LANCASTER COUNTY COMMUNITY CLEAN WATER TOOLBOX

A County-Based Action Plan for Clean Water

June 2018

LANCASTER COUNTY COMMUNITY CLEAN WATER TOOLBOX

Resources to Help You Develop A County-Based Action Plan for Clean Water

Pennsylvania Watershed Implementation Plan (WIP) Local Planning Process to Meet Countywide Goals

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Table of Contents

LANCASTER COUNTY TOOLBOX

Pennsylvania Phase 3 Watershed Implementation Plan (WIP)
Local Planning Process to Meet Countywide Goals

Introduction

Welcome to your Community Clean Water Toolbox.

This document has been prepared to help you improve local water quality. This collaborative effort is being made throughout Pennsylvania's portion of the Chesapeake Bay Watershed. Each Pennsylvania county within the watershed will have a Toolbox with similar components tailored to that county's specific conditions.

What is the Toolbox?

This toolbox has been developed as a starting point for each county to use to improve local water quality. It contains useful and specific data and information relevant to your county to assist you with reaching local water quality goals.

No county is required to use every tool in this toolbox! You are encouraged to add other tools as fits your local situation. This toolbox serves as a *guide* to assist with collaborative efforts, *not* as a regulatory tool.

You also will find a variety of resources that may be helpful in the Toolbox's Appendices.

Appendix I: The Local Story: Opportunities to Improve Local Water Quality and Meet Countywide Goals

Information is available that can help inform local planning strategies. This information can help answer questions like:

- What is the water quality like in my area?
- How has it been changing?
- What are important sources of nutrients and sediments in my area?
- What opportunities exist to address these sources?
- Where geographically should we focus our efforts?

This Toolbox provides information to help answer those questions and to tell the local story of water quality in your county. In this Toolbox, you'll find information on local water quality, local sources and drivers of nutrients and sediments, best management practice information, and additional available resources.

The information in this Toolbox and the guidance provided for its use are meant to act as a starting point to help answer some common questions that arise during planning. Local groups can utilize whichever pieces of information they find most useful, supplement with their own local knowledge, and use the additional resources listed to find more information.

We hope this Toolbox gives you a foundation to build off in telling Lancaster County's local story and in identifying opportunities for meeting local goals.

Pennsylvania's Clean Water Goal

Figure 1. Pennsylvania Planning Targets

Year	Nitrogen (M lbs/year)		Phosphorus (M lbs/year)	
	Delivered to the Bay	Delivered to Local PA Waterways	Delivered to the Bay	Delivered to Local PA Waterways
1985(Actual)	122.02	183.88	6.046	14.857
2017 (Actual)	107.31	161.94	3.801	9.640
2025 (Final TMDL Planning Target)	73.18	110.88	3.044	7.619
Remaining Reductions to be Achieved Through Local Planning Goals *	34.31	51.06	0.757	2.021

*This table does not account for future (beyond 2025) pollution loads and potential impacts such as climate change, development and growth, and potential infrastructure or (cost of doing business) which may alter the amount of sediment reaching the Bay (currently held in place by the Conowingo Dam).

Lancaster County's Clean Water Goal

Figure 2. Countywide Goal for Lancaster County

Year	Nitrogen (M lbs/year)	Phosphorus (M lbs/year)
	Delivered to Local Lancaster County Waterways	Delivered to Local Lancaster County Waterways
No Action	34,305,509	2,306,521
1985 (Actual)	32,610,837	1,789,271
2017 (Actual)	27,193,871	1,265,040
2025 (Final TMDL Planning Target)	15,729,211	796,735
Remaining Load to be Achieved Through Local Planning Goals *	11,464,660	468,305

The nitrogen and phosphorus planning targets for Pennsylvania in Figure 1 (above) are broken down into local planning goals for your county in Figure 2 (above). Added together across all counties, these goals will help Pennsylvania reach its assigned nutrient reduction planning targets.

Depiction of Lancaster County's Goal

Figure 3. Hypothetical Journey to Lancaster County's Goal

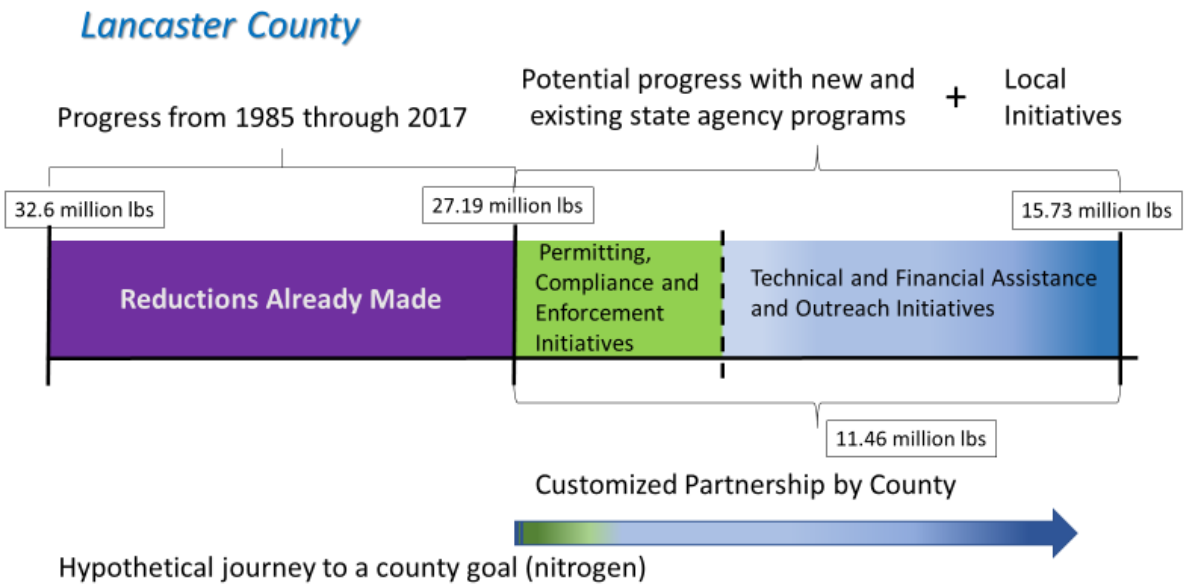


Figure 3 represents Lancaster County's hypothetical journey to countywide goals and overall water quality targets. Moreover, it represents Lancaster County's journey to clean water:

- The purple section represents the progress Lancaster County has made from 1985 through 2017.
- The green section depicts the estimated reductions that can be achieved between now and 2025 if all existing state agency permitting, compliance and enforcement initiatives are accomplished across the watershed. This will require ongoing effort to achieve these reductions through compliance. To be truly successful, these initiatives will also be more effective through additional assistance and collaboration at the local level.
- The blue section and the arrow across the bottom of the journey bar represent a series of technical, financial assistance and outreach initiatives that are now under development by the sector specific workgroups under the Phase 3 WIP Steering Committee. However, to be truly successful, these initiatives will need to be customized to each county's unique situation.
- Reductions from these initiatives will be estimated across the watershed, then customized as part of the individual countywide planning efforts to capture additional local resources and initiatives that can be added; as well as tailoring the watershed-wide initiatives to more effectively maximize these resources.
- The end result will be a countywide action plan for each county that identifies the customized partnership of local and watershed-wide initiatives that can be accomplished at the county level to reach the county planning target in the most effective manner.

A Summary of Lancaster County's Water Quality Story

Current Conditions of Lancaster County's Streams

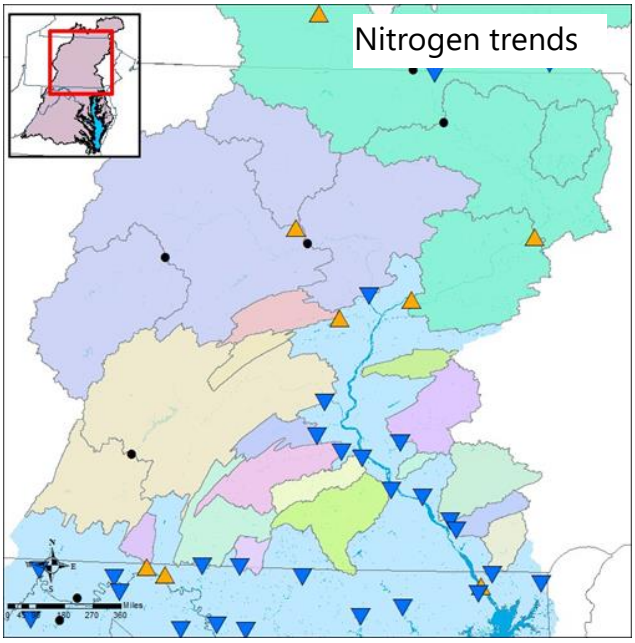
- Monitoring shows that streams in Lancaster County have the highest amounts of nitrogen, phosphorus and sediment of all monitored streams in the Chesapeake Bay region relative to watershed size.
- Water quality in Lancaster County's streams is changing over time:
  - The amount of nitrogen is going down in local streams, which means conditions are improving.
  - The amount of phosphorus is going up in the Pequea Creek and Conestoga Creek watersheds, which means conditions are degrading.
  - The amount of sediment is going up in the Octoraro Creek watershed, which means conditions are degrading. The amount of sediment is going down in the Conestoga River watershed, which means conditions are improving.

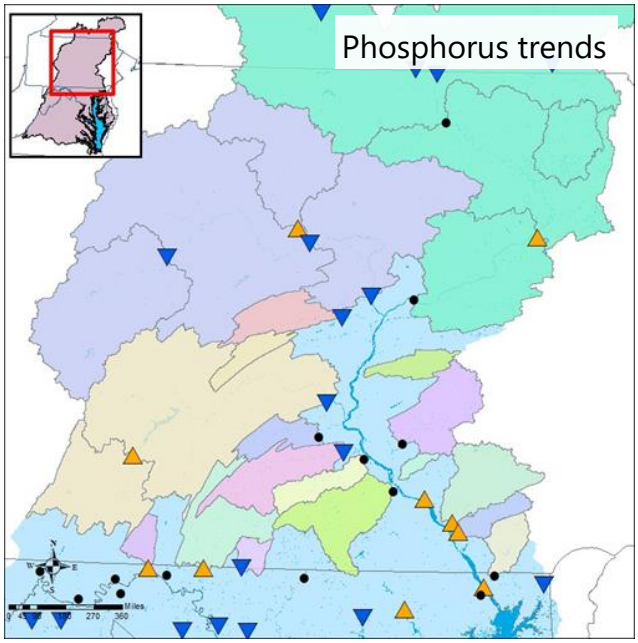
Sources of Nutrients & Sediment in Lancaster County

- Streams in agricultural and developed/urban areas have the highest amounts of nitrogen, phosphorus and sediment; most nutrients and sediment in Lancaster County's streams are coming from agricultural and developed/urban lands.
- Effective management will address the specific sources of nutrients and sediment in Lancaster County:
  - On agricultural lands, the majority of nutrients are applied to the land as manure.
  - On developed/urban lands, the majority of nutrients entering local streams comes from stormwater outside regulated municipal separate stormwater sewer system (MS4) areas.
  - Wastewater and septic contribute a small portion of the nutrients to local streams, but can be important locally.
  - Most of the phosphorus and sediment in local streams comes from overland runoff during rain events; the most effective management practices reduce application of phosphorus to the land, reduce runoff of sediment, and reduce soil erosion.
  - Most of the nitrogen in streams in Lancaster County comes from groundwater, therefore the most effective management practices will reduce application of nitrogen to the land or prevent nitrogen from entering groundwater.
  - In both agricultural and developed/urban areas, erosion of stream banks are important sources of sediment to local streams.

Opportunities for Implementation in Lancaster County

- Chiques Creek, Pequea Creek, Conestoga Creek and Cocalico Creek are all effective places to manage nitrogen, phosphorus and sediment in Lancaster County.
- Some effective practices to address nutrients and sediment are currently being implemented in Lancaster County, but there are many more opportunities within the county to increase implementation of those practices and to implement even more effective and cost-effective practices than those currently in place.





USGS. https://cbrim.er.usgs.gov

Water quality trends vary geographically and patterns are changing across Pennsylvania's Chesapeake Bay Watershed

Understanding Pennsylvania's regional water quality trends can put trends in local watersheds, like those in Lancaster County, in perspective.

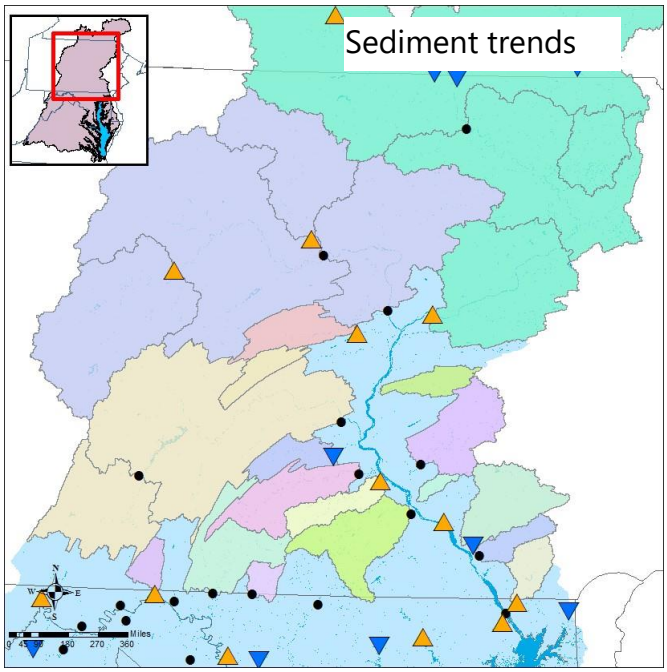
In addition to providing real-time water quality data, the USGS monitoring stations help to identify changes in water quality over time. These maps demonstrate nitrogen and phosphorus trends from 2007-2016.

- Blue downward triangles = improving conditions
- Orange upward triangles = degrading conditions
- Black dots = no trend

These results tell us that:

- Nitrogen levels in streams have been improving throughout the region with a few exceptions.
- Phosphorus levels show varying patterns depending on local watershed, reflecting local changes. Trends in the lower Susquehanna are degrading.

