



WATERSHED INFLUENCES

AIREAL VICKERS, ENVIRONMENTAL SCIENTIST, CITY OF DOVER

BRYN WAMBAUGH, STORMWATER COORDINATOR, CITY OF DOVER

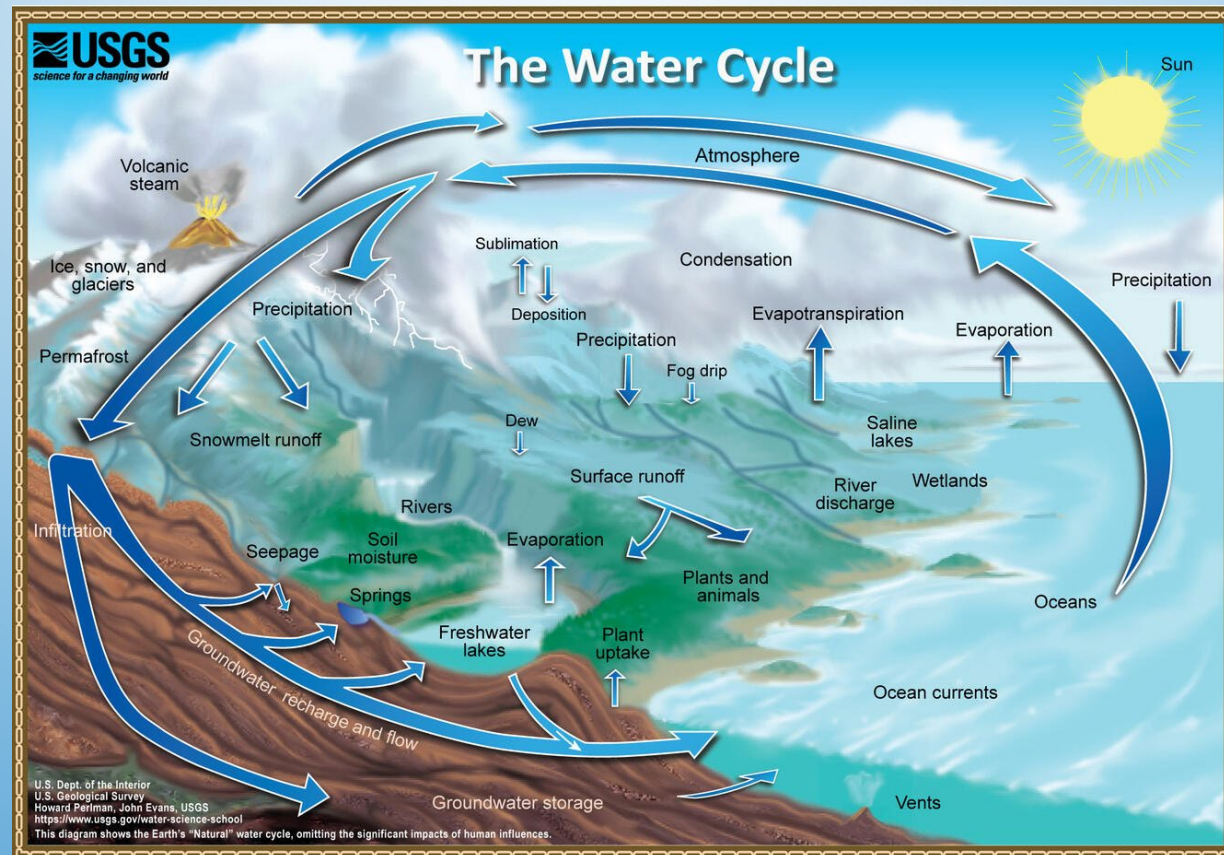
THE WATER CYCLE



THE CONTINUOUS MOTION OF WATER ON THE EARTH

MAKES / IS PART OF

- AIR
- CLOUDS
