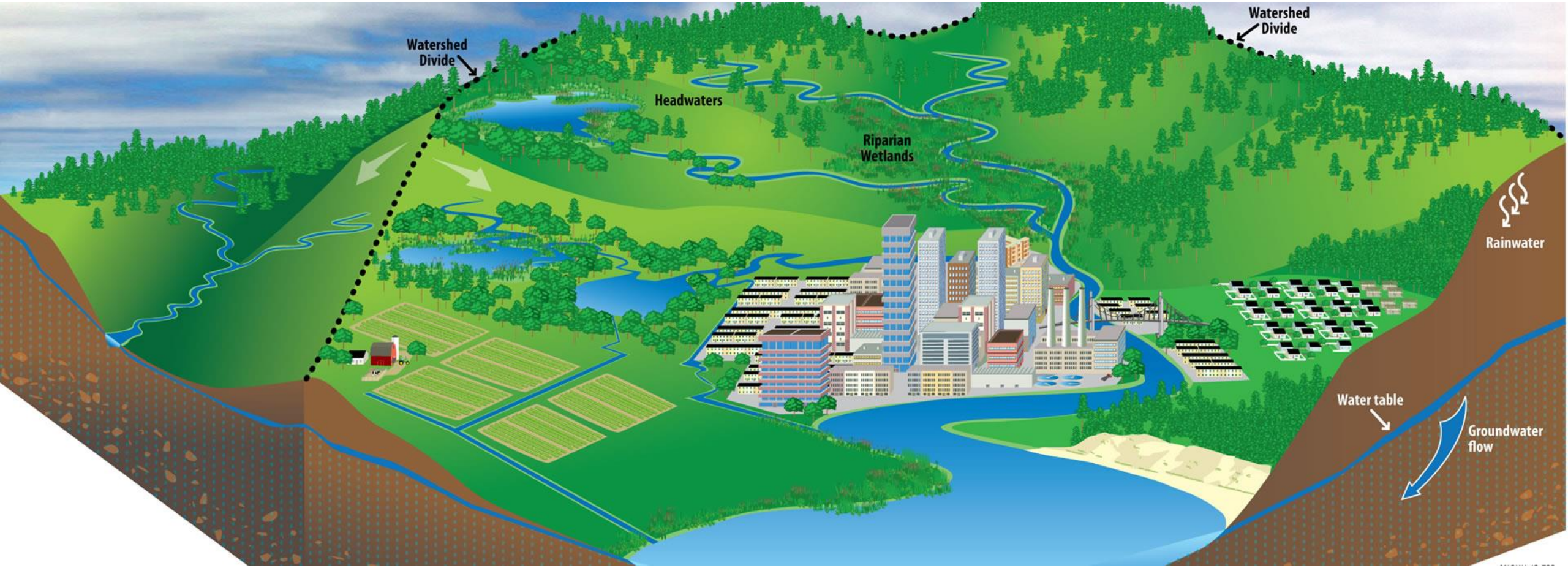
Introduction to Stormwater Management

Cody Obropta, PE
Environmental Engineer
Stormwater Engineering Team

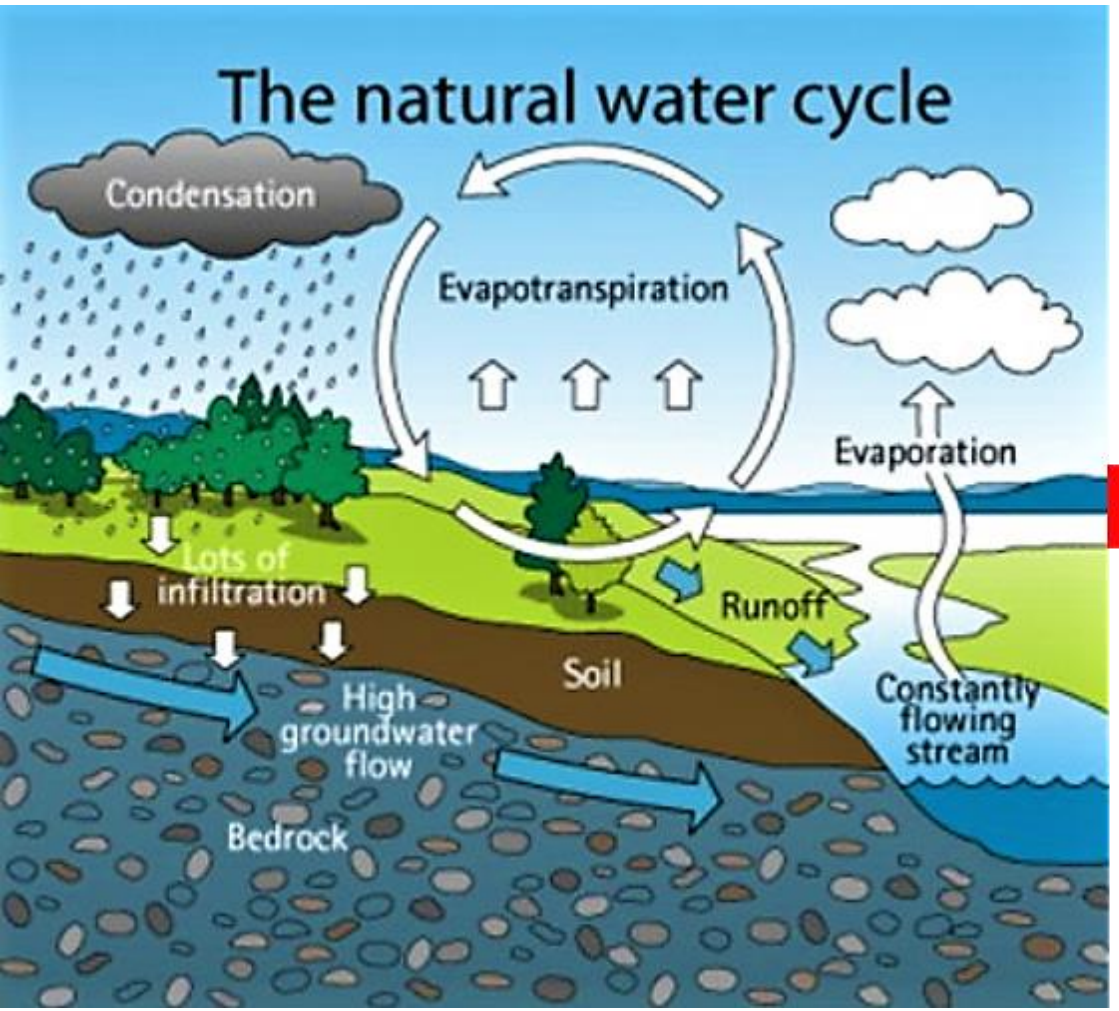
Overview

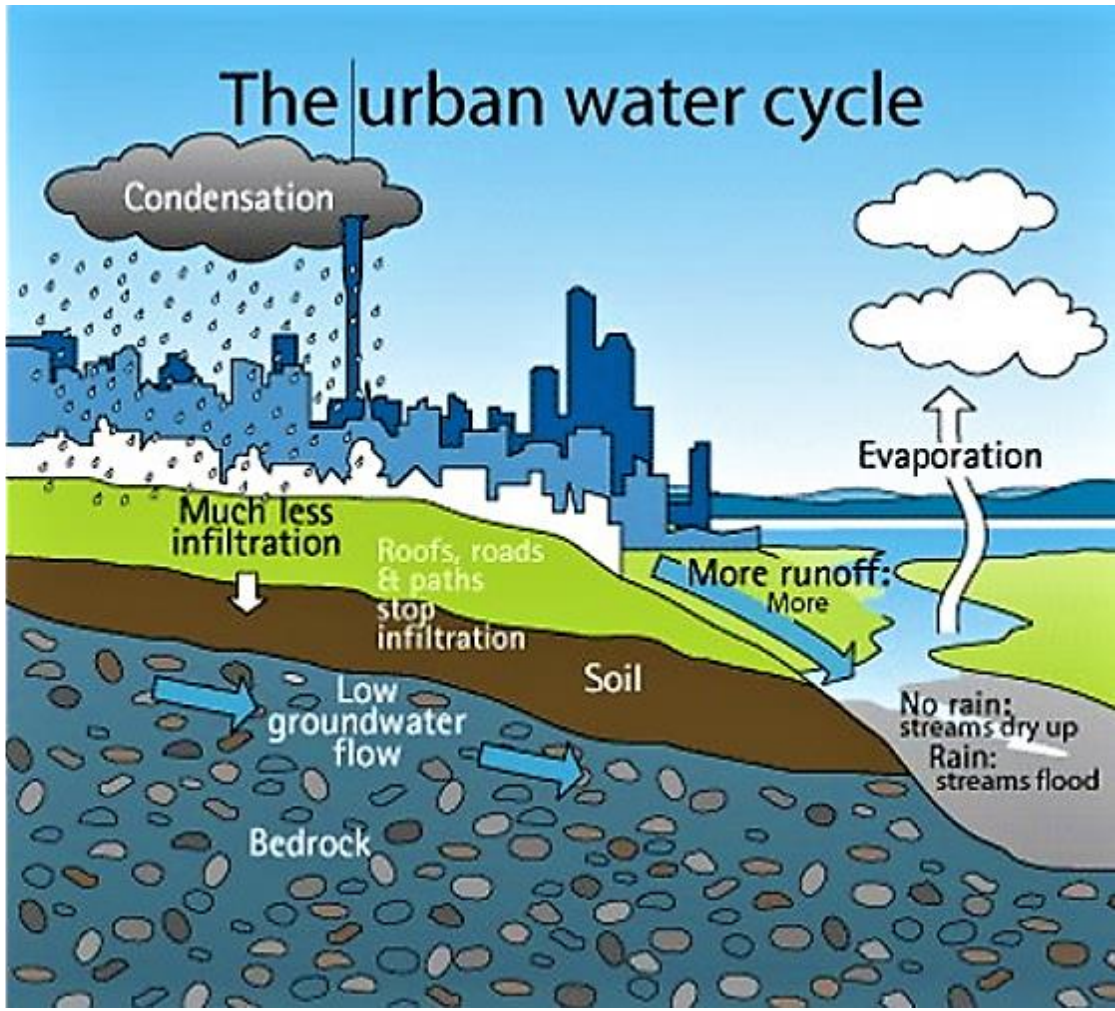
- Watersheds and the water cycle
- Why do we care?
- Goals of stormwater management
- How to accomplish these goals

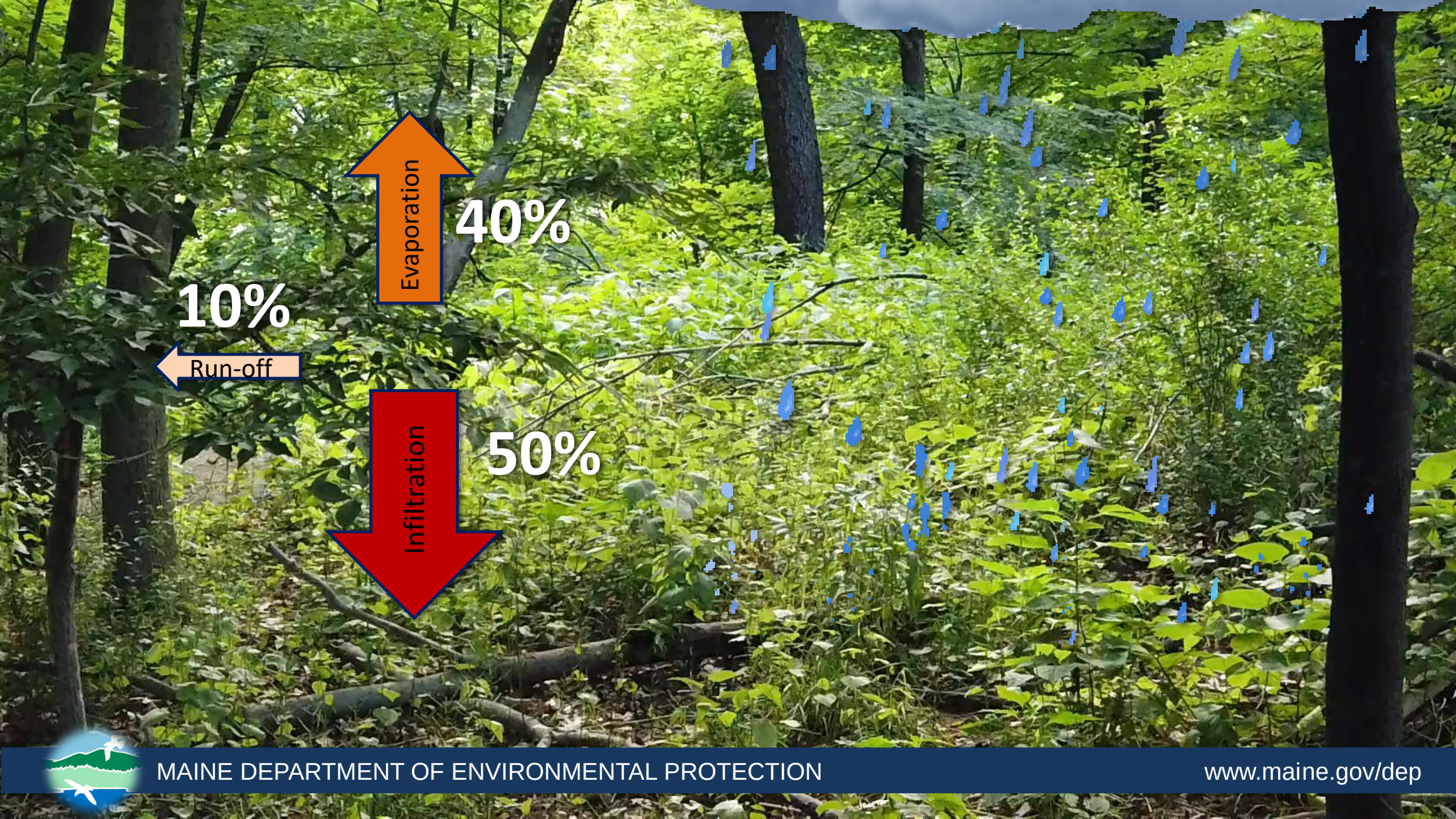
What's a Watershed?

