Our Eastern Shore Groundwater
Part IV
Groundwater Quality on the Eastern Shore:
How safe is our groundwater and are there ways we can protect it?

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Virginia's Eastern Shore

INDEPENDENT ENVIRONMENTAL ENGINEERS, SCIENTISTS AND CONSULTANTS

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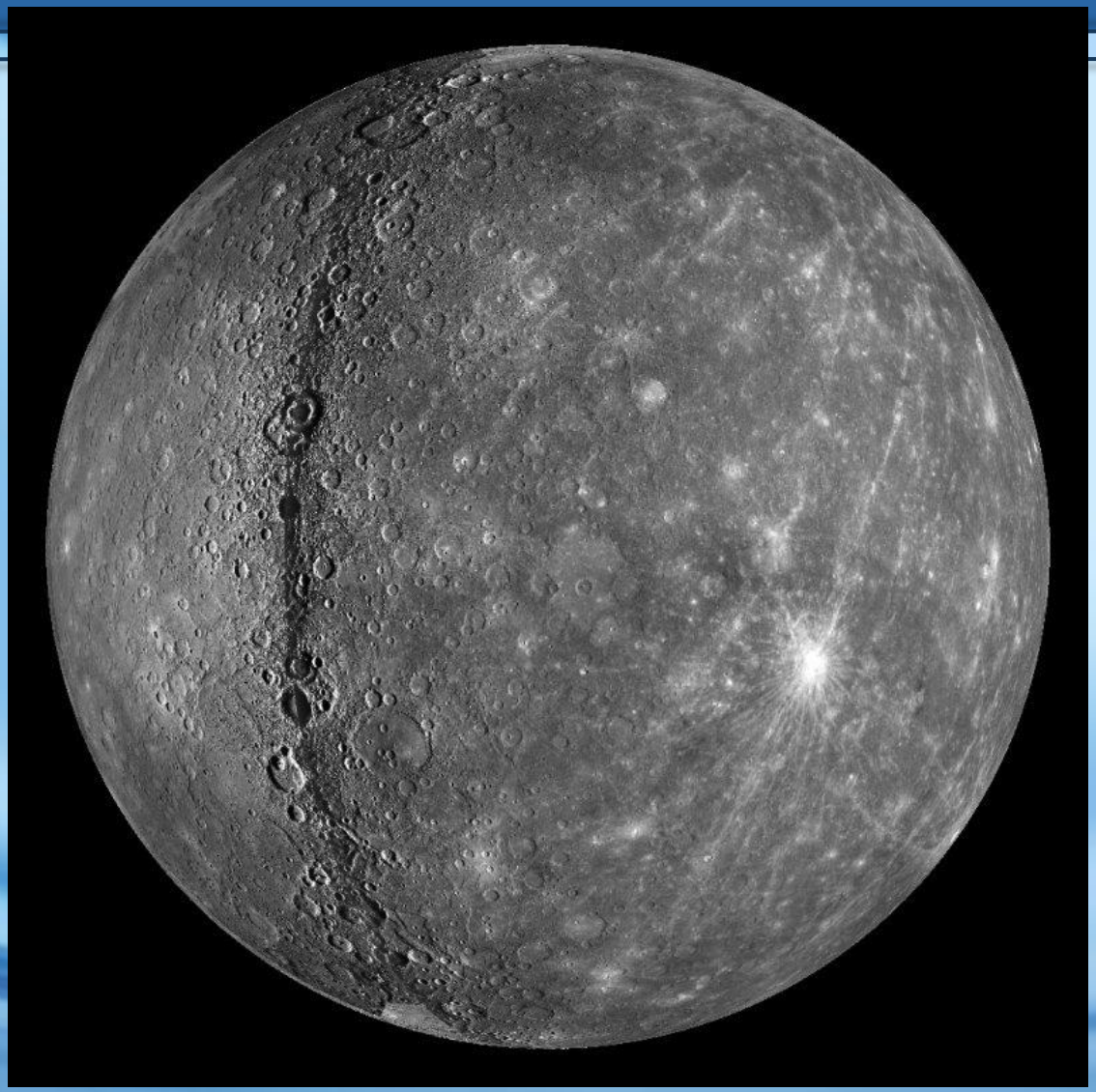
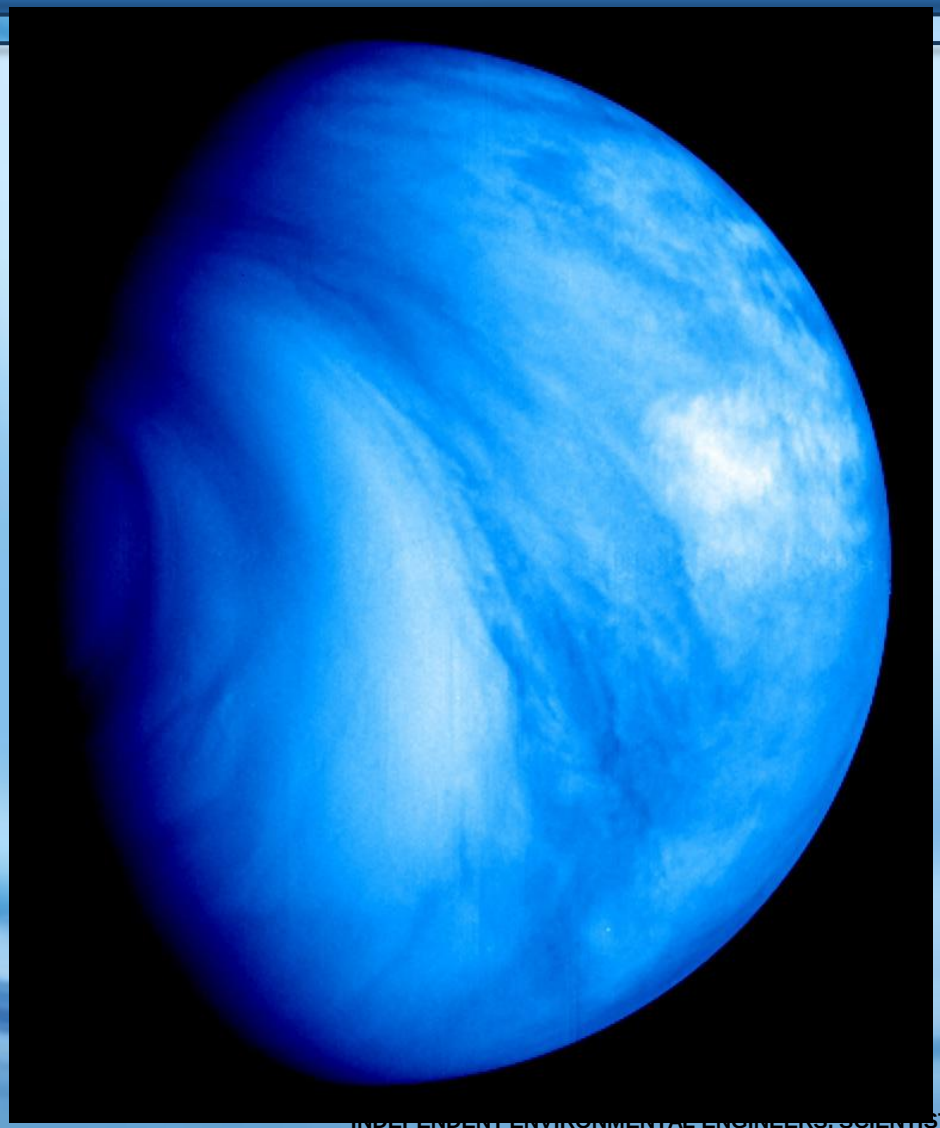
The Solar System's
Habitable Zone
Mars
Earth
Venus