- BODIES OF WATER
 - OCEANS
 - LAKES
 - STREAMS
- VEGETATION
- SNOW
- GLACIERS

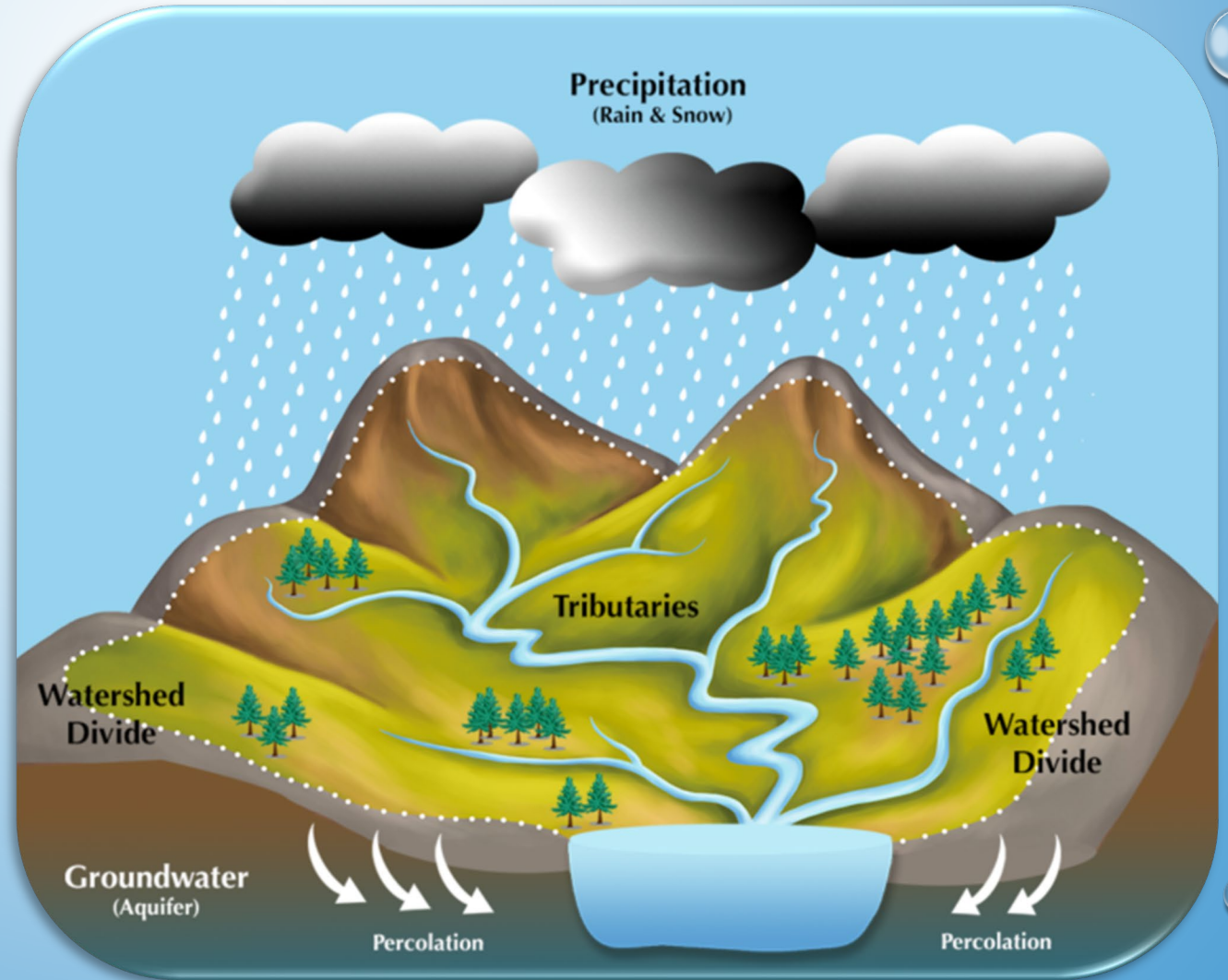


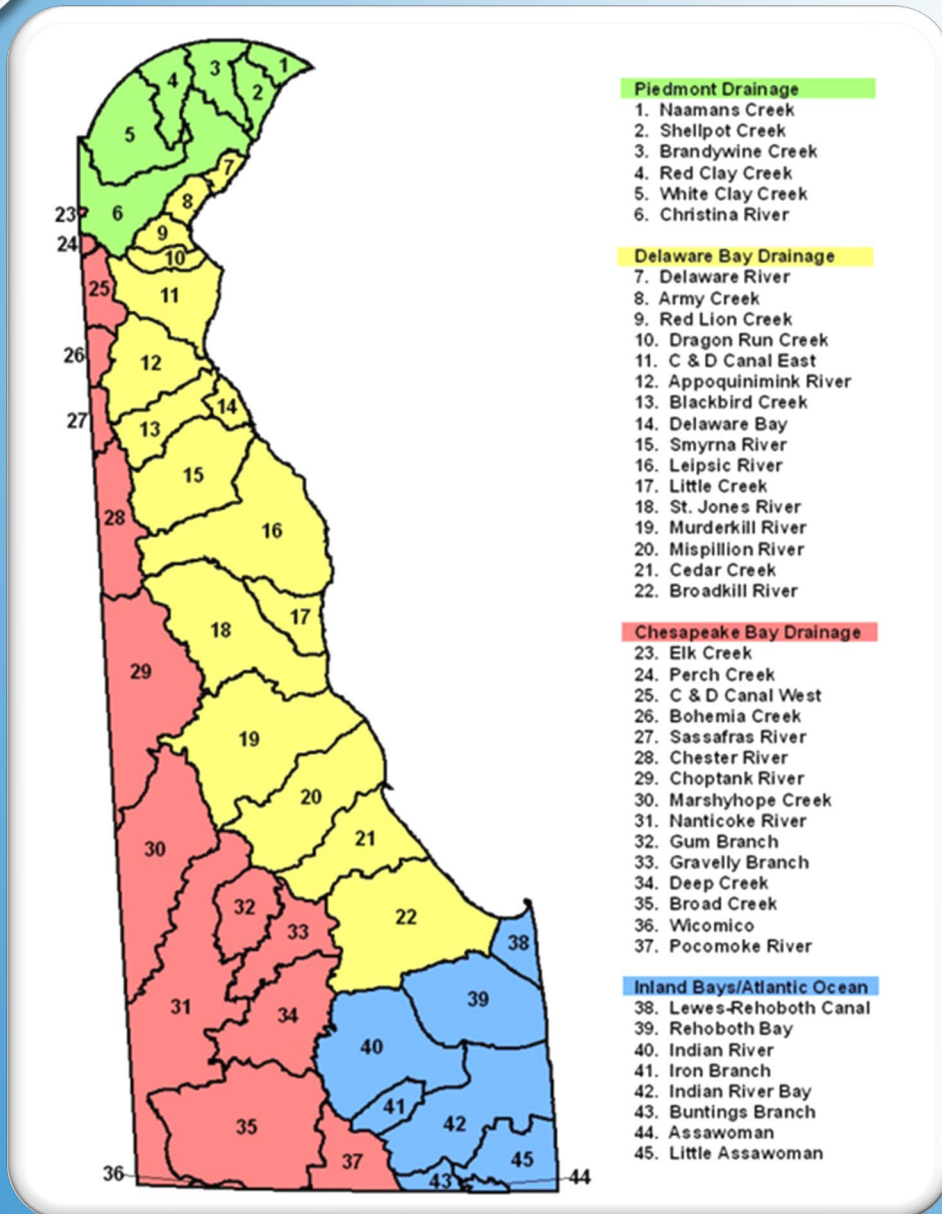
3 PHASES

- SOLID
 - ICE
- LIQUID
 - RAIN
- GAS
 - EVAPORATION

WATERSHED

AN AREA OF LAND THAT **ALL**
SURROUNDING WATER DRAINS INTO