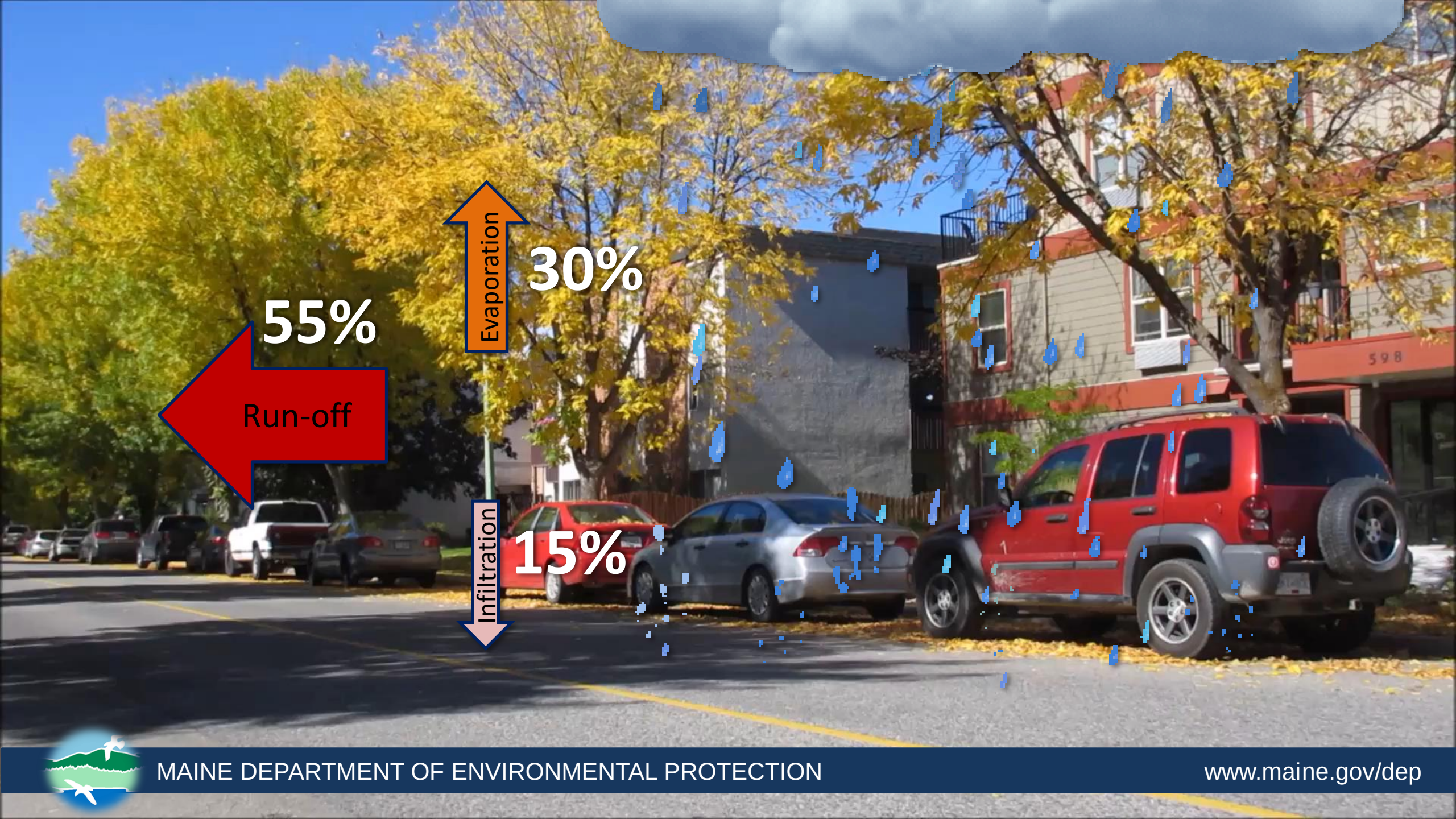


The Water Cycle



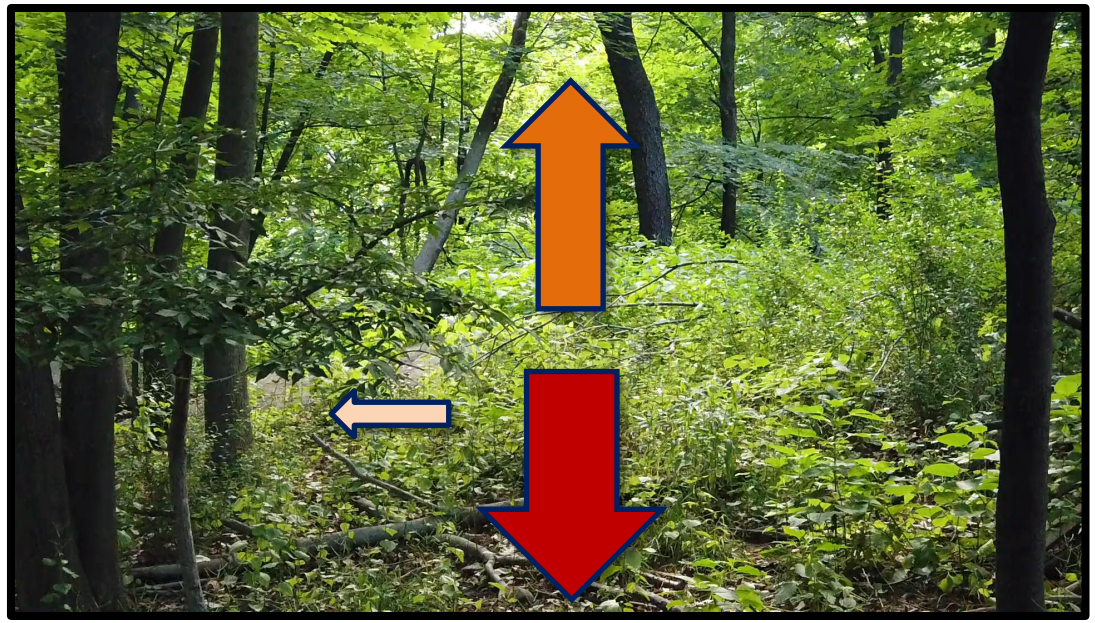



Evaporation
40%
10%
Run-off
Infiltration
50%

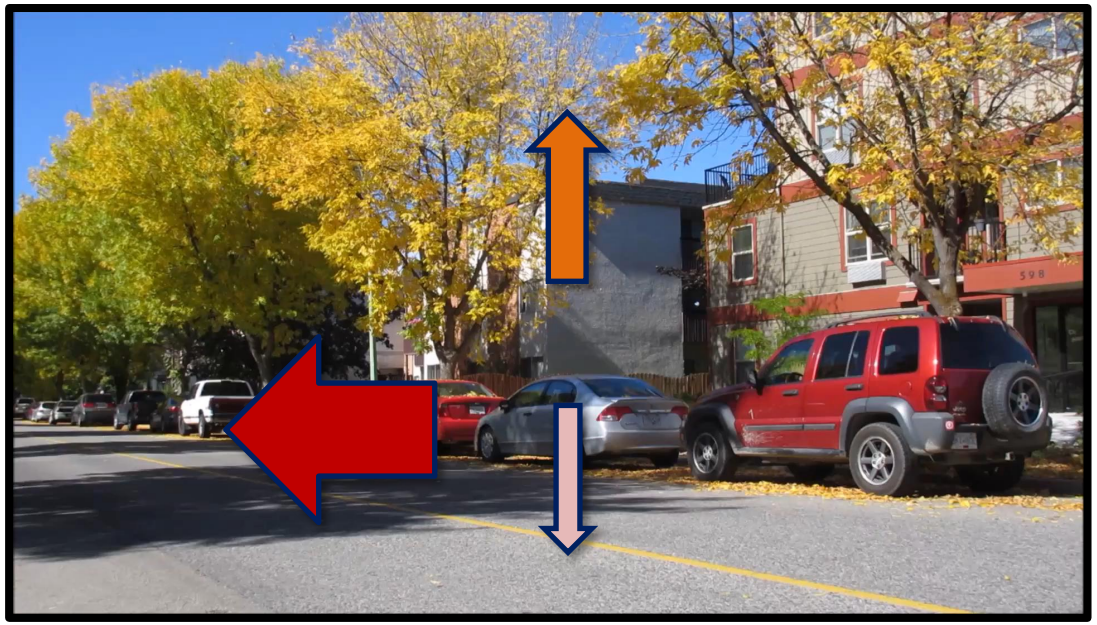

Evaporation
30%
55%
Run-off
Infiltration
15%

Effects of Impervious Surfaces on the Water Cycle

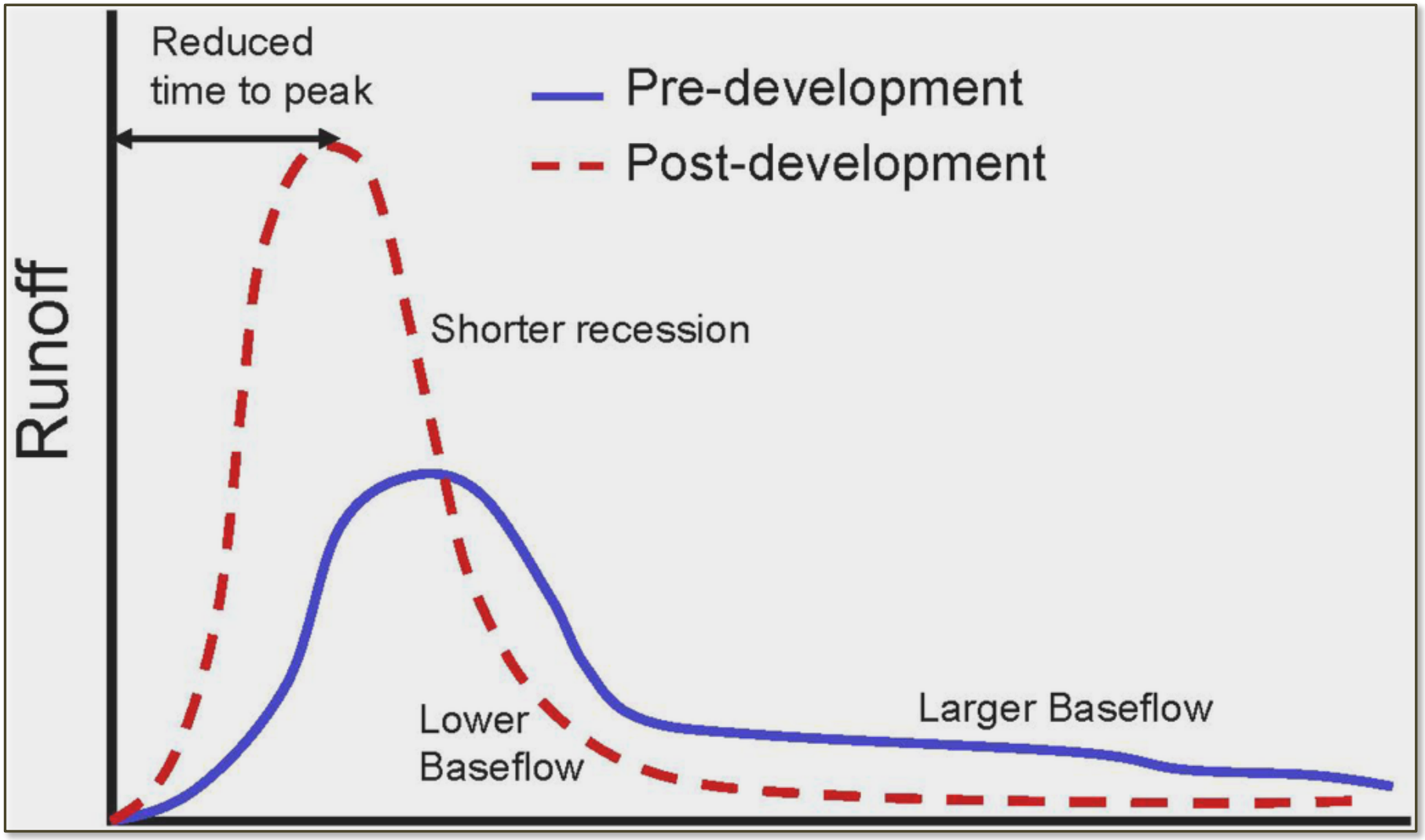
Natural Cover



75-100% Impervious



Too much water too fast!



