DRAFT GENERAL SOURCE AND CAUSE METHOD

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INTRODUCTION

The purpose of this method is to create a consistent, repeatable process for determining sources and causes of impairment in Pennsylvania surface waters as required by federal and state regulations. Section 303(d) of the Clean Water Act (CWA) and 40 CFR § 130.7 assessment responsibilities include identifying waters that do not meet Water Quality Standards (WQS), which is routinely referred to as an "impairment". Total Maximum Daily Loads (TMDLs) and individual water quality-based effluent limitations require identifying sources and causes of the pollutants and pollution that are contributing to impairments. Cause decisions are an important component of the 303(d) Program because they identify waters that require the development of a TMDL versus waters that require some other method of restoration. Cause decisions place waters into one or more impairment categories (i.e., 4a, 4b, 4c, 5, and 5r) in the Integrated Water Quality Report, which is how Pennsylvania Department of Environmental Protection (DEP) communicates the need for various restorative actions (TMDLs or some other restoration plan) and/or permitting requirements. In Pennsylvania, DEP must also create assessment methods for non-pollutants (i.e., anthropogenic physical alterations). The Pennsylvania Clean Streams Law (CSL) specifically brings non-pollutants to attention within the definition of Pollution:

> *"Pollution" shall be construed to mean contamination of any waters of the Commonwealth such as will create or is likely to create a nuisance or to render such waters harmful, detrimental or injurious to public health, safety or welfare, or to domestic, municipal, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life, including but not limited to such contamination by alteration of the physical, chemical or biological properties of such waters, or change in temperature, taste, color or odor thereof, or the discharge of any liquid, gaseous, radioactive, solid or other substances into such waters. The department shall determine when a discharge constitutes pollution, as herein defined, and shall establish standards whereby and wherefrom it can be ascertained and determined whether any such discharge does or does not constitute pollution as herein defined.*

Through the CSL, both pollutants and physical alterations of waters (non-pollutants) are characterized as "pollution". The CSL pollution definition effectively broadens the scope of DEP's assessment responsibilities beyond pollutants (e.g., iron, dissolved oxygen, siltation, etc.) to include non-pollutant causes (e.g., habitat alterations, flow regime modifications, physical substrate alterations, etc.) and creates the foundation for DEP's strong assessment program in Pennsylvania. The combination of CWA and CSL requirements also links DEP's assessment program closer with implementation programs. As a result, DEP must place emphasis on developing precise and accurate source and cause decision methods. The definitions of "source" and "cause" are below:

Source – The origin of pollutants and non-pollutants that create the impairment. Sources are classified as point source (e.g., via a NPDES-permitted discharge) or non-point source (e.g., via diffuse discharge) and may be refined further during the TMDL development process, after assessments occur. It is important to note that sources of impairment do not include pollutants or

non-pollutants that exacerbate the impairment by promoting conditions where a particular cause is more likely to be expressed. For example, Acid Mine Drainage is often the source of causes such as pH Low, Aluminum, Manganese, and Iron, but Acid Mine Drainage is likely not the source of Mercury even though the pH conditions exacerbate impairment by promoting conditions where Mercury is more likely to methylate, and therefore, accumulate to levels of concern in fish tissue. In this case, it is much more likely that the source of Mercury is “Atmospheric Deposition”.

Cause – A pollutant or non-pollutant that impairs the surface water. For example, persistent pH readings of 4.00 (exceeding 25 Pa. Code § 93.7 criteria) would identify pH, Low as a cause of impairment.

There are steps that are integral to all source and cause decisions, including documenting potential sources in watersheds and measuring evidence of stress (causes) onsite. When numeric or narrative criteria exist for the identified causes, this is referred to as conventional source and cause decisions. When numeric criteria or assessment thresholds that translate narrative criteria are absent for the suspected causes, the process differs slightly and is referred to as stressor identification. Stressor identification requires a defensible link to be established between a suspected cause and a biological effect.