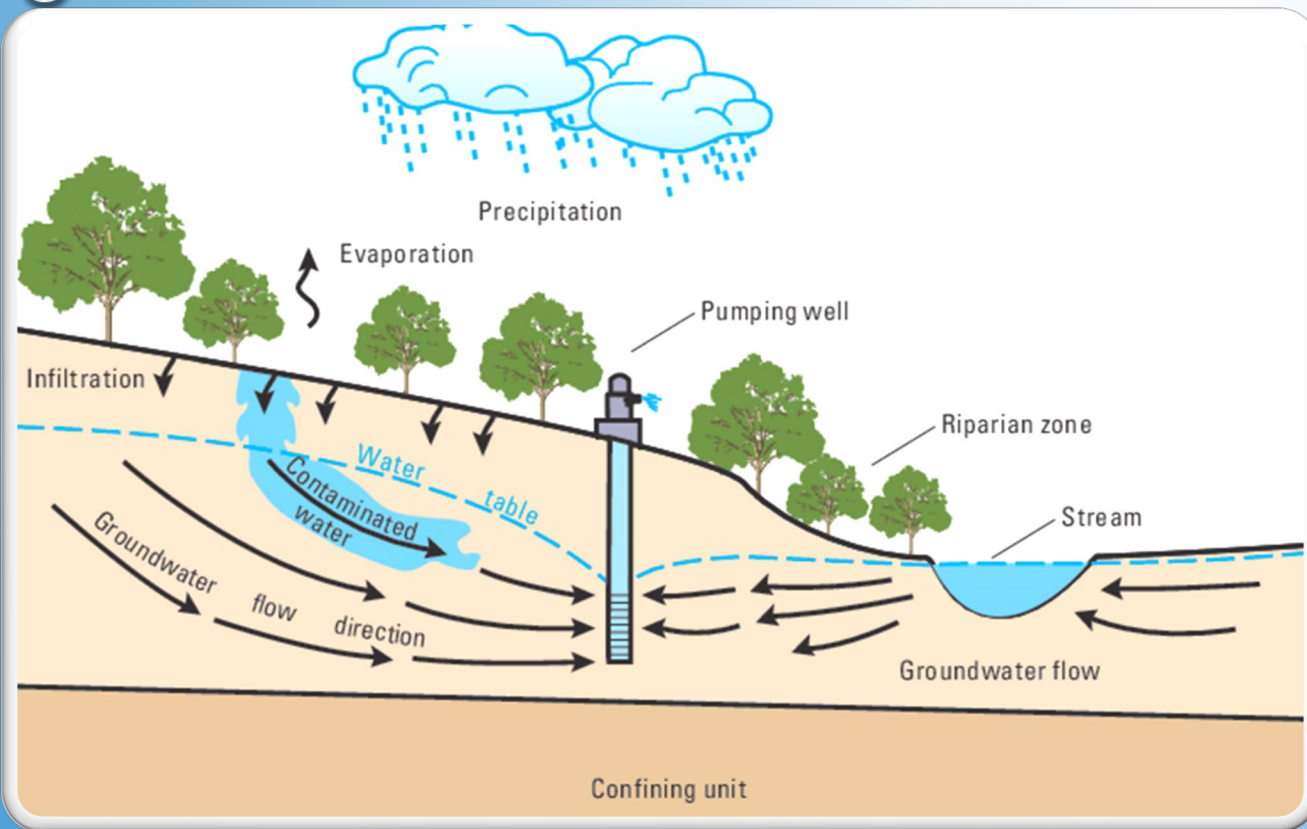




DELAWARE WATERSHEDS

- DELAWARE HAS 4 MAIN WATERSHEDS
 - PIEDMONT
 - DELAWARE BAY
 - CHESAPEAKE BAY
 - INLAND BAYS / ATLANTIC OCEAN
- BLACKBIRD STATE FORREST IS IN THE DELAWARE BAY WATERSHED
 - IT IS IN THE BLACKBIRD SUB WATERSHED
 - BLACKBIRD CREEK (#13)

[Learn more about Delaware Watersheds](#)



GROUNDWATER MOVEMENT

GROUNDWATER MOVES FROM AREAS OF HIGH PRESSURE TO LOW PRESSURE

GROUNDWATER CAN FLOW INTO...

- ✓ OCEANS
- ✓ RIVERS (GAINING STREAMS)
- ✓ WETLANDS
- ✓ LAKES

AQUIFERS

WHAT IS IT?