Mercury



Venus



Mars

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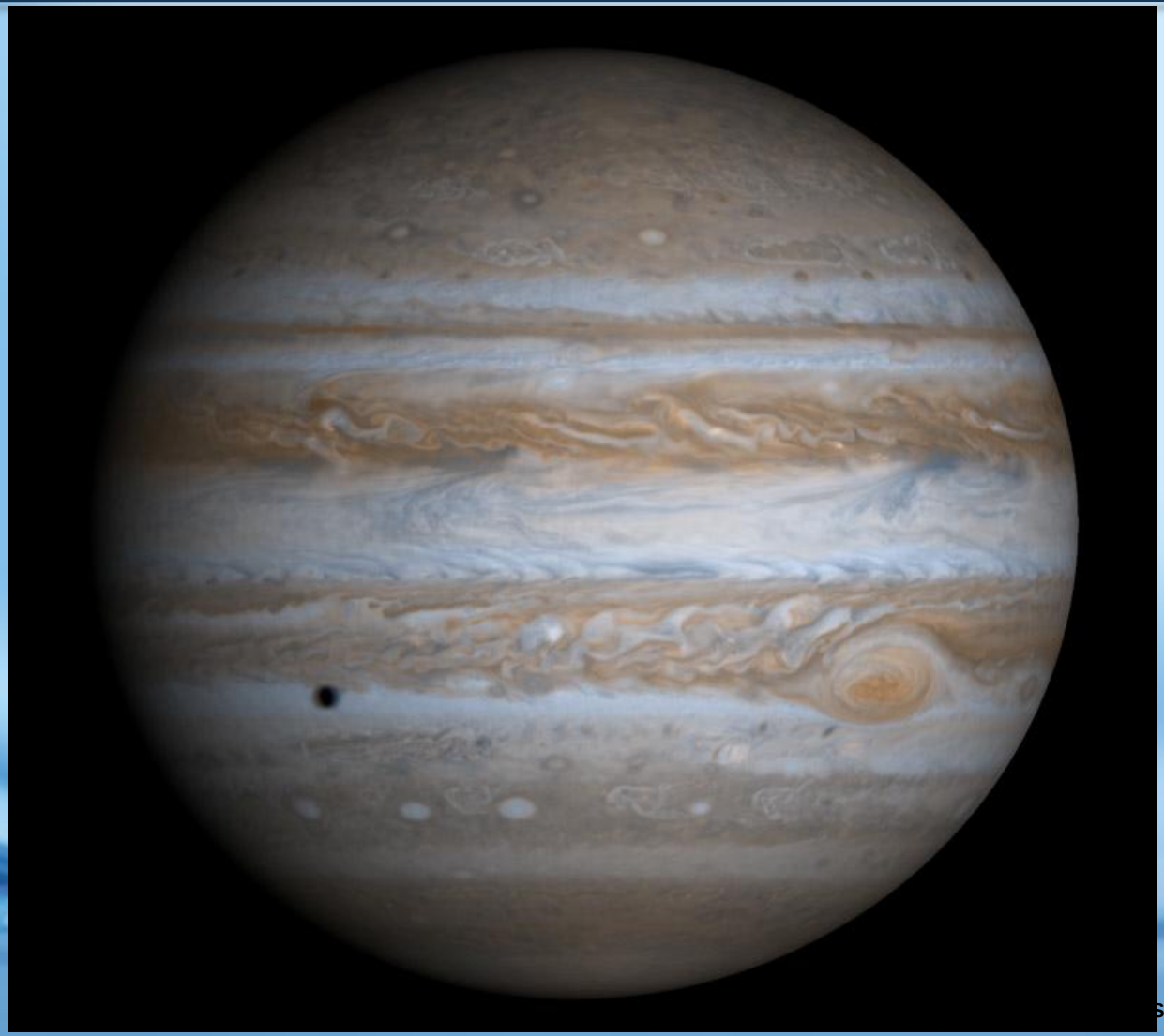
Jupiter



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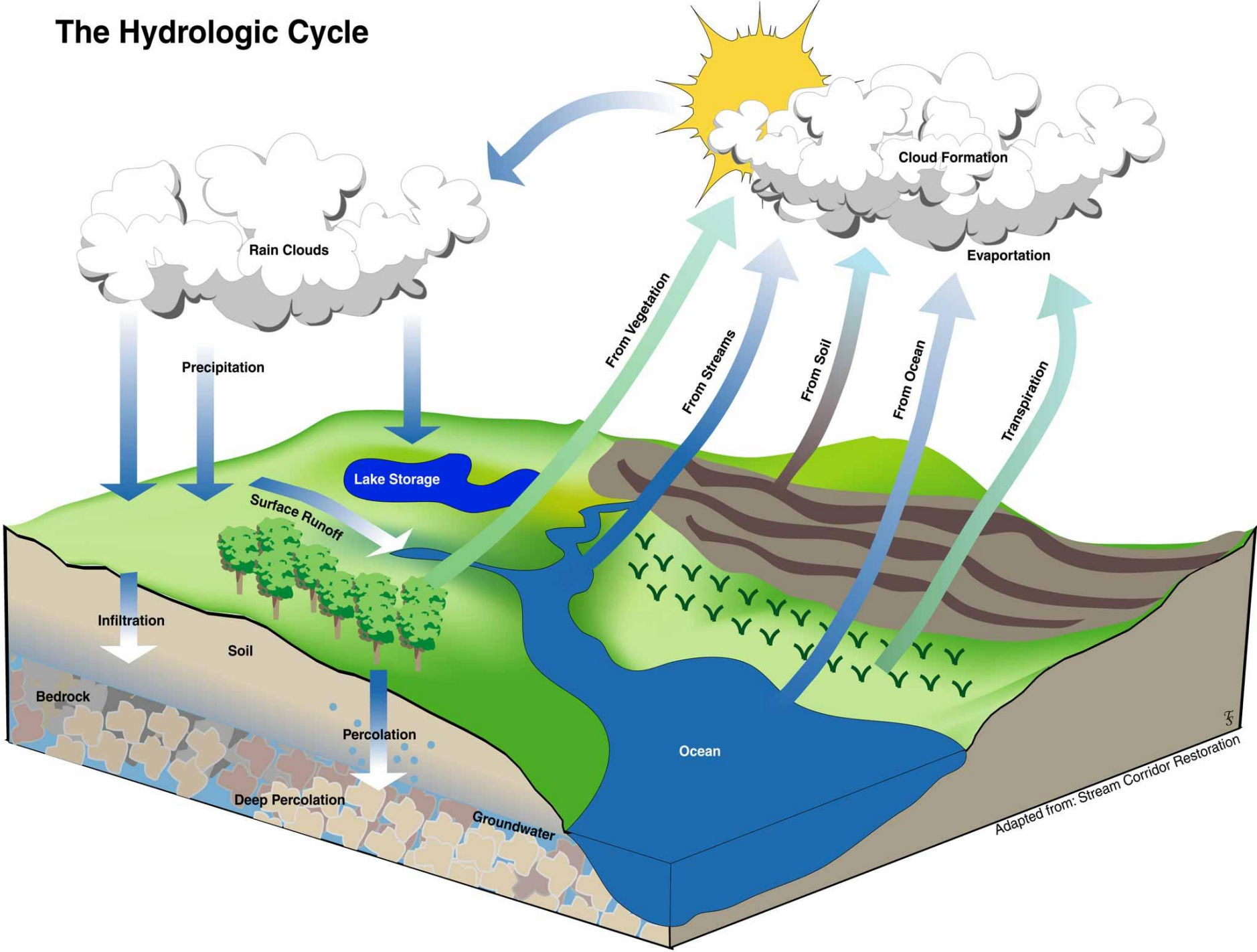
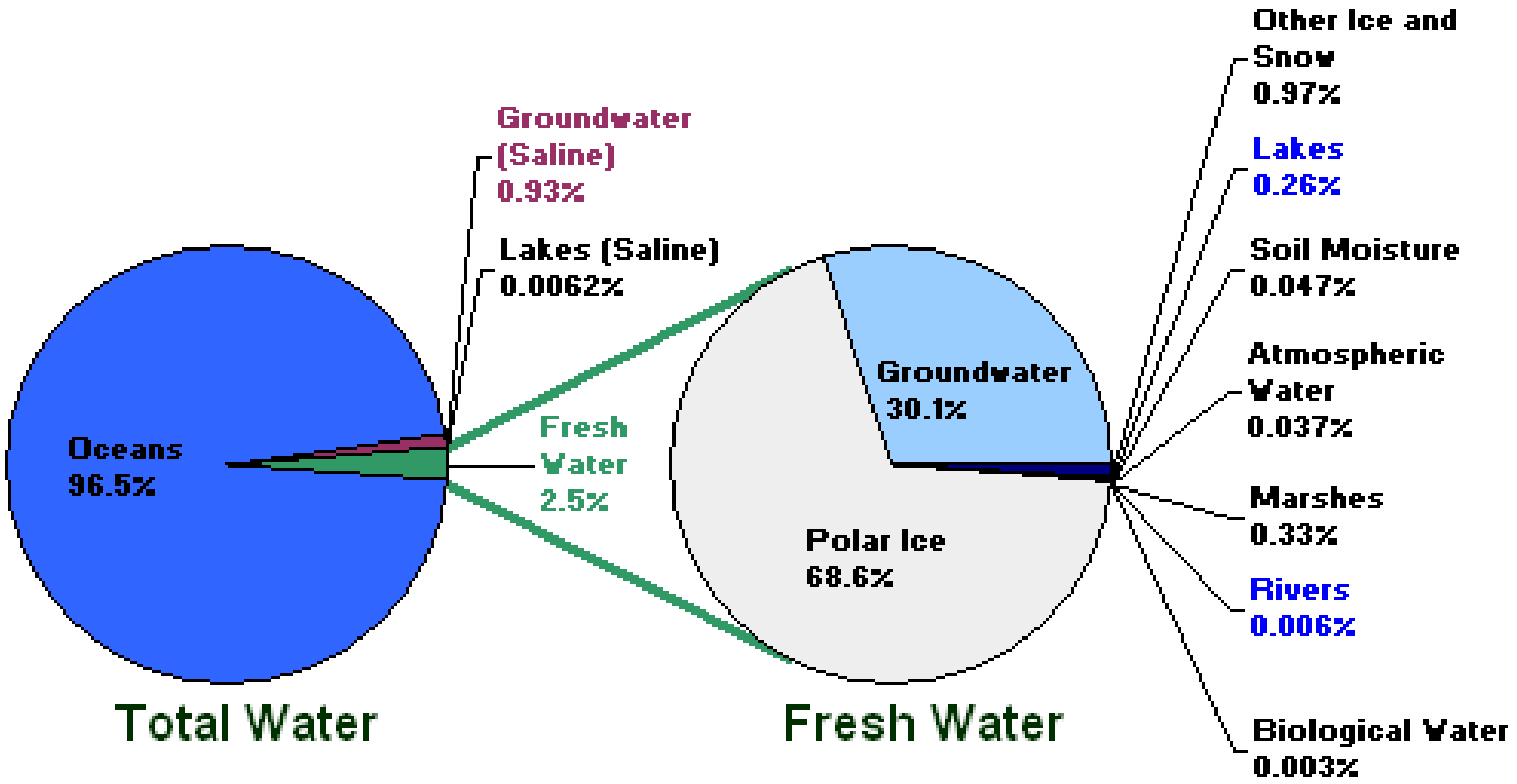
The Hydrologic Cycle