Water quality trends for the USGS non-tidal stations are available at: https://cbrim.er.usgs.gov/summary.html.



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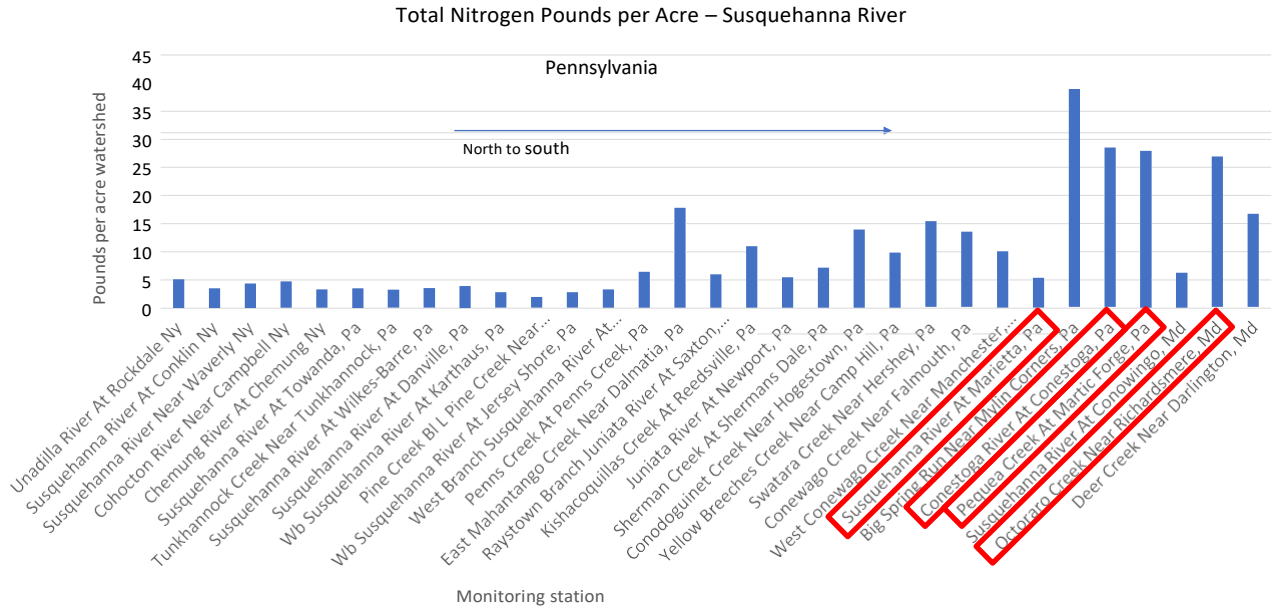
- Blue downward triangles = improving conditions
- Orange upward triangles = degrading conditions
- Black dots = no trend

These results tell us that:

- Sediment levels show varying patterns depending on local watershed, reflecting local changes. In many cases across the region these trends are degrading.

Water quality trends for the USGS non-tidal stations are available at: https://cbrim.er.usgs.gov/summary.html.

USGS Monitoring Data Show Excess Nitrogen Levels in the Lower Susquehanna River Watershed



Source: USGS https://cbrim.er.usgs.gov/

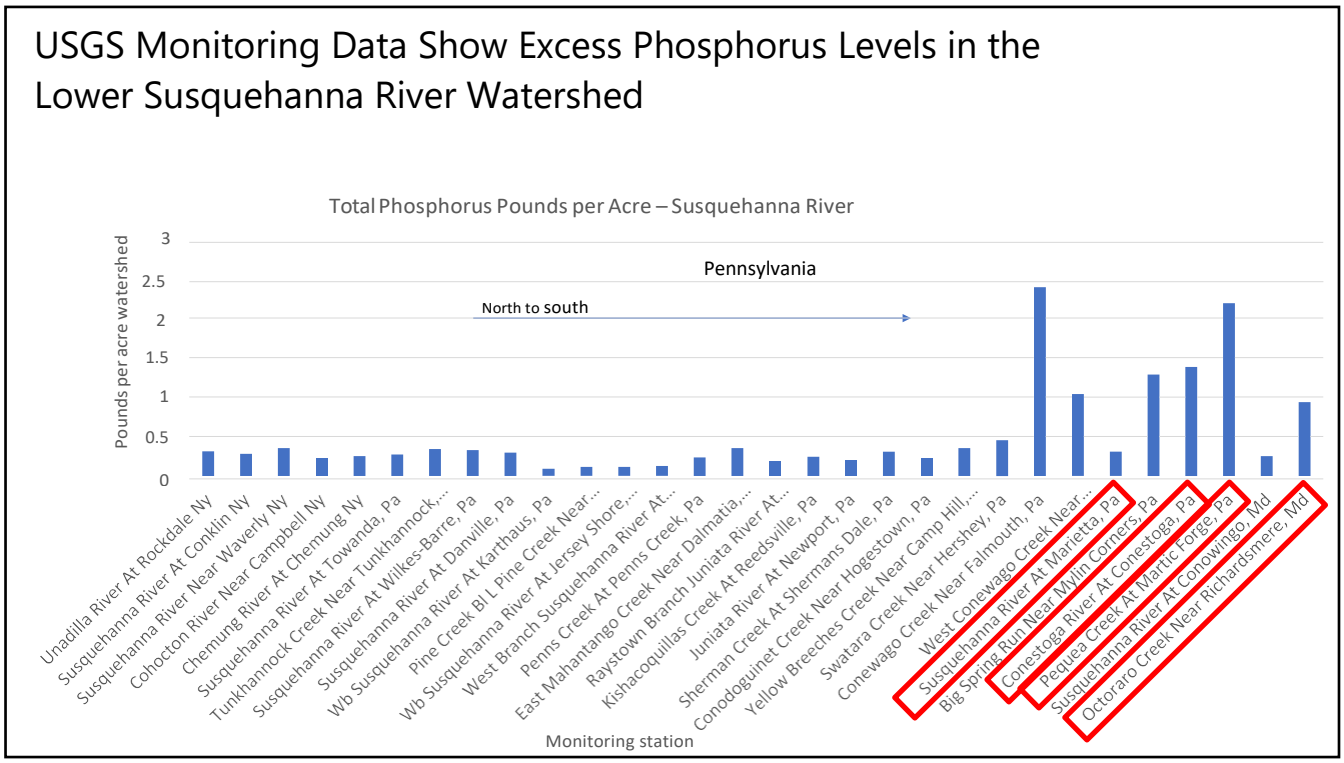
Understanding where nutrients and sediment are highest across Pennsylvania streams can help focus planning efforts, especially in small watersheds.

In the graph above, the bars show the annual pounds of nitrogen measured at monitoring stations divided by the acres of watershed draining into that station. The larger the bar, the more nitrogen there is in the watershed's streams relative to its size, and the greater the impact on streams.

Small watersheds in the Lower Susquehanna, including those in Lancaster County, have some of the highest amounts of nitrogen relative to their size. These watersheds can be some of the most effective places to manage nitrogen.

Lancaster County's small watersheds have high amounts of both nitrogen and phosphorus (next page), making them effective places to manage both simultaneously.

Water quality trends for the USGS non-tidal stations are available at:
https://cbrim.er.usgs.gov/summary.html



Source: USGS https://cbrim.er.usgs.gov/

Understanding where nutrients and sediment are highest across Pennsylvania streams can help focus planning efforts, especially in small watersheds.

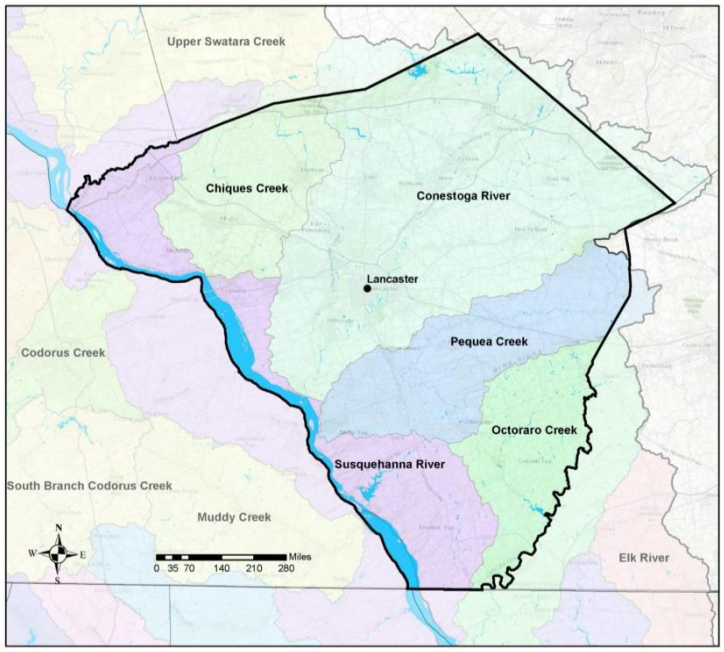
In the graph above, the bars show the annual pounds of phosphorus measured at monitoring stations divided by the acres of watershed draining into that station. The larger the bar, the more phosphorus there is in the watershed's streams relative to its size and the greater the impact on streams.

Small watersheds in the Lower Susquehanna, including those in Lancaster County, have some of the highest amounts of phosphorus relative to their size. These watersheds can be some of the most effective places to manage phosphorus.

Lancaster County small watersheds have high amounts of both nitrogen (previous page) and phosphorus, making them effective places to manage both simultaneously.

Water quality trends for the USGS non-tidal stations are available at: https://cbrim.er.usgs.gov/summary.html.

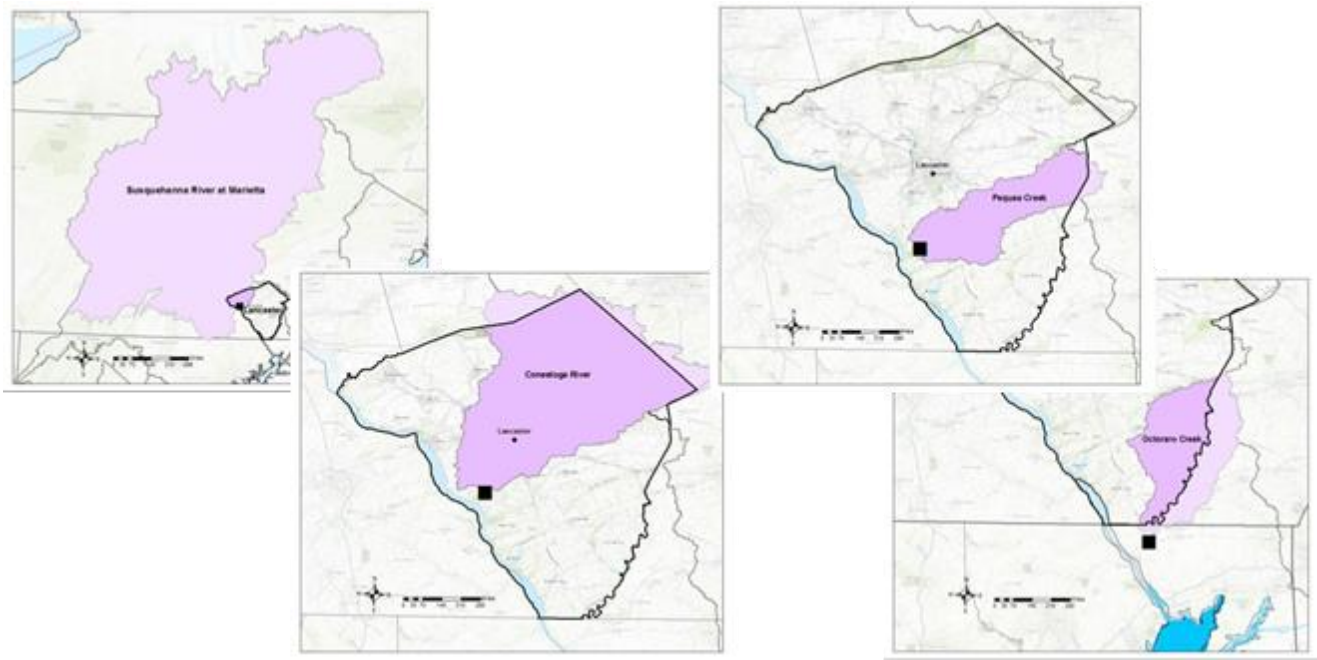
Lancaster County's Local Watersheds



https://cbrim.er.usgs.gov

The following pages provide in-depth information on local water quality in Lancaster County's monitored watersheds.

Water quality monitoring stations for Lancaster County's watersheds

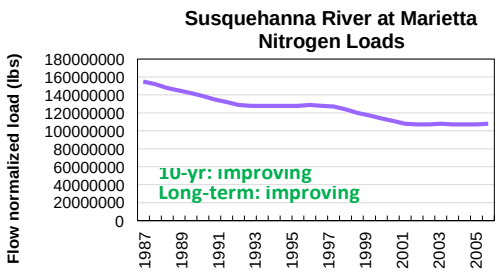


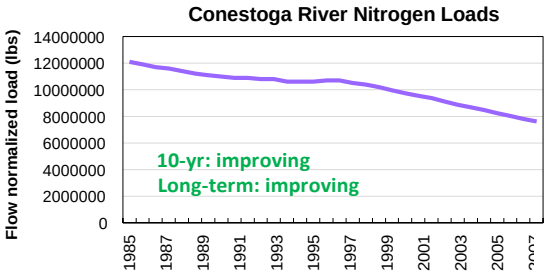
Four USGS monitoring stations (small squares) measure water quality in Lancaster County's watersheds. These maps depict the areas that drain into each of those monitoring stations.