AN AQUIFER IS A LAYER OF ROCK AND/OR SEDIMENT THAT CREATES A CHAMBER

THIS CHAMBER IS WHERE GROUNDWATER IS FOUND

PRECIPITATION "RECHARGES" THE AQUIFER WHEN WATER HAS BEEN PUMPED OUT

NOT ALL AQUIFERS HAVE THE SAME RECHARGE RATE

2 TYPES:

CONFINED

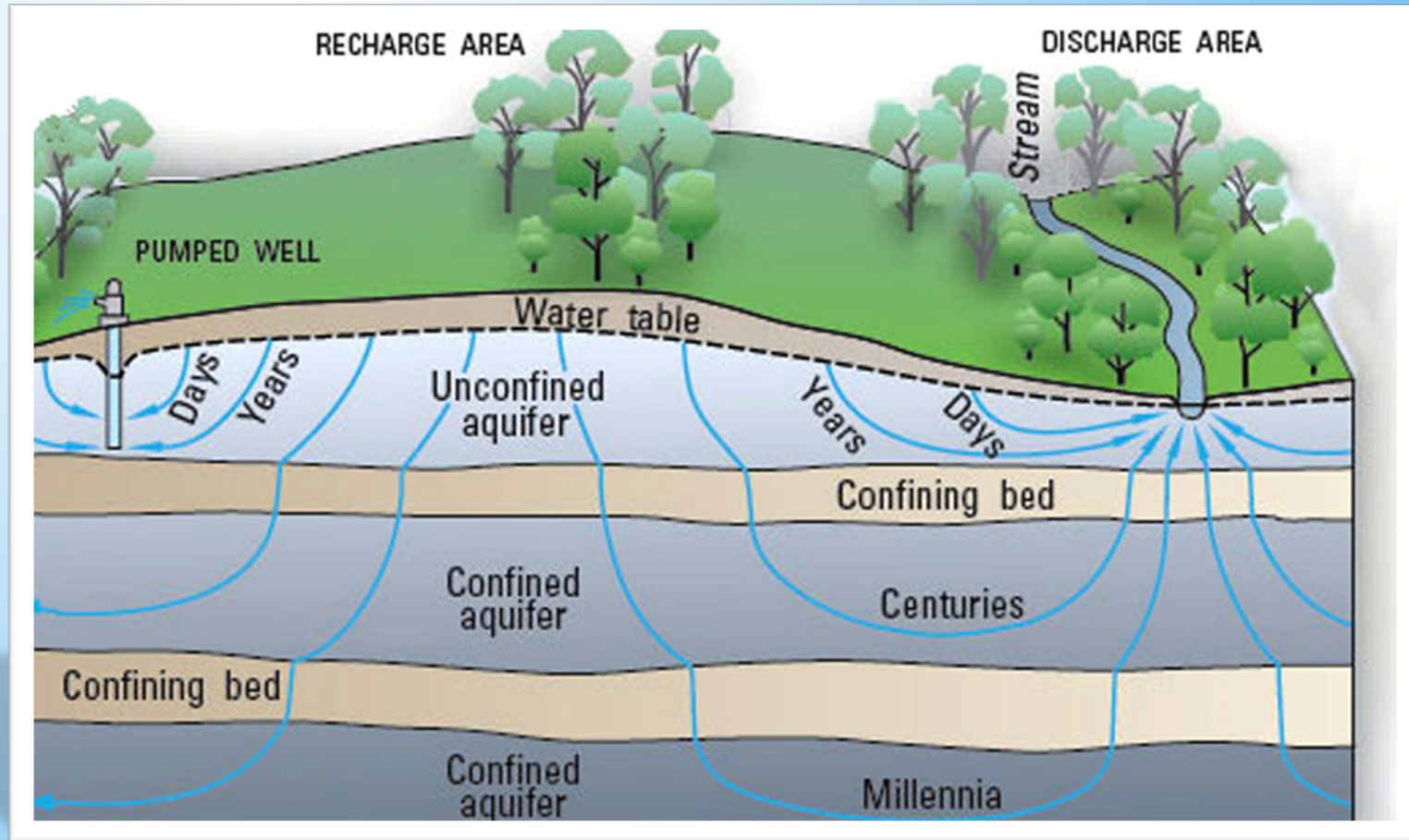
THE LAYER IS MADE OF ROCK OR CLAY

IS IMPENETRABLE

UNCONFINED

THE LAYER IS MADE OF SEDIMENT

IS PENETRABLE



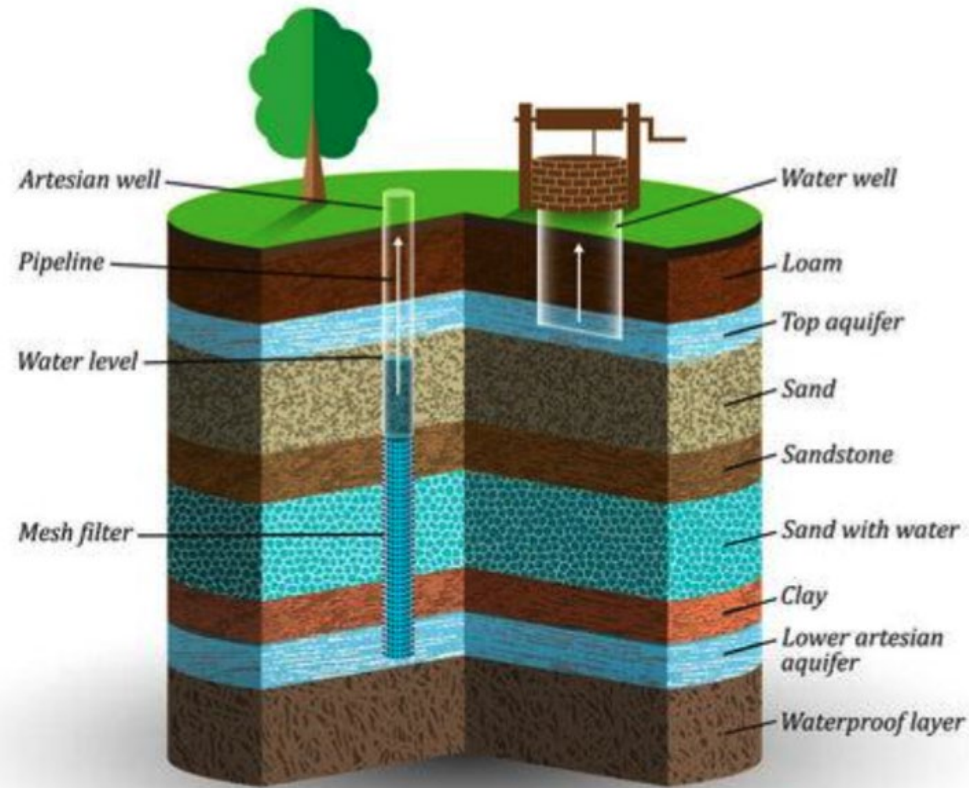
<https://education.nationalgeographic.org/resource/aquifers/>