GENERAL SOURCE AND CAUSE METHOD

Before source and cause decisions can occur, DEP must ensure that sample design and planning consistent with DEP’s monitoring objectives found in Chapter 2 of DEP’s *Water Quality Monitoring Protocols for Surface Waters* (Monitoring Book, Lookenbill and Arnold 2023) has occurred. Source and cause decisions are generally associated with protected use assessment objectives established in the Monitoring Book, including *Chapter 2.4, Lake Assessment Survey Design* (Arnold 2023a) and *Chapter 2.5*, *Stream And River Assessment Survey Design* (Shull and Arnold 2023). Some tools used during reconnaissance are restated in this method to provide contextual perspective on the larger source and cause decision process. Reconnaissance, and sometimes preliminary data collection efforts, could indicate the need to incorporate or consider additional sampling design including Monitoring Book, *Chapter 2.1*, *Cause and Effect Surveys* (Lookenbill and Wertz 2021), which can facilitate the source and cause decision process.

The sections below describe the approaches and tools currently available to make source and cause decisions. Although the discussion below separates source and cause decision processes, it is important to note that a source cannot be identified without a paired cause and vice versa, even if the source and/or cause is unknown.

Source Decisions

There are generally two classifications of sources, point and non-point sources. Point sources are regulated under the National Pollutant Elimination System. These include sewage, stormwater, industrial, mining, and other discharges. Regulated discharges are often referred to as water pollution control facilities. Non-point sources are not regulated under the National Pollutant Elimination System

and include larger landscape or watershed scale sources like agriculture, resource extraction, and physical hydrologic affects.

Reconnaissance performed throughout the sampling design and planning process can often identify obvious candidate sources that will influence sampling design and otherwise be verified with data collection and assessment. Larger landscape or watershed scale information like land cover will dictate sample locations that would otherwise characterize if watershed scale variables are actually sources of impairment. This information is electronically available as GIS layers and includes the National Land Cover Datasets (NLCD), soil type information, geologic formations, abandoned mine layers, etc. Reach scale or local scale information like the location of water pollution control facilities, oil and gas wells or mining activities will further identify candidate sources and often require additional sampling locations to verify if these are candidate sources. Desktop reconnaissance should identify many of these candidate sources, but field reconnaissance and preliminary data collection will often provide more detailed information needed to verify sources, especially at the reach or site level. In addition, previous data collection and/or assessment decisions for a particular waterbody should be used to evaluate candidate sources. See the *Source Decision Tools* Section below for a detailed list of reconnaissance and source tools.

Data collection protocols and assessment methods contain additional opportunities to identify sources. As discussed previously, identifying appropriate sampling locations will provide the geographical information needed to isolate potential sources. Often, verifying a source will need to be completed in tandem with cause identification discussed in the *Cause Decisions* Section below. Where appropriate and necessary, source methods (separate from this method) will be developed to identify specific sources. For example, the *Bacteriological Source Method* (Miller et al. 2023) includes specific source identification information to make advanced source decisions for Water Contact Sports (WC) Use assessments. Other tools are also available including the Water Quality Index (WQI) tool that reliably measures instream water quality and identifies the likely source of stress that can be tied to either point sources, non-points sources, or both (Wertz and Shank 2019). This tool can be extremely valuable when instream water quality is not representative of watershed land cover.

Cause Decisions

Cause decision occurs by evaluating pollutants and non-pollutants. Depending on the protected use of the waterbody and the data available, both pollutants and non-pollutants may need to be considered during the cause decision process. Previous data collection and/or assessment decisions for a particular waterbody should be used to evaluate candidate causes.

Pollutant causes are evaluated by comparing data to:

- numeric water quality criteria at 25 Pa. Code Chapter 93,
- assessment thresholds defined in assessment methods, and
- through the stressor identification process.

Non-pollutant causes are evaluated by comparing data to:

- assessment thresholds defined in assessment methods, and

- through the stressor identification process.

Numeric water quality criteria at 25 Pa. Code Chapter 93 are pollutants and apply to physicochemical and bacteriological parameters. Sampling design for all protected use objectives includes some level of physicochemical data collection through the implementation of protocols found in Chapter 4 of the Monitoring Book and corresponding use-specific assessment methods found throughout the Assessment Book. Sampling design for WC assessments includes following the Monitoring Book *Chapter 3.11, Bacteriological Data Collection Protocol* (Miller 2023) and the corresponding, *Chapter 5.1, Bacteriological Assessment Method* (Miller and Whiteash 2021), which provide detailed information to assess numerical bacteria criteria. Some assessment methods, like *Chapter 2.11, Physical Habitat Assessment Method* (Walters 2017), include assessment thresholds for pollutants, in this case sediment, for which numerical criteria have not been developed. In addition, there are opportunities to identify pollutant causes through the stressor identification process outlined below where numeric criteria for a particular pollutant have not been developed.

