, inlets, pipes, swales, and outfalls; collecting and conveying stormwater from impervious areas and discharging them into various locations.



Source: CalTrans

Stormwater run-off is rainwater and melted snow that runs off the surface of streets, lawns, farms and construction and industrial sites. In undeveloped areas, much of the stormwater run-off is absorbed into the ground. That which is not absorbed by the ground ultimately flows into streams and rivers. Developed areas contain impermeable surfaces such as pavement and buildings that prevent stormwater from being absorbed into the ground, and thus increase stormwater runoff into storm drains, storm sewer systems and drainage ditches.

PURPOSE OF THE IDDE FIELD GUIDE

This IDDE Field Guide is designed to assist field personnel with detection, investigation and elimination of illicit discharges to PTC regulated MS4's and is designed to complement the PTC Illicit Discharge Detection and Elimination Program Manual. This guide describes conditions in the field that field personnel may encounter and actions they need to take.

This guide is intended for use by field staff and should be kept in the work vehicle for use in the field.

The guide can also be accessed through the PTC Intranet Documents Page.

For additional technical guidance contact the MS4 Central Office Team at **PIDReport@paturnpike.com**

Definition of an Illicit Discharge

An illicit discharge is defined in PTC's MS4 permit as "any discharge to a municipal separate storm sewer that is not composed entirely of stormwater, except authorized non-stormwater discharges"

In short, any substance that is not regular rain water, and enters a PTC ditch, curb , gutter, inlet, or stream, could be considered an illicit discharge.

EXAMPLES OF ILLICIT DISCHARGES

Examples of illicit discharges include dumping of motor vehicle fluids, household hazardous wastes, grass clippings, leaf litter, animal wastes, or unauthorized discharges of sewage, industrial waste, restaurant wastes, or any other non-stormwater waste into a municipal separate storm sewer system. Illicit discharges can be accidental or intentional."

The follow pages contain pictures of discharges. Some are illicit and others are permitted. The pictures are marked with the following symbols to make classification of the discharges easy to categorize

Discharge in a picture marked with a check mark in a green circle is a permitted discharge. No need to report.

Discharge in a picture marked with an "X" in a red circle is likely an illicit discharge. Report is required.

.

Oil and Fuel from Vehicles and Equipment - including gasoline, motor oil, diesel fuel, antifreeze. For clarification, oil and fuel spills related to vehicle or other roadway accidents are **not** considered to be illicit discharges, and do not have to be formally reported as IDDE incidents.

Oil Sheen

Oil produces a rainbow colored sheen on the water surface that doesn't break apart when disturbed. Iron bacteria also cause an oily sheen. However they are naturally occurring and harmless to human health. Orange or brown slime (precipitate) and oily sheens (decomposing bacteria cells) are often the first indication that these bacteria are present. Unlike petroleum sheens the iron bacteria sheens break apart when they are disturbed.

Don't guess…Alert your supervisor to make the determination!

Antifreeze: Report incandescent green stormwater

Cooking Oil and Grease

Paint/Plaster/Concrete Washout

Chemical Cleaners: detergents, solvents, soaps, etc.

Mismanaged/Excess Road Salt

Misapplied/over-applied and excess ends up in stormwater system.

These are considered illicit discharges <u>IF</u> they enter the PTC storm sewer system.

Landscape Waste

Grass clippings and leaves *intentionally* blown or dumped into storm drains.

- **Solvents:** paint thinners, parts cleaners
- **Fertilizer, Pesticides and Herbicides** when misapplied and excess ends up in streams
- **Chlorinated Swimming Pool Discharges**

“Gray” Water

sanitary wastewater from showers, sinks, dishwashers, washing machines, etc.

Septic/Sewer Wastewater

Commercial/Industrial Vehicle Wash Water

The following are *Not Illicit* Discharges and are ALLOWED under PTC's MS4 Permit.