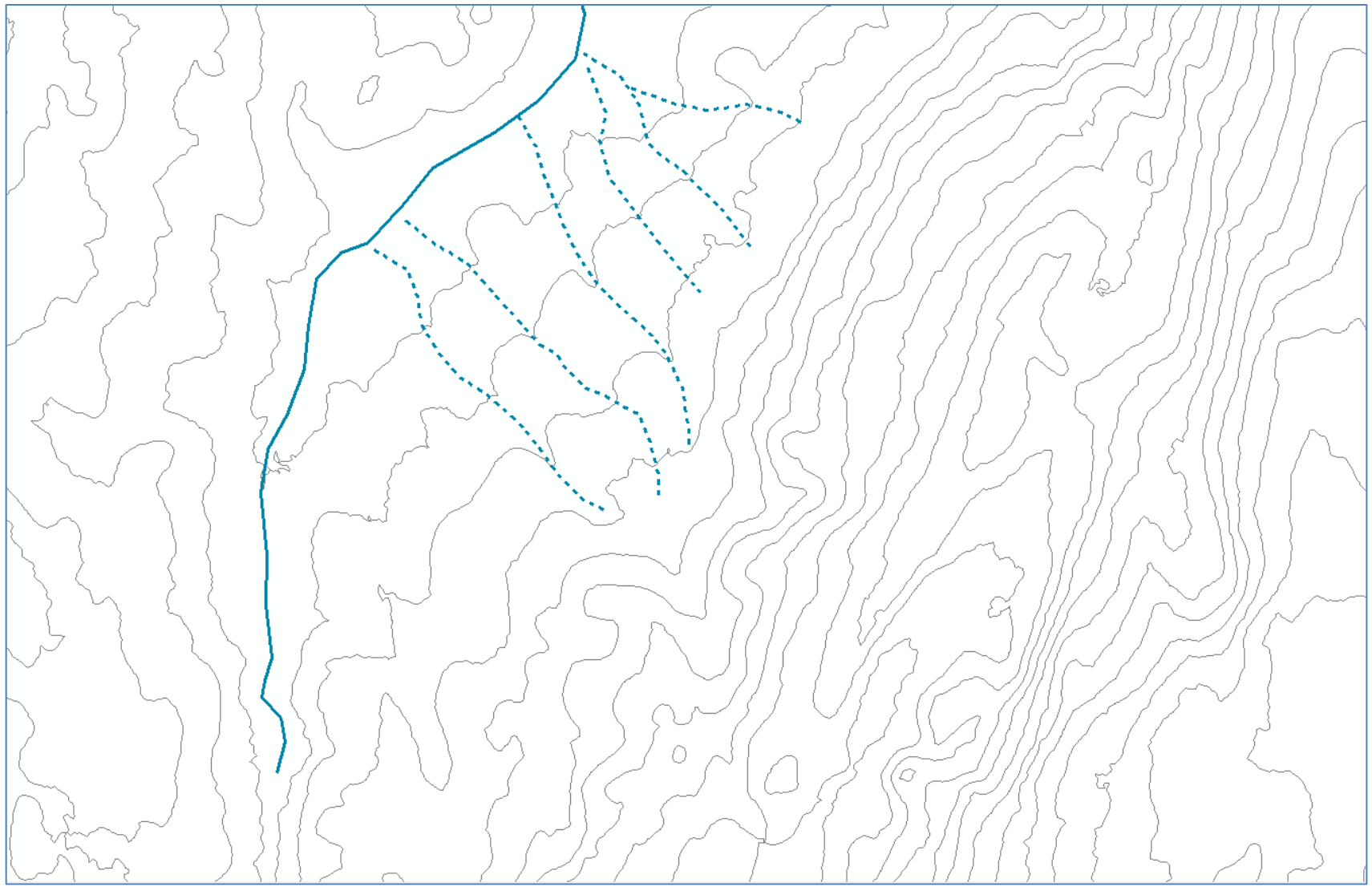
Why care about Stormwater? *Too much water too fast!*

- Unstable channel and habitat
- Bank failure
- Culvert failure
- Deposition of sediment downstream
- Flooding
- Erosion of contributing channels

Why care about Stormwater? *Too much water too fast!*

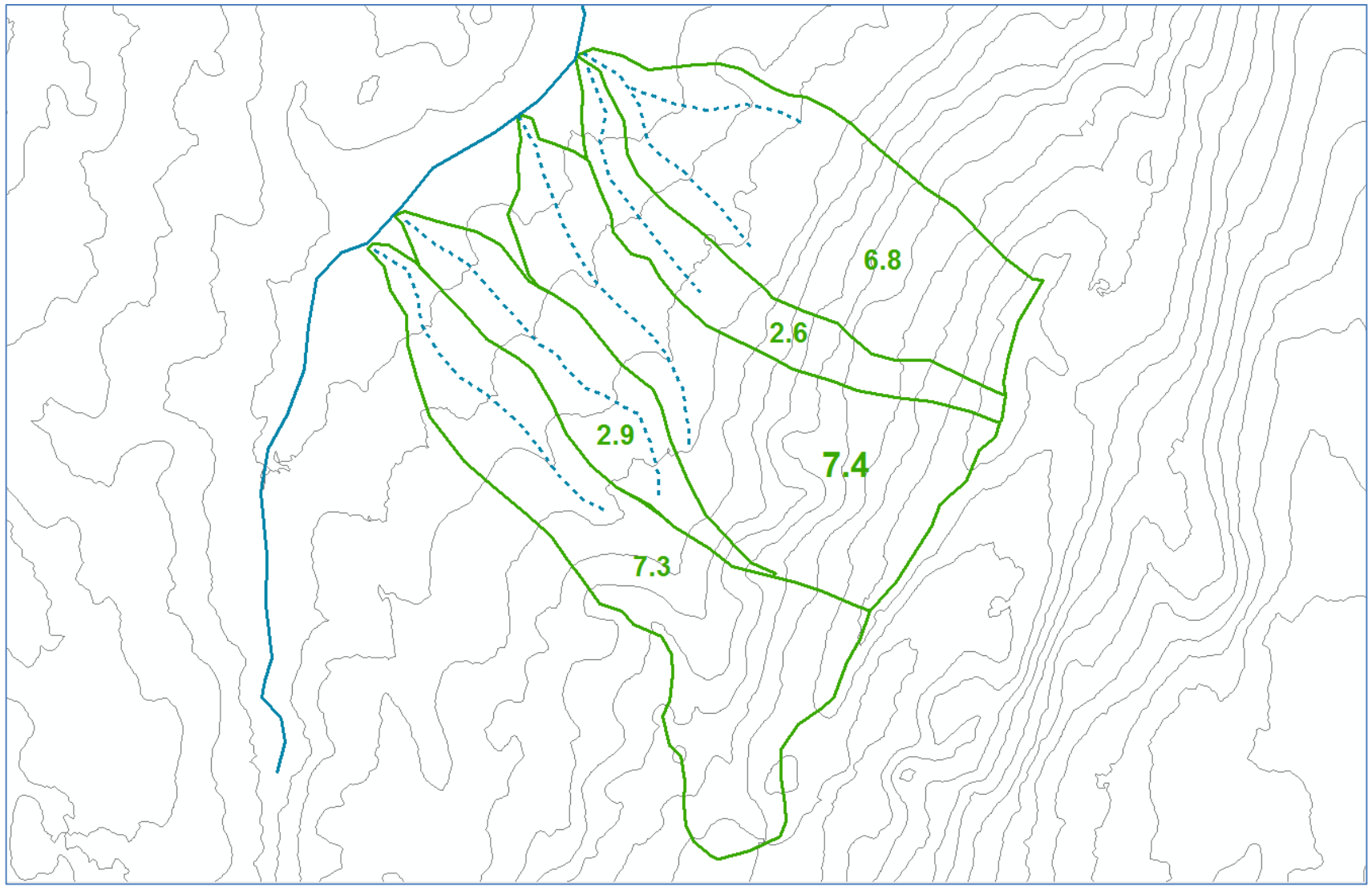
Why care about Stormwater?

Altered Drainage Patterns!



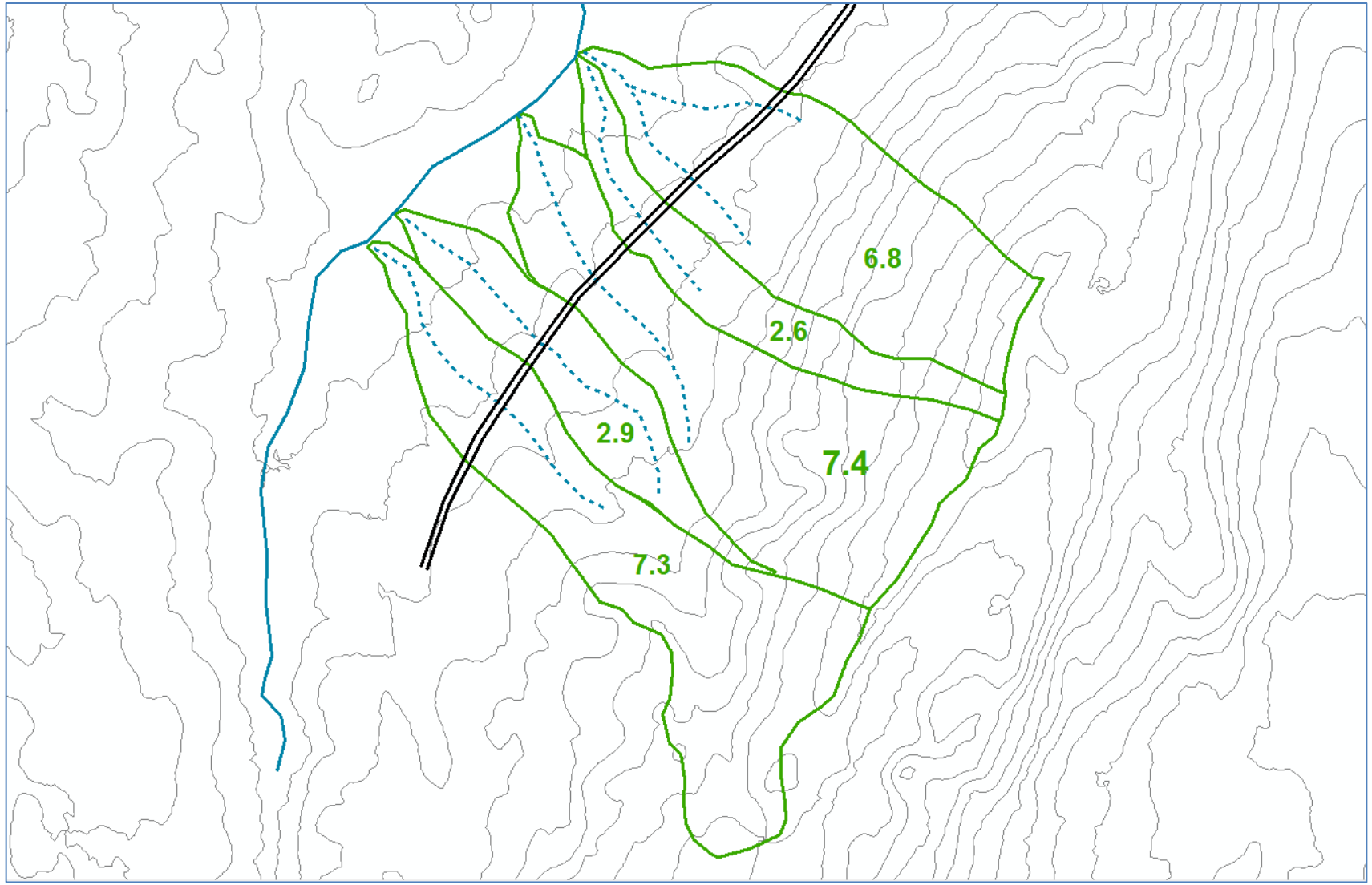
Why care about Stormwater?

Altered Drainage Patterns!



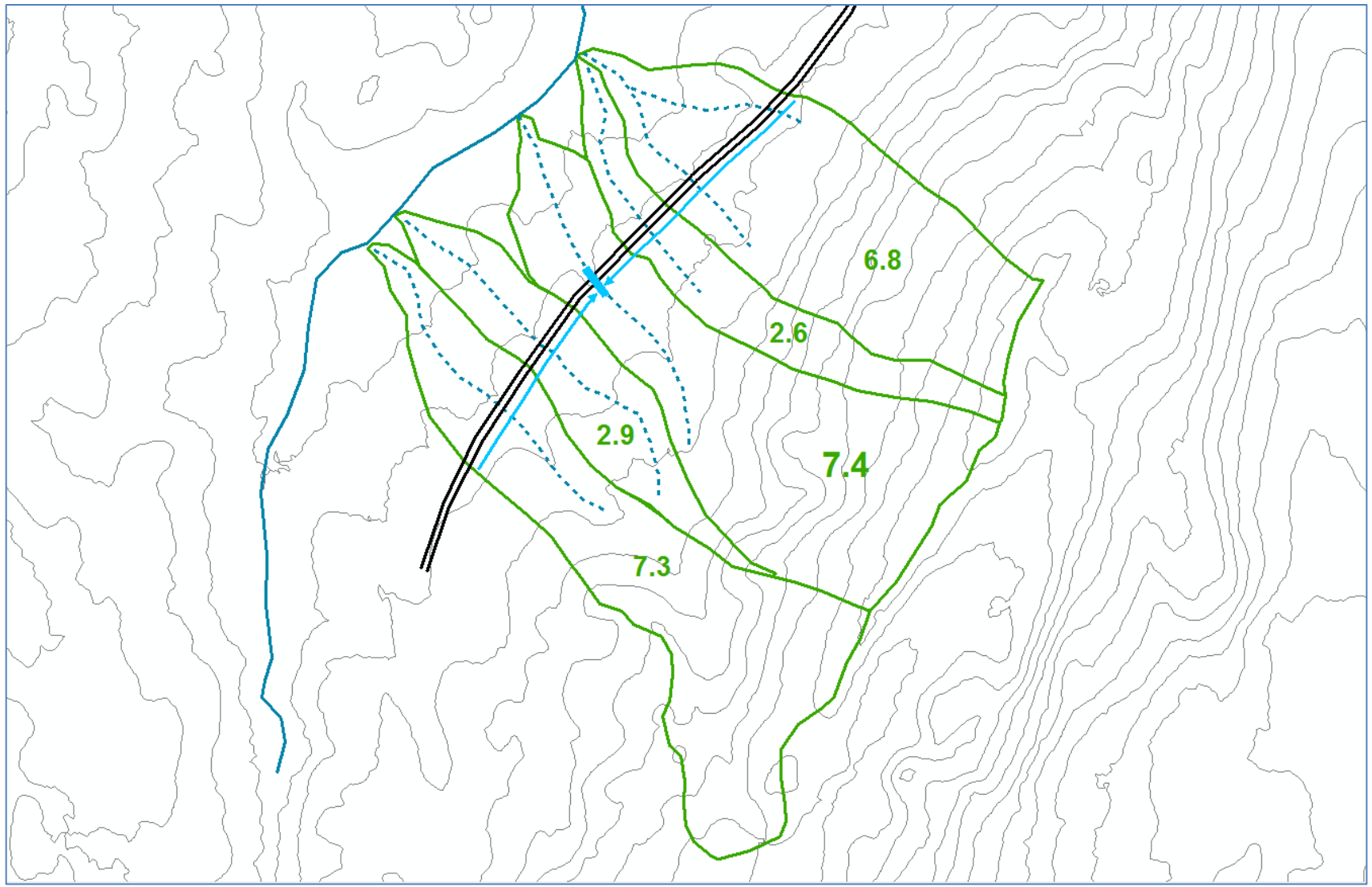
Why care about Stormwater?

Altered Drainage Patterns!