Narrative criteria are assessed through biological, chemical, and physical assessment methods that utilize assessment thresholds developed to identify causes of impairment. Most of the biological and physical assessment methods include assessment thresholds for making protected use assessment decisions but may also include cause decision tools. It is important to note that all methods cited herein were developed by DEP specifically for Pennsylvania surface waters and rely on defensible, peer-reviewed scientific information, made available for public comment.

In the absence of numeric criteria or assessment thresholds that translate narrative criteria, stressor identification can be used. Stressor identification relies on building a defensible relationship between one or more biological responses and a suspected cause. Stressor identification will utilize WQS and DEP assessment methodology but also provides the opportunity to use additional tools.

Finalizing Source and Cause Decisions

Once all source and cause decision opportunities have been evaluated, a weight-of-evidence for each source-cause combination can be built following the three-point process below:

1. Watershed scale evidence (recommended) – sources and activities related to each suspected cause will be documented. Watershed scale evidence should be initially compiled through desktop reconnaissance. At a minimum, this should include land cover analysis, a review of aerial photography, and a cursory evaluation of other more specific anthropogenic activities. For example, a watershed that is mostly forested in headwater reaches but highly urbanized through middle reaches has the potential for urban related sources and causes through the urbanized reaches. However, it is unlikely these potential sources and causes exist in the headwater reaches. A closer look using aerial photography at this hypothetical watershed, indicates that the urbanized area includes very large parking lots and many access roads. A review of DEP's Water Pollution Control Facility GIS layer indicates a concentration of permitted stormwater outfalls.

2. Site evidence (local/reach scale, recommended) – through field reconnaissance and preliminary data collection, sampling locations are established, and specific data collection protocols and assessment methods are implemented at the site level based on the information gathered thus far. This site level evidence verifies if potential sources identified at the watershed level are affecting water quality and if specific sources and causes are responsible for impairment. Often water quality conditions can change very quickly at the site level as the result of specific sources. To isolate specific sources, additional sampling designs, like the Monitoring Book's *Chapter 2.1, Cause and Effect Surveys* (Lookenbill and Wertz 2021) should be used to verify specific sources and determine cause(s).

   Continuing with the hypothetical watershed example above; at the site level, there is a dramatic change in the physical appearance of adjacent reaches upstream of the urbanized area vs. reaches through it. Upstream of the urbanized area, instream substrate appears stable and banks are vegetated. The urbanized reaches appear unstable, there is a general lack of vegetation, and there are many visible storm water outfalls that are likely conveying runoff from the impervious surfaces. Using Cause and Effect sampling design, a sampling location is established upstream of the urbanized area and two additional locations are established through the urbanized reaches. Macroinvertebrate IBI scores and habitat scores exceed assessment thresholds confirming Aquatic Life Use (ALU) impairment. Stream habitat, benthic macroinvertebrate, and physicochemical data collection protocols are implemented at each station. Through the implementation of assessment methods, data confirms that reduced instream habitat scores, increases in physicochemical parameters like chloride, bromide, and other ions, and decreases in macroinvertebrate IBI scores are the result of the urbanized area. As a result, Urban Runoff/Storm Sewers is identified as a source. Instream habitat scores exceeding thresholds indicate that Siltation is a cause.

3. Stressor identification evidence (local/reach scale, optional) – evidence that a suspected source(s) and cause(s) is affecting the biological community will be documented, when appropriate. This evidence can be particularly useful when the suspected cause does not have relevant numeric criteria or assessment thresholds that translate narrative criteria for Pennsylvania. Biological effects evidence (stressor identification) will leverage additional tools and evidence to identify source(s) and cause(s).