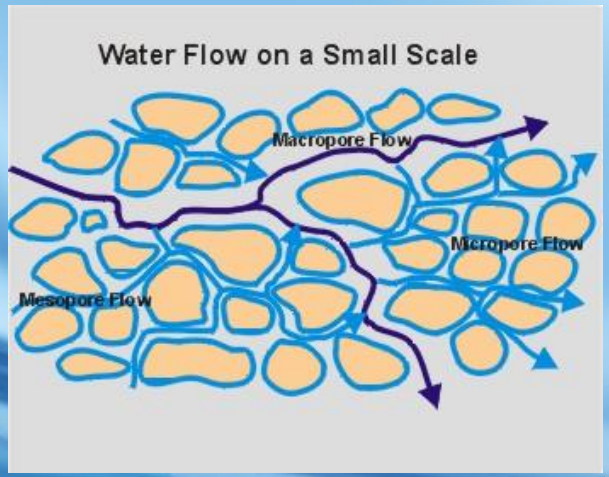


Distribution of Global Water



Groundwater is Not like an Underground River!

- **Groundwater flows through porous soils and sediment that includes gravels, sands, silts, and clay.**



Soil/Sediment Type Determines if it can be used as a source of water

An Aquifer is a Source for Groundwater and is:

Any coarse grained material (sand, gravel) that can supply sufficient water for a beneficial use

A Confining Unit Impedes Movement of Groundwater and is:

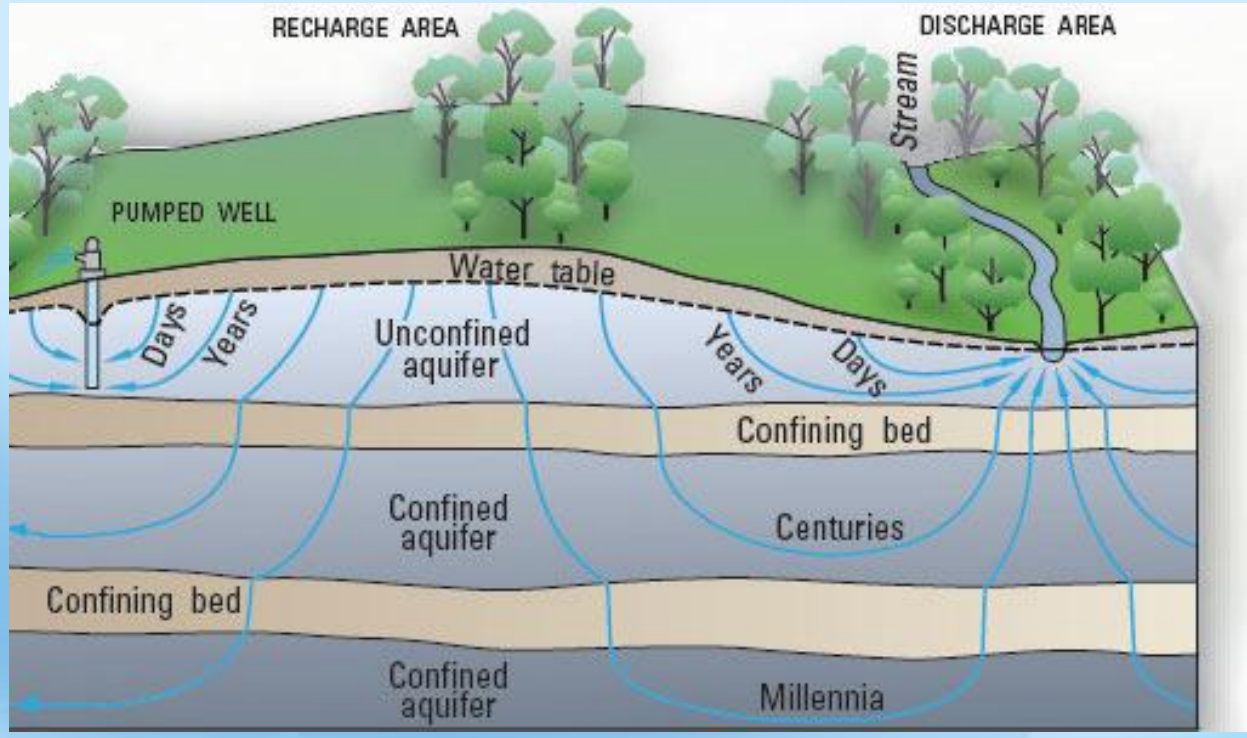
Any fine grained material (silt, clay) that can significantly restrict vertical movement of groundwater such that the resulting groundwater is under pressure.