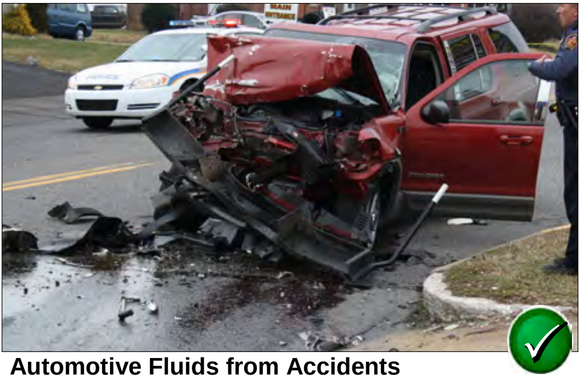
Water Line Flushing

Landscape/ Agricultural Irrigation

Air Conditioning Condensation

Foundation/Foot Drains & Crawl Space Sump Pumps

Firefighting Activities



Automotive Fluids from Accidents

Discharges from accidents are of concern, but as they are discrete occurrences that can't be totally controlled, PTC's MS4 permit only requires tracking and reporting as an illicit discharge if the discharged fluids enters a surface water .

Individual Residential Car Washing (where cleaning agents are not used)

While residential car washing is allowed, all PTC equipment must be washed in approved locations like a wash pad or wash bay.

Other ALLOWABLE Discharges:

- Flows from riparian habitats and wetlands
- Diverted stream flows
- Springs
- Non-contaminated Groundwater
- Water from crawl space pumps
- Air conditioning condensation
- Routine external building wash down, which does not use detergents or other compounds
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled material has been removed) and where detergents are not used
- Discharges complying with a National Pollutant Discharge Elimination System (NPDES) permit

Special Exception Discharges:

- **Fuel, oil or antifreeze spills related to a vehicular accident** that is properly cleaned up through normal incident management practices are not considered an illicit discharge.

- **Drums or other containers containing potentially hazardous materials** that are found abandoned along the roadside are considered unknowns, or other potential hazardous materials cargo, and are not considered an illicit discharge. **Do NOT open containers**. Report hazardous material according to current PTC Hazard Response Plans.

    - However, in the event that any of these activities are found to cause sewage, industrial wastes or other wastes to be discharged into the PTC Stormwater system, the county or city having jurisdiction over the source shall be notified and coordinated by Central Office. All field personnel will report potential illicit discharges according to the process required of the IDD&E Program Manual and as set forth in this field guide.

- Although these items are considered to NOT be illicit and do not require elimination, the PTC can designate them as illicit if they cause significant contribution of pollutants.

When in doubt, ALWAYS report potential illicit discharges.

2 - Potential Illicit Discharge Identification

During field observations, suspect discharges should be evaluated based on:

ODOR

Odor can be a strong indicator of an illicit discharge. You may be able to smell an illicit discharge before you can detect it with your eyes. Some common odors associated with illicit discharges are:

Fuel, Petroleum, or Chemical Smell - can indicate dumped or released products have entered the storm sewer system.

Sewage, Sulfide (Rotten-Egg) or Rancid Smell - can indicate an illicit discharge of sewage or failing septic system.

Chlorine or Floral Smell- can indicate an illicit discharge of fertilizer, detergent, or other cleaners.

DO NOT enter confined areas such as culverts, drop inlets, manholes, etc. to investigate the origin of odors. Gases may accumulate in these areas that can overcome the entrant.

It is important to recognize the difference between unusual *natural* phenomenon and *manmade* pollution.

COLOR

Certain water colors may also indicate the presence of an illicit discharge. Brown, gray, yellow, green, orange or red water should be noted. Turbid, cloudy water may indicate the presence of excessive siltation or other pollutants entering the stormwater. Water that is tinted brown may be due to the presence of naturally occurring tannins in the surrounding environment and may not be an illicit discharge. (Note: not all discoloration is illicit.)

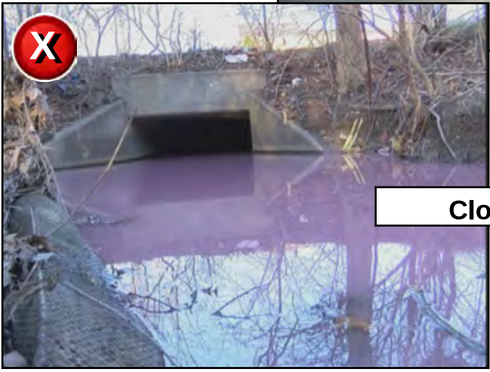
Any odd or unusually-colored water should be noted.

White, Milky, Grey, Cloudy -
usually associated with an illicit sewage discharge. Typically a discharge of sewage will be accompanied by an unpleasant odor.