   Again, with the hypothetical watershed example, a closer look at physicochemical data indicates that chlorides are not only higher through the urbanized reaches, but concentrations increase substantially between the upstream station with forested land cover and the next downstream station in the urbanized reach. There is also an increase in chloride concentrations between the two downstream locations, which establishes that there is more than a localized impact occurring. Macroinvertebrate IBI scores correspondingly decrease station to station at rates greater than method precision estimates and specific taxa intolerant to chlorides are completely missing or significantly reduced in samples from the two downstream samples. As a result, Chloride is added as a cause. This simple example

demonstrates how stressor identification can be used to identify a cause of impairment for a pollutant where numerical criteria has not been developed.

DESCRIBING SOURCES AND CAUSES

Descriptions of common sources and causes in Pennsylvania are provided below, advanced source and cause decision methods are described in Chapter 9 of the Assessment Book, and all currently available sources and causes are provided in Appendix A of the Assessment Book. The information used to verify sources is also listed in the *Source Decision Tools* section below.

Common Source Descriptions

Acid Mine Drainage – Acidic discharges from inactive mine sites. This source has replaced the previous commonly used source Abandoned Mine Drainage. If the source of impairment is from active mining, DEP will not use Acid Mine Drainage. Rather, alternative sources that may be considered are Mining, Surface Mining, Subsurface (Hardrock) Mining, or Coal Mining.

Agriculture – Agricultural activities that may include one or more of the following activities and landuses: crop production, pasture, animal feeding operations, fertilizer spreading, etc. DEP may consider selecting more specific sources of impairment such as Grazing In Riparian or Shoreline Zones, Crop Production (Crop Land or Dry Land), Animal Holding/Management Areas, and Animal Feeding Operations (NPS) when those activities are related to one or more causes of impairment.

Atmospheric Deposition – Precipitation of pollutants released into the air through the burning of fossil fuels. This can include both wet and dry deposition.

Combined Sewer Overflows (CSOs) – Intermittent overflow or other untreated discharge from a municipal combined sewer system which results from a flow more than the dry weather carrying capacity of the system. Such systems can combine domestic, industrial, and commercial wastewater with stormwater and are found in older towns and cities.

Construction – Earth disturbance related to the building of roads, bridges, and dwelling structures. DEP may consider more specific sources of impairment such as Site Clearance (Land Development or Redevelopment), Highways, Roads, Bridges, Infrastructure (New Construction) when those activities are related to one or more causes of impairment.

Habitat Modification - Other Than Hydromodification – Changes to stream physical habitat associated with various landuse activities. Reference *Chapter 2.11, Physical Habitat Assessment Method* (Walters 2017) for the following recommendations. For high-gradient wadable streams, the source of Habitat Modification - Other Than Hydromodification is recommended when the physical habitat evaluation sum of bank habitat scores (Condition of Banks + Bank Vegetative Protection) is 24 or lower, or when the total habitat score is 140 or lower. For low gradient wadable streams, the source of Habitat Modification - Other Than Hydromodification is recommended when the physical habitat evaluation sum of bank habitat scores (Bank Stability + Bank Vegetative Protection) is 20 or lower, or

when the total habitat score is 105 or lower. Other habitat evaluation scores within the marginal or poor category can also be used as evidence for habitat related sources of impairment. For example, DEP may consider selecting more specific sources of impairment such as Streambank Modifications/Destabilization, Channelization, and Removal of Riparian Vegetation when those activities are related to one or more causes of impairment.

Historical Source, No Longer Present – Features that were historically present on the landscape or in the watershed that had secondary effects persisting to present day. Evidence of this source may include identifying historic dams that impounded extensive portions of a watershed and resulted in accumulation of legacy sediment.

Industrial Point Source Discharge – Decentralized treatment systems that process wastes generated by manufacturing or industrial work. For smaller flow industrial or commercial discharges, DEP will consider selecting Package Plant or Other Permitted Small Flows Discharges.

Municipal Point Source Discharges – Centralized publicly owned treatment systems (e.g., sewage and wastewater treatment plants) that process domestic, industrial, and/or commercial wastewater.

On-Site Treatment Systems (Septic Systems and Similar Decentralized Systems) – Decentralized privately owned treatment systems that process domestic wastewater.

Source Unknown – Source that cannot be determined. This is only used when all source decision tools have been implemented and a source is still not able to be identified.