Aquifers are defined by where they appear relative to a confining layer

- **Water Table**
  - Replenished (recharged) directly by precipitation
  - More vulnerable to contamination from surface activities
- **Confined aquifer**
  - Confined and separated from the surface by overlying layer(s) of silt and clay
  - Replenished from vertical flow through the confining unit (recharge is much lower than a water table aquifer)
  - More vulnerable to saltwater intrusion

Movement through the Groundwater System

- **Horizontal flow typically toward a surface water body. Gradient is often low and the actual flow rate is low**
- **Vertical flow typically downward and very low**



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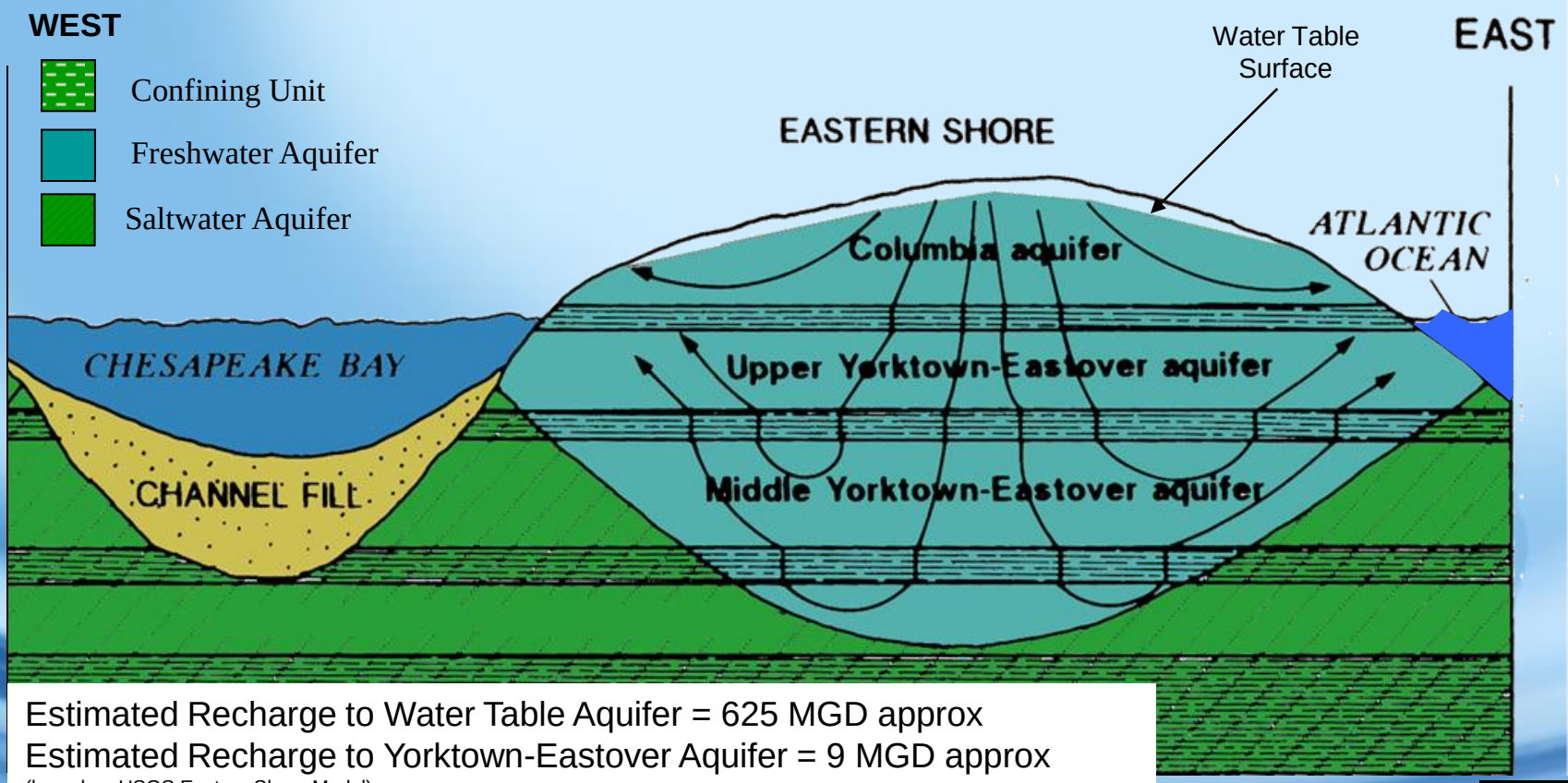
Water Table and Fresh Water Confined Aquifers on the Eastern Shore

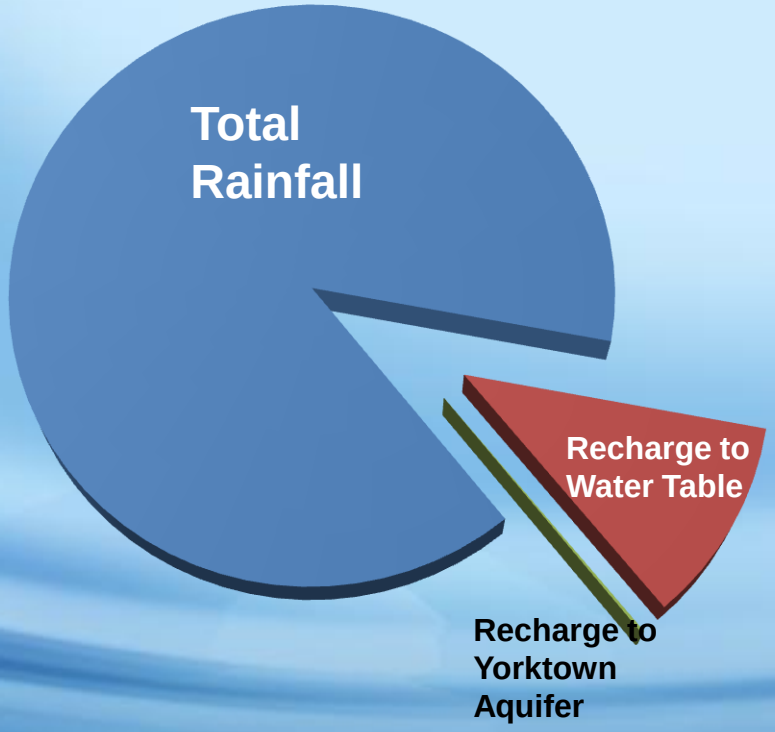
Fresh ground water is restricted to depths less than 350 feet

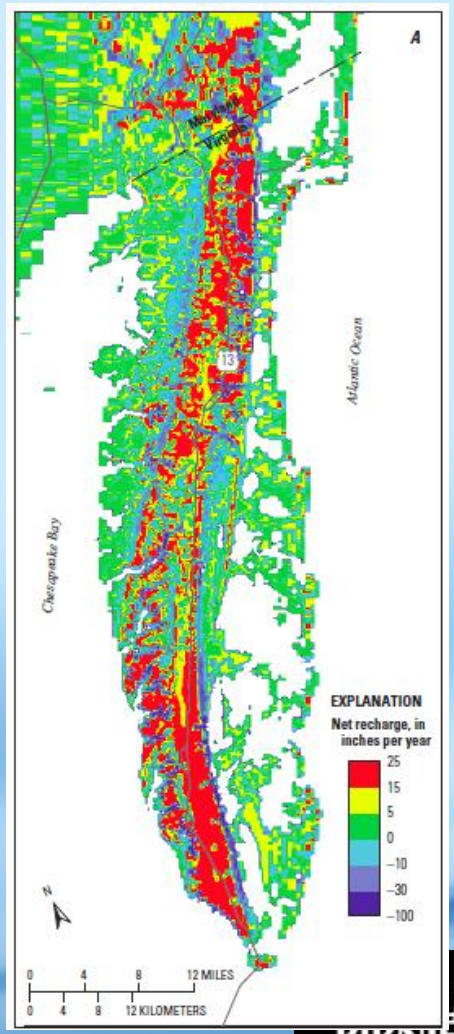


Estimated Recharge to Water Table Aquifer = 625 MGD approx
Estimated Recharge to Yorktown-Eastover Aquifer = 9 MGD approx
(based on USGS Eastern Shore Model)

How Much Water Recharges the Aquifers?