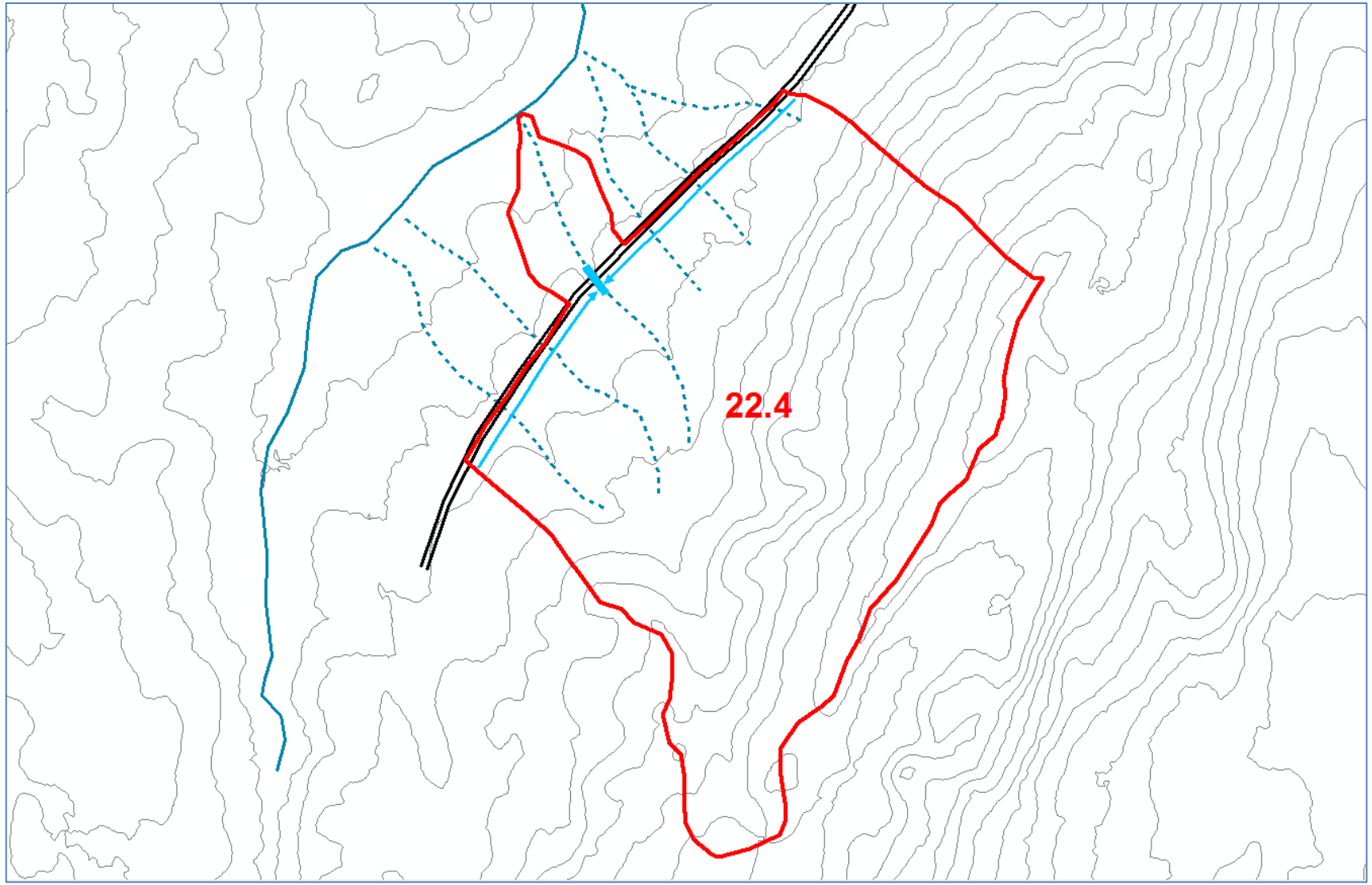
Why care about Stormwater?

Altered Drainage Patterns!



Why care about Stormwater?

Altered Drainage Patterns!



Why care about Stormwater? *Altered Drainage Patterns!*

Naturally, runoff reaches streams via a network of intermittent channels.

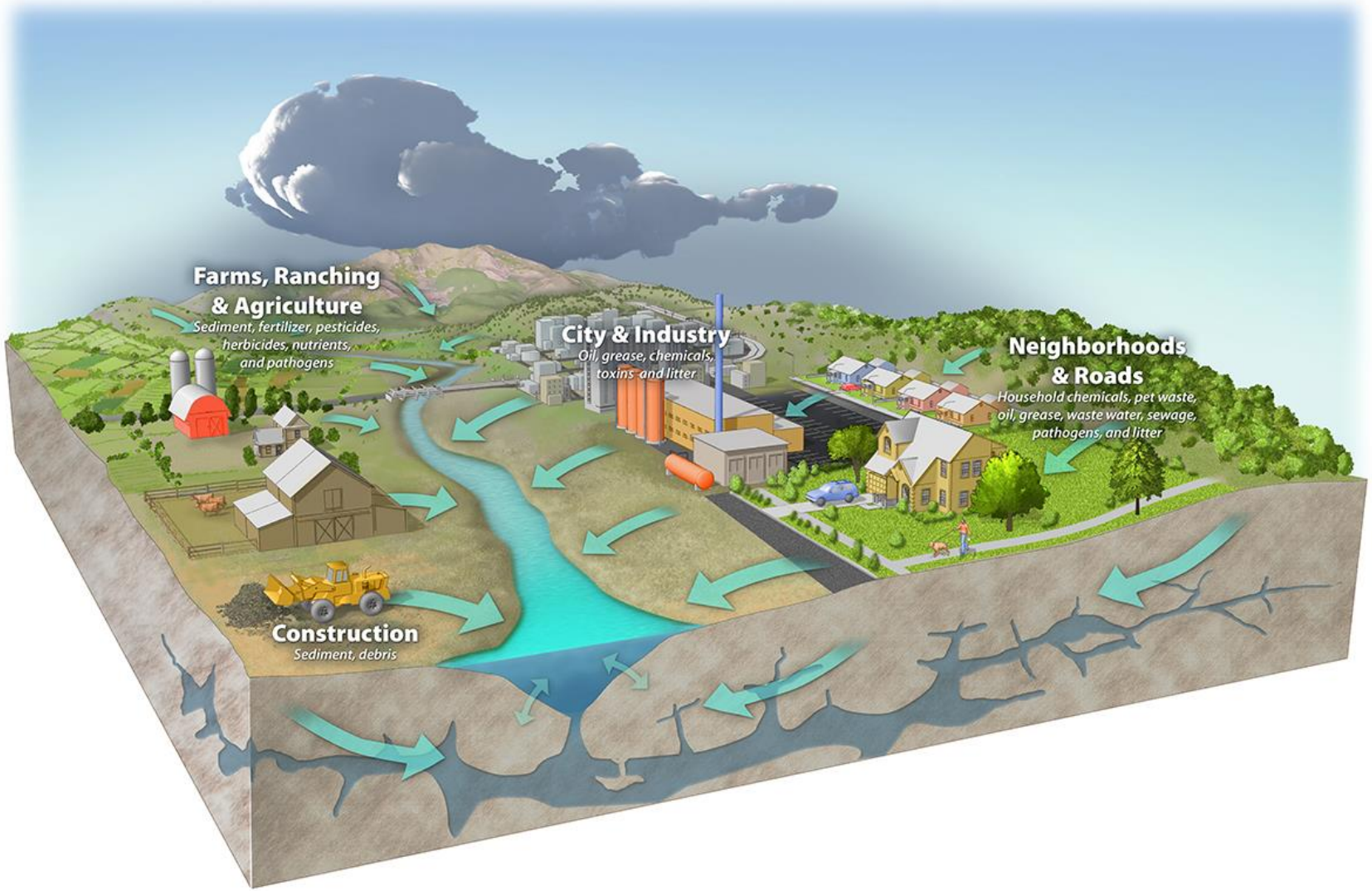
If the watersheds of some of these natural channels are combined by road ditching or other development activities, catastrophic erosion of the undersized receiving channel can occur, followed by severe downstream sedimentation.

Why care about Stormwater? *Pollution!*

Non-Point Source (NPS)

Point Source

Non-Point Source Pollution

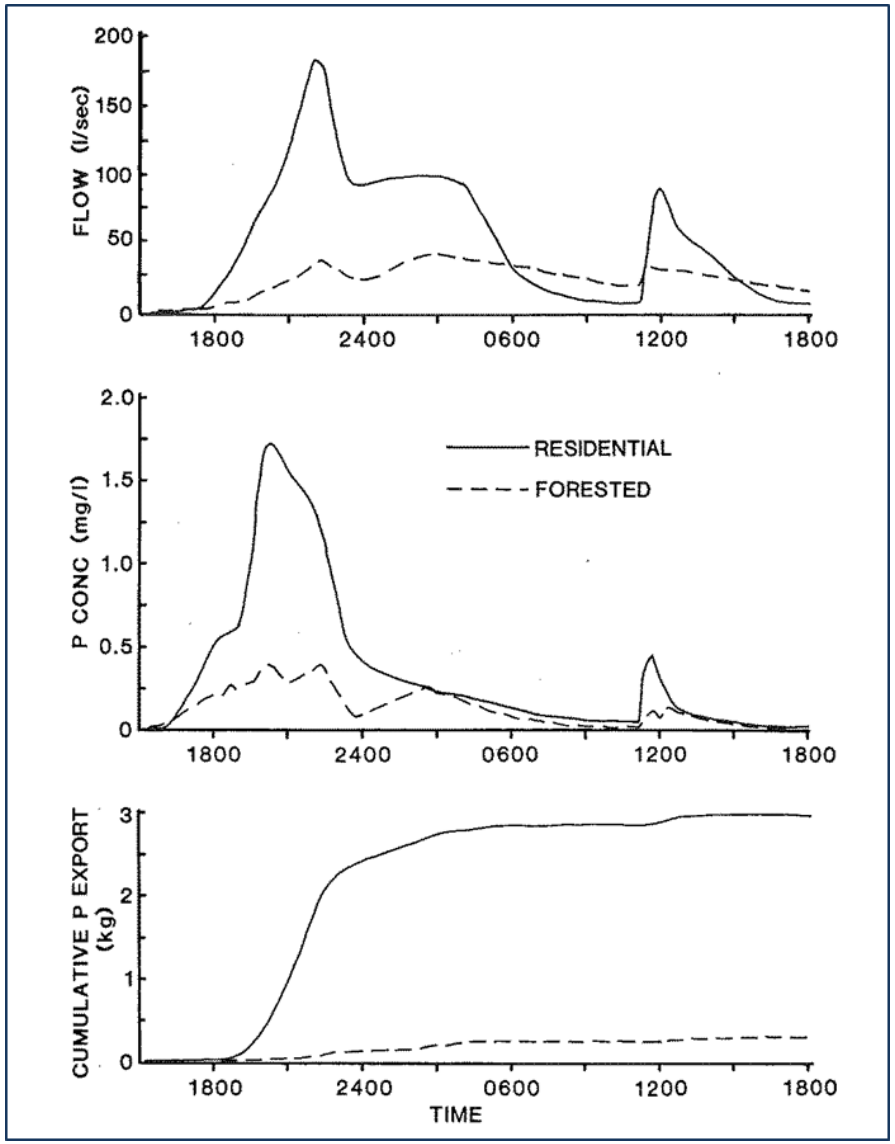


NPS Pollution – Nutrients: Phosphorous

- Phosphorus attached to very fine soil particles can be carried by stormwater to the lake or stream from anywhere in the watershed, even in relatively rural watersheds
- Maine lakes have very low phosphorus concentrations so small inputs of phosphorus can make a big difference
- Altered hydrology can also result in phosphorus discharge from eroded channels
- Stormwater runoff from urban areas is rich in phosphorus

NPS Pollution – Nutrients: Phosphorous

Stormwater from residential areas carries 5 to 10 times as much phosphorus as stormwater from forested areas



Lake Vulnerabilities - Eutrophication

- Phosphorus (**P**) ↑ → Algae ↑
- Algae ↑ → Water clarity ↓
- Algae ↑ → Deep water DO ↓

Most of the **P** comes from the watershed:

- forested watershed: **P↓**
- rural residential watershed: **P↑**
- urban watershed: **P↑↑**
- agricultural watershed: **P↑↑↑**

NPS Pollution – Nutrients: Nitrogen

- Nitrogen present in stormwater in multiple forms:
  - Nitrate
  - Nitrite
  - Ammonium
  - Dissolved Nitrogen
  - Particulate Nitrogen
- Nitrogen is limiting nutrient for Casco Bay and other coastal waterbodies

NPS Pollution – Nutrients: Nitrogen

- Nitrogen promotes algae growth (like phosphorous in lakes)
- Some algae has toxic blooms that kill aquatic wildlife
- Reduction in water clarity / quality harms keystone species like Eelgrass
- Dead algae adds CO_2 to coastal waters, creating acidification problems for shellfish

NPS Pollution – Toxins

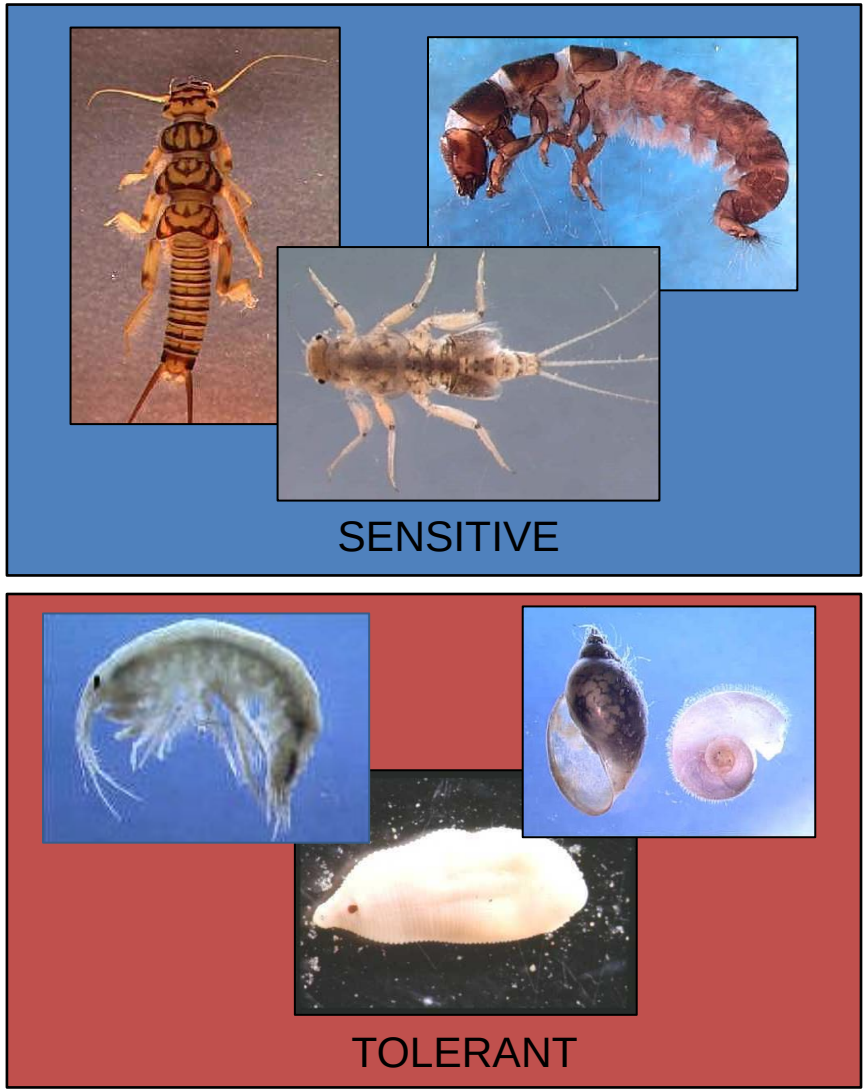
- Some toxins are delivered to the stream via stormwater runoff
  - heavy metals
  - hydrocarbons
  - pesticides
- Chloride (from salt) is delivered to the stream