Urban Runoff/Storm Sewers – Runoff from impervious or urban areas to surface waters from precipitation, snowmelt, and subsurface drainage which may be conveyed by storm sewers. DEP will use Rural (Residential Areas) to describe the source more accurately when less than 5% of the impaired portion of the watershed is developed. DEP may consider selecting more specific sources of impairment such as Commercial Districts (Industrial Parks), Commercial Districts (Shopping/Office Complexes), Highway/Road/Bridge Runoff (Non-Construction Related), and Impervious Surface/Parking Lot Runoff, as appropriate.

Common Cause Descriptions

Aluminum – High concentrations of total aluminum that exceed numeric criteria in 25 Pa. Code § 93.8c (i.e., ALU CMC = 750 µg/L). This cause may also be selected when total aluminum or dissolved aluminum is determined to be the causal stressor during the stressor identification process, or after a specific source/cause decision method is applied. This cause will replace the previous commonly used cause Metals when applicable.

Cause Unknown – This cause is only selected when no single cause of impairment can be identified, but biological assessment thresholds have been exceeded.

Dissolved Oxygen – Low concentrations of dissolved oxygen that exceed numeric criteria in 25 Pa. Code § 93.7. This cause is typically related to Eutrophication and/or Organic Enrichment so additional investigation may be needed when this cause is selected. See McGarrell and Gocek (2023) for additional guidance on Eutrophication.

Escherichia Coli (E. Coli) – All waters of Pennsylvania are subject to the criterion for *Escherichia coli* (*E. coli*) in 25 Pa. Code § 93.7. The criterion specifies that during the swimming season (May 1st through September 30th), the maximum *E. coli* level shall be a geometric mean of 126 CFU/100 ml in any 30-day interval. This cause will replace the previous commonly used cause Pathogens when applicable.

Eutrophication – The process by which elevated nutrient levels (especially phosphorus and nitrogen) stimulate the growth of algae and/or aquatic plants, which alters the quantity and quality of organic matter available as food for biological communities. See *Chapter 9.2, Eutrophication Cause Method* (McGarrell and Gocek 2023) for more details about this cause. In addition, this cause will be selected when using *Chapter 2.8, Lake Trophic State Assessment Method* (Arnold 2023c) and the narrative nutrient criteria found in *Chapter 2.9, Lake Physicochemical Assessment Method* (Arnold 2023).

Flow Regime Modification – Changes in hydrologic regime caused by anthropogenic activities such as water releases, increased surface runoff from impervious surfaces during storm events, water withdrawals, or other activities resulting in an unstable environment for biological communities. DEP may consider selecting Dewatering as a more specific cause of impairment due to water withdrawals.

Habitat Alterations – Habitat changes due to bank erosion, removal or lack of riparian vegetation, or existence of concrete channels and streambeds. For high-gradient wadable streams, this cause is recommended when the physical habitat evaluation sum of bank habitat scores (Condition of Banks + Bank Vegetative Protection) is 24 or lower, or when the total habitat score is 140 or lower. For low gradient wadable streams, this cause is recommended when the physical habitat evaluation sum of bank habitat scores (Bank Stability + Bank Vegetative Protection) is 20 or lower, or when the total habitat score is 105 or lower. DEP may consider selecting Alteration in Stream-Side or Littoral Vegetative Covers as a more specific cause of impairment when other habitat evaluation scores (e.g., Riparian Vegetative Zone Width), are within the marginal or poor category.

Iron – High concentrations of iron that exceed numeric criteria in 25 Pa. Code § 93.7 (i.e., ALU = 30-day average of 1.5 mg/L as total recoverable, PWS = 0.3 mg/L as dissolved). This cause may also be selected when total iron or dissolved iron is determined to be the causal stressor during the stressor identification process. This cause will replace the previous commonly used cause Metals when applicable.

Manganese – High concentrations of total manganese that exceed numeric criteria in 25 Pa. Code § 93.7 (i.e., maximum of 1.0 mg/L). This cause may also be selected when total manganese or dissolved manganese is determined to be the causal stressor during the stressor identification process. This cause will replace the previous commonly used cause Metals when applicable.