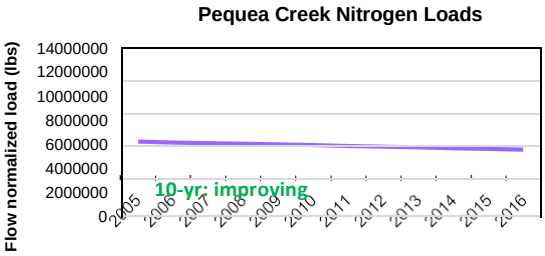
- The Susquehanna River at Marietta measures water quality in the Susquehanna River, and therefore captures the regional picture of the entire Susquehanna River watershed above the monitoring station. This is the last monitoring station on the Susquehanna River before the Conowingo Dam.
- The Conestoga River and Pequea Creek monitoring stations and majority of the watersheds' areas are in Lancaster County.
- The majority of the Octoraro Creek watershed is in Lancaster County, but the monitoring station is in Maryland.

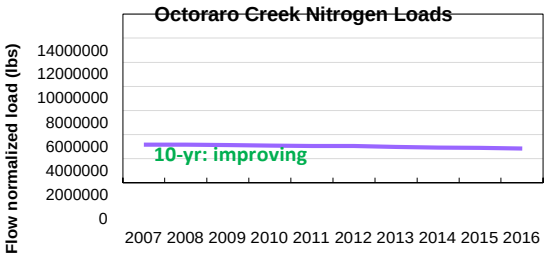
Water quality trends for the USGS non-tidal stations are available at: https://cbrim.er.usgs.gov/summary.html.

Nitrogen levels have been improving (going down) over time in Lancaster County's watersheds







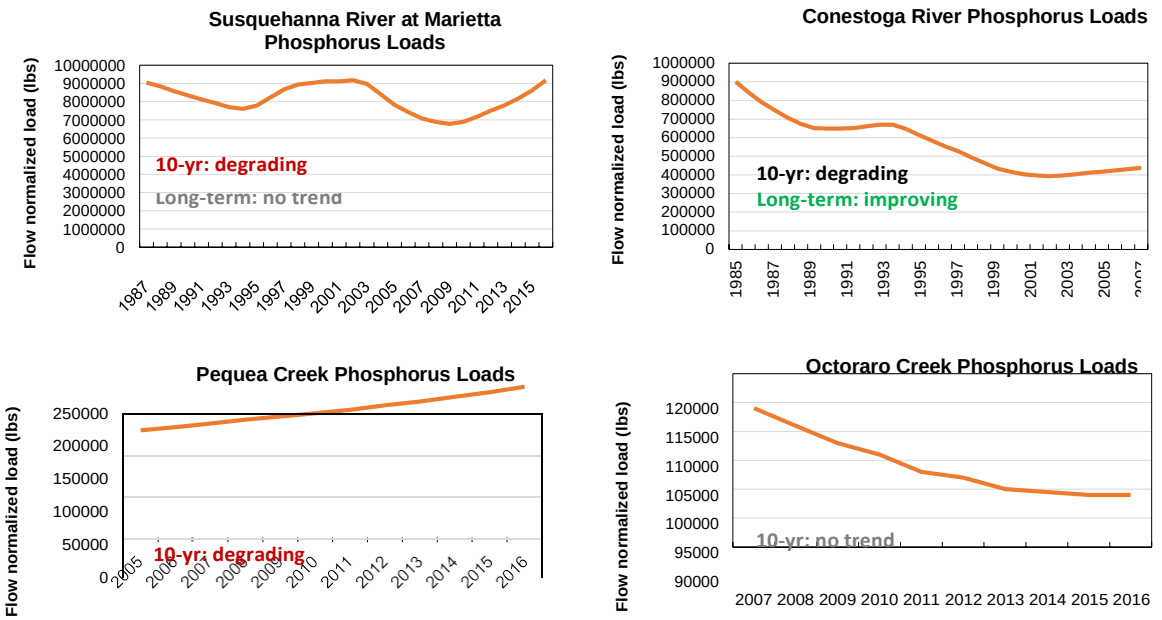


The monitored watersheds within Lancaster County show improving nitrogen trends (meaning that nitrogen is decreasing).

- Of Lancaster County's three local monitored watersheds (Conestoga, Pequea and Octoraro), Conestoga River has much higher nitrogen than Pequea and Octoraro. This is partially due to its larger size.
- The previous bar graphs show that when size is taken into account, the nitrogen load per acre of watershed is similar between these three, and that they are some of the highest loading watersheds in the Susquehanna River Basin.
- These watersheds would all be effective areas to focus efforts.
- Decreasing nitrogen is a result of decreasing deposition of nitrogen from the atmosphere onto the watershed (a result of the Clean Air Act), wastewater treatment plant upgrades, and some agricultural practices.

The graphs above take into account variability between years in river flow.
For more information, visit: https://cbrim.er.usgs.gov/summary.html.

Phosphorus levels in Lancaster County streams vary – most sites show degrading conditions over the past 10 years

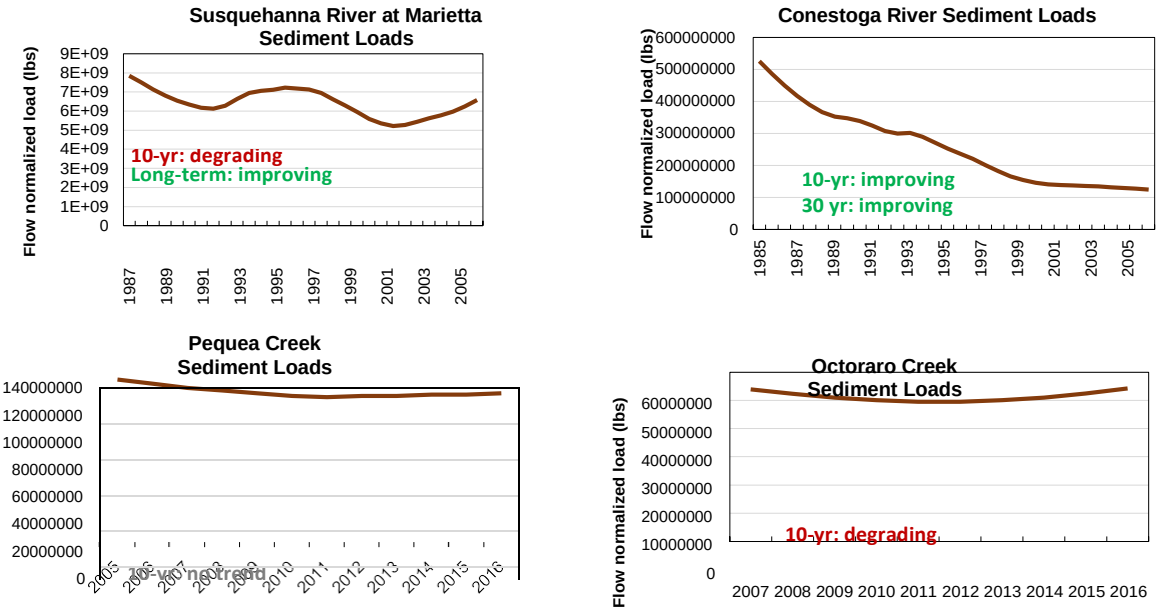


The monitored watersheds within Lancaster County show varying phosphorus trends (some are improving and some are degrading).

- Of Lancaster County's three local monitored watersheds (Conestoga, Pequea and Octoraro), Conestoga River has much higher phosphorus than Pequea and Octoraro. This is partially due to its larger size.
- The previous bar graphs shown previously show that when size is taken into account, the phosphorus load per acre of watershed is actually highest in Pequea Creek. All three are some of the highest loading watersheds in the Susquehanna River Basin.
- The high loads and degrading trends in these watersheds make them effective areas to focus efforts.

The graphs above take into account variability between years in river flow.
For more information, visit: https://cbrim.er.usgs.gov/summary.html.

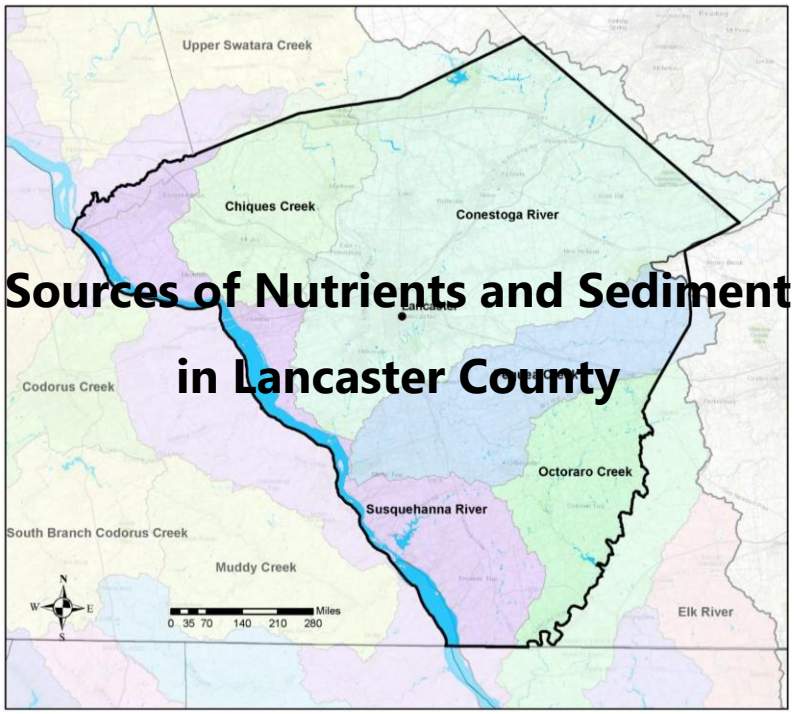
Sediment levels in Lancaster County's streams vary – some streams have improved while others have degraded

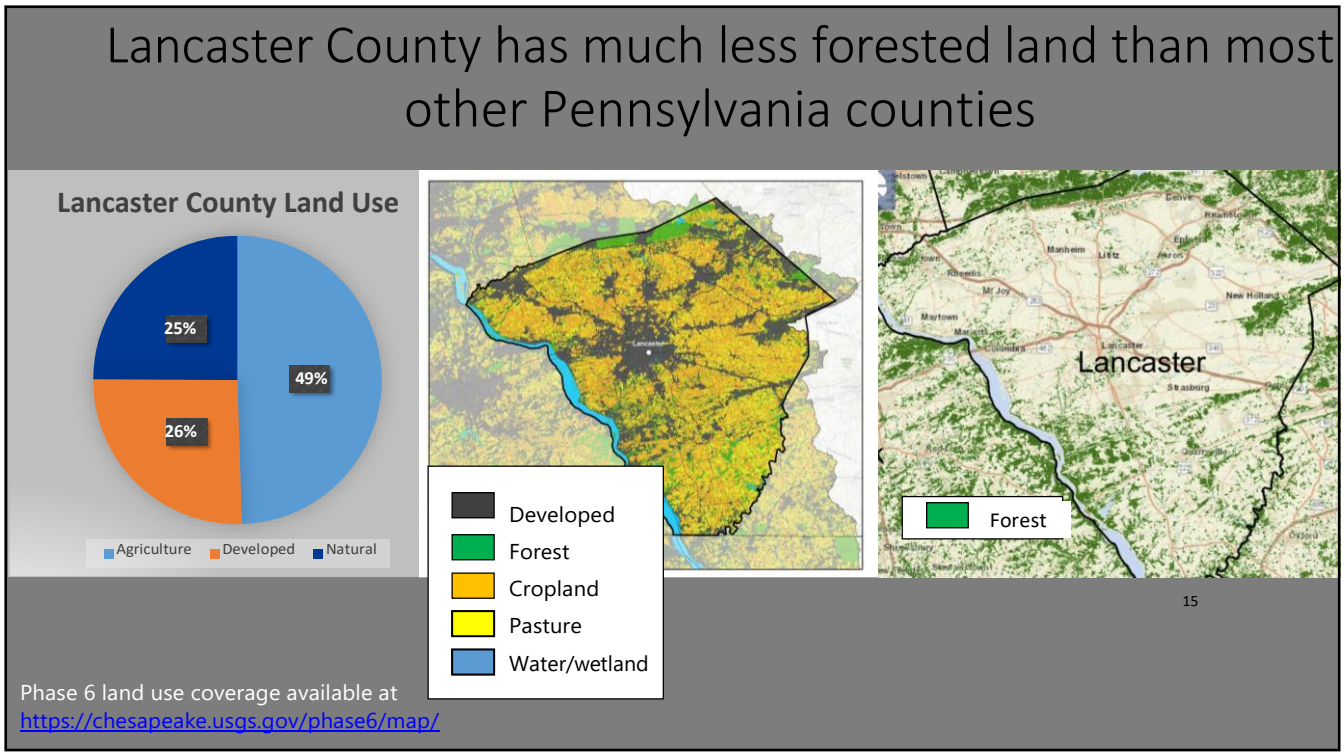


The monitored watersheds within Lancaster County show varying sediment trends (some are improving and some are degrading).

- Of Lancaster County's three local monitored watersheds (Conestoga, Pequea and Octoraro), Conestoga River has much more sediment than Pequea and Octoraro. This is partially due to its larger size.
- The bar graphs shown previously show that when size is taken into account, the phosphorus load per acre of watershed is actually highest in Pequea Creek. All three are some of the highest loading watersheds in the Susquehanna River Basin.
- The high loads and degrading trends in these watersheds make them effective areas to focus efforts.
- Phosphorus often travels attached to sediment. When phosphorus and sediment trends differ, it can be indicative of changes in dissolved phosphorus (not attached to sediment).

The graphs above take into account variability between years in river flow.
For more information, visit: https://cbrim.er.usgs.gov/summary.html.


