Water Pollution Science: Sources and Treatment

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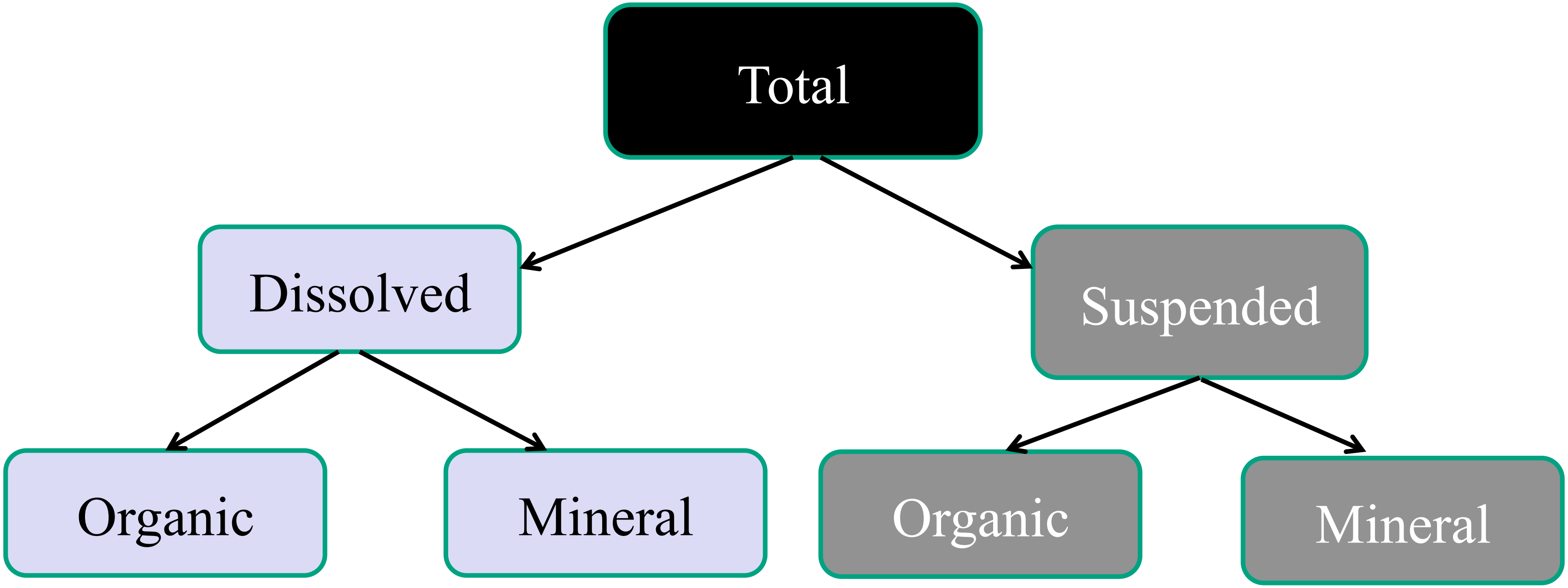
Water Pollution Sources

- Point Sources
  - Industrial (manufacturing and
  - Domestic (human waste)
- NonPoint Sources
  - Agricultural Runoff
  - Mine Drainage
  - Urban Stormwater Runoff
- Combined Sources
  - Urban Combined Sewer Systems
  - Hydraulic Fracturing

Categorizing Water Pollutants



Additional Characterizations:

- Toxic / Nontoxic
- Oxygen Demanding
- Infectious
- Algae Stimulating (Nutrient)

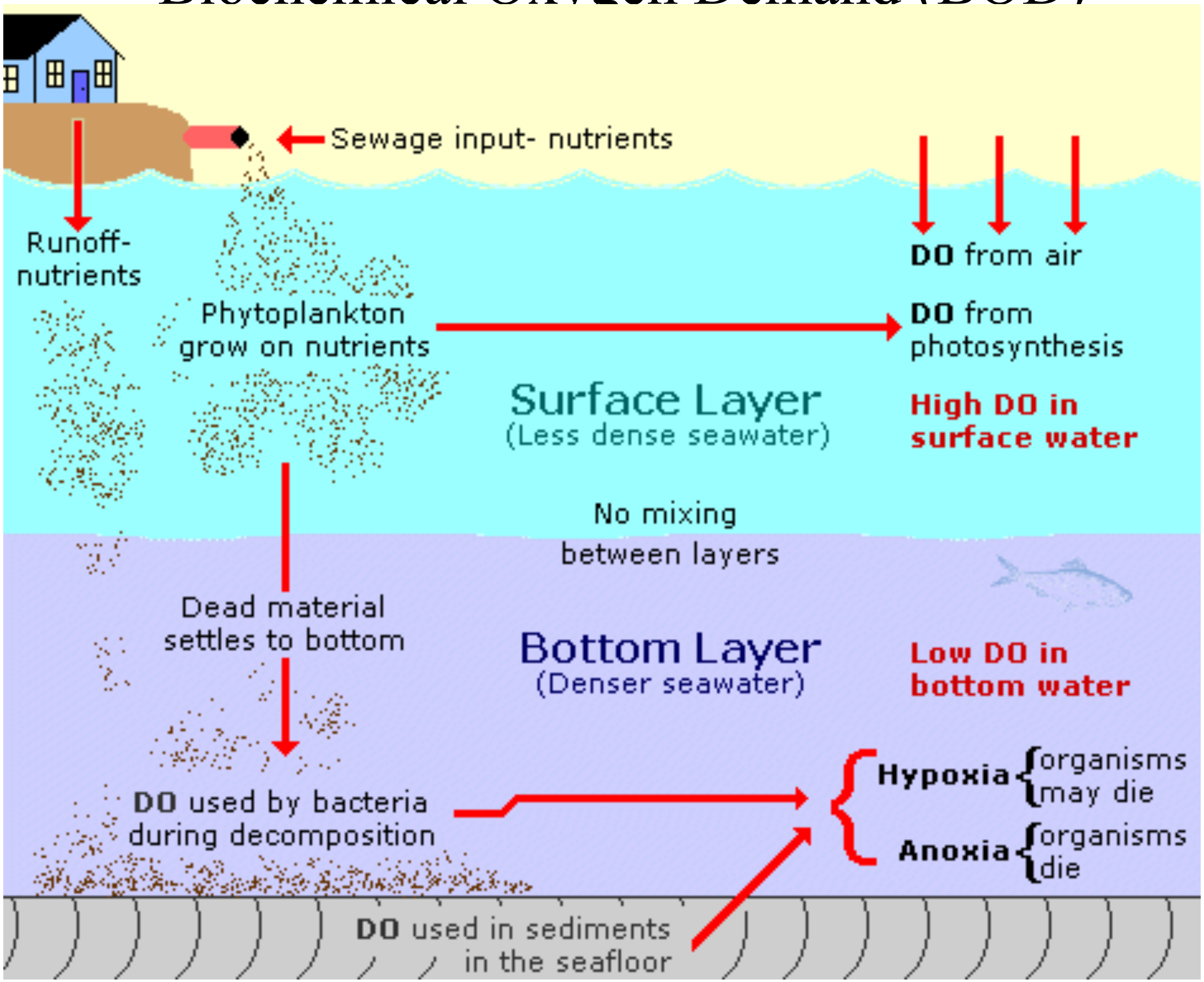
Measures of Water Pollution

(Typical numeric values – Concentrations)

Pollutants in mg/L	Raw Sewage	Urban Runoff	Fracking Waste	Sea Water (comparison)
Total suspended solids	230	650	99	--
Total dissolved solids	500	10,000 (road salt)	67,300	35,000
Biochemical oxygen demand	210	30	144	--
Total Nitrogen (nutrient)	40	8	86	0.5
Total Phosphorous (nutrient)	8	0.6	--	--