Mercury – High concentrations of dissolved mercury (Hg^{2+}) that exceed numeric criteria in 25 Pa. Code § 93.8c (i.e., ALU CCC = 0.77 µg/L, CMC = 1.4 µg/L; PWS/WC = 0.05 µg/L). This cause is also selected when fish tissue concentrations exceed thresholds established in *Chapter 8.1, Fish Tissue Consumption Assessment Method* (Wertz 2021a).

Organic Enrichment – Excessive quantities of organic material (e.g., sewage, manure, or organic fertilizers/substances) causing habitat impairment. Due to the potentially transient nature of organic materials in lotic systems, this cause may also be selected when a biological link is established during the stressor identification process (e.g., increase in organic pollution tolerant taxa such as oligochaetes and platyhelminths). DEP will select Algae as a cause when the organic material consists of algal biomass. This cause can be related to Eutrophication, so additional investigation may be needed when this cause is selected.

Perfluorooctane Sulfonate (PFOS) – Per- and polyfluoroalkyl substances (PFAS, including PFOS) are environmentally persistent chemical substances that have been used extensively in the manufacturing of fire-fighting foams and non-stick materials (as well as other industrial products) based on resistance to heat, grease, oils, and water. PFOS tends to bio-accumulate more than short-chain PFAS substances and is more toxic. This cause is selected when fish tissue concentrations exceed thresholds established in *Chapter 8.1, Fish Tissue Consumption Assessment Method* (Wertz 2021a).

pH, High – Hydrogen ion activity (measured as pH SU) that exceeds pH numeric criteria in 25 Pa. Code § 93.7 (i.e., above 9.0 SU). This cause is typically related to alkaline mine drainage and/or high photosynthetic production. This cause will replace the previous commonly used cause pH.

pH, Low – Hydrogen ion activity (measured as pH SU) that exceeds pH numeric criteria in 25 Pa. Code § 93.7 (i.e., below 6.0 SU). This cause is typically related to acid mine drainage and/or atmospheric deposition. This cause will replace the previous commonly used cause pH.

Polychlorinated Biphenyls (PCBS) – Anthropogenic compound used in electrical equipment, hydraulic fluids, and heat-conducting fluids and other industrial applications. Manufacture of PCBs ceased in 1977. PCBs primarily enter the environment through contaminated sites and sediments. When introduced into the environment, these compounds biomagnify up the food chain and, as a result, concentrations increase rapidly as wildlife and humans consume them. This cause is selected when PCBs exceed numeric criteria in 25 Pa. Code § 93.8c (i.e., ALU CCC = 0.014 µg/L; PWS/WC = 0.000064 µg/L) and other applicable WQS (i.e., PWS/WC = 0.000016 µg/L in Zones 2-6 of the Delaware Estuary). This cause is also selected when fish tissue concentrations exceed thresholds established in *Chapter 8.1, Fish Tissue Consumption Assessment Method* (Wertz 2021a).

Siltation – Accumulation of fine sediments or precipitates (e.g., iron or aluminum precipitates from acid mine drainage remediation) more than what can be transported naturally, which results in smothering of benthic habitat used by biological communities, thereby inhibiting the growth or survival

of these communities. Reference the *Physical Habitat Assessment Method* (Walters 2017) for the following recommendations. For high-gradient wadable streams, the cause Siltation is recommended when the sum of instream habitat scores (Embeddedness + Sediment Deposition) is 24 or lower. For low gradient wadable streams, the cause Siltation is recommended when the sum of instream habitat scores (Pool Substrate Characterization + Sediment Deposition) is 20 or lower. For semiwadeable rivers, the cause of Siltation is recommended when the sum of instream habitat scores (Instream Cover + Epifaunal Substrate + Embeddedness) is 30 or lower.

Thermal Modifications – Increases in natural water temperatures from heated wastewater sources (i.e., discharges with thermal limits in their permits). An appropriate cause decision of "Thermal Modifications" will include a temperature assessment and a biological assessment based on aquatic flora and fauna to determine whether the biological community is affected by the thermal regime. Typically, fish community evaluations have the best resolution in characterizing a waterbody's thermal regime because of their physiology and distribution patterns. Implementation of *Chapter 2.5, Stream Fish Assemblage Assessment Method* (Wertz 2021b) is required if this cause is suspected.