NPS Pollution – Toxins

Toxic substances in stormwater and groundwater from urban and agricultural areas:

- reduce the abundance of aquatic organisms
- reduce the diversity of aquatic community
- cause a shift from sensitive to tolerant organisms

Deicing salt (chloride) contamination of groundwater is very problematic in small, urbanizing streams

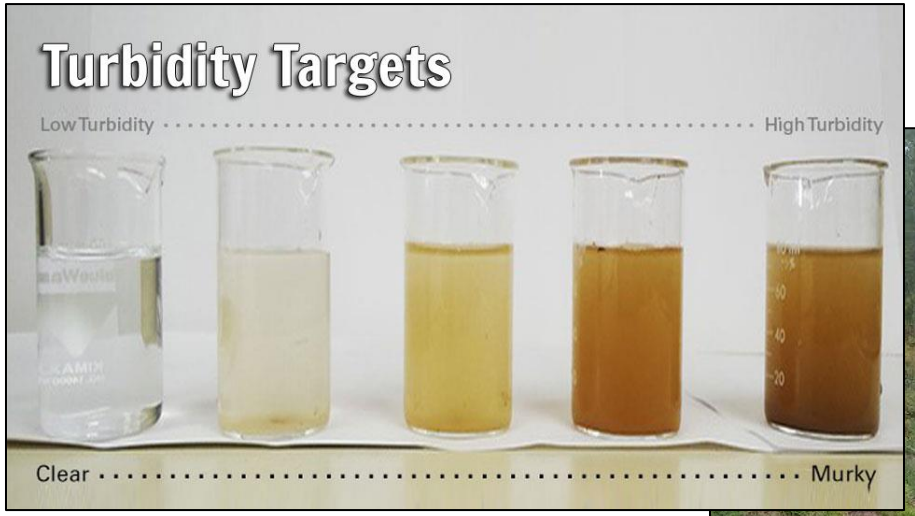


NPS Pollution – Sediment

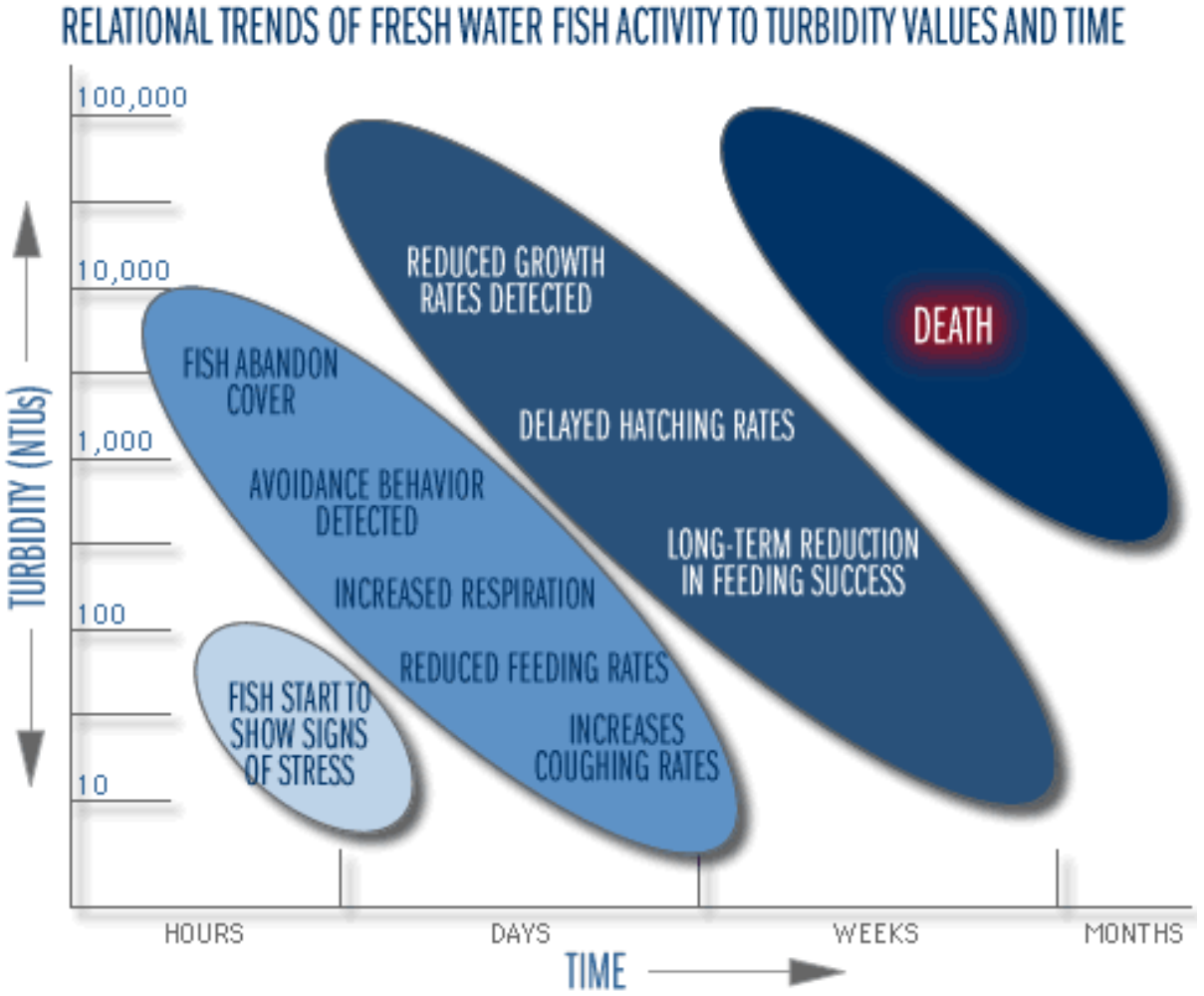
- Sometimes called TSS or total suspended solids
- **Turbidity** – measure of clarity
- Particle size matters

(Smaller particles = harder to remove = longer to settle out)

- Pollutant of concern leaving construction sites

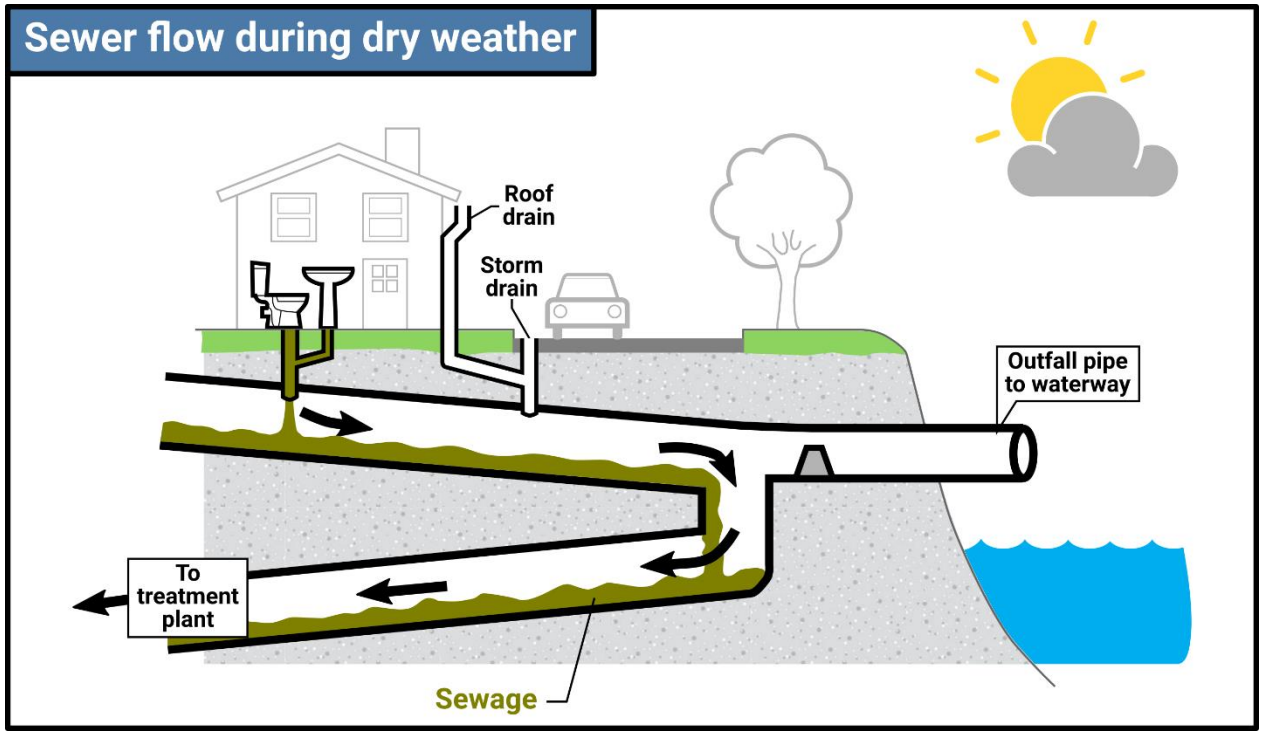


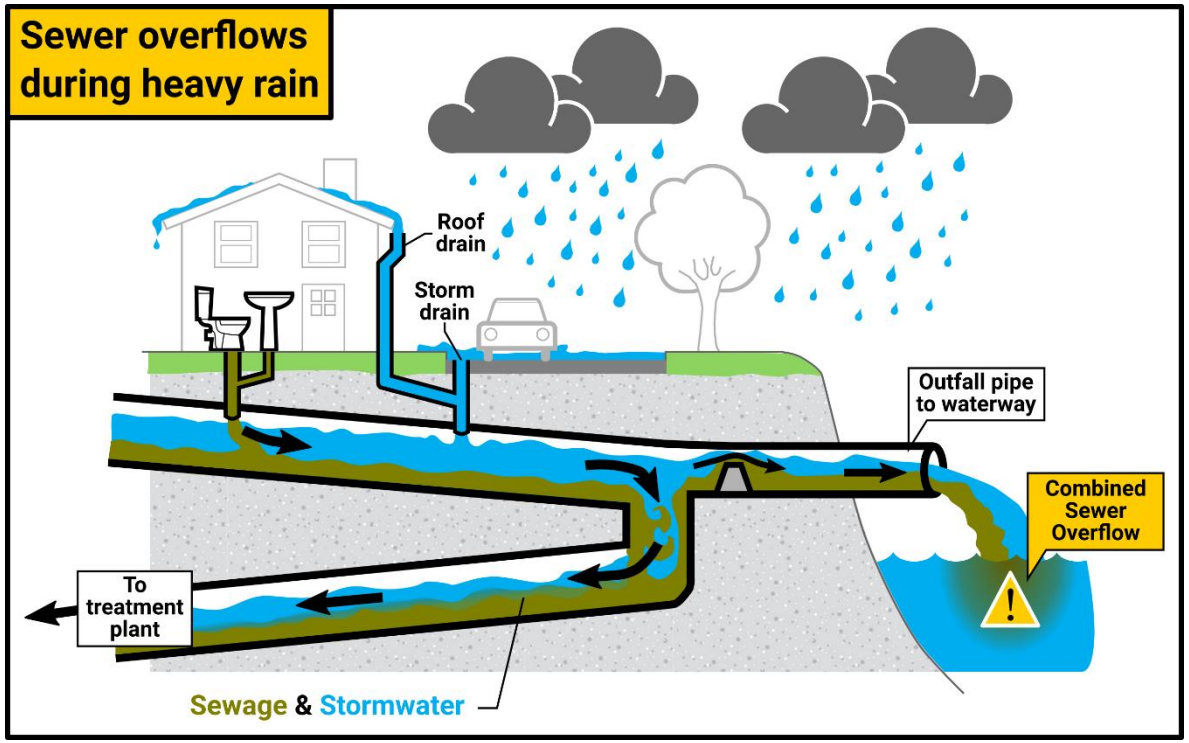
NPS Pollution – Sediment



Schematic adapted from "Turbidty: A Water Quality Measure", Water Action Volunteers, Monitoring Factsheet Series, UW-Extension, Environmental Resources Center