- All fresh water comes from precipitation falling directly on the Shore
- About 88% of the precipitation never infiltrates to the groundwater
- And less than 0.5% make it to the confined aquifer





Potential Threats To Water Table Water Quality

Sources:

Agriculture / Livestock

- **Nutrients (Fertilizers)**
- **Pesticides / Herbicides**
- **On-site waste disposal**

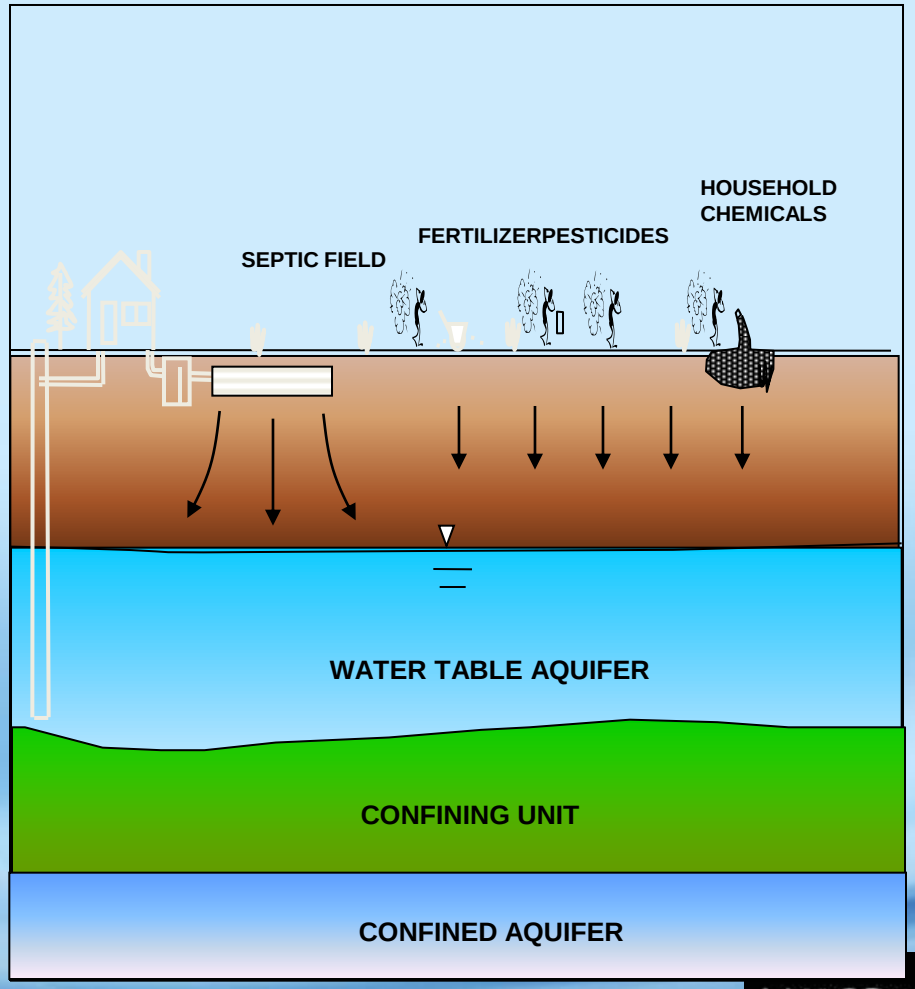
Waste Units

- ***Septic Systems / Drain Fields***
- **Public Sewers**
- **Underground Storage Tanks (USTs)**

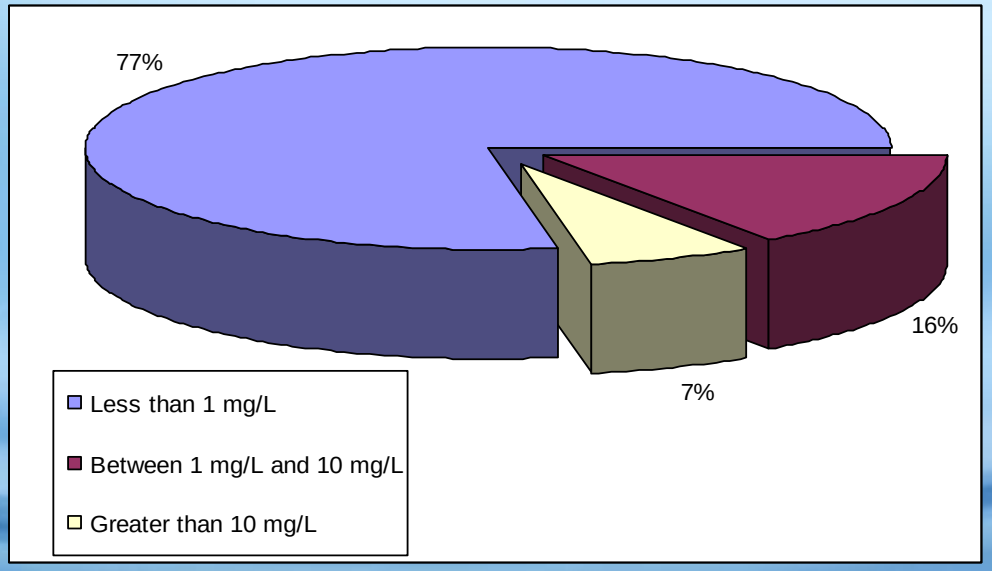
Residential

- ***Nutrients / Pesticides - Herbicides***
- ***Petroleum and solvents***

Function of amount (loading) and area of application

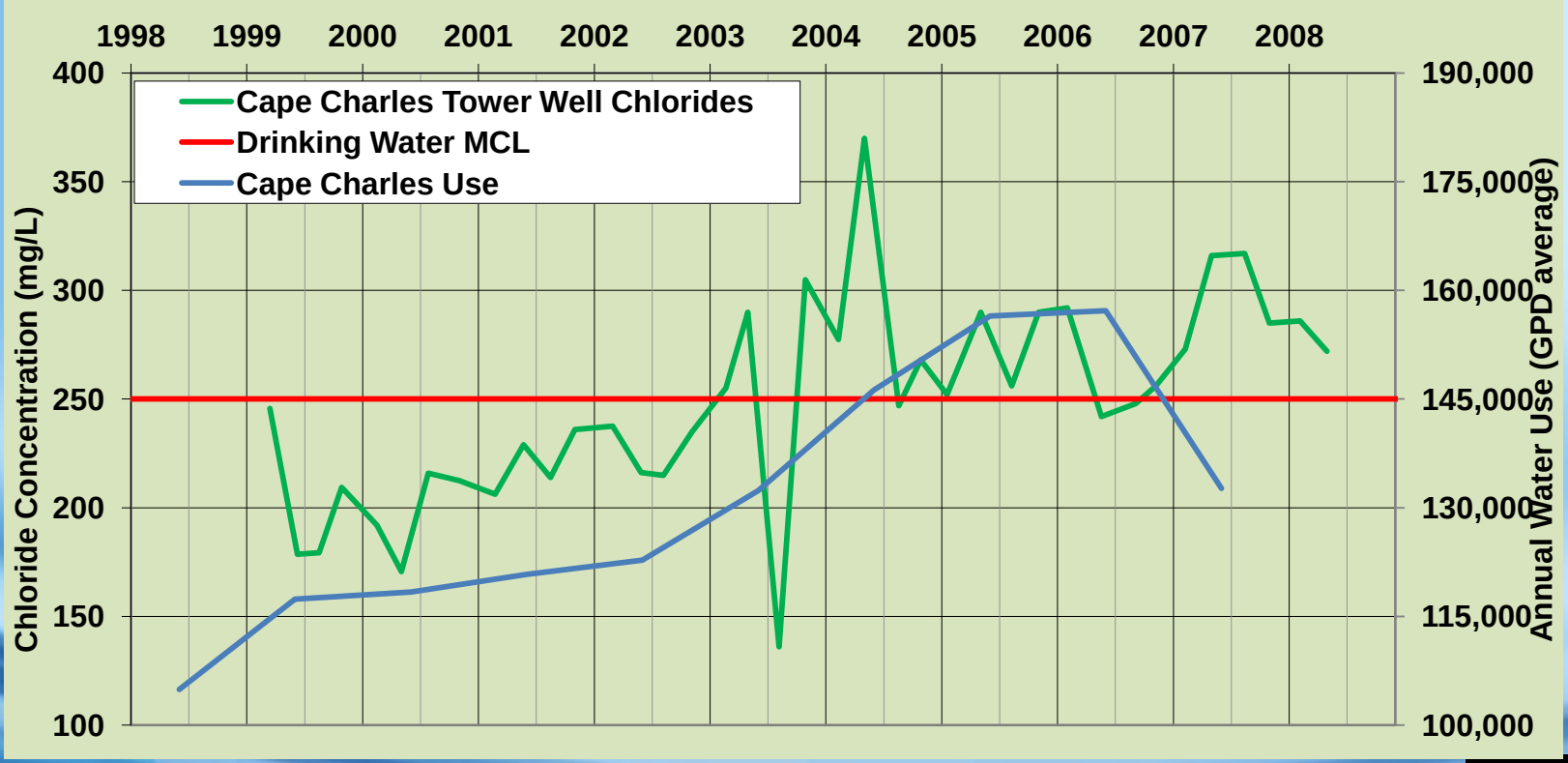


- **Shallow wells tended to have higher levels of turbidity, nitrates, coliform bacteria, iron and surfactants.**