SOURCE DECISION TOOLS

Table 1 includes several specific tools available to verify sources of impairment.

Table 1. Source Decision Tools.

Title	Resource Category	Source/Link
	General Tools	
Acidification Prioritization Tool	Internal Arc Online	https://padep-1.maps.arcgis.com/home/item.html?id=e861ea5bc5d8428ca2f5da86e5522997
Historical Aerial Photo Viewer	Online Resource	https://datacommons.maps.arcgis.com/apps/View/index.html?appid=10af5f75f9f94f01866359ba398cb6a9
Historical Mill Dams	GIS - Feature Layer	https://padep-1.maps.arcgis.com/home/item.html?id=54ef7ed6a4504e6fb1f6ccea952f0a4d
Model My Watershed	Online Resource	https://modelmywatershed.org/analyze
National Land Cover Dataset (NLCD)	Online Resource	https://www.usgs.gov/centers/eros/science/national-land-cover-database
EPA Freshwater Explorer	Online Resource	U.S. EPA Freshwater Explorer (arcgis.com)
USGS Stream Stats	Online Resource	https://streamstats.usgs.gov/ss/
Urban Areas	GIS - Feature Layer	https://www.pasda.psu.edu/ucl/DataSummary.aspx?dataset=26
Water Quality Index (WQI) Tool User Interface	R Shiny Application	Shiny Application https://fweco.shinyapps.io/padep_wqi_UI/
	Source Method Tools	
Bacteriological Source Method	Assessment Method	https://www.dep.pa.gov/Business/Water/CleanWater/WaterQuality/Pages/Assessment-Methodology.aspx
	Regulated Activities Tools	
Electronic Discharge Monitoring Reports (eDMR)	Online Resource	https://www.dep.pa.gov/Business/Water/CleanWater/WastewaterMgmt/eDMR/Pages/default.aspx
	Regulated Activities - Internal DEP GIS Tools[1]	
(Mining) Abandoned Mine Lands	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.MINE_AML_FPOLY_V)
(Mining) Active Underground Permit Boundaries	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.MINE_PERMIT_UG_V)
(Mining) Anthracite Coal Surface Mines	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.ANTHRACITE_SURFACE_MINE_PERMITS)
(Mining) Bituminous Coal Surface Mines	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.BITUMINOUS_SURFACE_MINE_PERMITS)
MS4 Areas	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl

Title	Resource Category	Source/Link
		(gNet: GDC.MS4)
Oil and Gas Storage Fields	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.OG_ACTIVE_STORAGE_FIELDS)
Oil and Gas Development	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.OG_WELL_PADS)
Urban Areas	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.URBAN_AREAS)
Water Pollution Control Facilities	Internal GIS - Enterprise Geodatabase View	epedc-scan.pa.lcl:1521/PGDC.pa.lcl (gNet: GDC.EF_WPCF_V)
	Regulated Activities - External GIS Tools	
Combined Sewer Overflow Outfalls	GIS - Feature Layer	https://edg.epa.gov/data/PUBLIC/R3/Combined%20Sewer%20Outfalls_042412.zip
(Mining) Coal Mining Operation - Surface Mines	GIS - Feature Layer	Coal Mining Operation - Surface Mines | Coal Mining Operation - Surface Mines | PA Department of Environmental Protection (arcgis.com)
(Mining) Coal Mining Operation - Underground Mines	GIS - Feature Layer	Coal Mining Operation - Underground Mines | Coal Mining Operation - Underground Mines | PA Department of Environmental Protection (arcgis.com)
(Mining) Bituminous Mining Permits Section - Active Underground Mine Permits	GIS - Feature Layer	https://newdata-padep-1.opendata.arcgis.com/datasets/cea4b401782a4178b139c6b5c6a929f2_71/explore
Water Pollution Control Facilities	GIS - Feature Layer	https://newdata-padep-1.opendata.arcgis.com/datasets/f227238ef4a0496b891d7f811cfc7a5f_283/explore?location=40.912660%2C-77.753758%2C9.00

[1] Most internal DEP GIS tools are publicly available through DEP's Open Data Portal.

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