Upper Swatara Creek
Chiques Creek
Conestoga River
Sources of Nutrients and Sediment
in Lancaster County
Codorus Creek
Octoraro Creek
Susquehanna River
South Branch Codorus Creek
Muddy Creek
Elk River
N
W
E
S
0 35 70 140 210 280
Miles

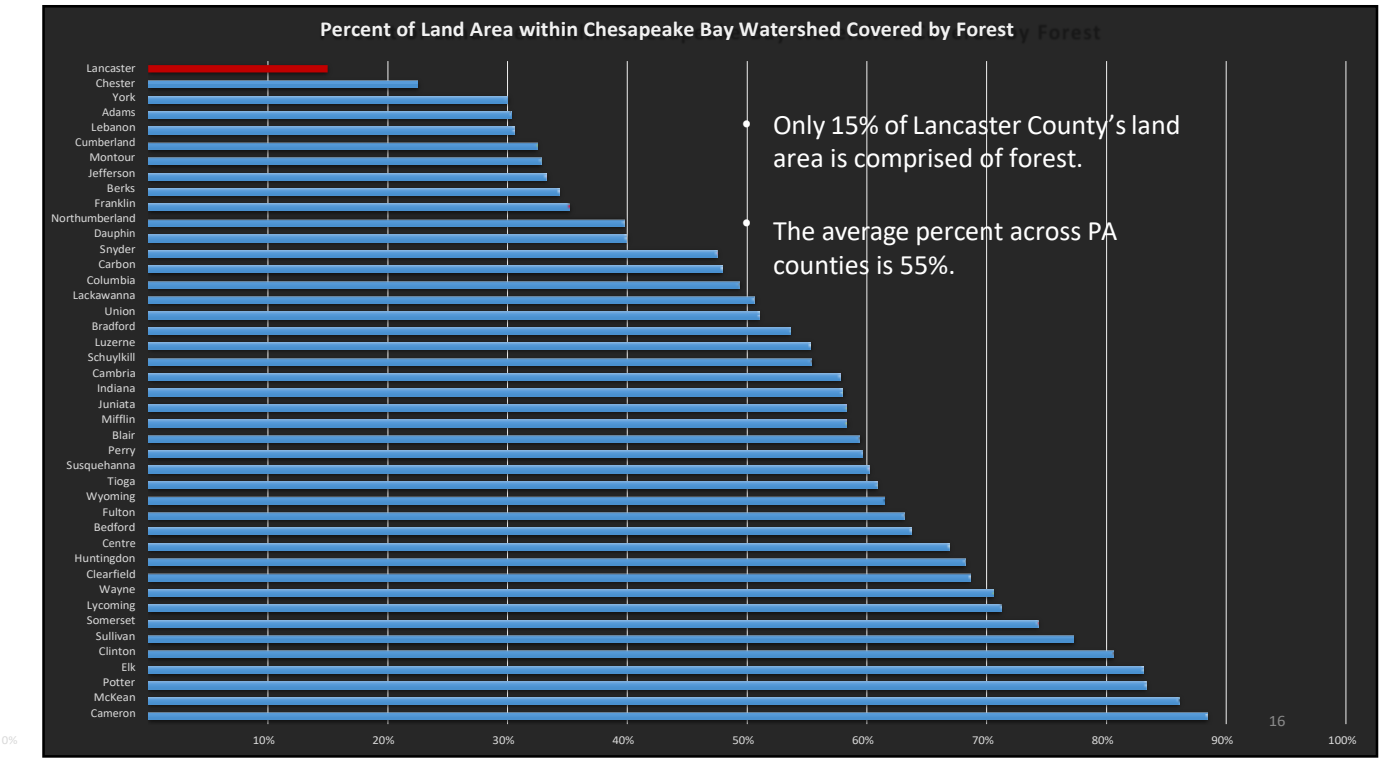


Lancaster County has unique challenges in restoring water quality.

- The pie chart above shows the breakdown of land uses in Lancaster County. Almost 75 percent of the county is agricultural or developed land, which is higher than most other counties in Pennsylvania.
- The maps above show the geography of land uses (middle) and specifically the small amount of forested land in the county (right).
- Agricultural and developed land generate more nutrients and sediment than forested land. Lancaster County has unique local water quality challenges in part due to its high acreage of these land uses.

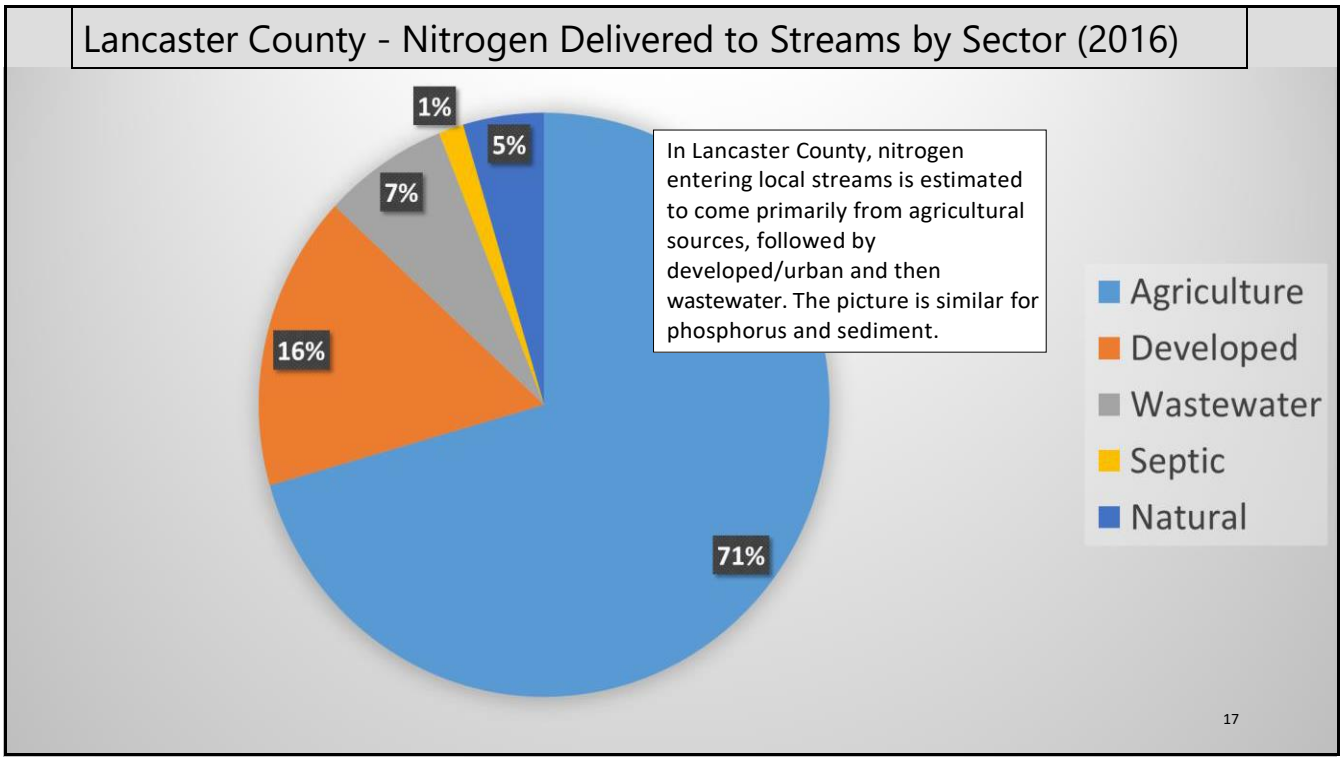
High resolution land-use for the Chesapeake Bay watershed is available from USGS and the Chesapeake Bay Program at: https://chesapeake.usgs.gov/phase6/.

The maps above are from Falcone, 2015 (middle) and Google Earth (right). The breakdown of land use by county can be found on CAST at: http://cast.chesapeakebay.net/.



Lancaster County's land is only 15 percent forested. This is the least forested county of all counties in Pennsylvania's Chesapeake Bay watershed, representing a unique challenge for Lancaster County. The average for Pennsylvania counties is 55 percent forested land.

The breakdown of land use by county can be found on CAST at: http://cast.chesapeakebay.net/.



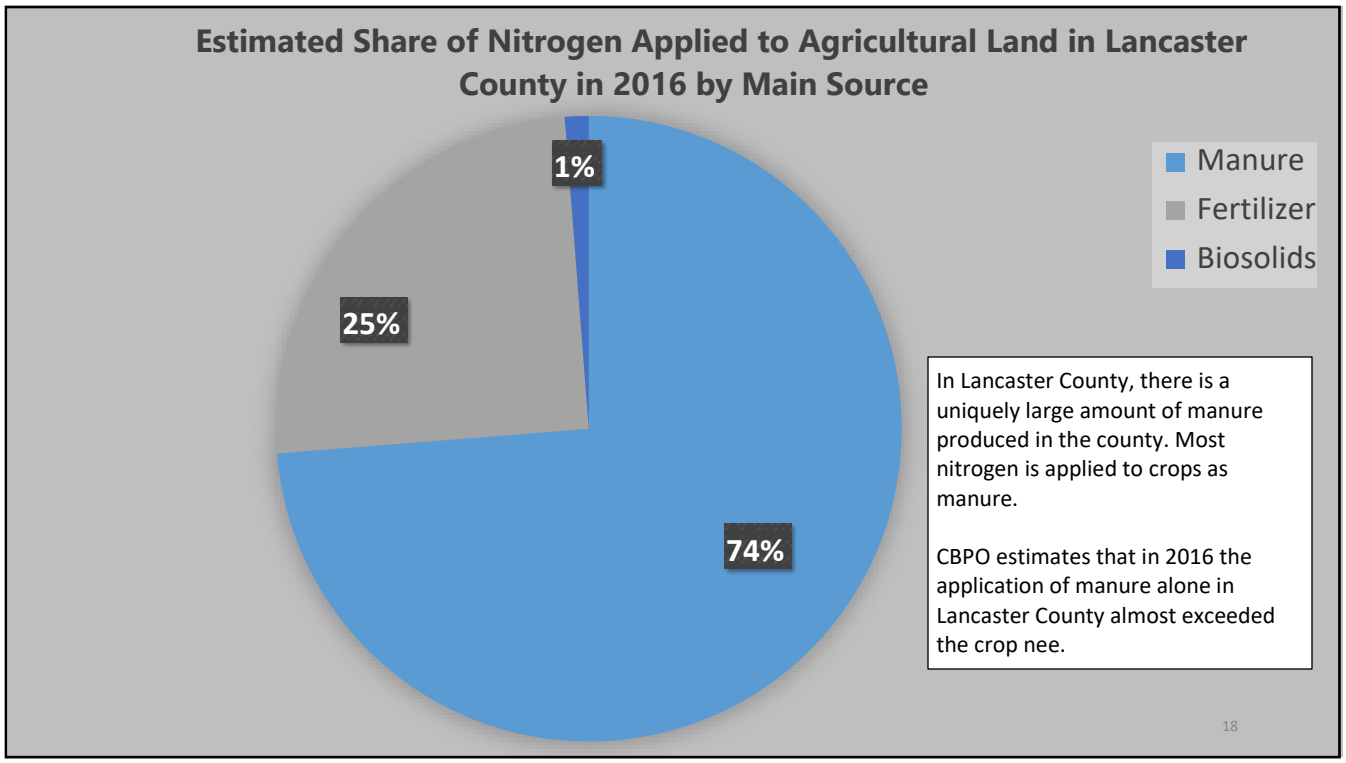
The pie chart above shows the percentage of nitrogen delivered to local streams based on land use or activity. Most nitrogen entering local streams in Lancaster County comes from agricultural sources including cropland, pasture and barnyards.

The developed/urban sector also contributes a fair amount of the load from stormwater.

Because agriculture and developed/urban sources make up the majority of the load in Lancaster County, these sectors will need to consider how they can supply the majority of the reductions to reach local goals. Wastewater and septic sources can also be reduced.

These estimates were generated using the Chesapeake Bay Program's Phase 6 Watershed Model. The model is generated using water quality monitoring data.

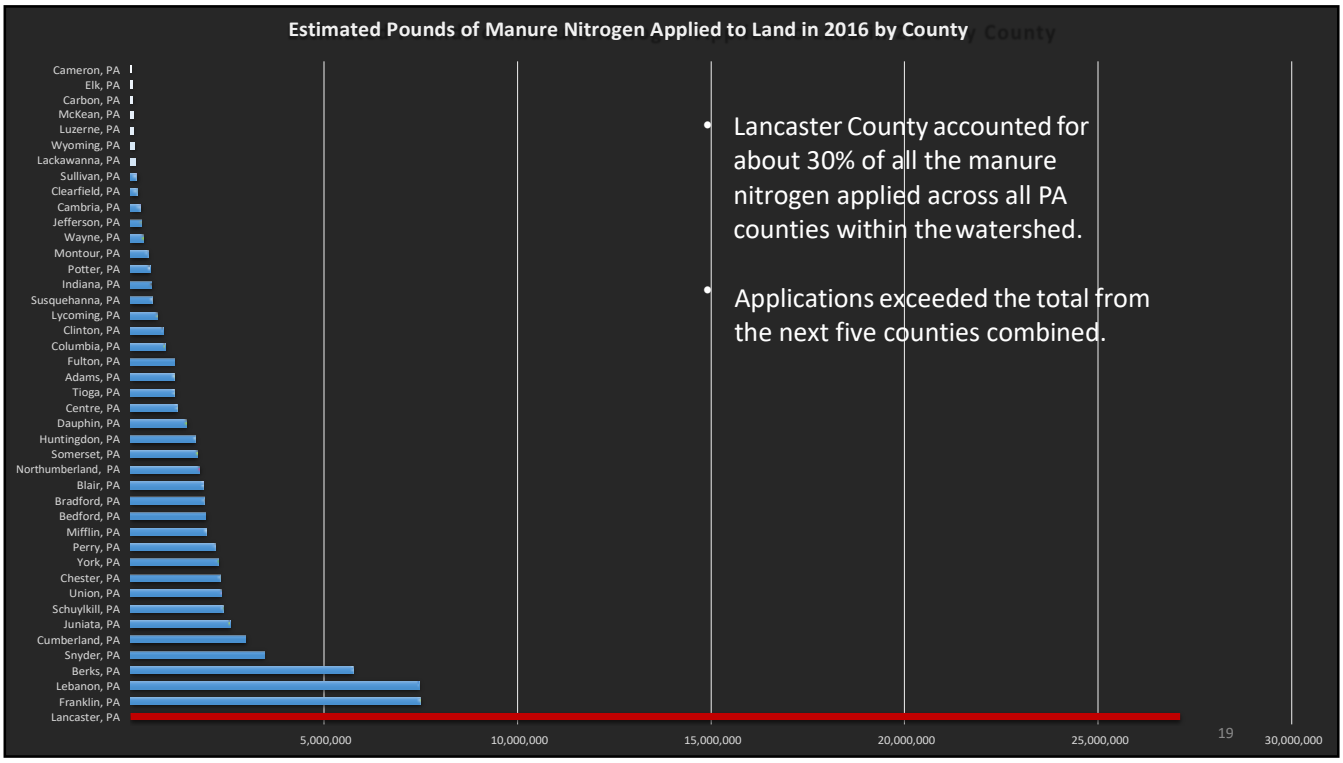
Estimated loads by sector can be found on CAST at:
http://cast.chesapeakebay.net/.