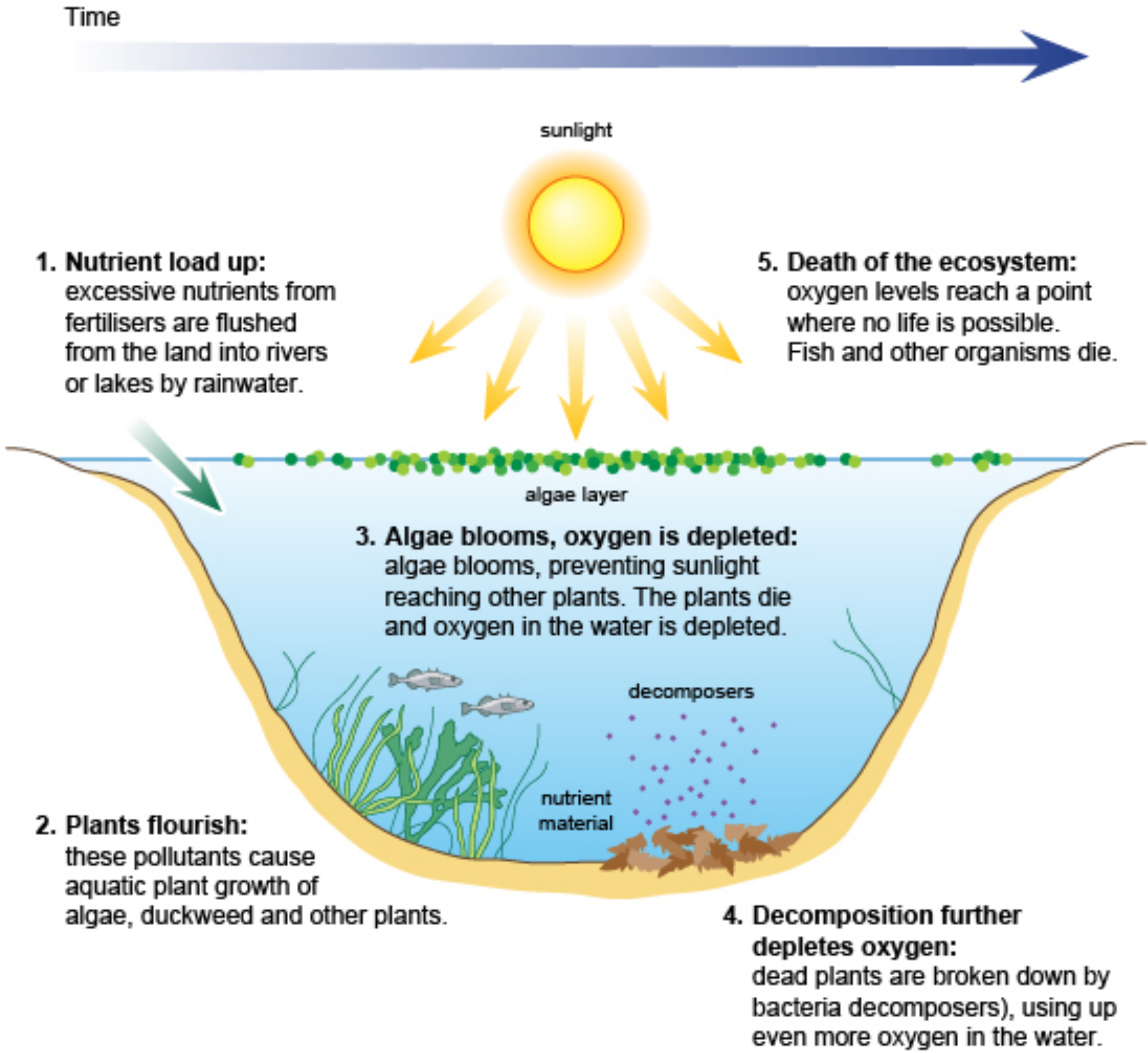
Organic Waste Pollution

Biochemical Oxygen Demand (BOD)

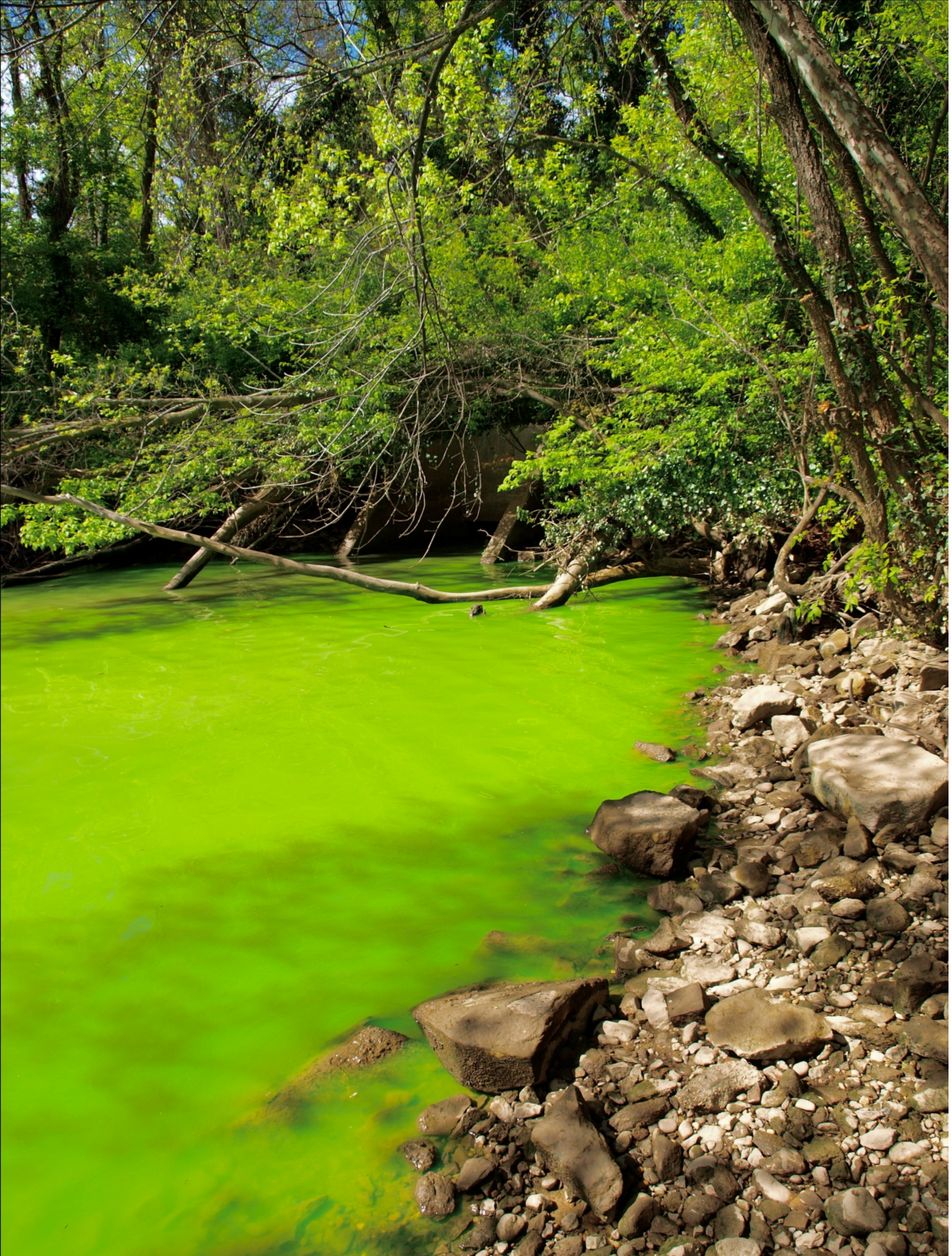


Source: blog.labplanet.com

Nitrogen & Phosphorous (Nutrient Pollution)



Source: www.bbc.co.uk



Nutrient Pollution: Causes Algae Bloom in a pond

Source: en.wikipedia.org

Hundreds of Dead Fish Found in Delco Lake, Creek

Authorities say water samples found nothing strange despite fish kill in Ridley Park Lake and Swarthmore's Crum Creek

By Teresa Masterson | Wednesday, Jun 15, 2011 | Updated 11:34 AM EDT

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AP

TOP STORIES

TODAY | MOST WATCHED | MOST EMAILED

Authorities Stiffing Rescuer?