Point Source Pollution – Combined Sewer Overflow





Point Source Pollution – Combined Sewer Overflow

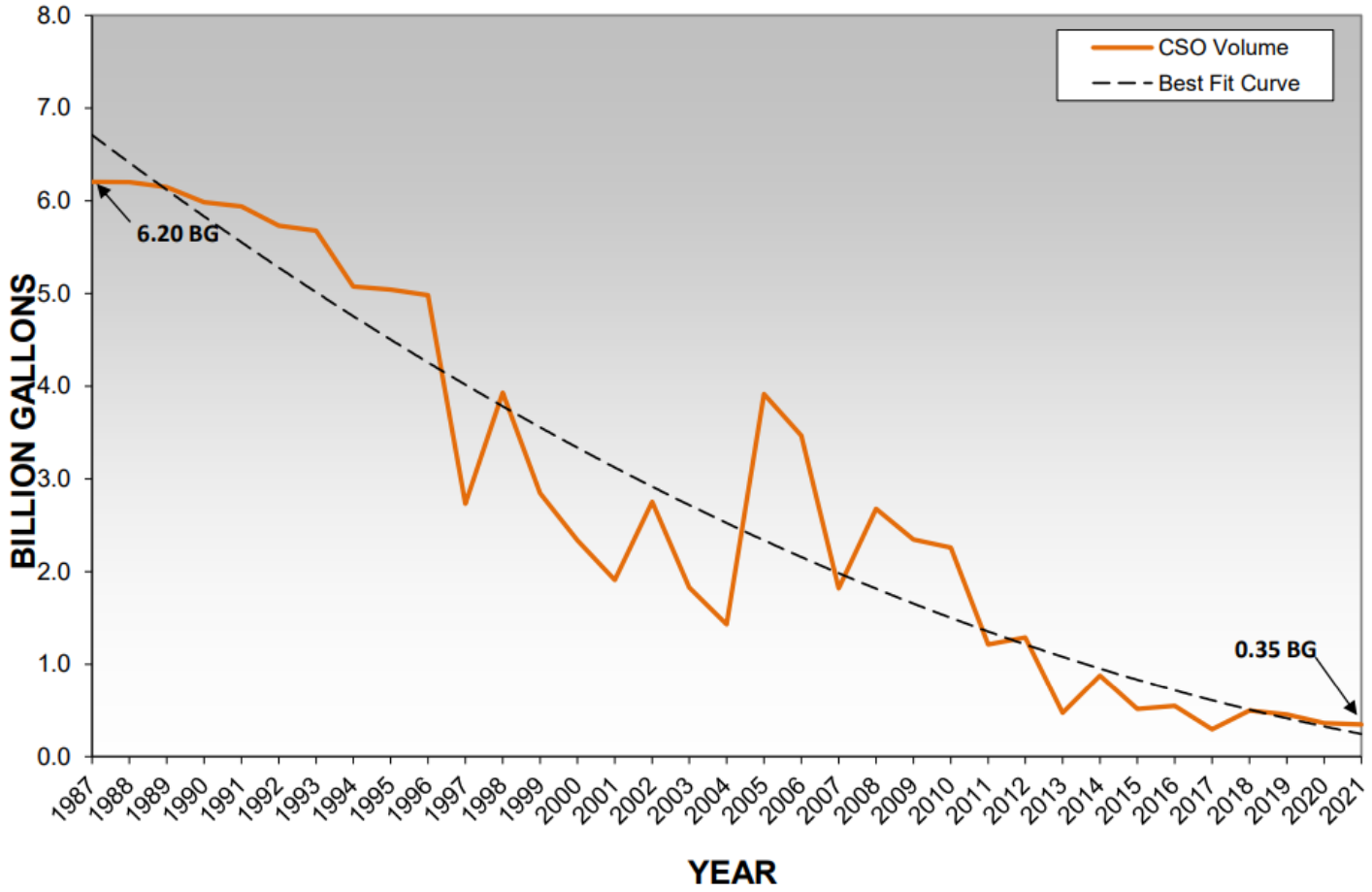
Maine Combined Sewer Overflow 2021 Status Report

June 2022

Contact: Michael S. Riley, P.E.
CSO Abatement Coordinator
Bureau of Water Quality
Phone: (207) 719-0809

Document No.: DEPLQ0972N-2022

Maine – Statewide Combined Sewer Overflow (CSO) Volume Discharged



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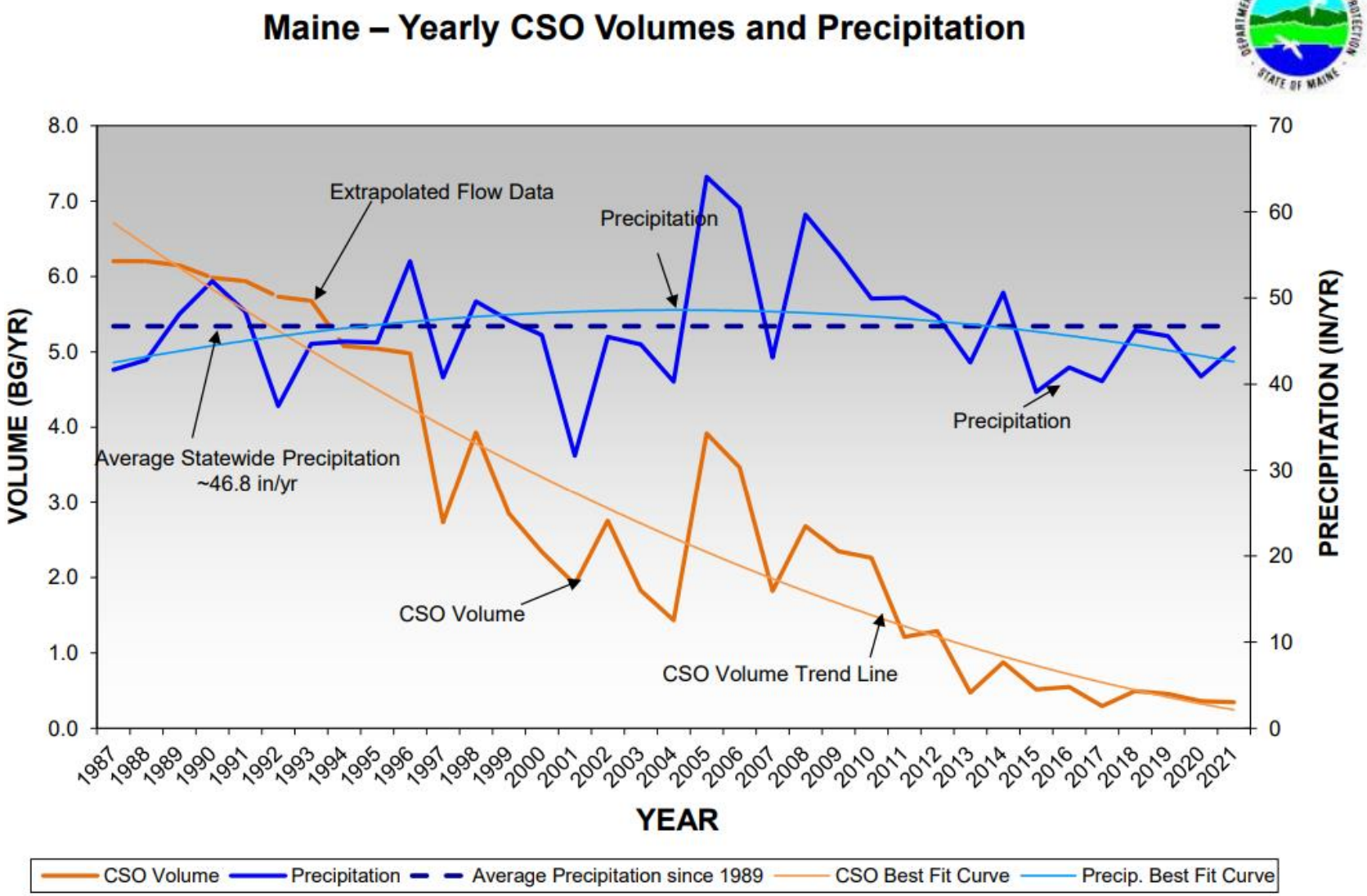
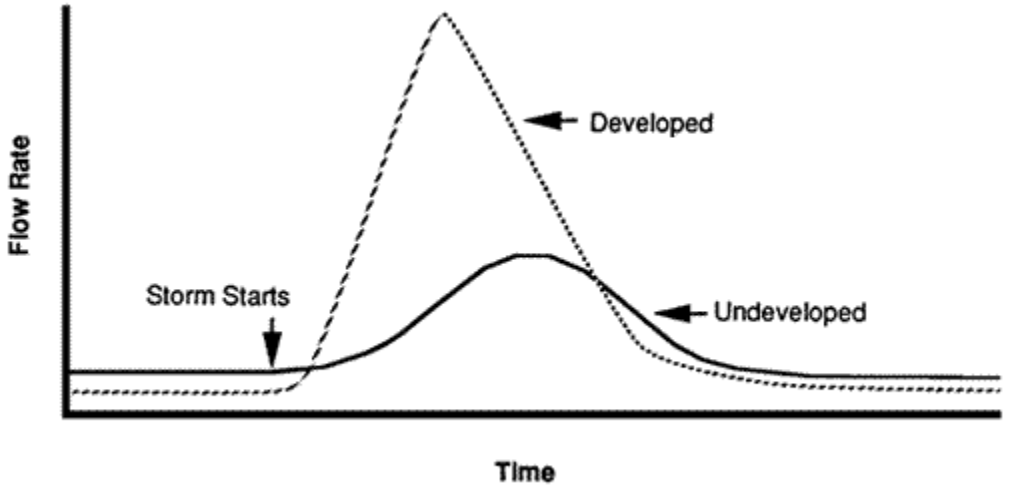


How do we manage it?

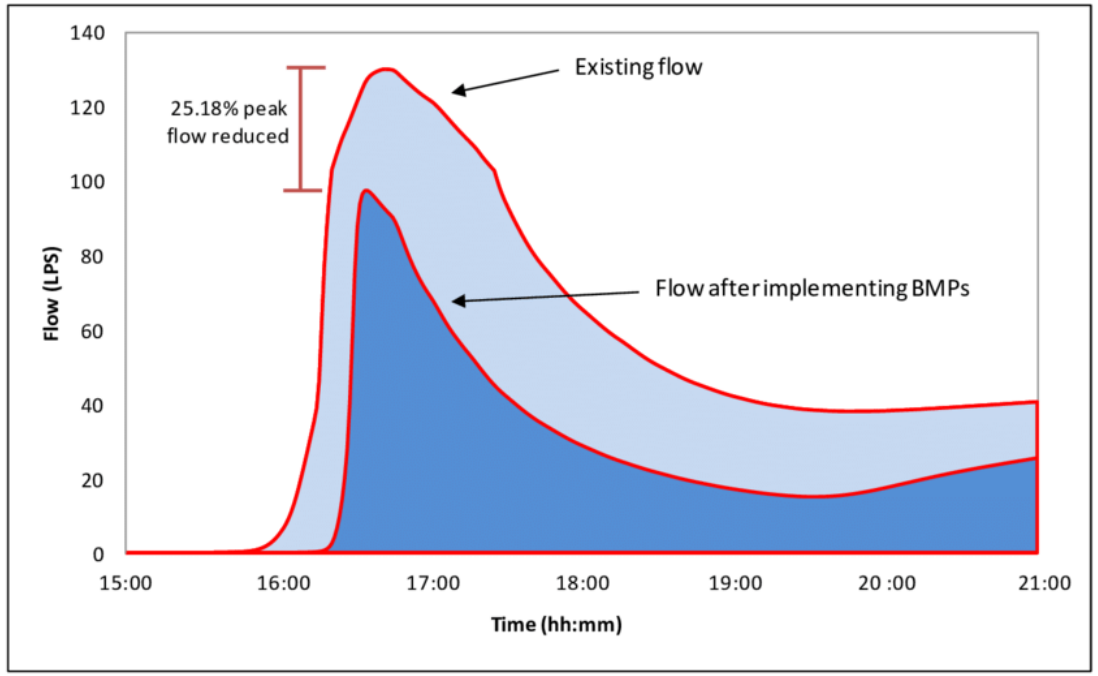
Stormwater Management Goals:

- Maintain pre-development hydrology
  - Avoid drastic changes to drainage areas
  - Control volume of runoff and peak flows
  - Maintain groundwater recharge
  - Provide water quality treatment
- Minimize non-point source pollution
- Separate combined sewers – disconnect drainage areas

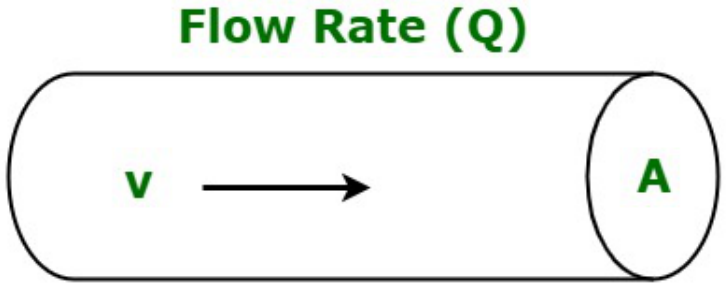
Maintain Pre-Existing Hydrology



Source: R.R. Horner

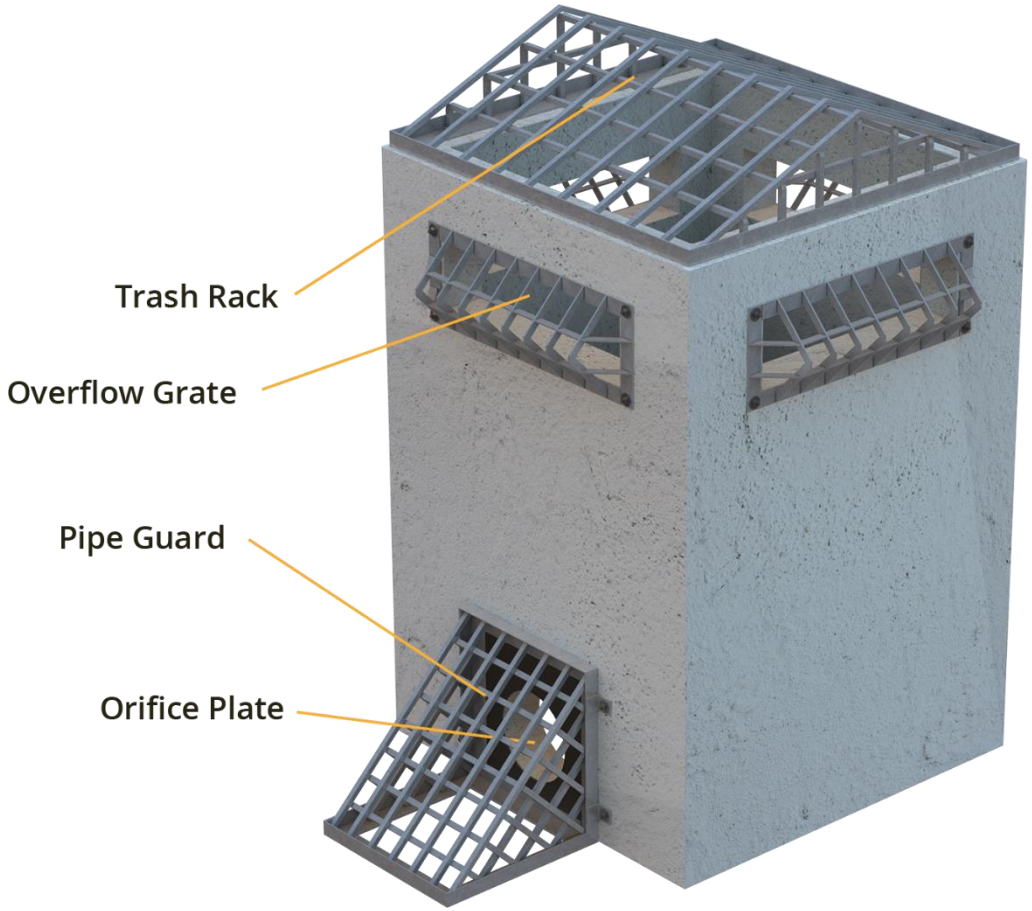


Get the hydrograph to resemble pre-developed condition.