Understanding how nutrients are being applied to the land can lead to the sources that may need to be managed.

- Most nutrients applied to agricultural land in Lancaster County are in the form of manure rather than fertilizer.
- The application of manure alone nearly exceeded the crop need in the county in 2016.
- Nutrients that are applied to agricultural land and not taken up by crops can negatively impact water quality.
- When identifying strategies to manage nutrient application, focusing on manure will address a large portion of the issue.

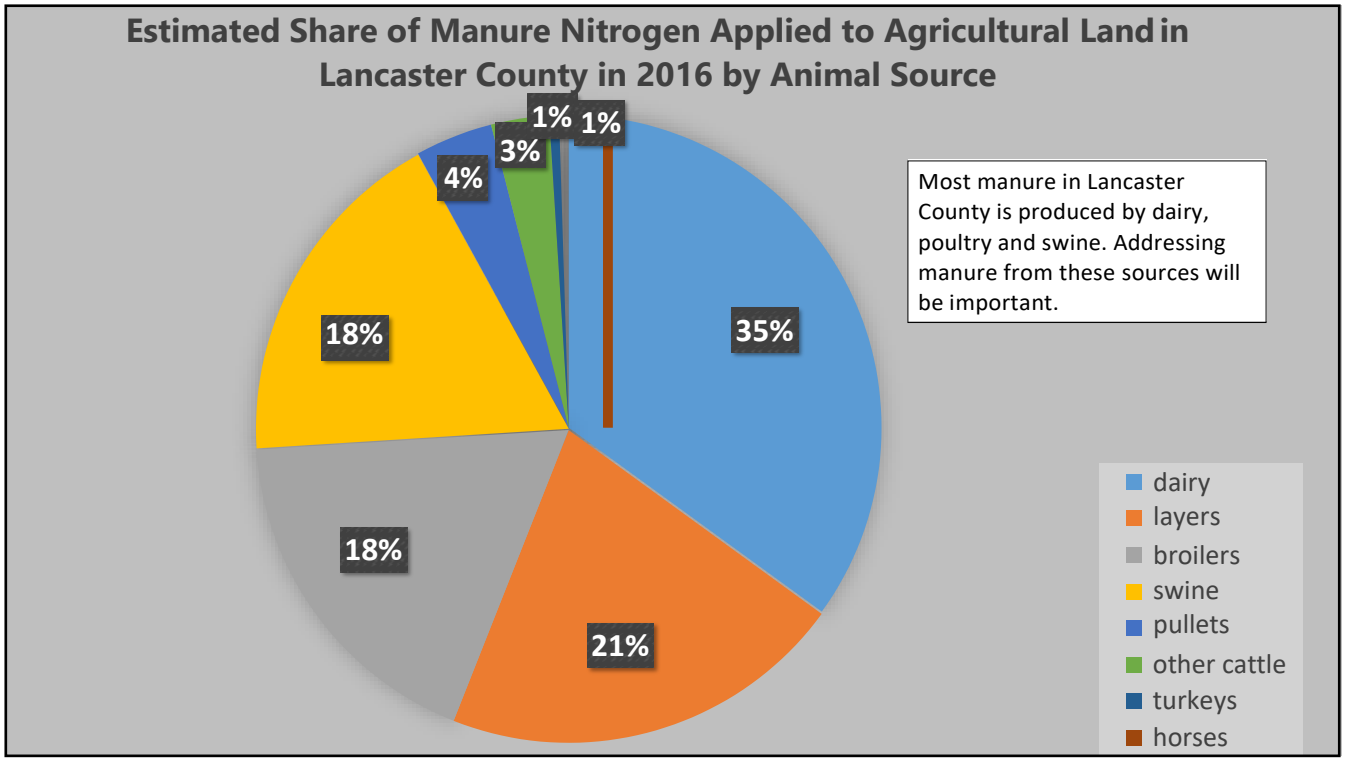
Estimated application of nutrients by source can be found on CAST at: http://cast.chesapeakebay.net/.



Lancaster County is unique in Pennsylvania with regard to the amount of manure that is produced and applied to the land. Practices that can effectively manage manure include:

- Practices that result in less application of nutrients to agricultural land, such as nutrient management, can address over-application of nutrients.
- Practices that manage manure, such as animal waste management systems and barnyard runoff control
- Practices that remove manure from the county, such as manure transport

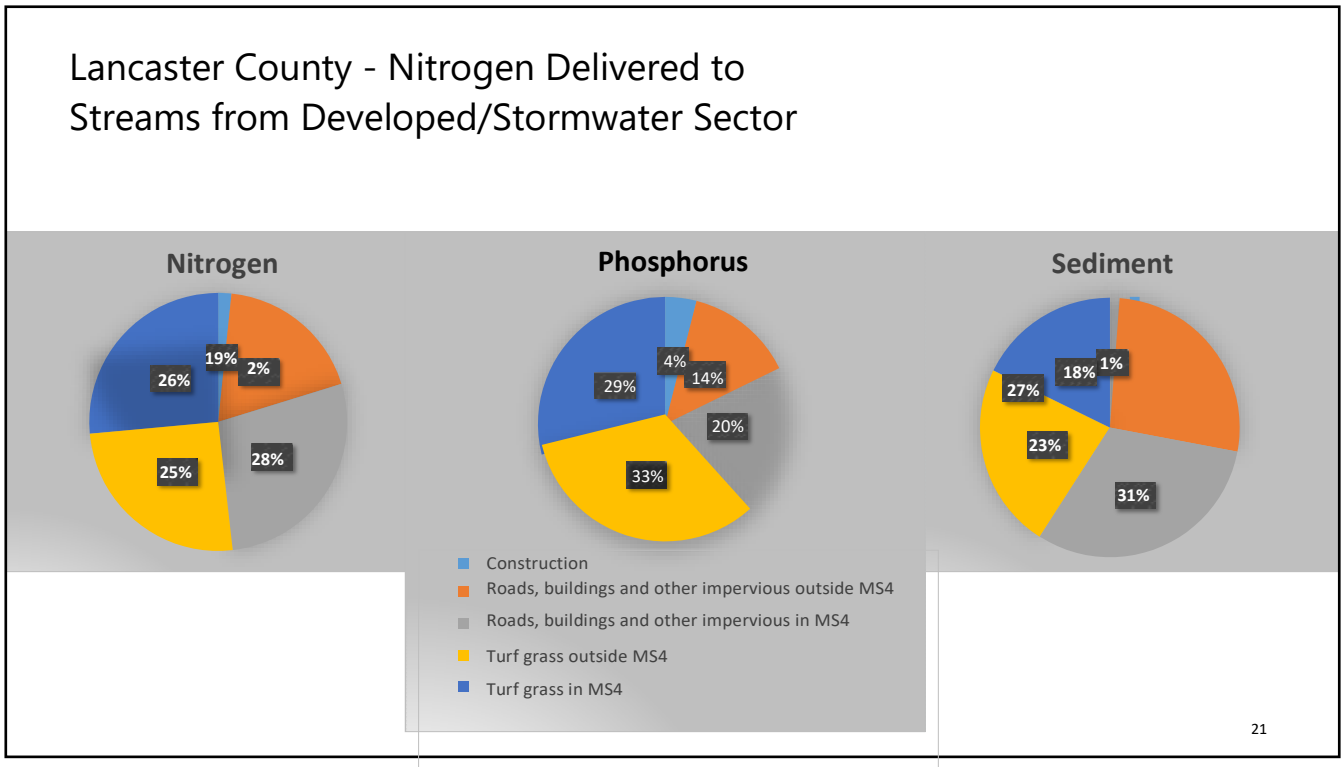
Estimated application of nutrients by source can be found on CAST at http://cast.chesapeakebay.net/.



Understanding where manure is coming from within the county will help identify opportunities to manage it.

Most manure in Lancaster County is from dairy, poultry and swine operations. Focusing efforts on implementing practices at these sort of operations can address a large portion of Lancaster County's manure management needs.

Estimated share of manure nutrient animal sources can be found on CAST at http://cast.chesapeakebay.net/.



The developed/stormwater sector is also an important source of nutrients and sediment in Lancaster County.

The charts above show the estimated breakdown of sources of nutrients and sediment to local streams exclusively from developed/urban lands.

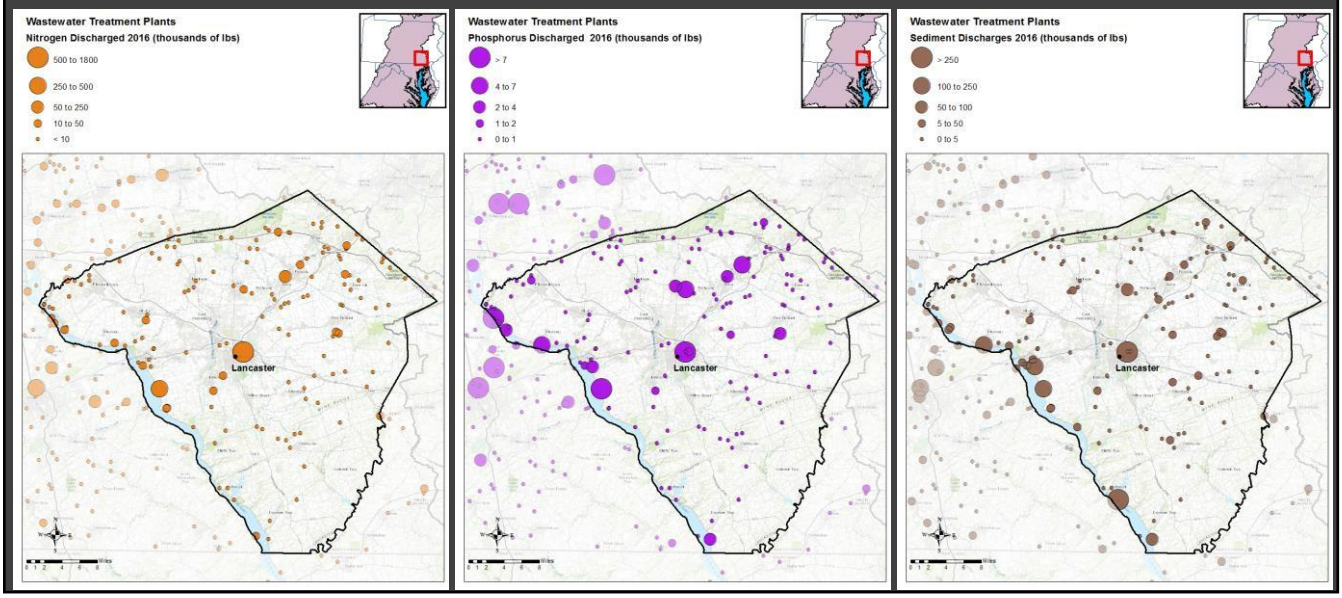
- MS4 (municipal separate storm sewer systems) areas are regulated by DEP.
- Land outside of MS4 areas is not regulated.
- Turf grass represents grassy and barren lands that have been altered through compaction, removal of organic material, and/or fertilization. These include all lawns and grassy areas in residential, commercial, recreational, cemeteries, shopping centers, etc.

Understanding where stormwater nutrient and sediment comes from is an important first step in addressing it.

- In Lancaster County, both impervious and turf grass areas are important sources to manage stormwater.
- Managing stormwater outside of regulated MS4 areas will also be important in Lancaster County.
- Managing these unregulated stormwater areas may take different outreach, voluntary programs and funding programs to implement practices.

Estimated loads by sources can be found on CAST at http://cast.chesapeakebay.net/.

Wastewater Treatment Plant Locations and Loads



The maps above show the locations of wastewater treatment plants within Lancaster County and their annual discharges of nitrogen, phosphorus and sediment in 2016.

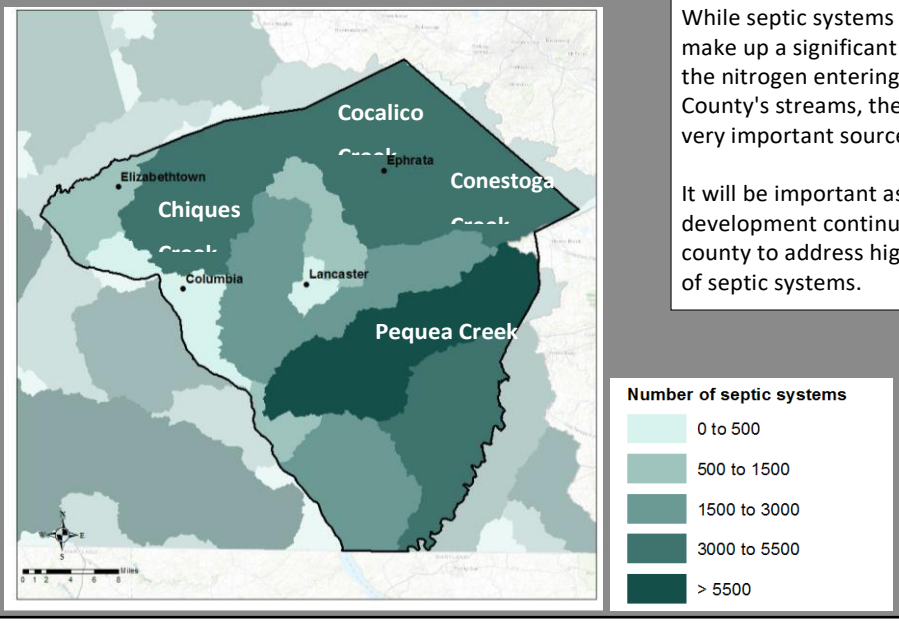
Although wastewater makes up a smaller portion of nutrient loads to streams in Lancaster County than agricultural or developed land, they are still important sources to control because their discharges enter streams directly.