Unnatural Colors -
Paint, dyes, and industrial chemicals come in a wide variety of colors, and would be considered an illicit discharge if observed in the storm sewer system.

Milky White Discharge

Milky Gray Discharge



Cloudy Water

STAINING/DISCOLORATION

The presence of stains or discoloration in or around an outfall may be signs that an illicit discharge is occurring or has occurred. Stains or discoloration on stone or concrete often originate from natural sources, including water with high concentrations of iron or other minerals, lichen/fungi, and mineral deposits and may not be illicit.

Manmade Stains - (2 photos above) Stains that have a sheen or odor, do not follow a normal flow path, or appear to come from a source other than normal stormwater runoff, could indicate a potential illicit discharge.

FOAM

Many instances of foam are natural; foam is produced when air is introduced to the water through stream turbulence, waterfalls or waves breaking on the shore. It can also occur from the natural breakdown of algae or other plant material.

Natural foam -(right) may appear white at first, but will generally turn brown over time

Manmade Foam - (2 photos above) is usually white in color and sometimes has a sweet or scented odor. Examples of these include detergents, soaps and shampoos. Always check the surrounding area for possible sources when foam is observed.

CONTAINERS

Drums and buckets may be found abandoned along the roadside. These containers might contain hazardous materials and should be avoided.

Do **NOT** open containers. Report hazardous material according to current PTC Hazard Response Plans and/or contact the Traffic Operations Center for assistance.

Discarded & leaking 5-gallon containers

Fuel tank ejected from a transport hauler load

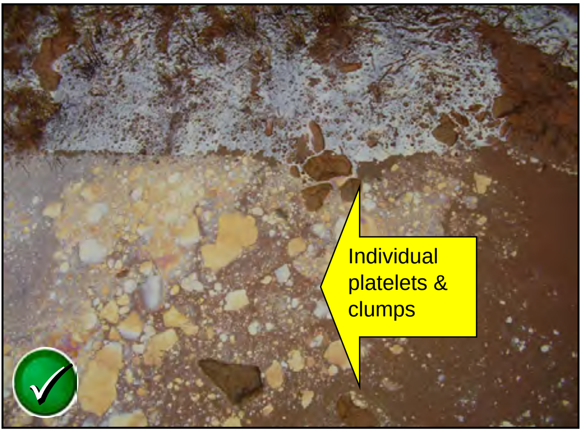
Discarded & leaking 30-gallon drum

SHEEN

A sheen may or may not be the result of an illicit discharge. Sheens due to naturally-occurring bacteria or organics are not indicative of illicit discharges. Oil sheens require IDDE reporting. In general, a sheen's origin can be determined by disturbing it:

- If the sheen breaks up into platelets or clumps, it is likely to be natural in origin.
- If the sheen swirls (separates) and reforms (re- adheres), oil is likely present on the water.

Additionally, oil sheens often appear thicker and more fluorescent and iridescent.



Nonpetroleum Sheen - breaks apart into clumps with jagged edges.

Oil Sheen - swirls and re-adheres if mixed.

STRESSED/DEAD FISH

Stressed or dead fish are a possible indication that an illicit discharge has occurred. A fish kill may be caused by naturally low dissolved oxygen levels during summer, or from lakes or streams freezing over during the winter. Fish kills can also be caused by diseases, overpopulation, or polluted runoff. Nevertheless, if multiple dead or stressed fish are observed, refer to the MS4 Central Office Team for further evaluation.

STRESSED VEGETATION

Discharges of chemicals can cause vegetation to become stressed or die. Stressed or dead vegetation in areas where indication of an illicit discharge.

IRON OXIDATION/BACTERIA

In areas throughout the state, an orange brown benthic growth may be observed in pipes, outfalls, and streams. This growth may appear as an orange, brown, red, yellow or grayish gelatinous slime, a stain, or as a "feathery" filamentous growth. There might also be a rainbow sheen to it. While unsightly, this growth is from iron-oxidizing bacteria, which are **naturally-occurring** in the soil and oxidize dissolved iron or manganese found in groundwater.

The presence of iron bacteria does not indicate an illicit discharge.