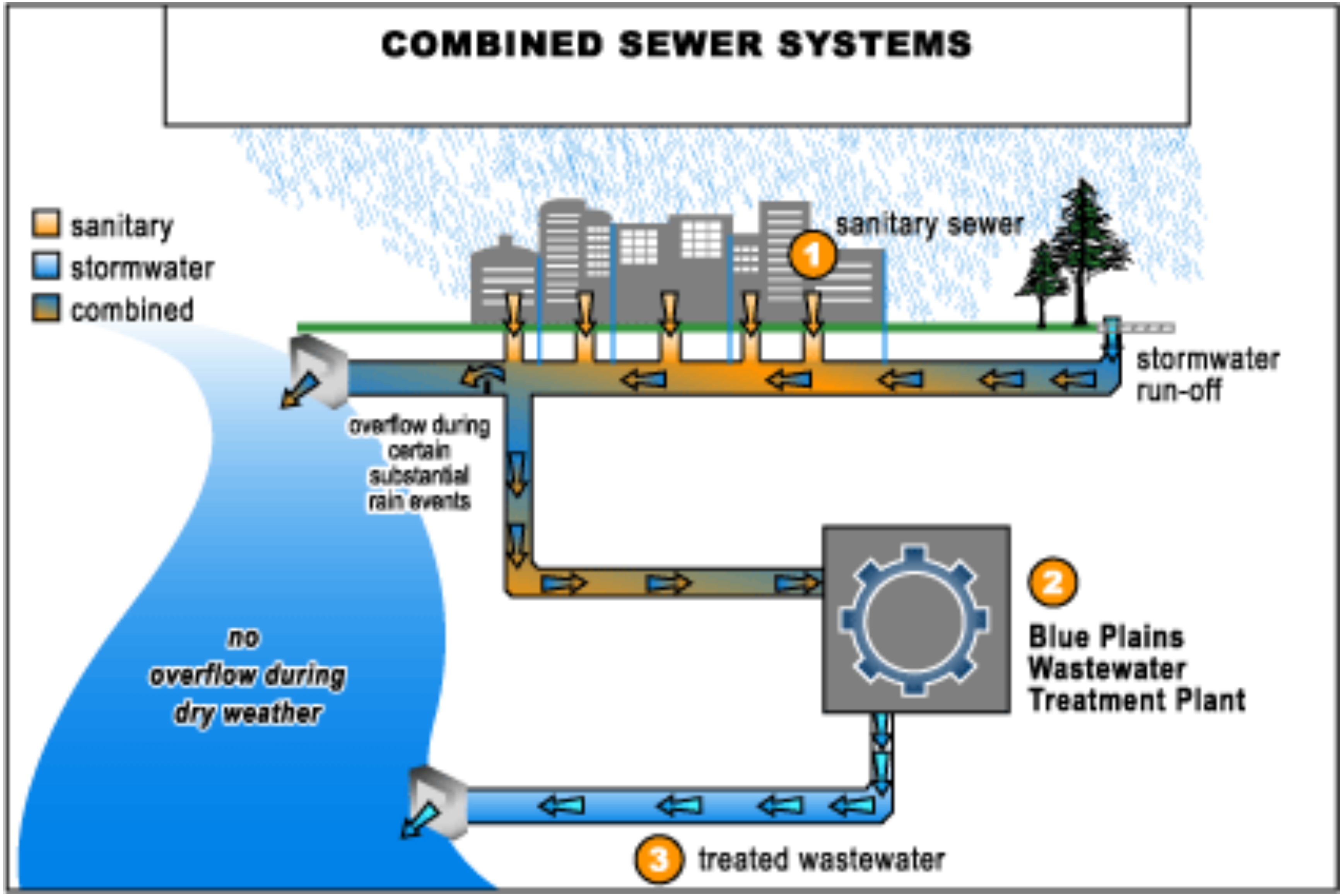
Off-Duty Cop Tackles Attacker in TSA Line