Understanding where the higher loading plants are can help identify opportunities for treatment plant upgrades in the future, if possible.

Reported wastewater treatment plant discharges and treatment plant locations are available from the Chesapeake Bay Point

Source Database:
https://www.chesapeakebay.net/what/downloads/bay_program_nutrient_point_source_database

Septic System Density in Lancaster County



While septic systems do not make up a significant portion of the nitrogen entering Lancaster County's streams, they can be very important sources locally.

It will be important as development continues in the county to address high densities of septic systems.

Although on-lot septic systems do not make up a large portion of the load in Lancaster County, they can be very important local sources of nitrogen, especially when leaking into groundwater.

The map above shows the number of septic systems in different watersheds in the county, identifying potential areas of focus where septic system density is high.

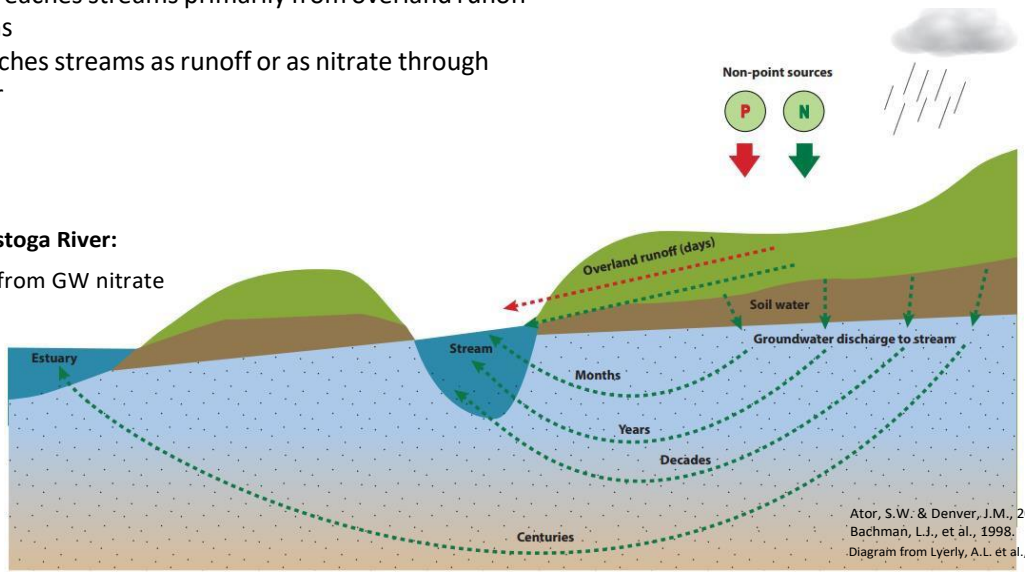
Number of septic systems in each watershed can be found on CAST at http://cast.chesapeakebay.net/.

The transport of nutrients matters for planning implementation

- Phosphorus reaches streams primarily from overland runoff during storms
- Nitrogen reaches streams as runoff or as nitrate through groundwater

Conestoga River:

64% of nitrogen is from GW nitrate



Ator, S.W. & Denver, J.M., 2015.
Bachman, L.J., et al., 1998.
Diagram from Lyerly, A.L. et al., 2014.

The way in which nutrients and sediment reach our streams impacts which practices will be effective at controlling them.

Phosphorus and sediment travel over the top of the land during high runoff events such as storms and rainfall.

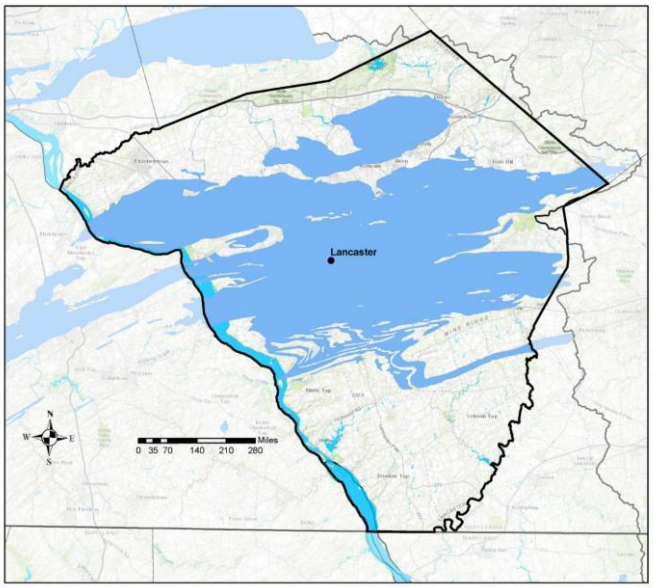
Nitrogen can travel over land as well, but in many watersheds, including those in Lancaster County, it travels to streams primarily at nitrate underground in groundwater.

- For example, 64 percent of the nitrogen in the stream at the Conestoga River comes from groundwater nitrate.
- If agricultural practices only focus on overland runoff, they could be missing a lot of the nitrogen that is entering streams through groundwater.
- Once nitrogen is in groundwater, it is very difficult to remove. Effective practices include those that stop nitrogen from entering groundwater in the first place, like applying less nitrogen and planting cover crops.
- Riparian buffers can remove nitrate from groundwater if placed in effective locations.

Lancaster County contains a large area vulnerable to groundwater contamination

- Geology makes the groundwater (and therefore streams) in some areas especially vulnerable to high nitrogen inputs
- These areas can be the most effective to focus practices for nitrate in groundwater
- Agricultural land on top of this vulnerable geology can particularly impact groundwater

Areas of vulnerable geology



Karst/carbonate areas

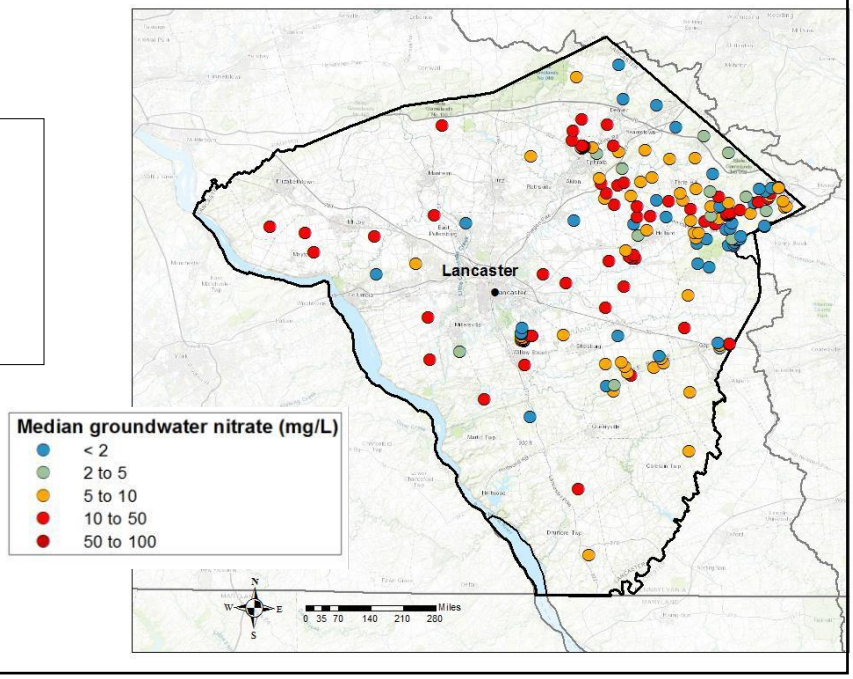
Modified from Jimmy Webber, USGS, using Brakebill, JW 2000, Ator, S. et al. 2005 and Nolan & Hitt, 2006.

Certain areas of the watershed are more vulnerable to nitrate contamination of groundwater because the geology under the soil makes it easier for nitrogen to enter groundwater and provides less opportunity for its removal to occur naturally.

- The map above shows these vulnerable areas, which have Karst or carbonate geology.
- Agricultural land on top of these areas makes the groundwater especially vulnerable due to the high inputs of nitrogen onto the landscape.
- These areas can be very effective for focusing efforts that keep nitrogen from getting into groundwater and are especially important areas to manage application of nitrogen.

Certain areas of the watershed aremore vulnerable

- Groundwater sampled in over the last few decades has Lancaster County consistently shown high nitrate levels
- In many cases, nitrate levels are above the safe drinking water threshold (>10 mg/L)



Modified from Jimmy Webber, USGS, using Brakebill, JW 2000, Ator, S. et al. 2005 and Nolan & Hitt, 2006.

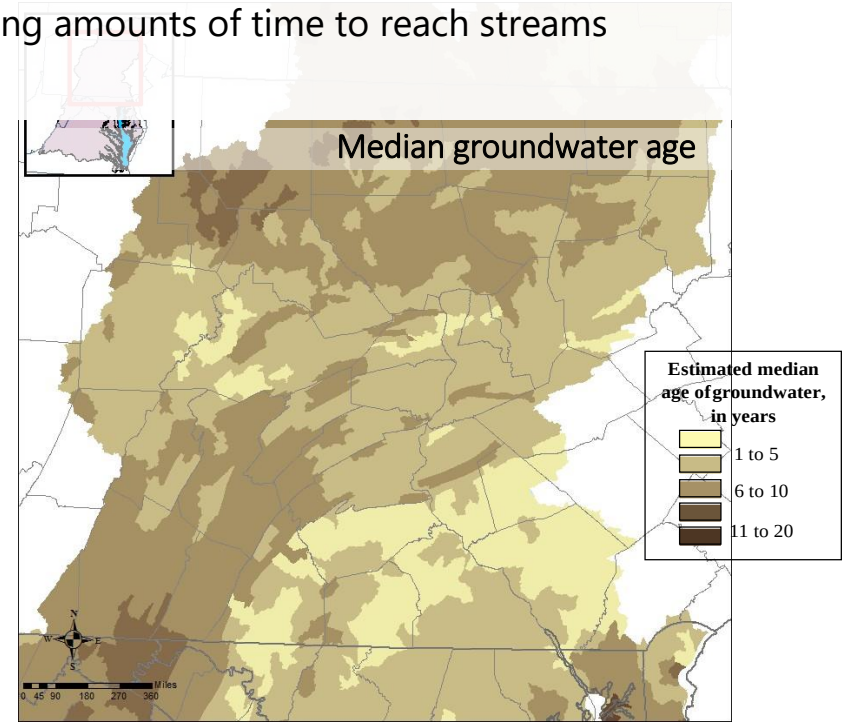
Groundwater in Lancaster County has some of the highest nitrate levels in the United States.

- This is partially due to the vulnerable geology, and also to the over-application of nutrients over time.
- Because groundwater contributes a significant portion of nitrogen to streams in these watersheds, groundwater nitrate levels are good indicators of what will eventually enter streams.
- In many cases throughout Lancaster County, groundwater nitrate levels exceed the EPA's safe drinking water threshold of 10 mg/L. Many of these groundwater samples include those taken from private wells in rural areas.

Groundwater quality data over multiple years can be found from USGS: https://water.usgs.gov/owq/data.html.

Groundwater takes varying amounts of time to reach streams depending on location

- Nitrate in groundwater represents a range of ages from recent to decades old
- Benefits from management actions will manifest immediately as well as into the future
- Chesapeake Bay Program estimates the median groundwater age across Lancaster County is between 1 and 10 years, with much of the groundwater being less than 5 years old.
- This means we expect very little "lag time" between when a practice is implemented and when that practice's impact can be seen in local streams. That presents a unique opportunity for quick, verifiable results that does not exist across most of the watershed.



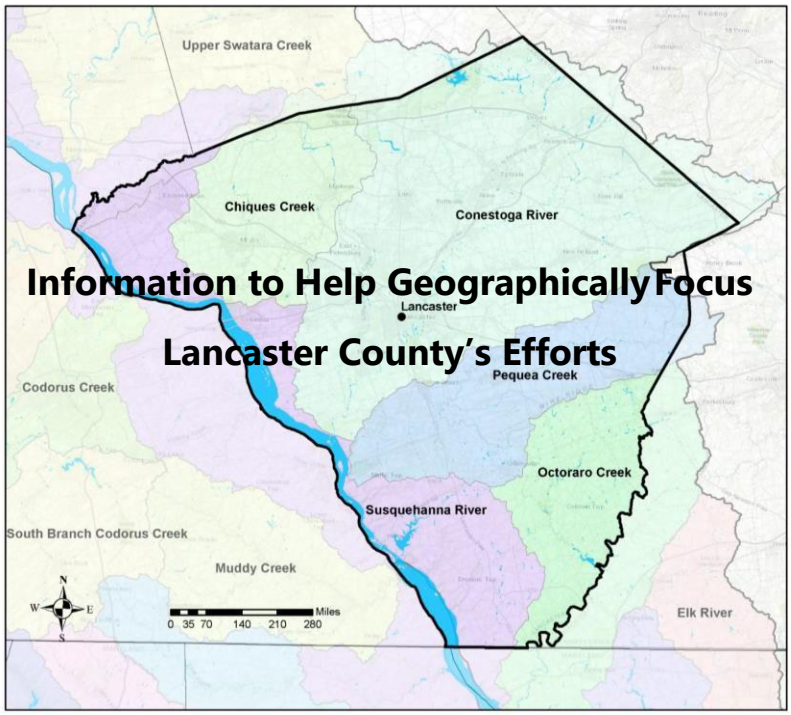
Phase 6 WSM groundwater age estimates. DRAFT from Jimmy Webber, USGS and Ghopal Batt, Chesapeake Bay Program.

Groundwater takes anywhere from days to years to reach nearby streams.