WELLS

ARTESIAN WELL

- AQUIFER IS PRESSURIZED
- NO PUMP IS NEEDED

Artesian well in cross section



What are they?

These are used to access groundwater in aquifers

WATER WELL

- AQUIFER IS NOT PRESSURIZED
- A PUMP OR BUCKET IS NEEDED



HOW ARE WELLS MADE?



- 3 METHODS...

- DUG
- DRILLED
- DRIVEN

- DUG WELLS

- MADE BY HAND
- CAN ONLY BE DONE IF GROUND IS SOFT
- USES A SHOVEL AND/OR A PICKAXE

- DRILLED WELLS

- HOW MOST MODERN WELLS ARE MADE

- USES A DRILL RIG
- CAN BE USED ON SOFT OR ROCKY SOIL TYPES
- CAN DRILL A WELL MORE THAN 1000 FT BELOW THE SURFACE

- DRIVEN WELLS

- A SKINNY PIPE WITH A SCREEN ON THE END FOR FILTRATION IS DRIVEN INTO THE GROUND
- CAN BE USED IN SOFT GROUND INCLUDING SAND AND GRAVEL
- CLOSER TO THE SURFACE
- RUNS THE RISK OF CONTAMINATION

HOW DOES A WELL BECOME CONTAMINATED?

- WHEN A WELL IS CLOSE TO THE SURFACE IT RUNS THE RISK OF SURFACE POLLUTANTS AND CONTAMINATED RUNOFF INFILTRATING



POLLUTION

THE RELEASE OR DISCHARGE OF A SUBSTANCE INTO THE ENVIRONMENT (US EPA)

TYPES OF POLLUTION

POINT SOURCE

You can "point"
with one finger



NON-POINT SOURCE

You would need
multiple hands to
point at it



WHAT TYPE OF POLLUTION IS THIS?

(POINT OR NON-POINT)

Point source pollution!

You can point to the source
of pollution.
(a construction site)





HOW DOES LAND USE IMPACT POLLUTION & WATER QUALITY?

Consider
development,
agriculture, roads,
etc.