2 Survive Plane Crash in South Jersey

Toxic Contamination

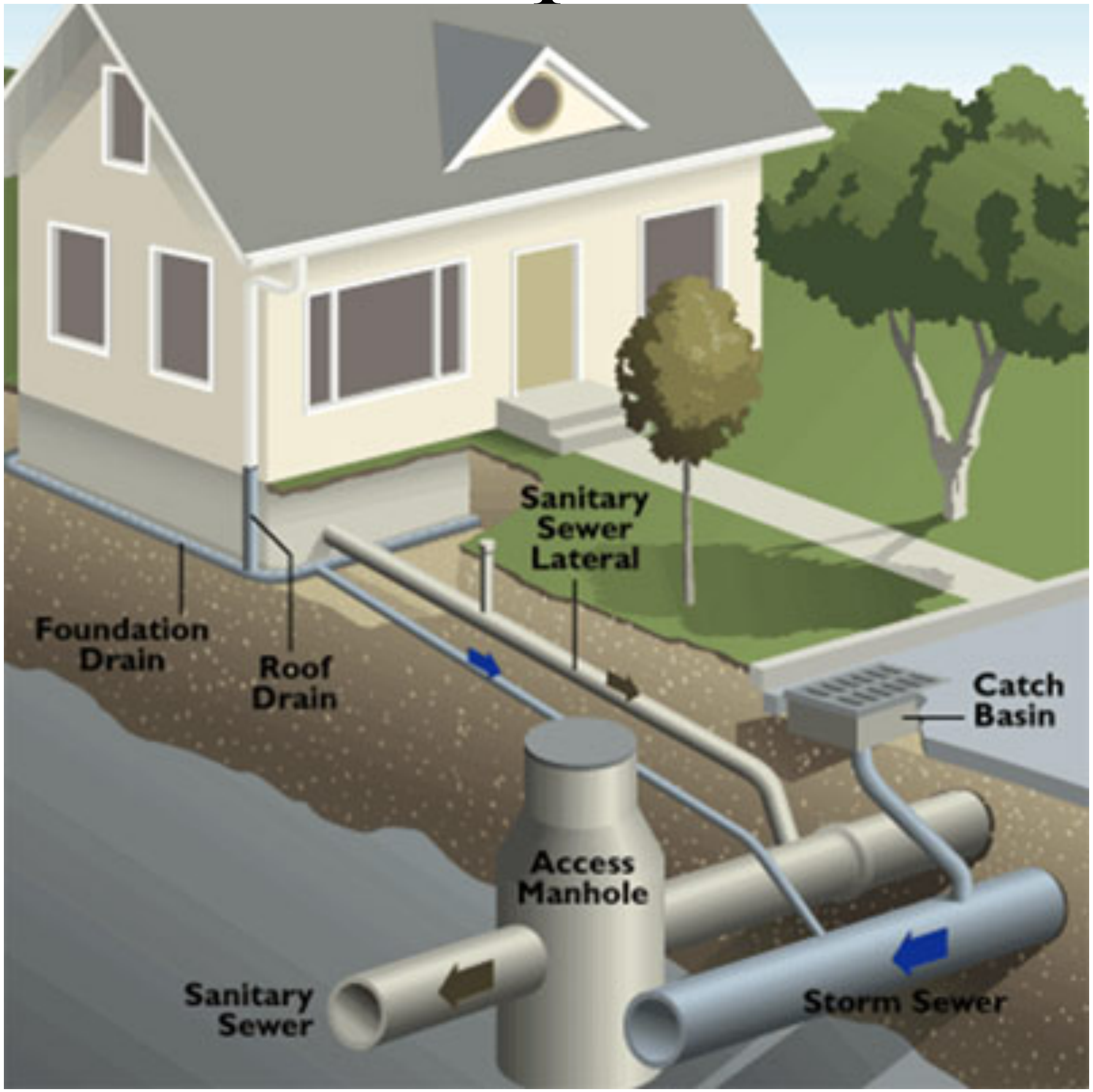
WATER POLLUTION SOURCES

Urban Sewers



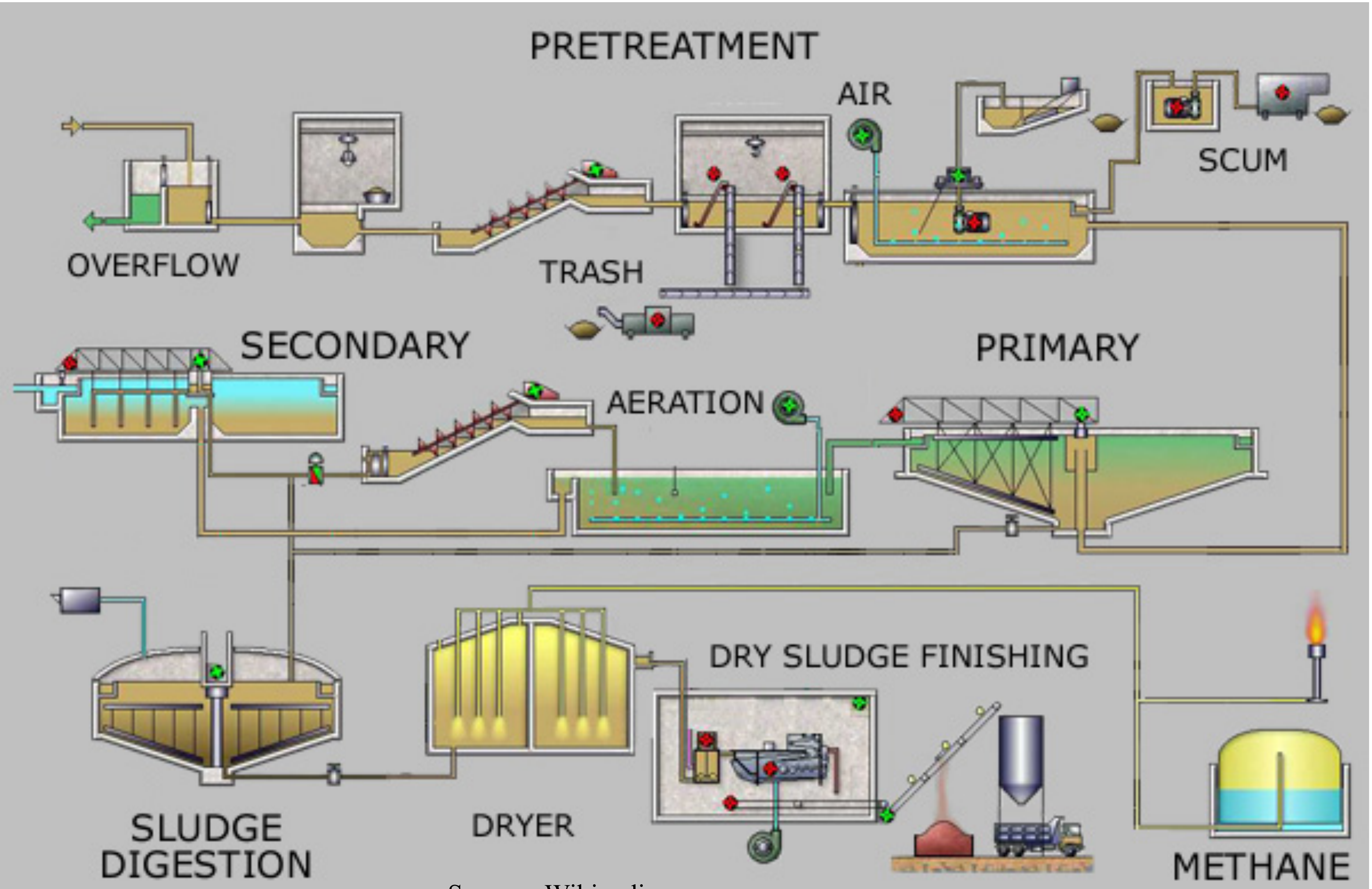
Source: www.dcwater.com