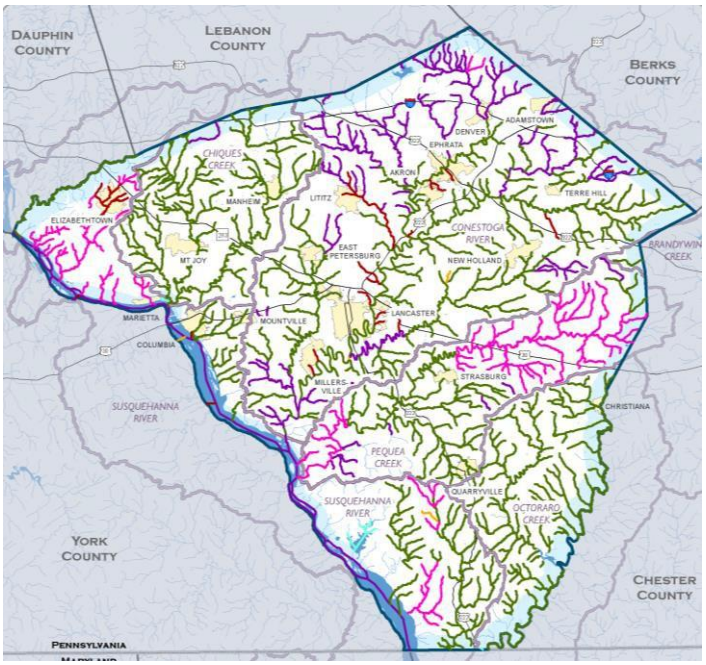
In Lancaster County, the groundwater is some of the youngest in the Chesapeake Bay watershed, meaning that it doesn't take long to reach streams.

This means that we should see decreased nutrient benefits in groundwater from local stream restoration and conservation efforts relatively faster than anywhere else in the Chesapeake Bay watershed.

Estimated groundwater age can be obtained from the Chesapeake Bay Program at www.chesapeakebay.net.

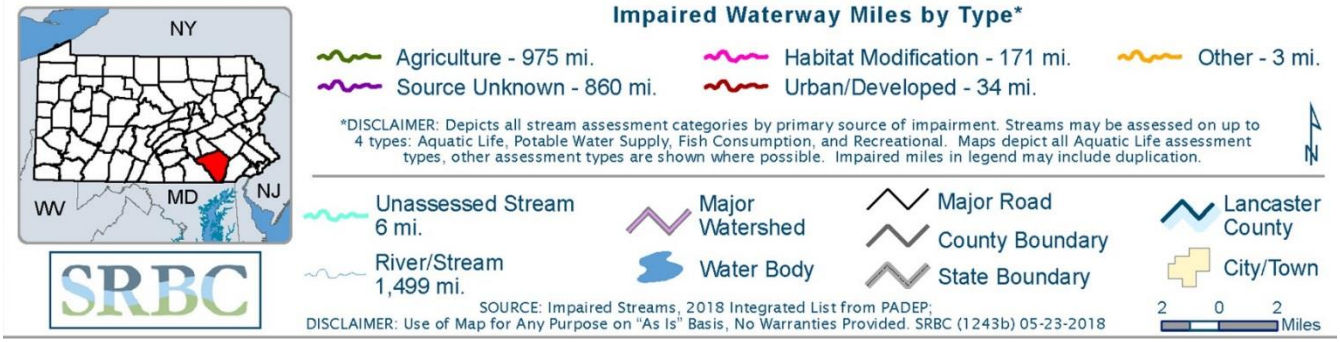

Upper Swatara Creek
Chiques Creek
Conestoga River
Information to Help Geographically Focus
Lancaster
Lancaster County's Efforts
Pequea Creek
Codorus Creek
Octoraro Creek
Susquehanna River
South Branch Codorus Creek
Muddy Creek
Elk River
N
W
E
S
0 35 70 140 210 280
Miles

Lancaster County's local sources of nutrients and sediment are impacting its streams



PADEP & SRBC

29



Lancaster County has many streams that are impaired for different reasons.

Knowing the sources of these impairments help to prioritize or coordinate efforts.

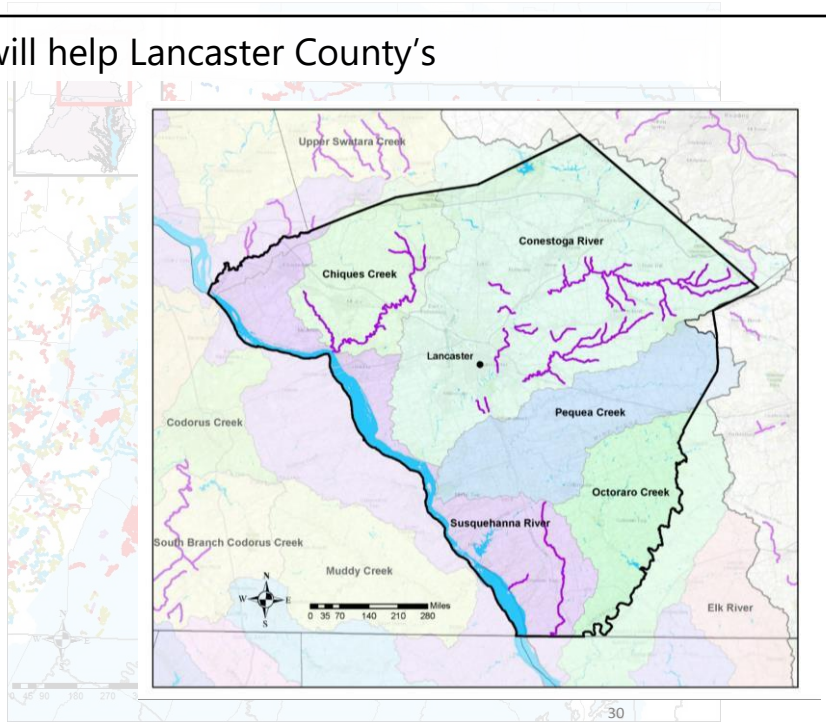
- For example, many agricultural practices that address nutrients can also address siltation impairments from sediment.
- Many urban/developed practices that address nutrients and sediment also address the same causes of pathogen impairments.

Local impaired waters listed on the 303(d) list can be found at PADEP: http://www.depgis.state.pa.us/integratedreport/index.html.

Local restoration efforts will help Lancaster County's waters first

Pennsylvania's impaired streams

Local TMDLs

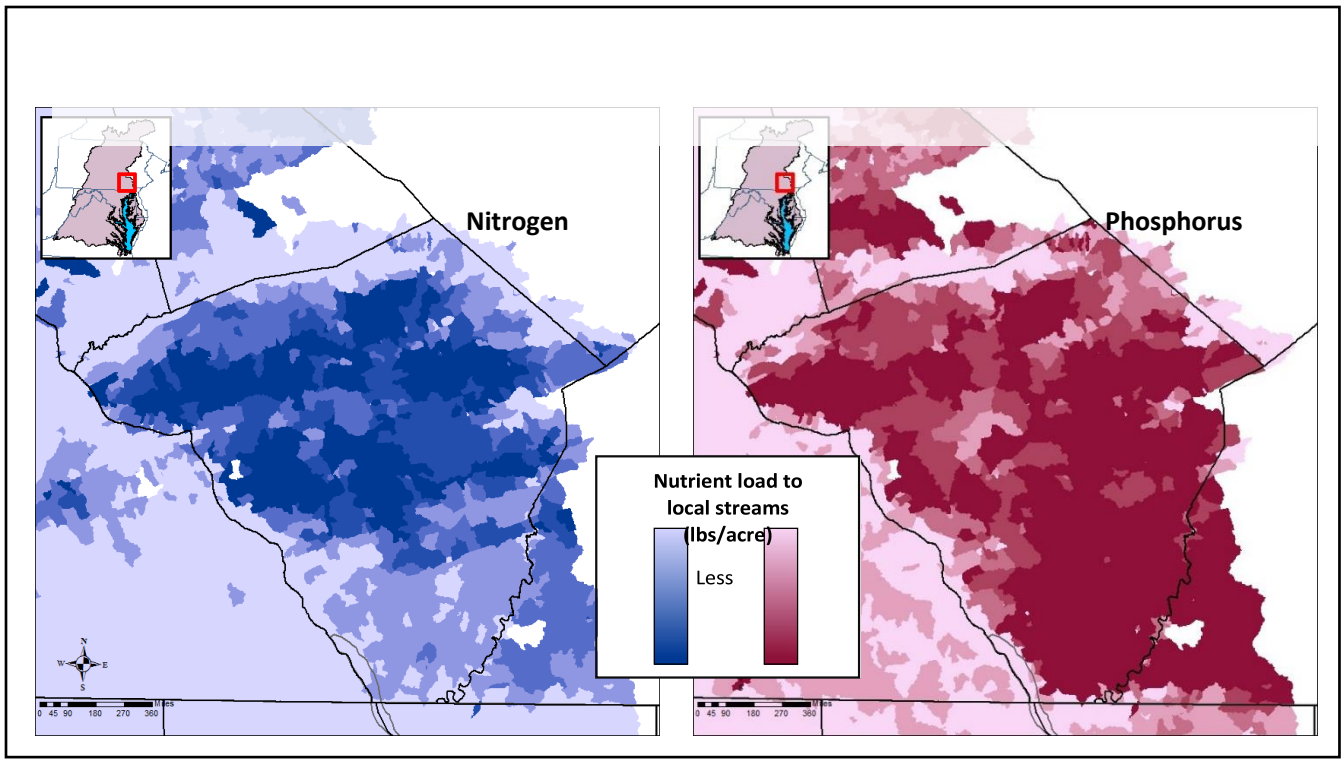


PADEP

While many waters are listed as impaired, only some of these impairments are being addressed through regulatory Total Maximum Daily Loads (TMDLs).

Local groups may want to coordinate restoration efforts to focus on the watersheds that already have these local TMDLs.

Local impaired waters listed on the 303(d) list that have TMDLs can be found at PADEP: http://www.depgis.state.pa.us/integratedreport/index.html.



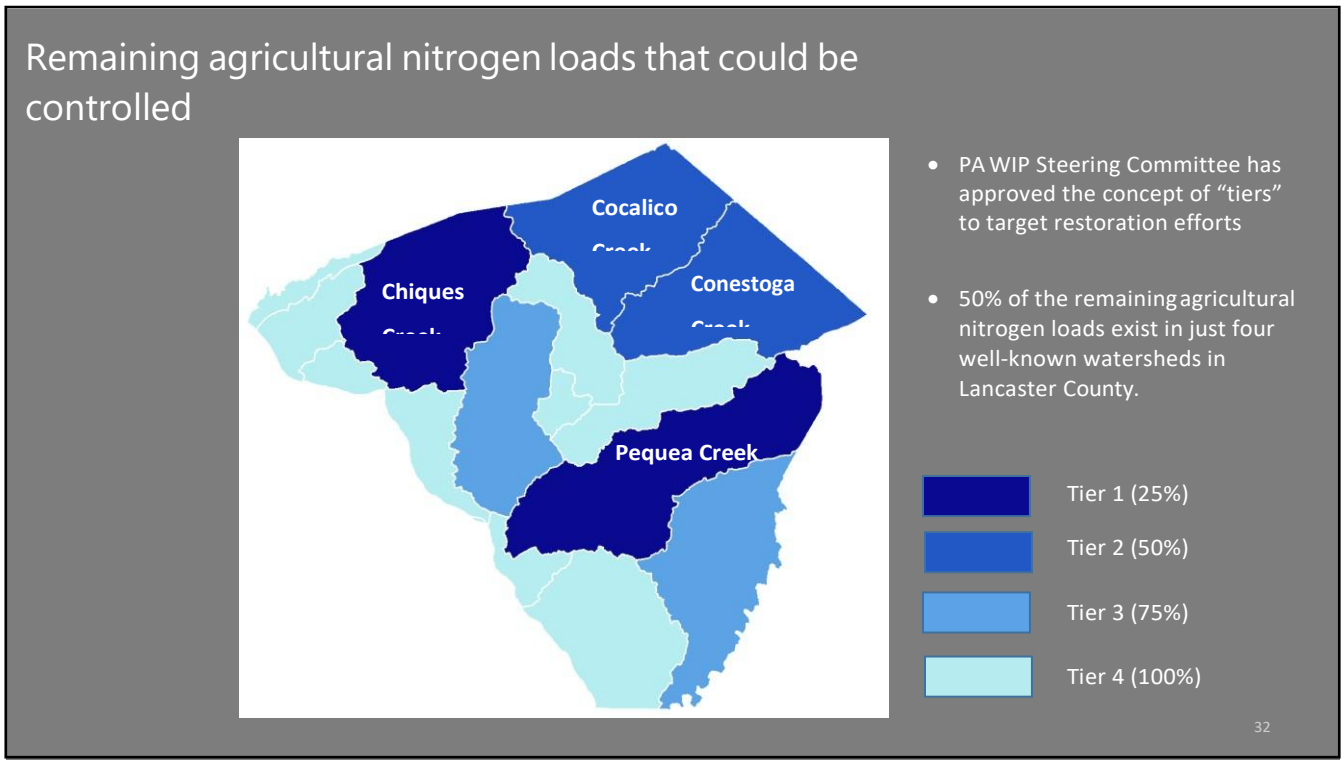
Focusing efforts on the highest loading areas within Lancaster County can result in the greatest water quality benefits

We can estimate where the highest amounts of nitrogen and phosphorus are entering local streams.

The maps above show these higher loading areas within Lancaster County.

Focusing efforts on the highest loading areas can result in the greatest water quality benefits by addressing a larger portion of the nutrients entering streams.

The maps above are generated from the USGS SPARROW model for the Chesapeake Bay watershed:
https://pubs.usgs.gov/sir/2011/5167/.