LAND USE AND WATER QUALITY IN BLACKBIRD CREEK RESERVE

#1 LAND USE IS AGRICULTURE

DATA IS FROM 2006

**NOTE: THE LAND USE "OTHER" INCLUDES INLAND NATURAL SANDY AREAS AND TRANSITIONAL CONSTRUCTION

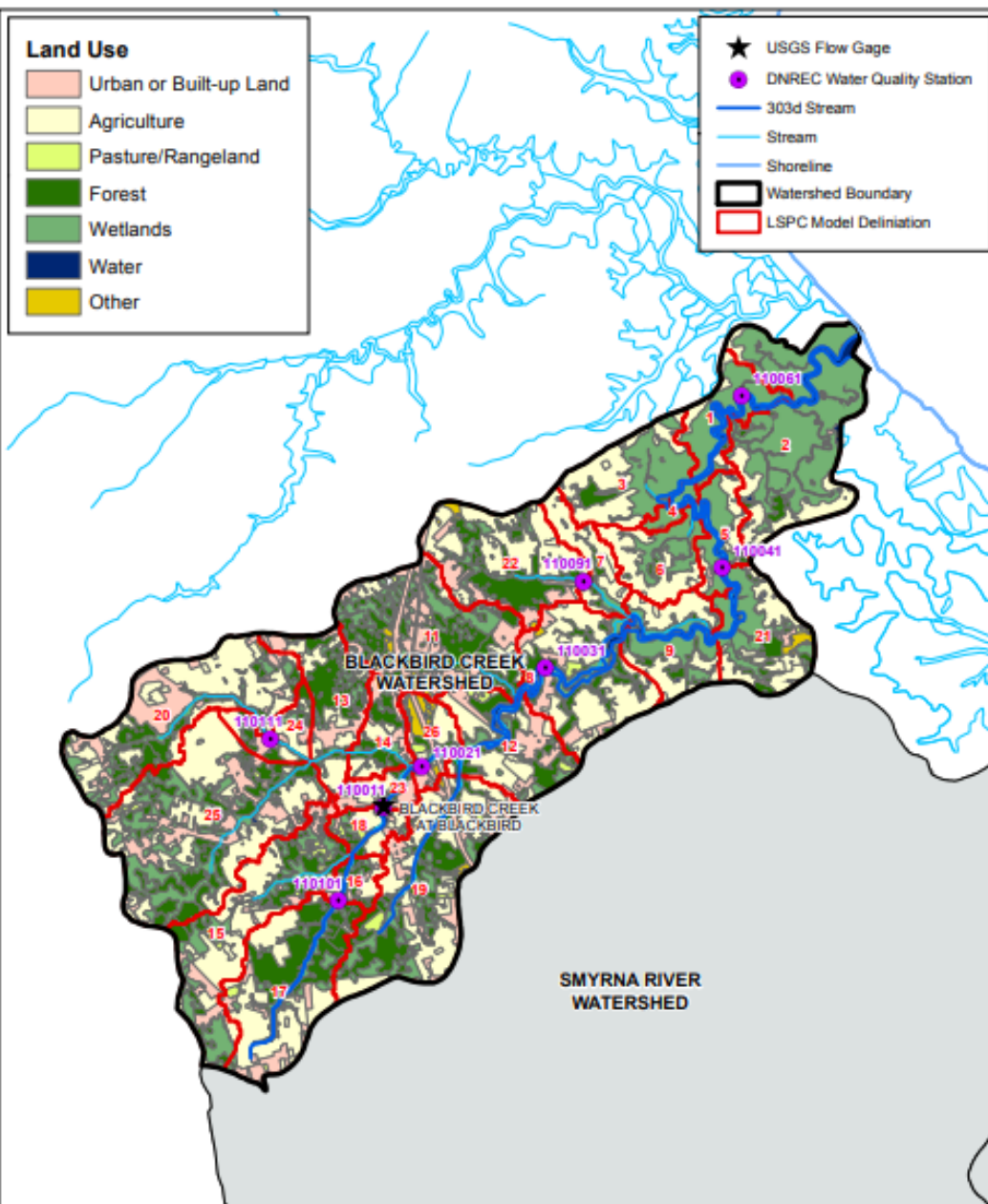


Table 2. Summary of Land Use in the Blackbird Creek Watershed

Land Use	Area (ha)	% Total Area
Agriculture	2,896	36.1
Forest	1,613	20.1
Pasture/Rangeland	79	1.0
Urban/Built-up Land	1,060	13.2
Water	216	2.7
Wetland	2,123	26.5
Others	35	0.4
Total	8,022	100.0

WHY THIS IMPACTS WATER QUALITY

- IN AGRICULTURE...
 - RUNOFF FROM FARMS CAN CONTAIN HIGH AMOUNTS OF NUTRIENTS (N AND P) FROM FERTILIZERS OR MANURES
 - HIGH AMOUNTS OF NUTRIENTS IN THE WATER CAN CAUSE ALGAL BLOOMS WHICH ALSO WILL LOWER THE DISSOLVED OXYGEN (DO) LEVELS IN THE WATER.
- IN THE BLACKBIRD CREEK WATERSHED, THERE ARE NO EXISTING POINT SOURCES (PS) (DNREC, 2006).

TMDLs IN THE BLACKBIRD WATERSHED

WHAT ARE TMDLS?

- TMDLs= TOTAL POLLUTANT LOAD THAT A WATERBODY CAN RECEIVE WITHOUT VIOLATING WATER QUALITY STANDARDS
- SECTION 303(d) OF THE CLEAN WATER ACT REQUIRE STATES TO DEVELOP TMDLs FOR IMPAIRED WATERBODIES.

WHICH TMDLS?

BLACKBIRD CREEK HAS TMDLS FOR...

- NON-POINT SOURCE (NPS) NUTRIENTS INCLUDING NITROGEN AND PHOSPHORUS (N AND P)
- BACTERIA (*ENTEROCOCCUS*)
- DISSOLVED OXYGEN (DO)

WHY ARE THESE BAD?