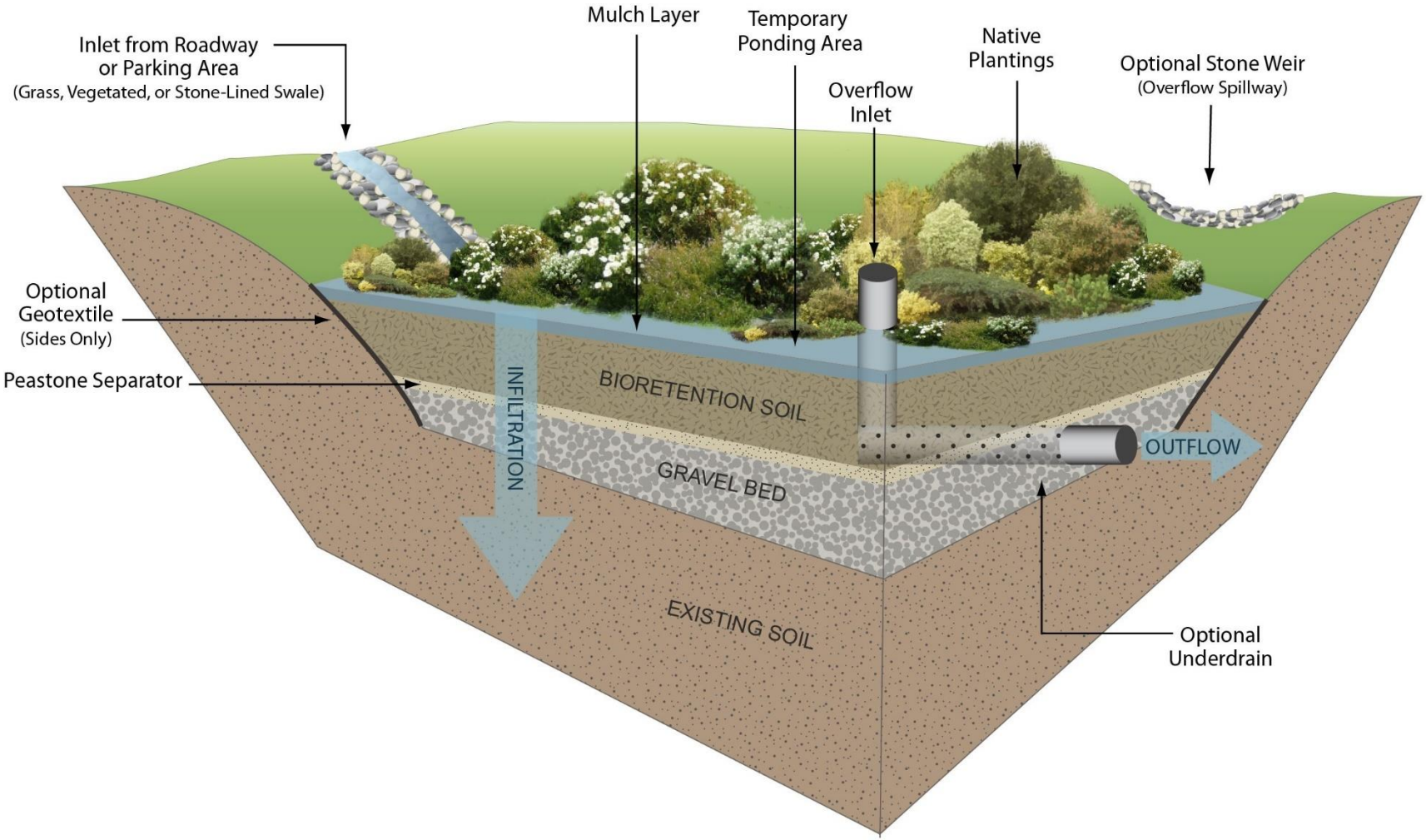
Maintain Pre-Existing Hydrology

$$Q = A \times v$$



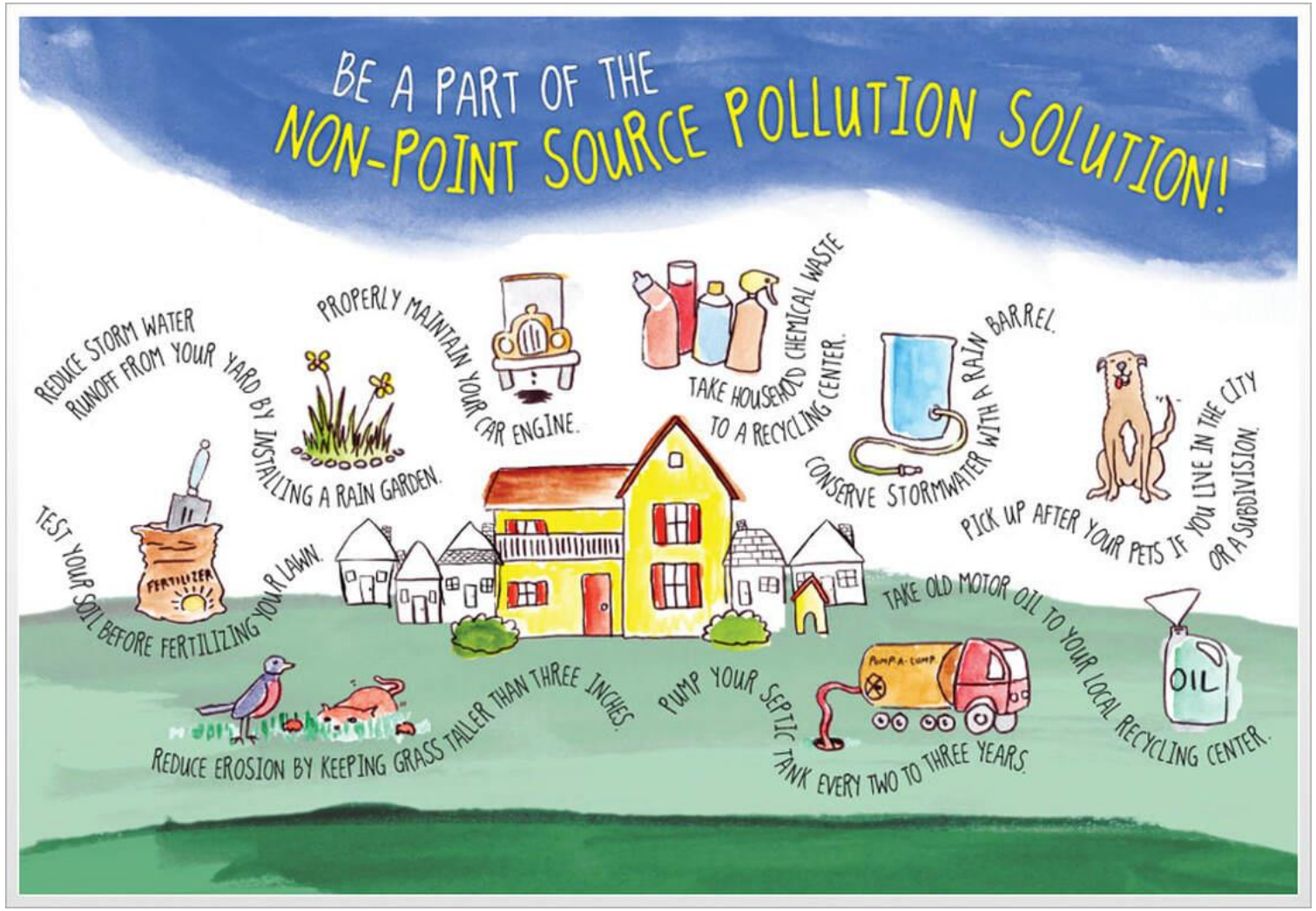
Maintain Pre-Existing Hydrology + Treating Pollutants

- Groundwater recharge via infiltration
- Pollutant removal via physical filtering, microbial activity, vegetation uptake, etc.
- Reduce peak flow via temporary ponding, forcing slow filtering through media, controlling outlet size



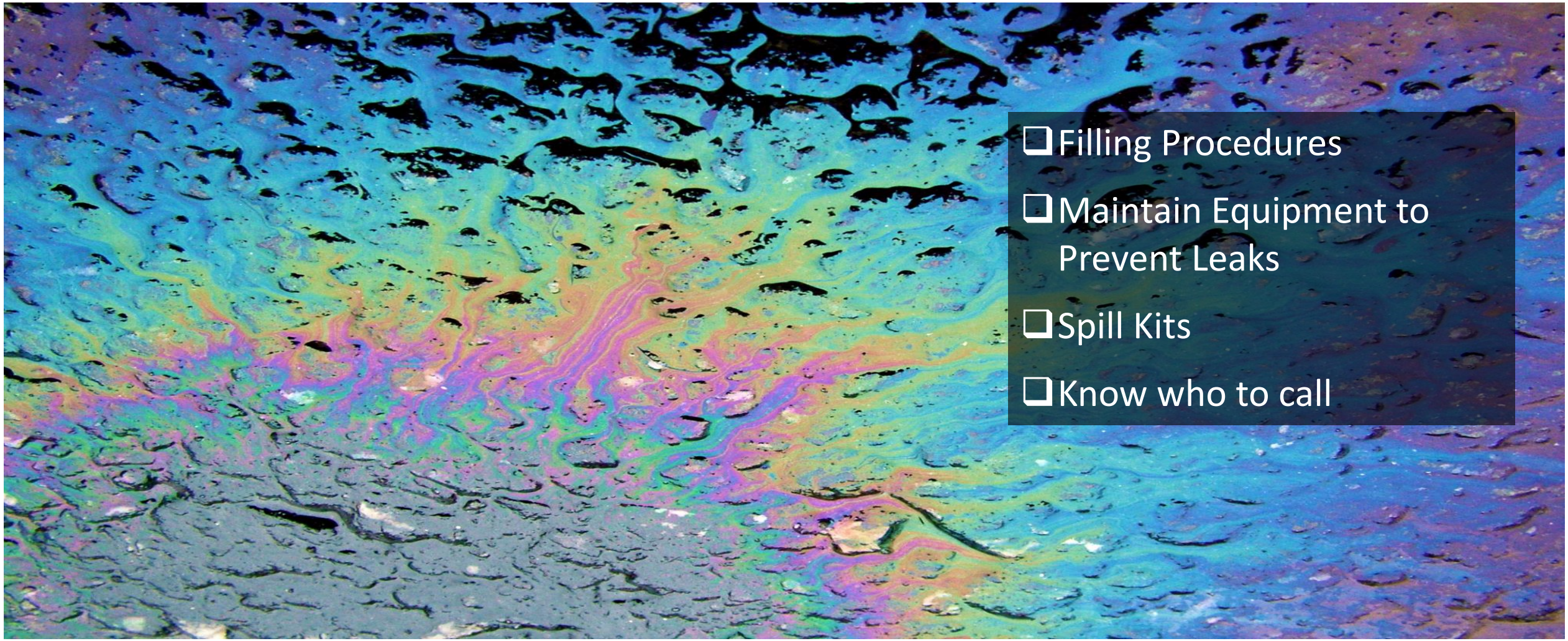
Minimize Non-Point Source Pollution

- SESC – soil erosion and sediment control on construction sites
- Limits on fertilizer use
- Spill prevention & response
- Covered material storage
- Pick up after pets



Soil Erosion & Sediment Control

Spill Prevention and Response



- ❑ Filling Procedures
- ❑ Maintain Equipment to Prevent Leaks
- ❑ Spill Kits
- ❑ Know who to call

Spill Prevention and Response

How to Report a Spill:

Maine DEP Oil Spill Hotline

(24 Hours/Day)

1-800-482-0777

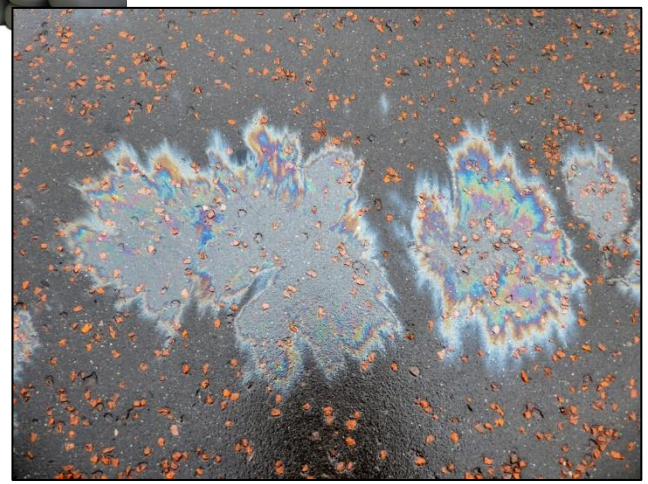
Department of Public Safety - Hazardous Materials Spill/Incident

(24 Hours/Day)

1-800-452-4664

Minimize Non-Point Source Pollution

Keep supplies of spill control materials (Spill Kits) on–site and clean up spills immediately