3 - Potential Illicit Discharge Investigation

DETERMINING THE SOURCE OF THE ILLICIT DISCHARGE

If the discharge is found in the PTC drainage system, the Foreman or Assistant Foreman can use the steps on the following page for gathering essential information about the probable source of the discharge to include on the Potential Illicit Discharge Report Form:

SAFETY REMINDER! At no time should anyone violate PTC safety rules in the investigation of a potential illicit discharge, including entering confined spaces.

At times, it may be difficult to determine the source of a discharge.

If a potential illicit discharge is located in an area where the storm sewer system is complex and the originating location is difficult to locate, the observer should report the attempt to locate the origin/entry point of the discharge. This information can be provided within the body of the email used to transmit the Potential illicit Discharge Report Form.

Steps for Determining Illicit Discharge

Inspect the area in the vicinity of the discharge. Does stormwater flow into a ditch, a curb inlet, or directly into a stream?

1. INSPECT

Track the illicit discharge upstream of the initial observation location to its point of origin/entry into the PTC MS4 system

2. TRACK

Search for Source: At the point of origin/entry look to see if the source can be identified; examples include a leaking drum used to store used oil or a PVC pipe from a residence that is discharging gray water. ***Do not enter private property to do this, at no time should the observer leave PTC property.***

3. SOURCE SEARCH

Take pictures and notes on observations and exact location where the pollutant enters PTC's right-of-way. If the origin/entry point varies drastically from the originally observed location of the potential illicit discharge, record and report the milepost or other distinguishable feature for the follow-up investigator to locate the origin/entry point

4. DOCUMENT

REPORT

Inspect: Investigators inspection determined the majority of the area contributing stormwater to the discharge was collected by this inlet.

Track illicit discharge upstream: *From inside PTC property*, look upstream for clues regarding pollutant source. In this picture, unusually dark green grass indicates elevated nutrients and would support a conclusion of sanitary failure, if consistent with other observations.

ILLICIT CONNECTIONS

Illicit connections to the storm sewer system can be a source of illicit discharges.

Illicit connections occur when unauthorized connections to the PTC's storm water system deliver non-water – only substances into the system.

Examples include:

- A sewer pipe improperly connected to the storm sewer (adds raw sewage to stormwater)
- A pipe that discharges water from a washing machine or sink to a roadside ditch
- A shop floor drain that is connected to PTC's storm sewer system

Any connection of a private storm sewer pipe into PTC's storm sewer system or a private storm sewer pipe that discharges on PTC right of way must be in compliance with PTC's regulatory requirements.

Illicit "Gray" Water Connection: Water from washing machines, and sinks that connect to the PTC's stormwater system via direct tap-in to a drain pipe or discharge to a drainage ditch is illicit.

CONTAINERS

If the suspected source appears to be abandoned containers (drums, tanks, buckets, etc.) follow the DO's and Don't below:

Don't

- ⇒ Do not approach the container
- ⇒ Do not open the container
- ⇒ Do not kick or cause other impact to the container
- ⇒ Do not try to figure out the contents of the container
- ⇒ Do not enter private property to investigate an off-site container

Do

- ⇒ Avoid contact with the container and its contents
- ⇒ Document the findings per Section 4 Documenting/Reporting Illicit Discharges (take pictures and write notes).

Do **NOT** open containers. Report hazardous material according to current PTC Hazard Response Plans and/or contact the Traffic Operations Center for assistance.

Containers: Containers might contain hazardous materials and should be avoided.

4 - Potential Illicit Discharge Documenting and Reporting

If you SEE something ...SAY something!

All reports of illicit discharges and any field observations MUST BE DOCUMENTED on the Potential Illicit Discharge Report Form.

Important: *If the suspected illicit discharge results in (or is the result of) an emergency situation, immediately find a safe and secure location. Then, call you're the Traffic Operations Center (*11) prior to attempting to collect any other information or documentation related to the discharge.* ***REMEMBER: SAFETY FIRST!!***

DOCUMENTING ILLICIT DISCHARGES

Good documentation is important to quickly resolve an illicit discharge report. The following pieces of information are necessary to submit an accurate illicit discharge report.

A bullet list of the basic data you need to complete the form is provided below. (More detailed information will also be requested, if available, and will be addressed in the review of the form on the following pages.)