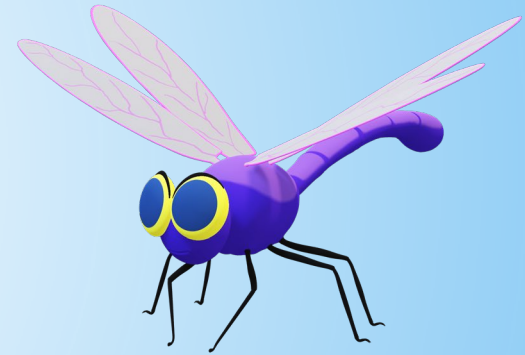
- NUTRIENTS CAN CAUSE ALGAL BLOOMS WHICH CAN LEAD TO LOW DO LEVELS
- BACTERIA CAN CAUSE ILLNESS AND INFECTION
- LOW DO CAN MAKE THE WATER LESS HABITABLE... BECAUSE EVERYTHING NEEDS OXYGEN!

HOW TO DETERMINE IF A STREAM/RIVER IS POLLUTED

- CHEMISTRY
 - pH
 - DISSOLVED OXYGEN (DO)
- MACROINVERTEBRATES
 - CAN INDICATE POOR OR EXCELLENT WATER QUALITY
- BACTERIA
- PHYSICAL FACTORS
 - TURBIDITY



MACROINVERTEBRATES



- “MACROINVERTEBRATES ARE SMALL ORGANISMS WITHOUT A BACKBONE THAT ARE VISIBLE TO THE NAKED EYE AND LARGE ENOUGH TO BE EASILY COLLECTED.” – EPA
- INSECT LARVAE ARE THE MOST COMMON MACROINVERTEBRATES IN AQUATIC SYSTEMS
- THEY INDICATE THE HEALTH OF A WATERWAY
- THERE ARE SOME THAT ARE MORE POLLUTION TOLERANT WHILE OTHERS ARE POLLUTION SENSITIVE





Leech



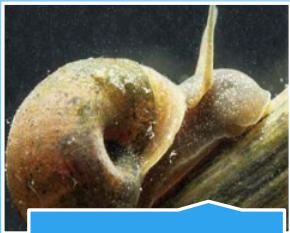
Planarian



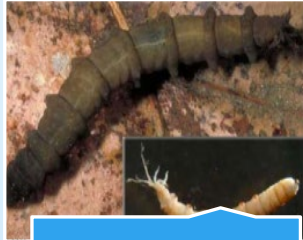
Aquatic Worms



Blood Midge Larvae



Orb Snail



Cranefly Larva



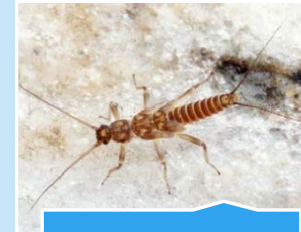
Scuds



Damselfly Larva



Dragonfly Nymph



Stoneflies Larvae



Caddisflies Larvae



Mayflies Larvae



Pollution Tolerant

Pollution Intermediate

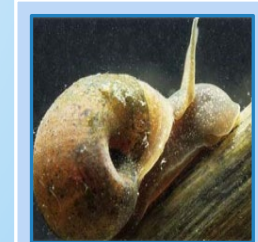
Pollution Sensitive

WHICH STREAM IS HEALTHIER?

STREAM A



STREAM B



BNMP

BEST MANAGEMENT PRACTICES

Best Management Practices (BMPs)

Public Education

- Education about proper residential car washing

Public Involvement

- Stream cleanup and monitoring

Illicit Discharge Detection and Elimination

- An ordinance prohibiting illicit discharges
- A plan to address illicit discharges

Construction

- Filter Socks

Post-Construction

- Grass swales
- Programs to ensure long-term maintenance of BMPs

Pollution Prevention / Good Housekeeping

- Spill response and prevention plan



[See more examples of the 6 types of BMPs](#)

WHAT TYPE OF BMP IS IT?

1

Illicit Discharge Detection and Elimination

- To prevent illegal dumping, a town starts a recycling program for batteries, electronics, and oil.

2

Post-Construction

- To allow for easier access for future maintenance, a construction company dictates a 20ft easement around grass swales.

3

Public Involvement

- The Conservation District partners with the City to host a planting event in the local wetland.



An Infiltration Basin is a Post-Construction BMP



Let's Go Outside!

Rain Gardens are used for flood management, reduce runoff, reduce erosion, and pollutant filtration.

They are filled with native plants and can provide habitat for the native life!