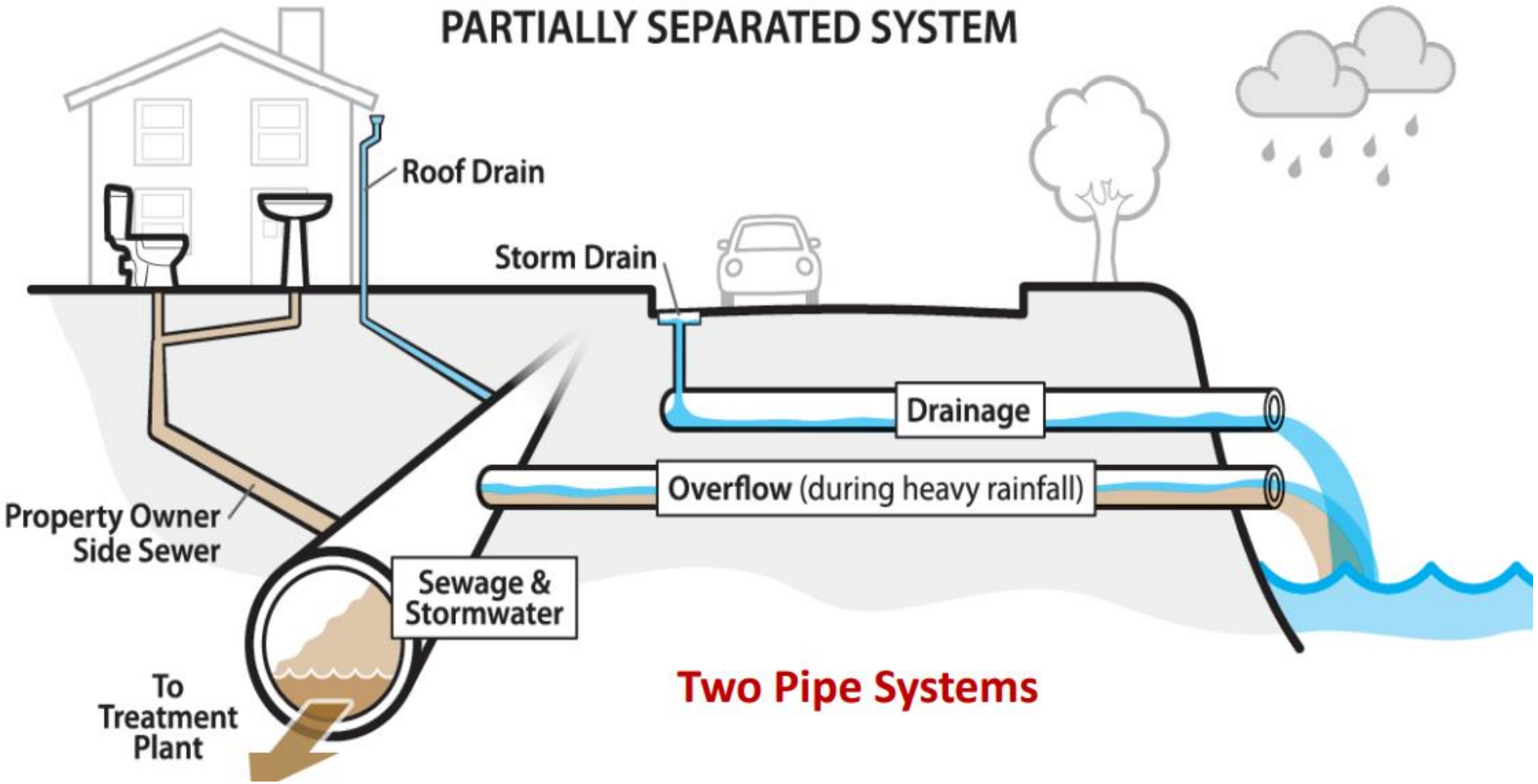
Provide Secondary Containment for Fuel

Minimize Non-Point Source Pollution

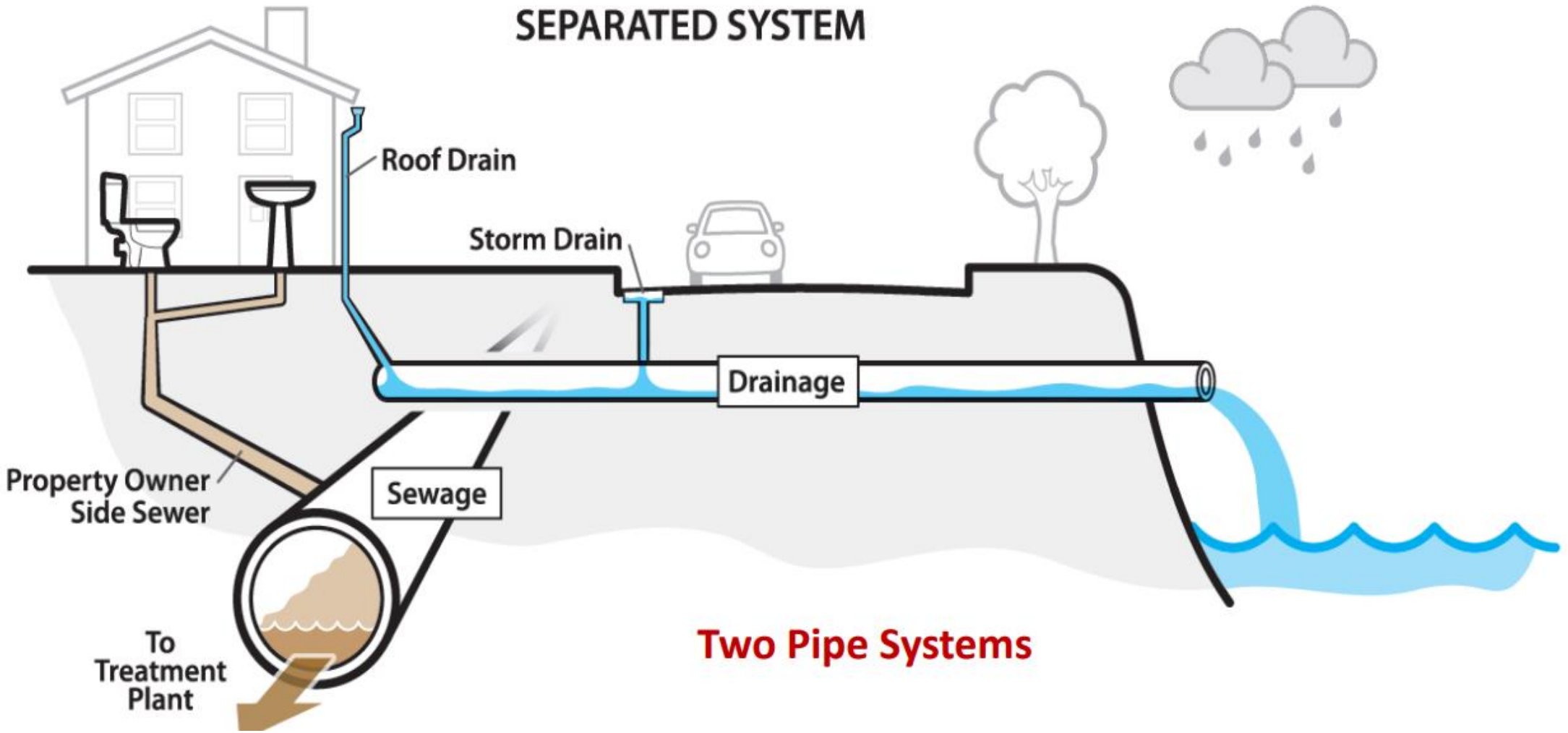
Road Salt Storage

Pet Waste Stations

Separate Combined Sewers



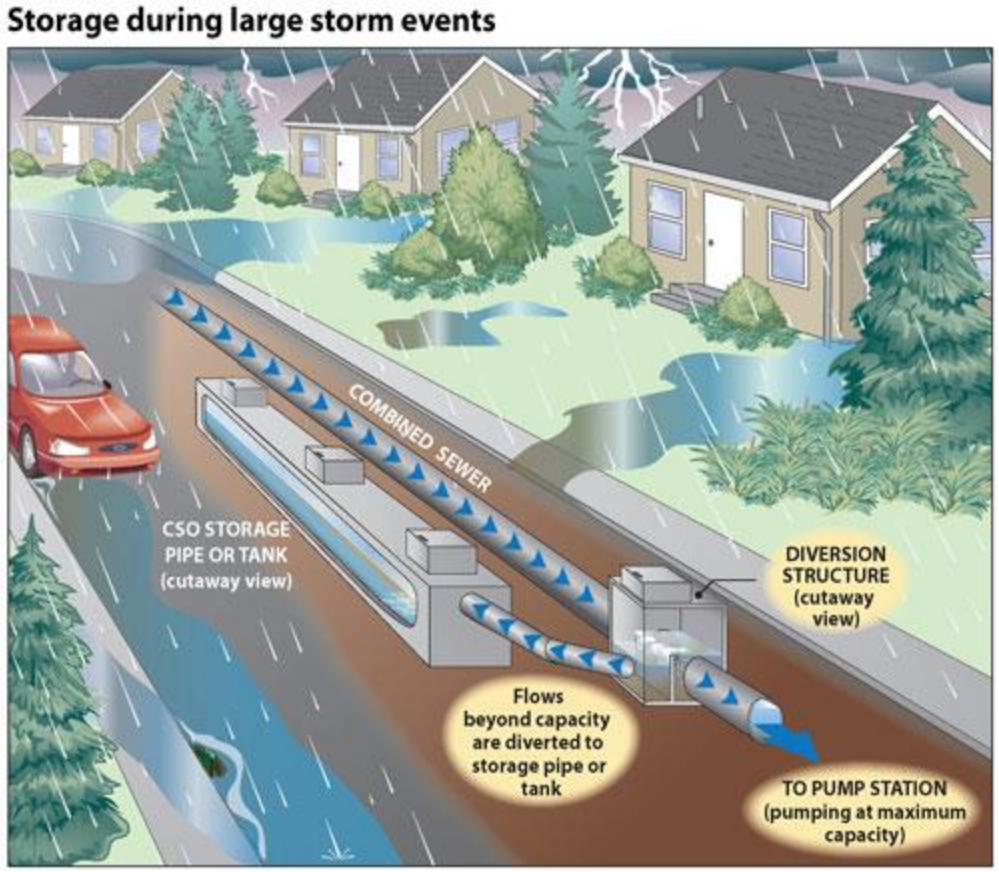
Separate Combined Sewers



Two Pipe Systems

Separate Combined Sewers

Separate Combined Sewers



Separate Combined Sewers

illustration B+O design studio, PLLC

Wrapping Up

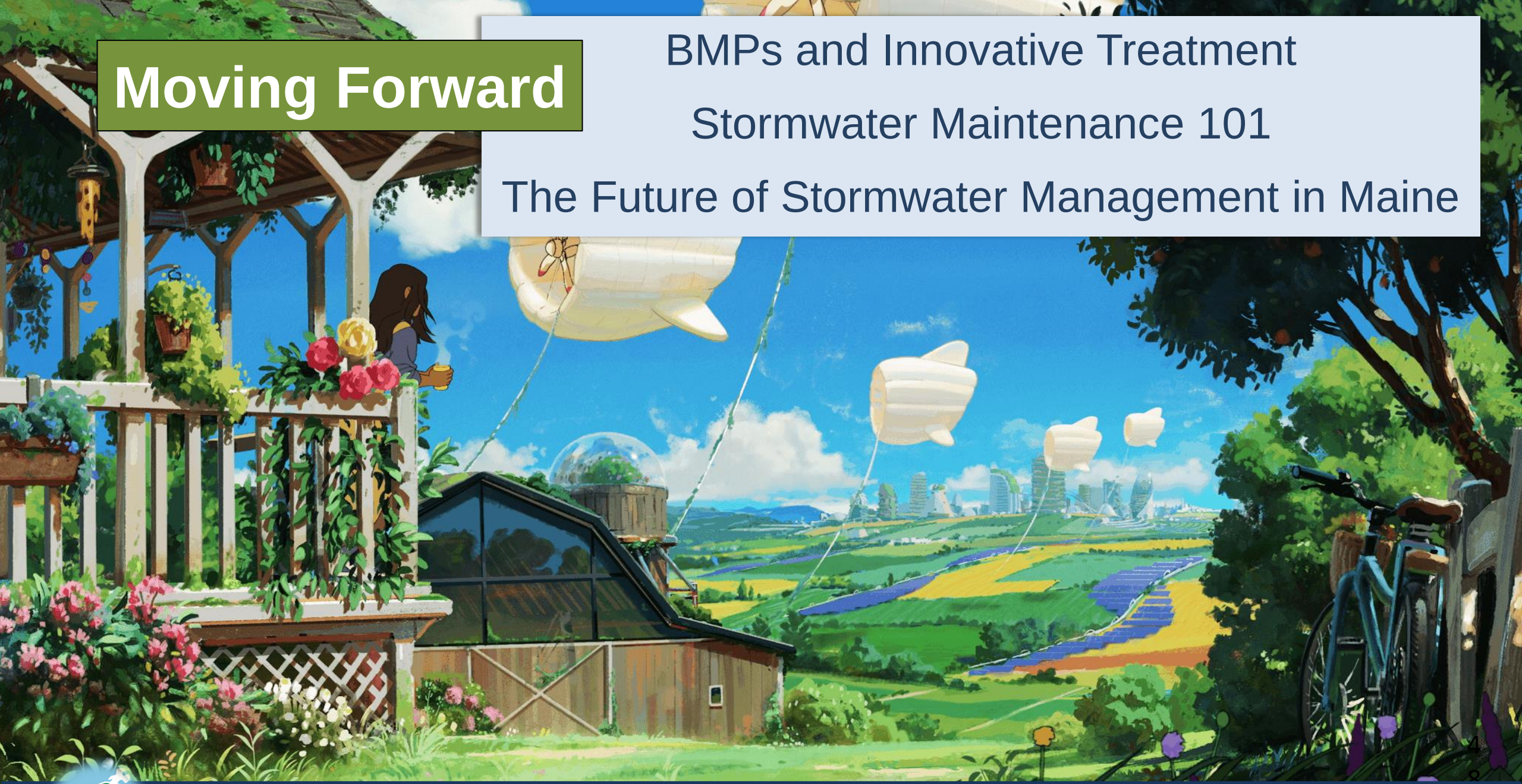
- Common stormwater challenges include peak flow changes, altered drainage areas, non-point source pollution, and combined sewers.
- We can address these issues by attempting to maintain pre-development hydrology, minimizing NPS pollution, and separating combined sewer systems.

Moving Forward

BMPs and Innovative Treatment

Stormwater Maintenance 101

The Future of Stormwater Management in Maine



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www.maine.gov/dep