Suburban Separate Sewers



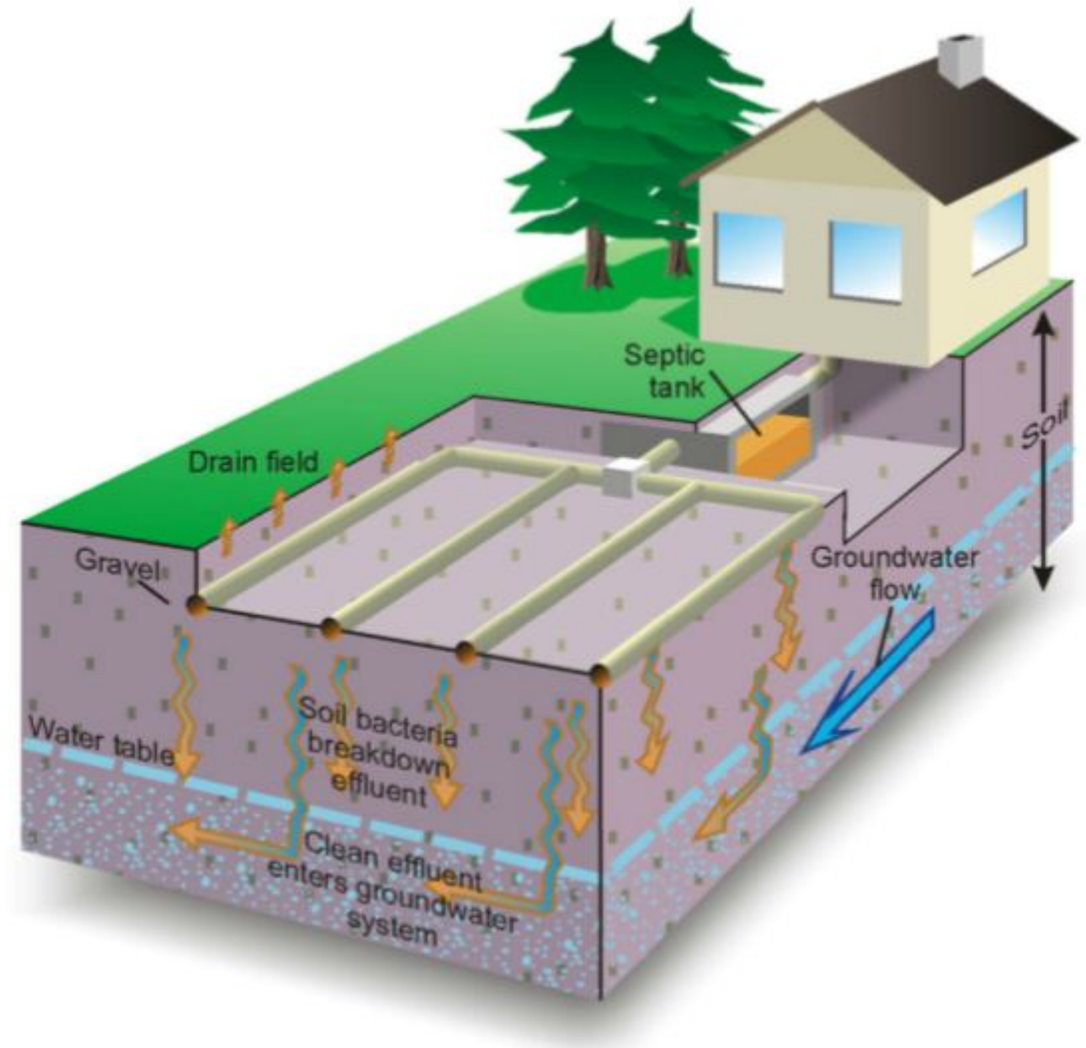
Source: Village of Spencerport NY

Conventional Wastewater Treatment Plant



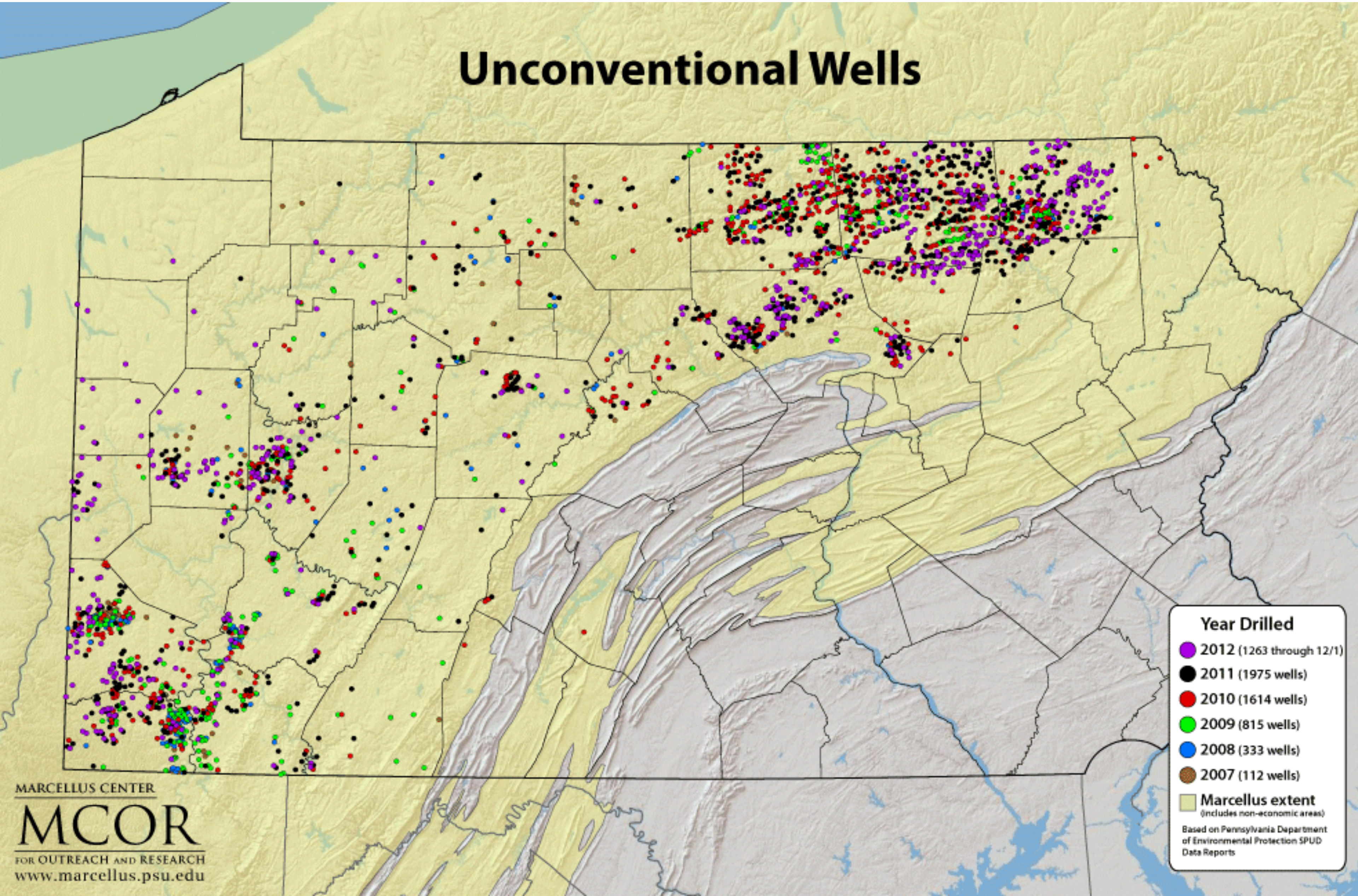
Source: Wikipedia

Rural "Sewers"