Basic Documentation Information List

- **Observer Contact Information** (in case additional information is required)
- **Location**
- **Description of the discharge characteristics**
- **Suspected pollutant source or entry point into PTC property**
- **Photographs**

PHOTOGRAPHS

Photographs should be taken during the initial observation to support information in the Potential Illicit Discharge Report Form. This helps the follow-up investigation to:

1. provide a visual record of conditions observed
2. provide information to staff when further investigation is required, and
3. document changes in the outfall conditions over time

'Upstream' and 'Downstream' photos are important and can document the source and extent of a suspected discharge.

Close-up Photograph: Take a photograph with sufficient detail to capture the character of the suspected pollutant. Take proper precaution to not lose balance and cause a fall while trying to capture the image. Use the zoom feature of the camera as necessary to maintain safety.

Big Picture Photograph: In addition to close-up detailed photos, also take photos that capture the outfall and surrounding area ("Big Picture"). A "Big Picture" photo provides a frame of reference for anyone who has to perform a follow up investigation at the site.

The close-up photo by itself provides good detail of the discharge; however, it is difficult to determine the true scale or location of the issue through viewing this photo alone. The "Big Picture" photo gives the investigator context as to the nature and severity of the discharge.

Photographs are provide on the following page using bit the close-up and Big Picture approach

"Close Up" photo of discharge of oily substance from pipe. Provides good detail of the nature of the illicit discharge.

"Big Picture" photo of the pipe and partially filled culvert from which the illicit discharge originates. Provides evidence that can help identify the source of the discharge.

INSTRUCTIONS FOR FILLING OUT A POTENTIAL ILLICIT DISCHARGE REPORT FORM

Below, the PID Report Form has been broken down into its distinct sections and a brief explanation of the fields have been included to aid the observer to properly fill in the data needed for the follow-up investigation of the potential illicit discharge. Included immediately following the break down of each distinct section is a report form in its entirety for your reference. The PID form can be found on the PTC Intranet.

Observer Information

Name:	
Contact Phone Number:	Date and Time Discharge Discovered:

Observer Information

- Name
- Contact Phone Number
- Date and Time the Observation was initially made, not the date and time the report was filled out.

Discharge Information

Mile Marker/Lane Direction/Facility:		
District:	Nearest Intersection/Landmark:	
GPS location, if known:	Lat:	Long:

Discharge Information

- Give the closest mile marker location and the direction of travel associated with the side of the Turnpike the discharge was observed. If observed in or near a facility, give the facility name.
- Give the Maintenance District.
- Any identifying intersection or landmark that can easily identify location of discharge.
- GPS Coordinates, if available.

How Long since Last Rainfall: ☐ Raining Now ☐ 0-2 Days ☐ 3 or more Days	Nature of Discharge or Flow: ☐ Solid (Continuous) ☐ Intermittent (Occasional) ☐ Pulsing (Fluctuating) ☐ Transitory (Prior Spill)
If possible, identify the source of the discharge* ☐ Pipe Outfall ☐ Gutter ☐ Sanitary Wastewater ☐ Ditch ☐ Septic System ☐ Spill ☐ Storm Sewer ☐ Other: ____________ * Add descriptions of discharge/source to Field Photograph Log Sheet	Potential for Discharge to enter into: ☐ Stream/Water Body ☐ Wetland ☐ Storm Drain ☐ Other: ____________
Was water flow observed? ☐ Yes ☐ No Direct Connection to pipe/inlet? ☐ Yes ☐ No	Was a photo taken? ☐ Yes ☐ No If yes, attach photos.

Discharge Information (Continued)

- Estimate of timeframe of last rainfall occurrence.
- Nature of discharge flow during observation.
- Identify where/what the discharge is coming from, not necessarily the most upstream cause of the source
- Indicate if a stream, wetland, storm drains, or list other receiving bodies of water on the PTC property.
- Indicate if flow was observed, if discharge was a dry substance or refuse, this could be marked “NO”
- Indicate if there was a direct connection to part of the PTC’s stormwater conveyance system by an entity other than the PTC

- Check all boxes for the odors present from the discharge.
- Describe the clarity/turbidity the discharge is causing in the receiving waters.
- Describe the color of the discharge.
- Described any solids or floatables present due to the discharge.
- Indicate if there any apparent impacts to vegetation (i.e. dead vegetation or abnormal growth of vegetation compared to surrounding area)
- Indicate the upstream land use.