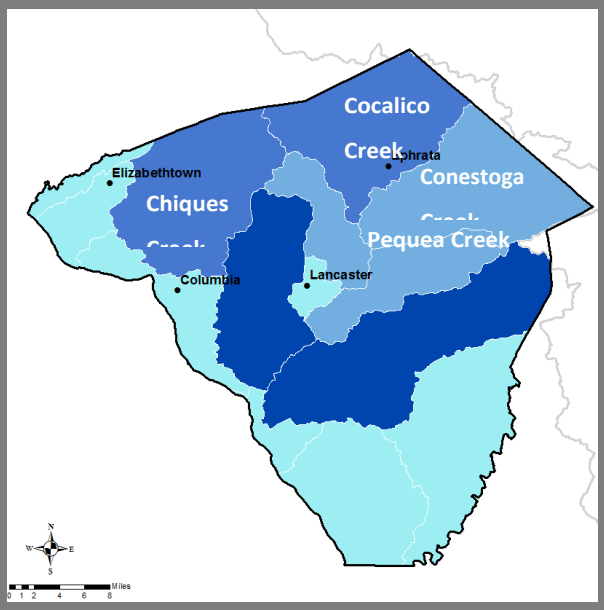


For each watershed within Lancaster County, we can estimate the remaining nitrogen and phosphorus reductions that are feasibly possible from the agricultural sector.

- Although we can never expect these areas to reduce all of these loads, identifying where the remaining reductions can come from can help to geographically focus efforts.
- The map above shows, for the total remaining nitrogen reductions possible in Lancaster County, where the remaining loads exist, broken into 25 percent tiers.
- For example, if we were to reduce nitrogen loads in the four darkest watersheds as low as feasibly possible, that would address 50 percent of the entire remaining nitrogen load.
- Pequea Creek, Chiques Creek, and Cocalico Creek are frequently in the top two tiers across nitrogen and phosphorus and both agricultural and developed sectors.

Remaining controllable agricultural loads represent the difference between 2016 Progress and the E3 scenario.

Remaining developed land nitrogen loads that could be controlled



- PA WIP Steering Committee has approved the concept of "tiers" to target restoration efforts
- 50% of the remaining developed nitrogen loads exist in just four watersheds in Lancaster County.

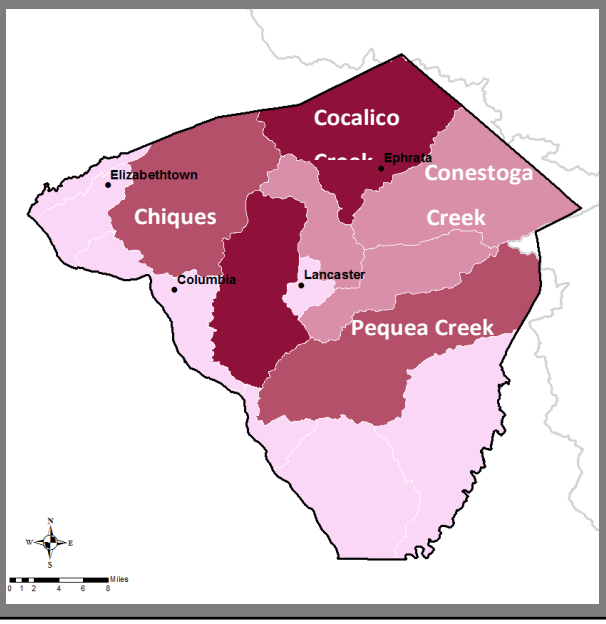
Tier 1 (25%)
Tier 2 (50%)
Tier 3 (75%)
Tier 4 (100%)

For each watershed within Lancaster County, we can estimate the remaining nitrogen and phosphorus reductions that are feasibly possible from the developed/urban sector.

- Although we can never expect these areas to reduce all of these loads, identifying where the remaining reductions can come from can help to geographically focus efforts.
- The map above shows, for the total remaining nitrogen reductions possible in Lancaster County, where the remaining loads exist, broken into 25 percent tiers.
- For example, if we were to reduce nitrogen loads in the four darkest watersheds as low as feasibly possible, that would address 50 percent of the entire remaining nitrogen load.
- Pequea Creek, Chiques Creek, and Cocalico Creek are frequently in the top two tiers across nitrogen and phosphorus and both agricultural and developed sectors.

Remaining controllable developed land loads represent the difference between 2016 Progress and the E3 scenario.

Remaining developed land phosphorus loads that could be controlled



- PA WIP Steering Committee has approved the concept of "tiers" to target restoration efforts
- 50% of the remaining developed phosphorus loads exist in just four watersheds in Lancaster County.

Tier 1 (25%)
Tier 2 (50%)
Tier 3 (75%)
Tier 4 (100%)

For each watershed within Lancaster County, we can estimate the remaining nitrogen and phosphorus reductions that are feasibly possible from the developed/urban sector.

- Although we can never expect these areas to reduce all of these loads, identifying where the remaining reductions can come from can help to geographically focus efforts.
- The map above shows, for the total remaining phosphorus reductions possible in Lancaster County, where the remaining loads exist, broken into 25 percent tiers.
- For example, if we were to reduce phosphorus loads in the four darkest watersheds as low as feasibly possible, that would address 50 percent of the entire remaining phosphorus load.
- Pequea Creek, Chiques Creek, and Cocalico Creek are frequently in the top two tiers across nitrogen and phosphorus and both agricultural and developed sectors.

Remaining controllable developed land loads represent the difference between 2016 Progress and the E3 scenario.

Identifying Opportunities and Choosing Best Practices

Most Cost-effective Agricultural Practices for Nitrogen Reduction in Lancaster County

Sector	BMP	Cost per unit BMP	Nitrogen Lbs Reduced per unit BMP	Nitrogen $/lb reduced/year
Agriculture	Dairy Precision Feeding and/or Forage Management	-9.95	3.1329	-3.18
Agriculture	Conservation Tillage	0	4.92294	0
Developed	Nutrient Management Plan	0	1.06001	0
Agriculture	Alternative Crops	18.26	47.93361	0.38
Agriculture	Grass Buffer	56.95	84.09757	0.68
Agriculture	Soil Conservation and Water Quality Plans	1.94	2.37917	0.82
Agriculture	Wetland Restoration on floodplains	96.58	81.17254	1.19
Agriculture	Forest Buffer	157.35	108.37584	1.45
Agriculture	Narrow Grass Buffer	56.95	36.61654	1.56
Agriculture	Streamside Grass Buffer w/ Exclusion Fencing	277.3	178.08983	1.56
Agriculture	Water Control Structures	17.74	10.65233	1.67
Agriculture	Barnyard Runoff Control	567.46	332.68128	1.71
Agriculture	Agricultural Stormwater Management	1584.68	579.68926	2.73
Agriculture	Cropland Irrigation Management	4.57	1.50721	3.03

Most Cost-effective Developed Practices for Nitrogen Reduction in Lancaster County

Sector	BMP	Cost per unit BMP	Nitrogen Lbs Reduced per unit BMP	Nitrogen $/lb reduced/year
Developed	Forest Planting	92.23	10.41	8.86
Developed	Forest Buffer	153.28	13.81	11.10
Developed	Bioswale	865.95	10.31	84.02
Developed	Infiltration Practices w/o sand, veg. – A/B soils, no underdrain	1,093.35	11.78	92.83
Developed	Tree Planting – Canopy	107.78	1.09	98.81
Developed	Wet Ponds and Wetlands	330.44	2.94	112.21
Developed	Dry Extended Detention Ponds	342.62	2.94	116.35
Developed	Vegetated Open Channels a/b Soils, no underdrain	819.32	6.63	123.66
Developed	Bioretention/raingardens – C/D soils, underdrain	1,059.40	3.68	287.81
Developed	Storm Drain Cleaning	0.62	0.00	337.71

The list above reflects the top 15 agriculture and top 10 developed, most cost-effective practices at reducing nitrogen in Franklin County.

This list can serve as a starting point to assess feasibility of practice implementation.

For example, even though Alternative Crops are cost-effective, this practice involves replacing crops with others such as switchgrass, which may not be a feasible practice to implement.

Descriptions of the BMPS and the methods for generating cost-effectiveness can be found on the CAST website at http://cast.chesapeakebay.net.

The most effective practices were determined using CAST and isolating reductions from individual BMPs. Most effective practices list are available from CAST at http://cast.chesapeakebay.net.

Remaining Opportunities in Lancaster County for Agricultural Practices

Practice	Current Reported Implementation	Acres Remaining
Basic Nutrient Management	21%	241,286
Conservation Tillage	44%	112,976
Cover Crop	32%	138,385
Prescribed Grazing	7%	41,532
Barnyard Runoff Control	76%	386
Prescribed Grazing	7.1%	41,700
Soil & Water Conservation Plans	16.2%	260,409
Forest Buffers	N/A	24,000

37

This chart shows the current implementation in Lancaster County of some effective agricultural practices, and the remaining acres of land in the county available to implement those practices.

The current reported implementation percent reflects how much of the land that is available for a particular practice already has that practice reported to be implemented on it.

For example, prescribed grazing's current percent implementation reflects that 7 percent of pasture land in Lancaster County is currently reported to have prescribed grazing implemented. 41,532 acres of pasture remain in the county without prescribed grazing, which may represent an opportunity for further implementation of that practice.

Remaining opportunity is determined as the difference between reported implemented acres and all available acres on which the practice can be implemented. Land on which BMPs can be implemented are available in CAST. Reported implementation is available on CAST at http://cast.chesapeakebay.net.

Remaining Opportunities in Lancaster County for Stormwater Practices on Developed/Urban Land

Practice	Current Reported Implementation	Acres Remaining
Erosion & Sediment Control	100%	0
Stormwater Management	5.3%	150,739

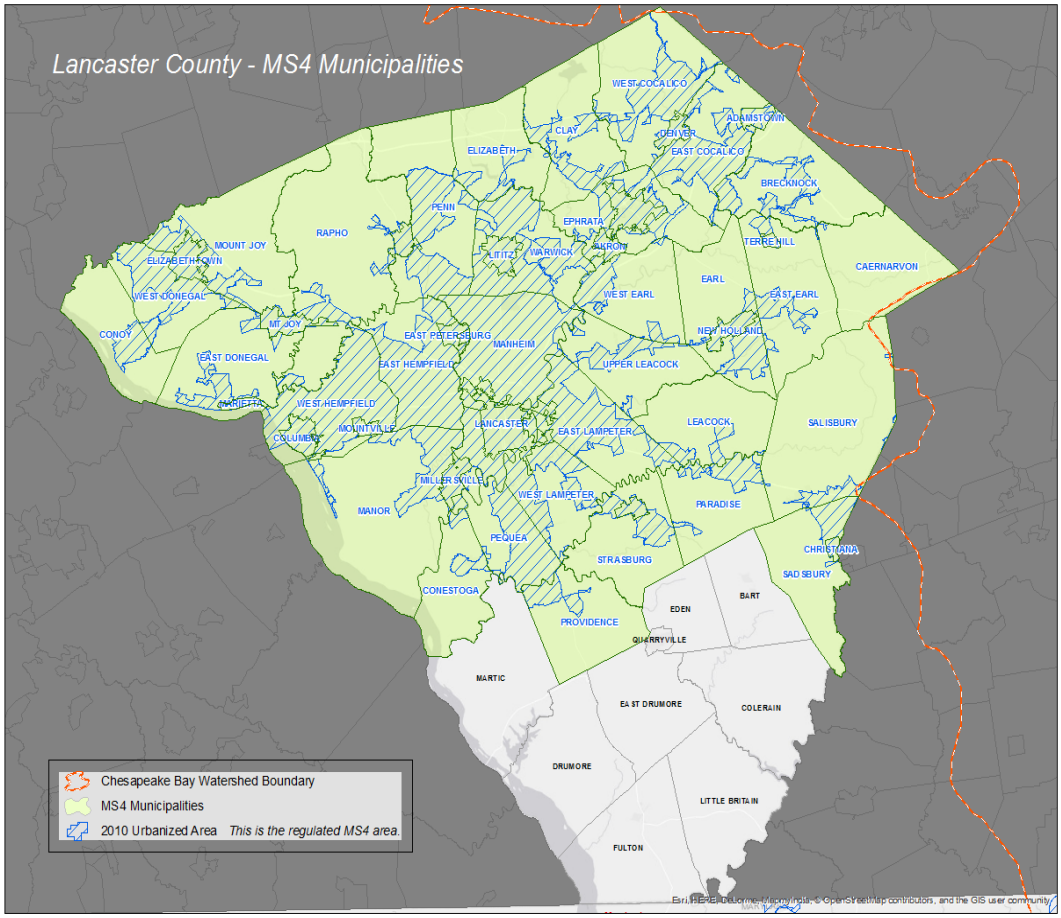
38

This chart shows the current implementation in Lancaster County of stormwater practices, and the remaining acres of land in the county available to implement those practices.

Erosion and sediment control addresses construction areas and time periods. However, sediment from developed land and from erosion of streams on developed land persist as issues long after construction is over. Therefore, stormwater management is incredibly important for managing these issues once construction ends.

Opportunities exist in Lancaster County to implement stormwater management practices in developed and urban areas.

Remaining opportunity is determined as the difference between reported implemented acres and all available acres on which the practice can be implemented. Land on which BMPs can be implemented are available in CAST. Reported implementation is available on CAST at http://cast.chesapeakebay.net.


Lancaster County - MS4 Municipalities
WEST COCALICO
ADAMSTOWN
CLAY
DENVER
ELIZABETH
EAST COCALICO
BRECKNOCK
PENN
EPHRATA
RAPHO
MOUNT JOY
LITITZ
WARWICK
AUBURN
TERRE HILL
CAERNARVON
ELIZABETHTOWN
EARL
WEST DONEGAL
WEST EARL
EAST EARL
MT JOY
CONOY
EAST PETERSBURG
MANHEIM
NEW HOLLAND
EAST DONEGAL
EAST HEMPFIELD
UPPER LEACOCK
MARIETTA
WEST HEMPFIELD
LEACOCK
SALISBURY
COLUMBIA
MOUNTVILLE
LANCASTER
EAST LAMPETER
MILLERSVILLE
WEST LAMPETER
PARADISE
MANOR
PEQUEA
CHRISTIANA
STRASBURG
SADSBURY
CONESTOGA
BART
EDEN
PROVIDENCE
QUARRYVILLE
MARTIC
EAST DRUMORE
COLERAIN
DRUMORE
LITTLE BRITAIN
FULTON
Chesapeake Bay Watershed Boundary
MS4 Municipalities
2010 Urbanized Area This is the regulated MS4 area.