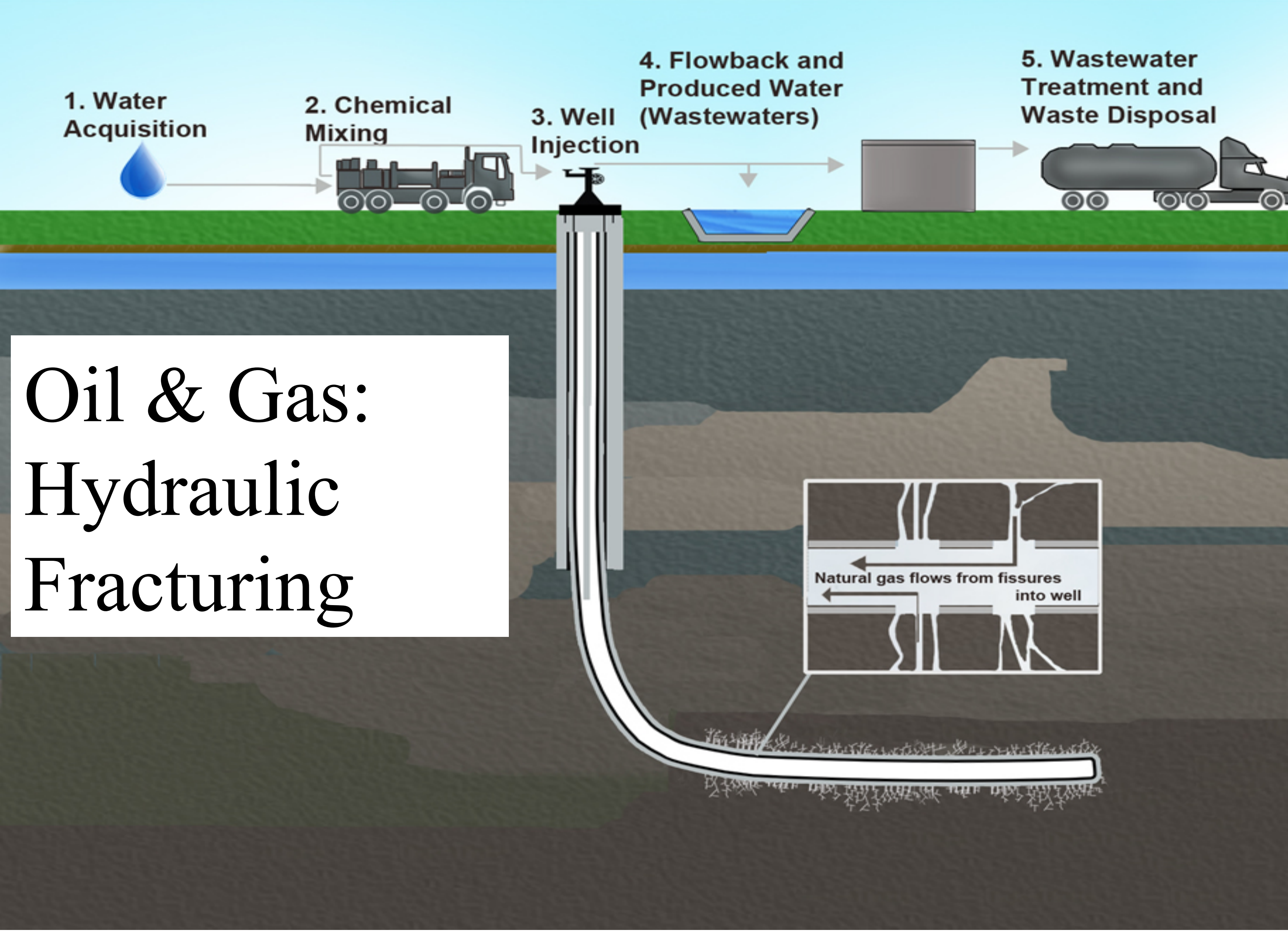


Source: meeksplumbing.com

Hydraulic Fracturing in PA



Oil & Gas: Hydraulic Fracturing



Source: Wikipedia

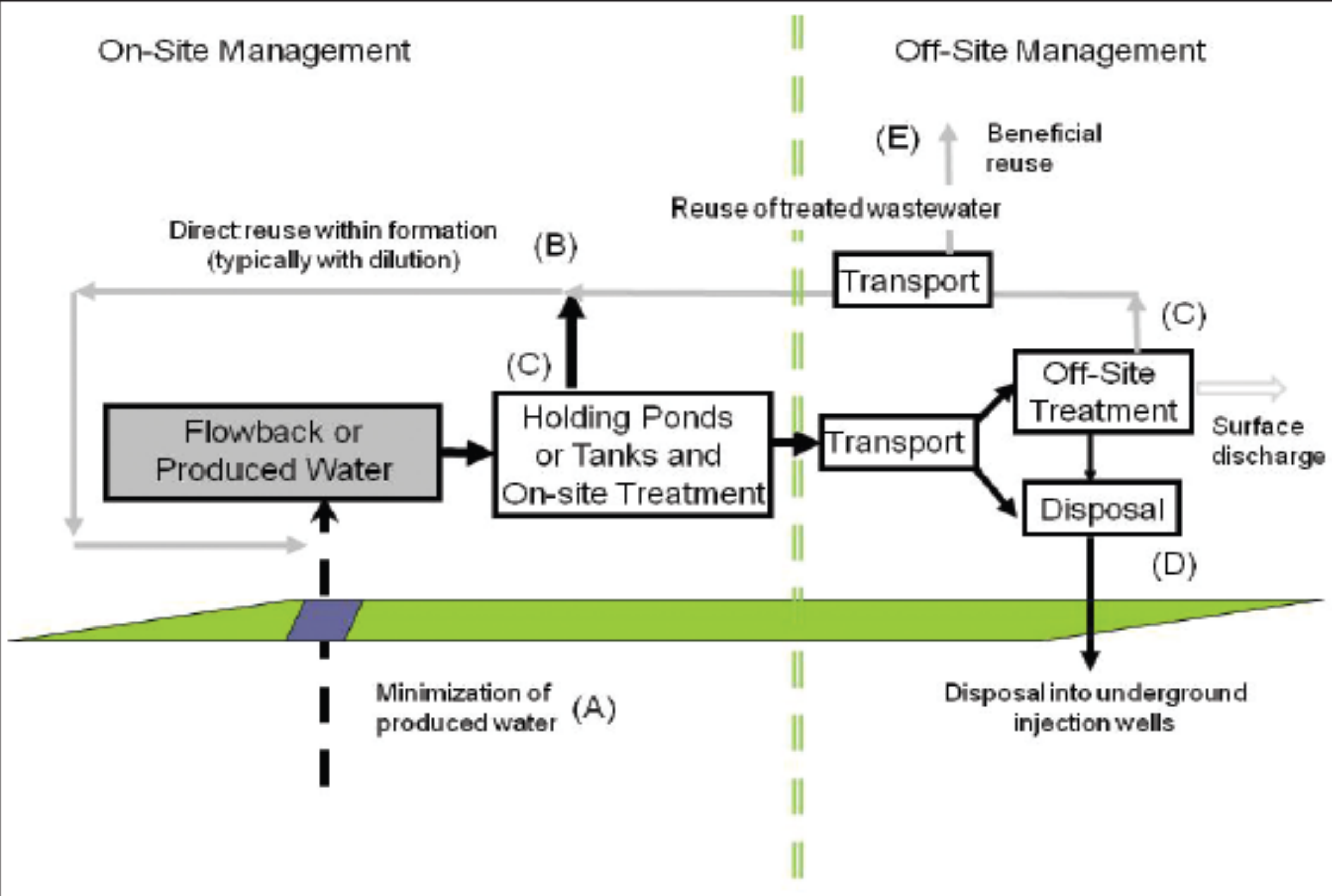
Water Taken from Natural Streams

Source: Cornell University

Wastewater from Hydraulic Fracturing

Source: thefisheriesblog.com

Figure 1. Summary of Management Options for Shale Gas Wastewater



Source: NRDC

Problems on Urban Streams

- Used as “storm sewers”
- Carry excess sediment and many pollutants
- Surging flows cause stream bank and bed erosion – loss of land from yards and parks
- Groundwater recharge is cut off so creeks dry up soon after rain
- Declining quality of aquatic life – low diversity and only pollution tolerant species can survive

Impaired Streams

- Suspended Solids loads deposit sediment
- Excess Nutrients in runoff and sediments – Nitrogen and Phosphorous
- High flow velocities erode banks

Bank-Full Storm Events are Too Frequent

- Channel Erosion
- Flood Hazard

Low Base Flow

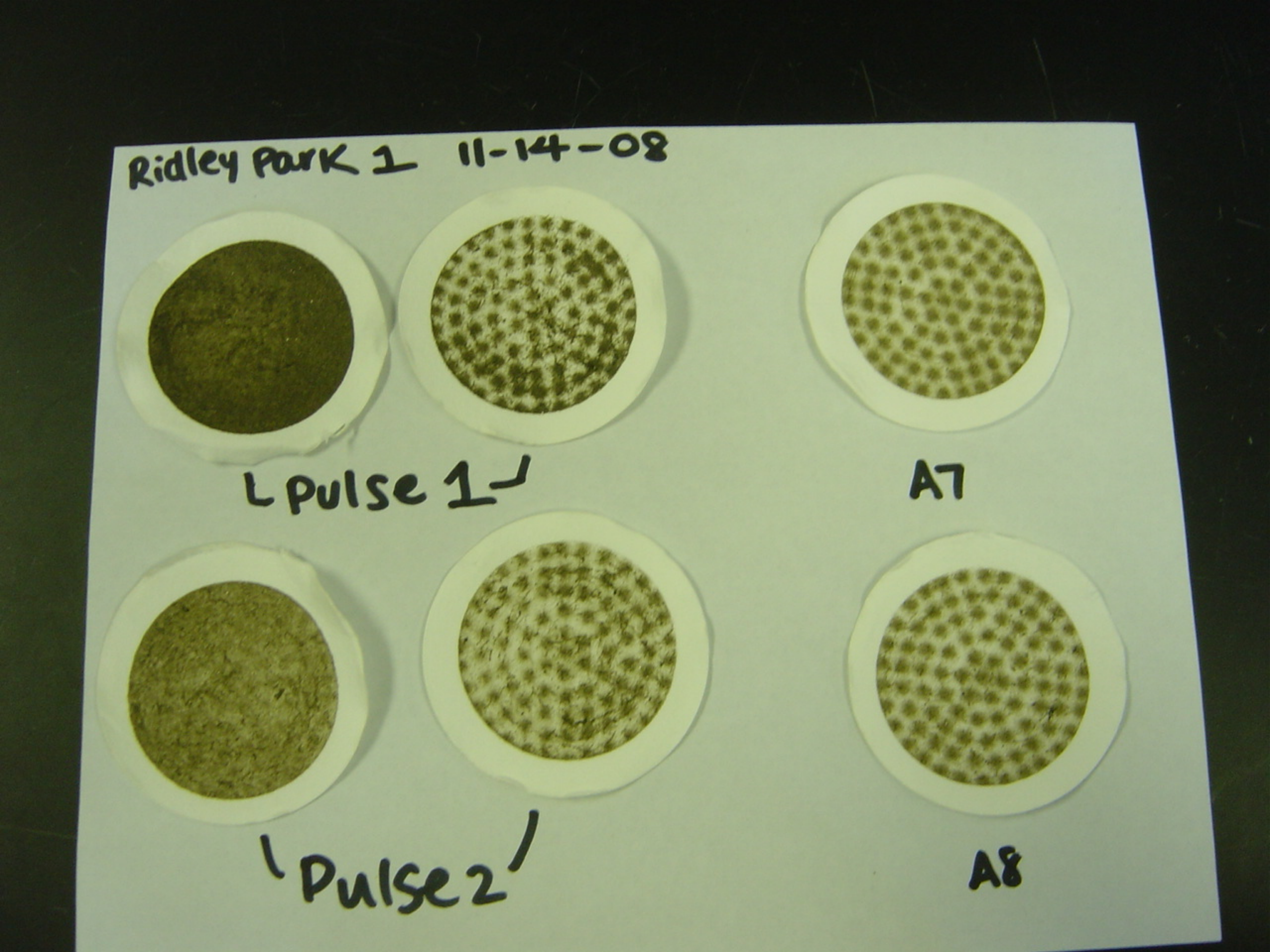
- Impervious Surfaces Cut Off Groundwater Recharge

The Cause: Urbanization & Stormwater Runoff

Stormwater piped directly to nearest stream with no treatment

More than 250 Tons of sediment added every year from upstream runoff and erosion

Sediment Bars Above Ridley Park


Ridley Park 1 11-14-08
Pulse 1
A7
Pulse 2
A8


99 8 10

What Can We Do to Restore Water Quality?