Follow up Investigation (to be completed by other)
Outfall Number: ______ Within UA? Y ☐ N ☐ District ______
FIELD ANALYSIS:

Odor:	Solids/Floatables:	Flow:
Clarity:	Sheen/Scum:	Source Confirmed? Y ☐ N ☐
Color:	Condition of Vegetation:	Direct Connection? Y ☐ N ☐

Comments: (Immediate Environmental Concern? Y ☐ N ☐

DATE: ______ InspectorName ______ Additional notes to file: ______
Follow-up with Complainant: ______ Send Confirmed ID Elimination/Removal Letter: ______

Follow up Investigation (to be completed by other)

- It is important to note that the bottom of the Report form is to be filled out by the responding entity.
- The employee making the initial observation and/or filling out the top of the form does not need to do anything within this area of the report.

Instructions to Complete Potential Illicit Discharge (PID) Report

- The second page of the Report Form provides examples of what could be considered an illicit discharge and what should not be considered a potential illicit discharge.
- There will be cases where a discharge is occurring that could not be listed here.
- It is critical that PTC employees report all potential illicit discharges, there is no harm in reporting a potential discharge that is determined to not be illicit upon further investigation.

Instructions to Complete Potential Illicit Discharge (PID) Report

- The second page of the Report Form also provides short detailed descriptions of what the report fields are asking of the observer.

POTENTIAL ILLICIT DISCHARGE REPORT FORM

POTENTIAL ILLICIT DISCHARGE REPORT FORM
(Instructions)

ADAPTED FROM:
Virginia Department of Transportation
Illicit Discharge Detection and Elimination
Field Guide, February 2019

Illicit Discharge Detection and Elimination Field Guide
A Pennsylvania Turnpike Commission Clean Water Initiative

Pennsylvania Turnpike Commission
PO Box67676

Appendix D
Potential Illicit Discharge Report

POTENTIAL ILLICIT DISCHARGE REPORT

Version Date: January 8, 2019

Observer Information

Name:	
Contact Phone Number:	Date and Time Discharge Discovered:

Discharge Information

Mile Marker/Lane Direction/Facility:		
District:	Nearest Intersection/Landmark:	
GPS location, if known:	Lat:	Long:

How Long since Last Rainfall: ☐ Raining Now ☐ 0-2 Days ☐ 3 or more Days	Nature of Discharge or Flow: ☐ Solid (Continuous) ☐ Intermittent (Occasional) ☐ Pulsing (Fluctuating) ☐ Transitory (Prior Spill)
If possible, identify the source of the discharge* ☐ Pipe Outfall ☐ Gutter ☐ Sanitary Wastewater ☐ Ditch ☐ Septic System ☐ Spill ☐ Storm Sewer ☐ Other: ____________ * Add descriptions of discharge/source to Field Photograph Log Sheet	Potential for Discharge to enter into: ☐ Stream/Water Body ☐ Wetland ☐ Storm Drain ☐ Other: ______________________
Was water flow observed? ☐ Yes ☐ No Direct Connection to pipe/inlet? ☐ Yes ☐ No	Was a photo taken? ☐ Yes ☐ No If yes, attach photos.

Describe Odor:
☐ None ☐ Musty ☐ Rotten Eggs (Sulphur) ☐ Rancid/Sour Milk
☐ Sewage ☐ Gas/Petroleum ☐ Cooking Oil ☐ Other: ____________

Describe Clarity:
☐ Clear ☐ Cloudy ☐ Opaque ☐ Sheen ☐ Gray

Describe Color:
☐ Red ☐ Yellow ☐ Brown ☐ Green ☐ Gray ☐ White ☐ Other: ____________

Solids/Floatables:
☐ Garbage ☐ Sewage ☐ Tissue ☐ Oil Sheen ☐ Suds ☐ Scum ☐ Iron Sheen ☐ Unknown

Additional Information to assist in the Investigation (Vegetation Impacts?): ______________________
Describe Upstream/Source Origin/Land Use: ☐ Forest ☐ Ag ☐ Res ☐ Farmstd ☐ Com ☐ Ind ☐ Vac ☐ Inst ☐ Muni ☐ Mng

Follow up Investigation (to be completed by other)
Outfall Number: ____________ Within UA?: Y ☐ N ☐ District____________
FIELD ANALYSIS:

Odor:	Solids/Floatables:	Flow:
Clarity:	Sheen/Scum:	Source Confirmed? Y ☐ N ☐
Color:	Condition of Vegetation:	Direct Connection? Y ☐ N ☐
Comments: (Immediate Environmental Concern? Y ☐ N ☐		

DATE: ____________ InspectorName ____________ Additional notes to file: ____________
Follow-up with Complainant: ____________ Send Confirmed ID Elimination/Removal Letter: ____________

INSTRUCTIONS TO COMPLETE POTENTIAL ILLICIT DISCHARGE (PID) REPORT

WHAT IS AN ILLICIT DISCHARGE:

An illicit discharge is any discharge into the highway storm sewer system that is not composed entirely of stormwater. Examples:

- Dry weather discharges of wastewater into the storm sewer system from illegal dumping; spills and other non-stormwater pollution sources
- Discharges of pollutants, contaminants or illicit materials into storm drainage/sewer systems (oil, grease, solvents, metals, nutrients, toxics, viruses, bacteria)
- Improper antifreeze, oil disposal from vehicle maintenance, service stations
- Vehicle washing wastewaters
- Autobody/repair facility waste waters
- Plating shop waste water
- Manufacturers waste water
- Private service agencies waste water
- Wholesale/retail est. waste water
- Sanitary wastewater/connections
- Mobile rug cleaning waste dumping
- Laundry waste waters
- Disposal of auto/household toxics
- Vehicular/accidental spills
- Dairy barn waste waters
- On-lot disposal system- sewage effluent.

WHAT IS NOT AN ILLICIT DISCHARGE:

The following non-stormwater discharges are not illicit discharges:

- Discharges from firefighting activities
- Potable water sources including dechlorinated waterline and fire hydrant flushings
- Irrigation drainage
- Lawn watering
- Water from individual residential car washing
- Dechlorinated swimming pool discharges
- Water from crawl space pumps
- Uncontaminated water from foundation or footing drains
- Routine external building wash down which does not use detergents or other compounds
- Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless spilled material has been removed) and where detergents are not use
- Air conditioning condensate
- Springs
- Uncontaminated groundwater

Observer Information

a. **Name:** Observer's Name.
b. **Contact Phone Number:** Observer's Contact Number.
c. **Date and Time Discharge Discovered:** Indicate the date and time the discharge was first observed.

Discharge Information for source identification/verification.

a. **Mile Marker/Lane Direction/Facility:** Give the closest mile marker, direction of travel lane for discharge location, and/or facility name.
b. **District:** Give the Maintenance District the discharge is located within.
c. **Nearest Intersection/Landmark**: Provide the closest intersection of landmark, if available, that can most easily identify the location of the observed discharge.
d. **GPS Location, if known:** Provide Coordinates, if available.
e. **How Long since Last Rainfall:** Estimate of when the last rainfall event occurred.
f. **Nature of Discharge or Flow:** Indicate the type of flowing occurring during the observation.
g. **If possible, identify the source of the source of the discharge:** Indicate from what feature the discharge is originating from, not necessarily the most upstream source or cause.
h. **Potential for Discharge to enter into:** Indicate what downstream water body or other infrastructure the discharge will enter.
i. **Was water flow observed?:** Indicate if active water flow is observed.
j. **Direct Connection to pipe/inlet:** Indicate whether a direct connection made to the PTC stormwater conveyance system by other than the PTC is causing the discharge to be observed.
k. **Was a photo taken?:** Indicate if photos were taken of teh observed discharge; it is best practice to take photographs of the discharge and any immediately adjacent areas affected by the discharge.
l. **Odor:** Determine which odors apply.
m. **Clarity:** How clear is the discharge?
n. **Color:** Discharge color and colors in swale, pipe, ditch, etc.(Document if red/green deficient)
o. **Solids/Floatables:** Identify indicators of source.
Description of Solids/Floatables: • Iron vs. Oil Sheens:
Iron leaches from soils forming a breakable sheen on stagnant water surfaces when poked with a stick. Oil sheens will conform around and coat the surface of the stick.
p. **Vegetation Impacts?:** Describe any vegetation that could indicate the illicitness of the discharge (e.g. abnormal plant growth at discharge compared to the surrounding area, dead or decaying plant material in vicinity of dishcarge, etc.).
q. **Describe Upstream/Source Origin/Land Use:** Indicate land uses within area discharge is originating.