Greatest Threat to the Confined Yorktown aquifer is Saltwater Intrusion

Saltwater intrusion is caused by over pumping. To date, the effects of saltwater intrusion on the Shore is limited to very small areas



What is being done to Protect and Preserve the Resource?

- New Technologies
  - Low Impact Development
  - Membrane Treatment
  - Advanced On-Site Systems
- Regulations
  - EPA Sole Source Aquifer
  - DEQ Groundwater Management Areas
  - DEQ Water Reuse / DEQ Water Supply Planning
  - Health Department On-Site Systems
  - DCR Storm Water Management
  - DCR Nutrient Management
- Programs
  - Groundwater Committee Programs
  - Agricultural EQUIP Program
  - Agricultural Cooperative Extension

Low Impact Development (LID) Methods

- **Storm water management methods that:**
  - **Retain more storm water on the land**
  - **Reduces peak storm flow to surface water**
- **Benefits:**
  - **Increased recharge to groundwater compared to conventional storm water methods**
  - **Can reduce erosion**
  - **Can improve water quality**
- **Negatives:**
  - **May be more expensive to construct**
  - **Require more Operation and Maintenance**

BMP FACT SHEET

Bioretention Filter

Aliases: Rain Gardens / Green Alleys

Description: planting areas in shallow basins designed to increase storm water infiltration to groundwater while providing treatment through filtering and biological

Purpose: pollution removal, groundwater recharge

Siting Considerations:

Drainage Area: < 1 acre
Slope: flat at bottom of basin
Soil: may not be feasible in low permeability soils

Potential Pollutant Removal Rate:

Total Suspended Solids:	80 %
Total Phosphorus:	50 %
Total Nitrogen:	50 %
Metals:	50-70 %
VDEQ Target Efficiency:	50-65 %

Footprint: Typically 2-3 % of drained area (linear)

Source: EPA, 2004. Section 5 of The Best Management Practices for Stormwater Phase II Manual.
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm

BMP FACT SHEET

On-Lot Treatment

Aliases: Roof-Runoff Treatment System, Dry Well, Cistern, Rain Barrel

Description: Used to infiltrate, divert, or detain runoff from individual residential lots. The most effective method is to detain roof-runoff.

Purpose: impervious area mitigation

A rain barrel is used to collect rooftop runoff using a gutter/downspout system

Siting Considerations:

Drainage Area:	single residential lots
Slope:	design specific
Soil:	design specific

Potential Pollutant Removal Rate:

Total Suspended Solids:	N/A	*see also: bioretention*
Total Phosphorus:	N/A	*grassed filter strip*
Total Nitrogen:	N/A	*grass swale*
Nitrate Nitrogen:	N/A	
Metals:	N/A	
Bacteria:	N/A	
VDEQ Target Efficiency:	N/A	

Footprint: (point BMP)

Cost: Total construction cost is approximately $50-200 per lot (typically paid for by homeowner)

Operation and maintenance costs are typically negligible

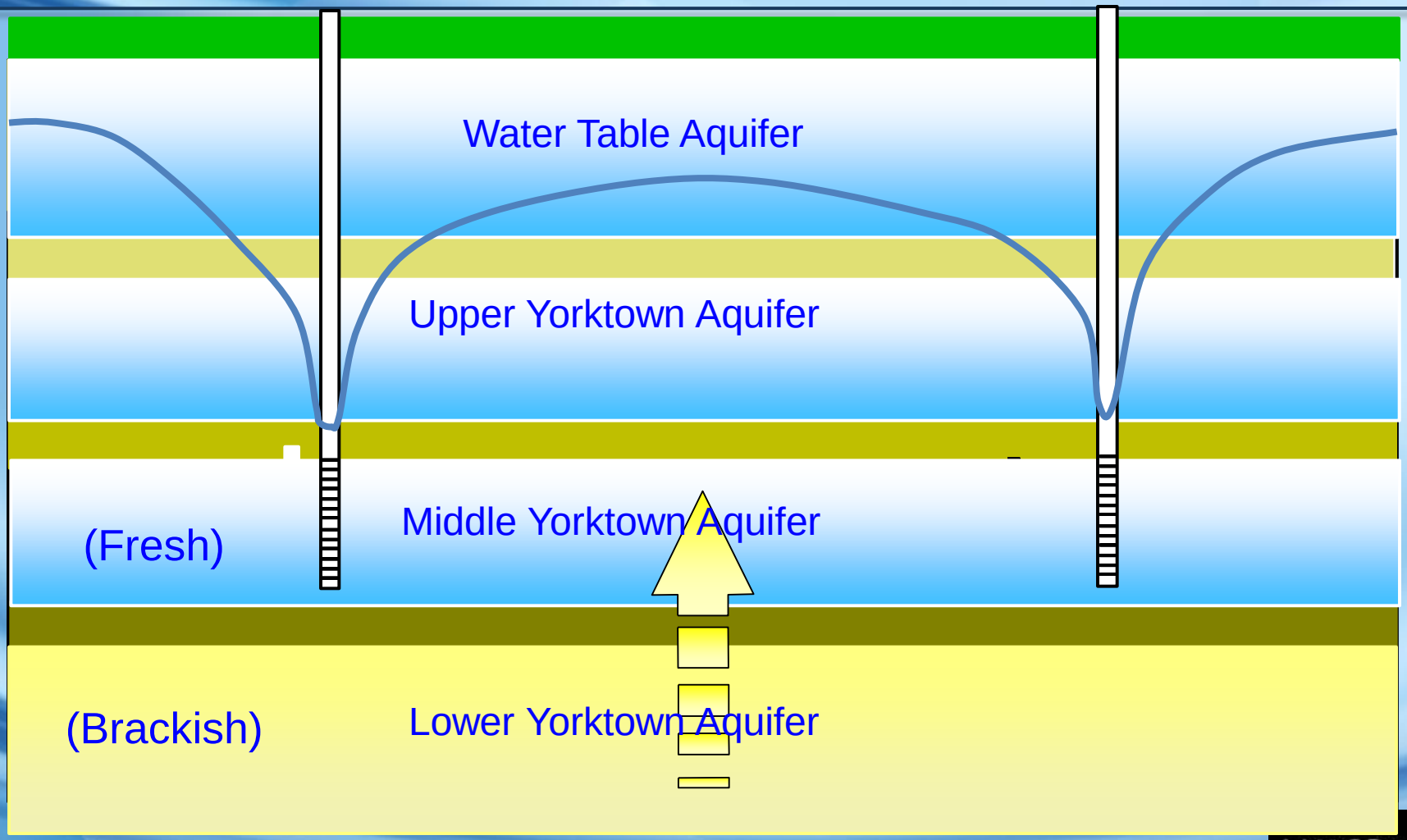
(see also bioretention, grassed filter strip, and/or grass swale)

Source: EPA, 2004. Section 5 of The Best Management Practices for Stormwater Phase II Manual.
http://cfpub.epa.gov/npdes/stormwater/menuofbmps/menu.cfm