- **Install** Green Infrastructure Technologies throughout the watershed
  - hold back the runoff from 90% of storms and infiltrate whenever possible
  - remove pollution using biological and mechanical filters
- **Restore** tree canopy and other vegetation in the *riparian buffer zone*
- **Preserve** remaining forests and wetlands by conservation easements and land purchases

Bioretention Cell

Vegetative Swale

Porous Pavement

Rain Barrel

Infiltration Trench

Green Roof

Chicago City Hall

Green Roof

Swarthmore's Alice Paul and David Kemp Residences


GreenPhilly Research Group
SWARTHMORE
TEMPLE UNIVERSITY
UMBC
AN HONORS UNIVERSITY IN MARYLAND
JOHNS HOPKINS UNIVERSITY
AKRF

Maximizing GI Benefits through Measurement, Modeling, and Community-Based Implementation

- Multi-Objective Benefit-Cost Framework: the Storm Water Investment Strategy Evaluation (StormWISE) model combines outputs from the different project components: hydrologic, engineering, socio-economic, environmental

Community Engagement in "Bottom-Up" Benefits Model Development
(Christina Rosan - Temple)

- Create a <u>Community Advisory Research Board</u> – hold workshops:
- to prioritize factors influencing GI <u>site selection</u> and <u>which GI technologies</u> to install
- to obtain guidance on how to <u>evaluate co-benefits</u>: community, economic, environmental, and social <u>benefits and impacts</u> of GI
- to delineate <u>Zones of Green Infrastructure</u> (ZGIs) in CSO area
- to obtain feedback for <u>adaptive management</u>
- to develop protocols for <u>future human subjects research</u> on community involvement in GI implementation

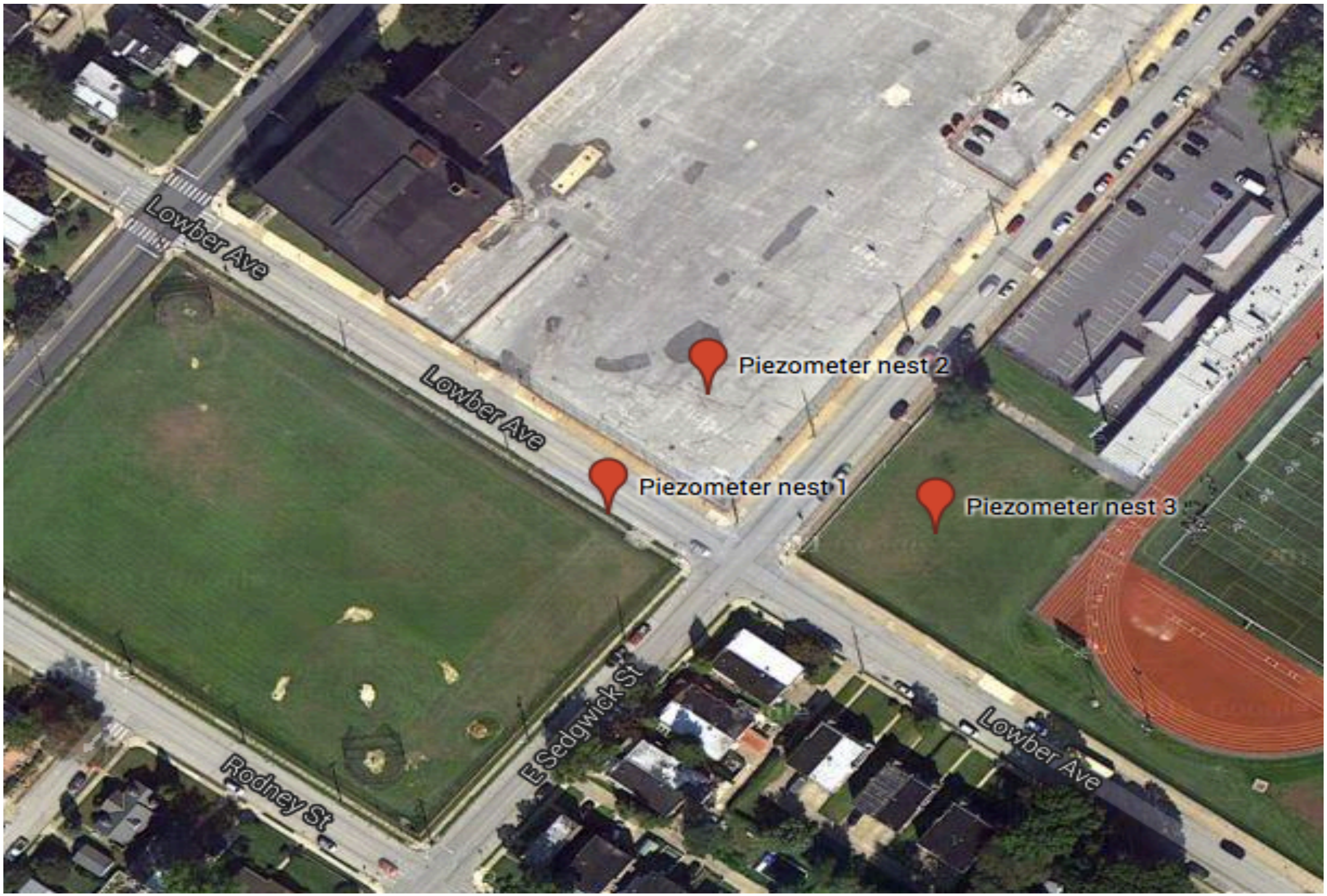
Adapt StormWISE Model for Philadelphia Green Infrastructure

(Art McGarity, Swarthmore College)

- Develop web version to facilitate interaction with community advisory board
- Incorporate calibrated benefit-cost functions for runoff & load reductions developed from SWMM-Borg coupled model
- Include co-benefits analysis, as quantitative benefit-cost functions that vary with land use and geographic zone (ZGI)
- Generate initial decision support results: trade-off different benefits for competing strategies influencing GI siting and practice choices

Subsurface Monitoring – Claire Welty, UMBC

Leeds Middle School Site, Philadelphia



Wakefield Park Site, Philadelphia

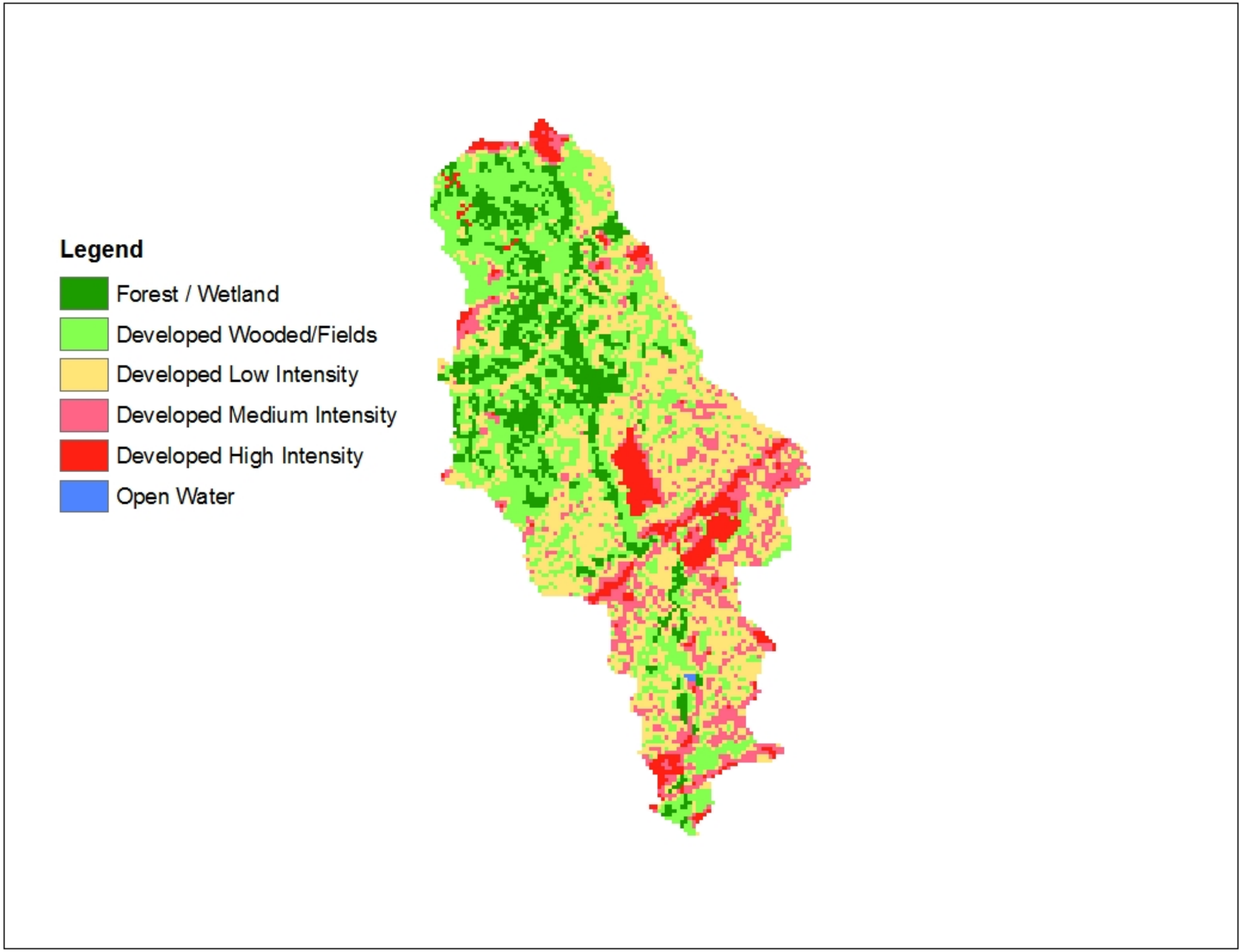
Can We Do It?

- Lots of Money: How much? Who pays?
- Regulations: MS4 Permits and Municipal Ordinances – site based, neglect watershed
- But Impaired Streams violate Federal Law!
  - TMDL Process – slow, litigious
  - Watershed Associations – can help, can sue
  - Stormwater authorities – assess fees based on impervious area: make polluters pay

Screening: StormWISE

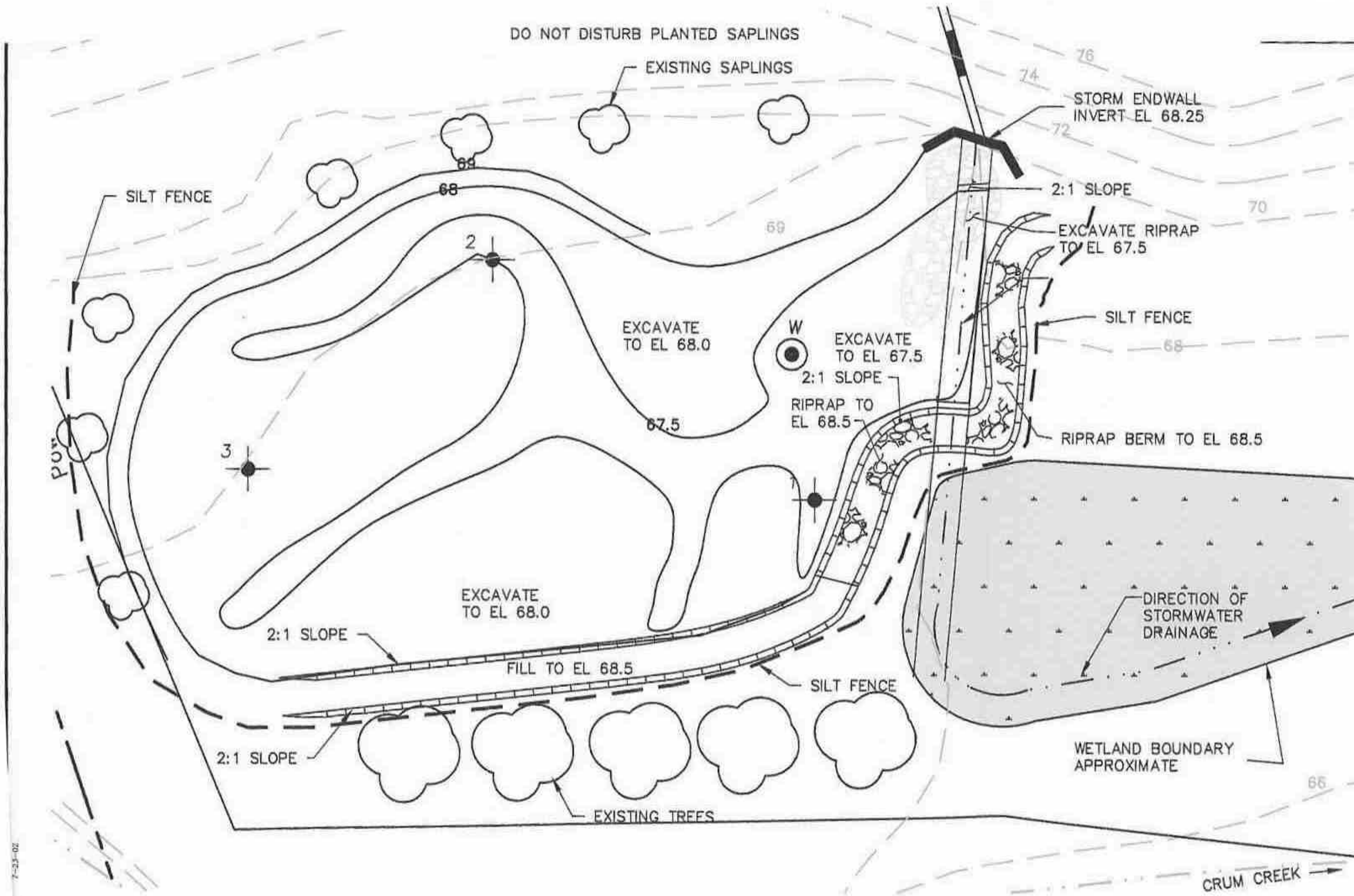
- **Storm W**ater **I**nvestment **S**trategy **E**valuator
- Screening Model: high level, guidance for early stages of watershed management process
- Prioritizes drainage zones, land uses, and BMP technologies for funding of implementation projects
- Identifies opportunities to reduce runoff volume and pollutant loads while maximizing effectiveness of available funds
- Extends pollutant loading models to include BMP cost minimization over entire watershed

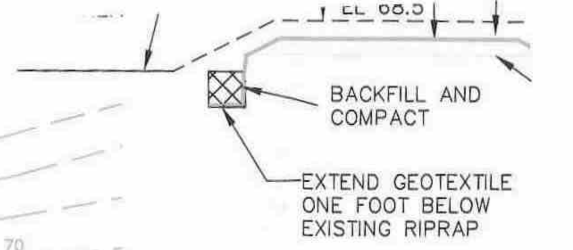
Example: Little Crum Creek Watershed
Delaware County, PA



Results

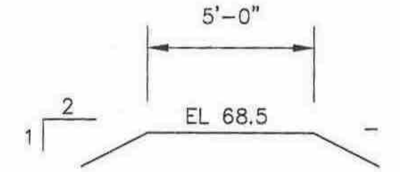
- 12 sites chosen and 18 projects developed
- Up to 18 tons/year sediment reduction at Ridley Park Lake
- $19 Million total capital cost for all projects fully deployed
- Costs of sediment removal range: $1.6 to $309 per ton - Prioritization possible
- Details: watershed.swarthmore.edu: Little Crum Creek Action Plan Project





RIPRAP TYPICAL BERM SEC

SCALE 1/4" = 1'-0"



EARTH FILL SECTION

SCALE 1/4" = 1'-0"

LEGEND

68 EXCAVATED CONTOUR LINE

69 EXISTING CONTOUR LINE

EXISTING TREE

RIPRAP

1 INFILTROMETER

W GROUNDWATER WELL

REFERENCE: The base drawing for this plan was provided by FC
PROJECT NO: 9778, Issued 25 MARCH 1999, Revise
SITE LOGISTICS PLAN, PHASE 2, X011

GRAPHIC SCALE

0 10 20

1 inch = 20 ft.

NOTE:
Silt fence denotes extent of disturbance.
Work shall be performed in accordance with:
SPECIFICATIONS FOR RESTORATION PLANTING
* General Notes, specifications, standards and
additional detail are provided in
RESTORATION PLAN

LITTLE CRUM CREEK


OCT 3 2002


16 5:09PM


JUN 19 2004

QUESTIONS?