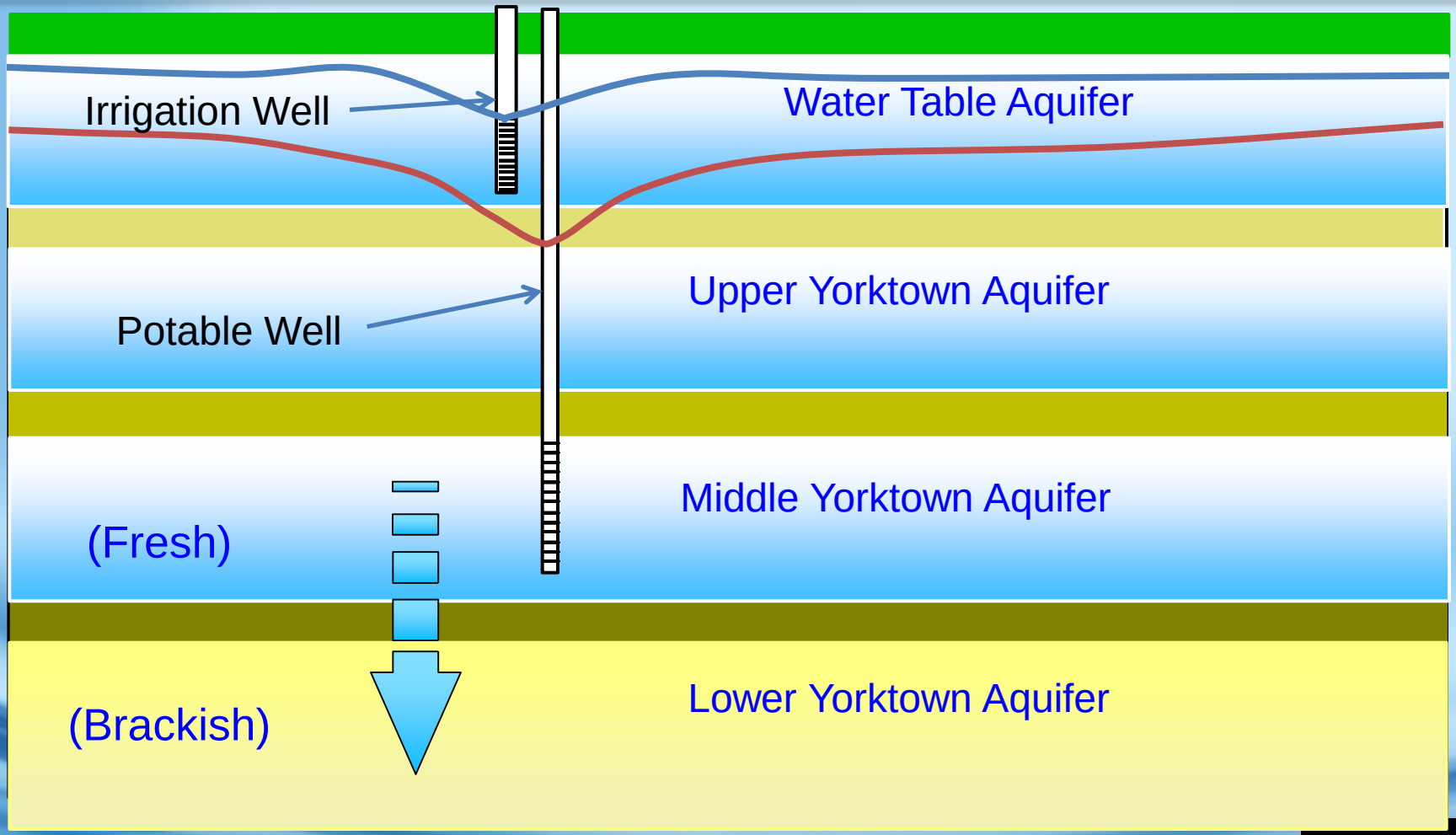
Water Table Irrigation Wells

- **Lawns and gardens that are irrigated often increase residential use over 2x**
- **Most residential wells use the confined Yorktown aquifer**
- **Benefit:**
  - **Using the unconfined water table aquifer for irrigation can greatly reduce potential for saltwater intrusion**
- **Negative:**
  - **Increased cost to construct shallow well and pump**

Withdrawing all water from the Confined Yorktown aquifer has resulted in Saltwater Intrusion



Using a Combination of Water Table and Yorktown Groundwater Reduces Saltwater Intrusion



Household Hazardous Waste Program

- **A-NPDC has managed a Household hazardous waste collection program since 2004**
- **On an annual basis several tons of hazardous waste has been collected and properly disposed**

A-NPDC staff and Care Environmental, Inc at the 2008 Household Hazardous Waste Collection

Low Flow / Ultra-Low Plumbing Fixtures

Includes low flow water fixtures (showerheads), toilets, clothes washers.

- **Benefits:**
  - Significantly decreases water use
- **Negatives:**
  - Currently more expensive to install
  - Some may not function as effectively as non-low flow fixtures

Xeriscape Landscaping

Use Native Species with low water requirements

- **Benefit:**
  - **Significantly reduces Irrigation demand**
  - **Native species more disease / pest resistant**
- **Negative:**
  - **May be more expensive to establish**

Chincoteague Nature Trail

Storm Water Reclamation and Reuse

There is a strong commitment by DEQ and DCR to promote reclamation and reuse of stormwater:

- **Storm water harvesting for landscape irrigation, fire protection systems, water closets and urinals, and other water handling systems.**
- **New DCR regulations effective October 2011 and implemented July 2014**

On-Site Systems

Includes:

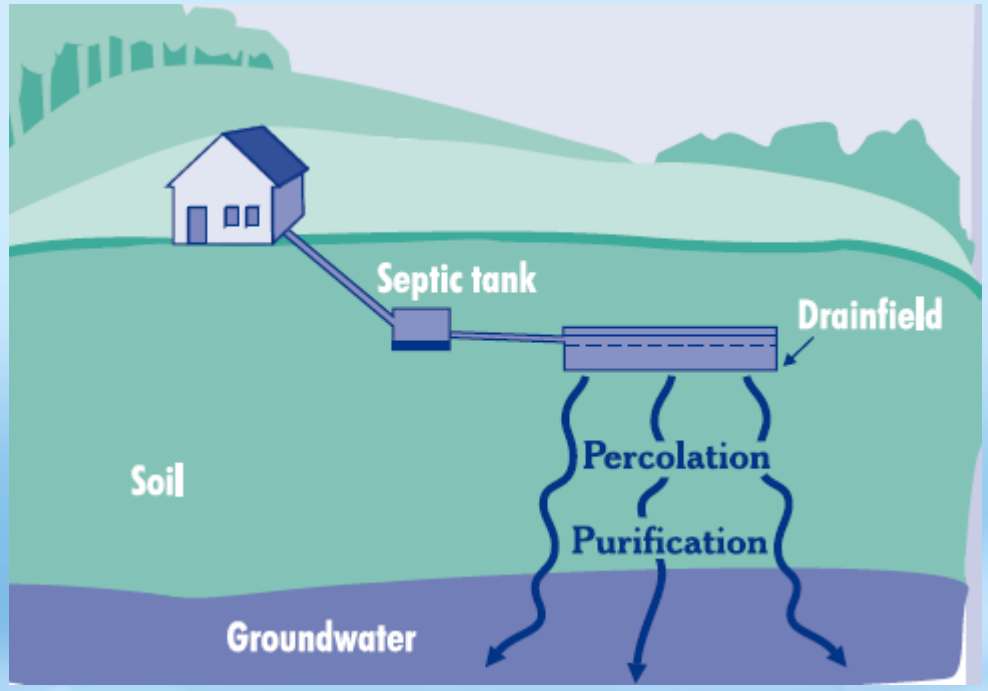
Septic tanks and drain fields

Mass Drain Fields

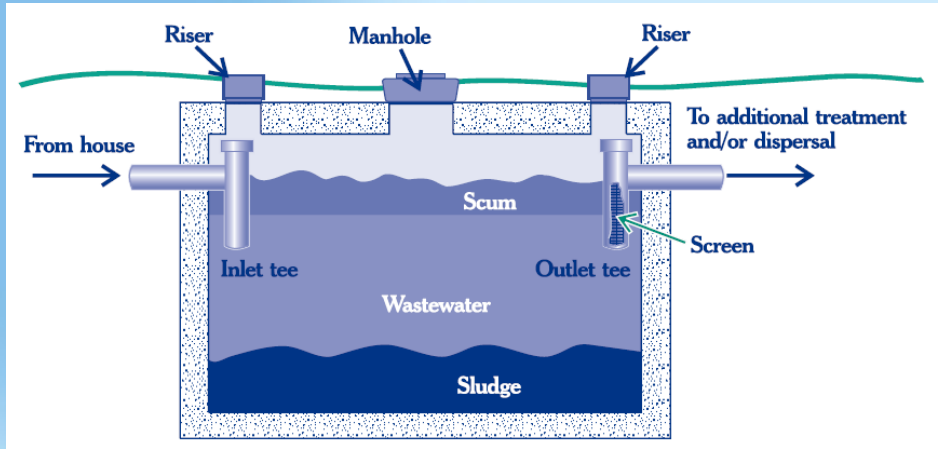
Land Application

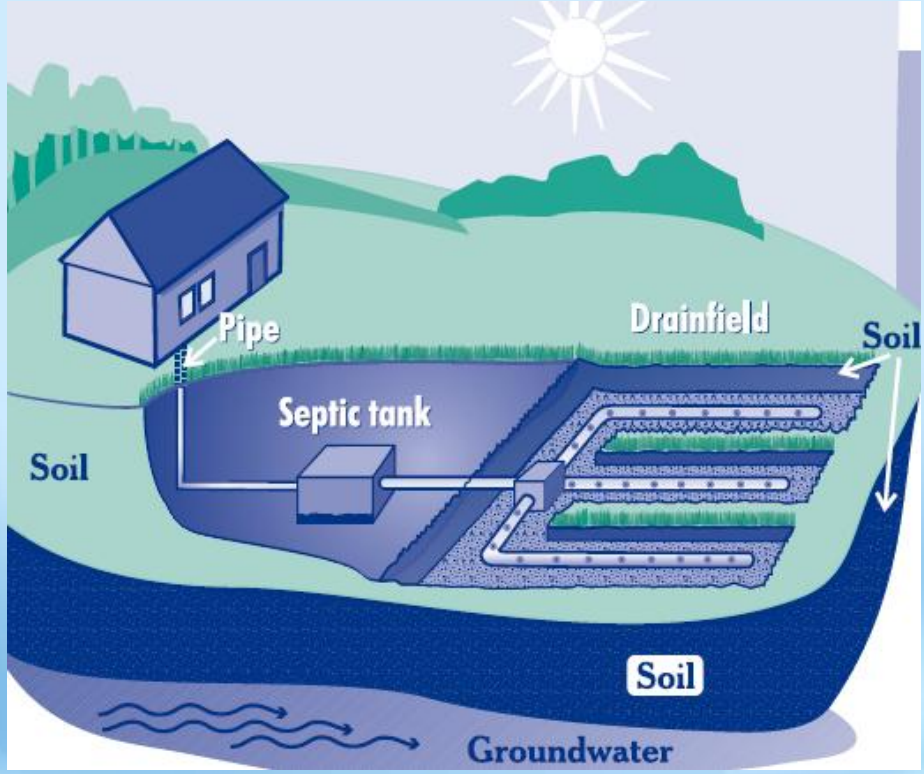
- **Advantages:**
  - **Modular and flexible: easily sized to meet requirements**
  - **Can avoid storage: allow irrigation in growing season and disposal in non-growing season**
  - **Reduce nitrogen and phosphorus**
  - **Can accommodate reuse**
- **Disadvantages**
  - **Can have higher operation and maintenance costs**
  - **Limited to site specific soil characteristics**

Septic Systems are Safe and Effective if Properly Constructed and Maintained



EPA Home Owners Guide to Septic Systems
http://www.epa.gov/owm/septic/pubs/homeowner_guide_long.pdf





EPA Home Owners Guide to Septic Systems
http://www.epa.gov/owm/septic/pubs/homeowner_guide_long.pdf

Land Application

- **Wastewater is currently land applied on the Shore**
- **Benefits:**
  - **Increases recharge to groundwater**
  - **Can reduce groundwater use**
  - **Reduces discharges to surface water**
  - **Can improve water quality**
  - **Can reduce cost of fertilizer**

- **Negatives:**
  - **There is a cost to construct, however may be less than other systems**
  - **If not properly maintained, can impact groundwater quality**
  - **May require significant land area**

Water Reuse

- Includes Storm Water and Wastewater
- Water is currently beneficially reused on the Shore
- Benefits:
  - Reduces groundwater use
  - Reduces discharges to surface water
  - Can improve water quality
- Negatives:
  - There is a cost to construct
  - Cannot be used with edible crops
  - A limited volume of water is used (only the amount required by the crop
  - Generally not used in the winter

Nutrient Management

- **Nutrient Management Plans**

Use Ponds and Impoundments for Irrigation Water

Currently used on the Shore in some areas

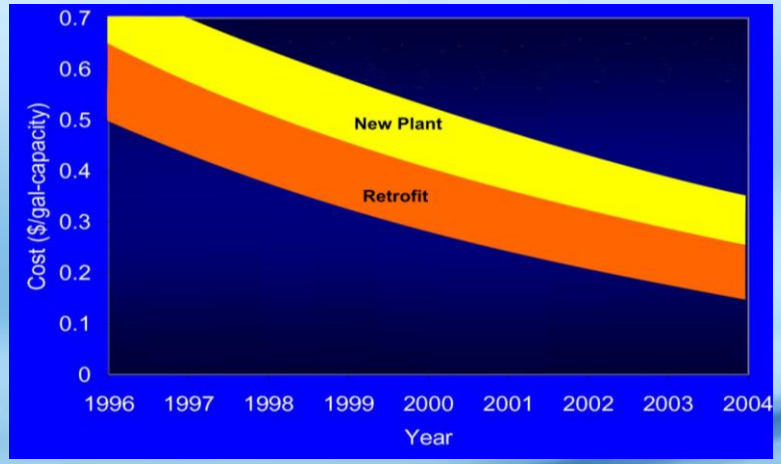
- **Benefit**
  - **Reduces groundwater use**
  - **Can recapture storm water / irrigation water**
  - **Can improve water quality**
  - **Lower energy cost**
- **Negative:**
  - **Requires land area**
  - **May require more operation and maintenance (sand filter)**

High efficiency irrigation equipment

- **Benefit:**
  - **Reduces groundwater use**
- **Negative:**
  - **Increased capital cost to install**
- **Federal EQIP assistance available**

Membrane Desalting

- **Technologies to desalt groundwater have improved dramatically over the past 20 years:**
  - **Available in a great variety of sizes: large systems, small package systems, and home systems**
  - **Costs have decreased on average 10% per-year over the past 10-years**
- **Benefits:**
  - **Can effectively reduce high salt levels in water**
- **Negatives:**
  - **Does not necessarily prevent salt water intrusion from occurring**
  - **Higher cost to treat the water**
  - **Higher energy cost**
  - **Requires more operations and maintenance**



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Past Groundwater Committee Awards for Resource Protection and Preservation

- **Ivy Farm Nursery: Technology to recycle irrigation water and reduce impacts of fertilizer (2006)**
- **Woodland Farm: upgrading irrigation equipment and adding buffers to farm ditches (2006)**
- **Hermitage Farms Nursery for reuse of treated water from Shore Memorial Hospital and Preserving High Water Quality (2007)**
- **Tankard Farms: Installing high efficiency irrigation systems & Water Conservation Measures and increasing the use of the surface water (2008)**
- **Eastern Shore Nursery of Virginia: Promoting water conservation and pollution protection measures by incorporating state of the art practices related to reuse of water and recharge area protection and preservation (2009)**
- **Wal-Mart of Onley for practicing water conservation and pollution protection by incorporating state of the art practices related to water conservation and recharge area protection and preservation.**