PRWD Rule Revision Board Workshop #2

Establish Baseline Knowledge

moore engineering, inc.

Rule Making is a Process

- When we work the process we
  - Stay focused
  - Systemically address each item
  - Provide important background information
  - Make informed decisions
  - Work towards consensus
- We're not starting from scratch
  - This will be a refinement and clarification process
  - We will revisit and either edit or reaffirm as needed

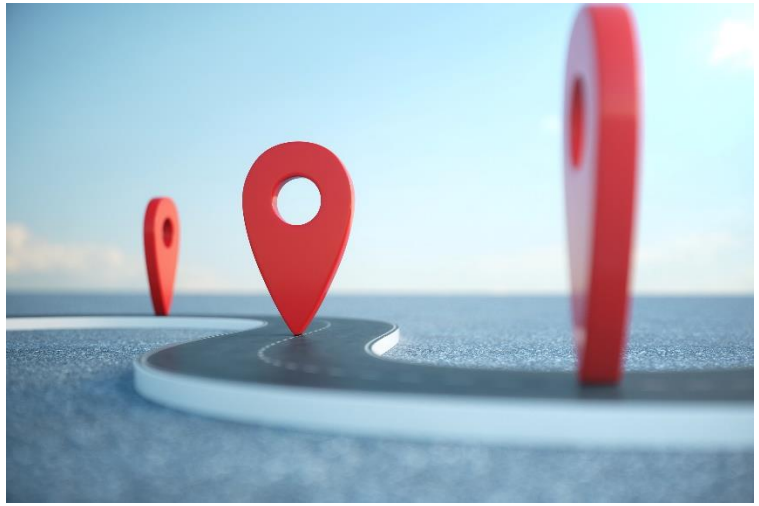
What is the Process?

BWSR Rule Making Handbook

Statutory Requirements

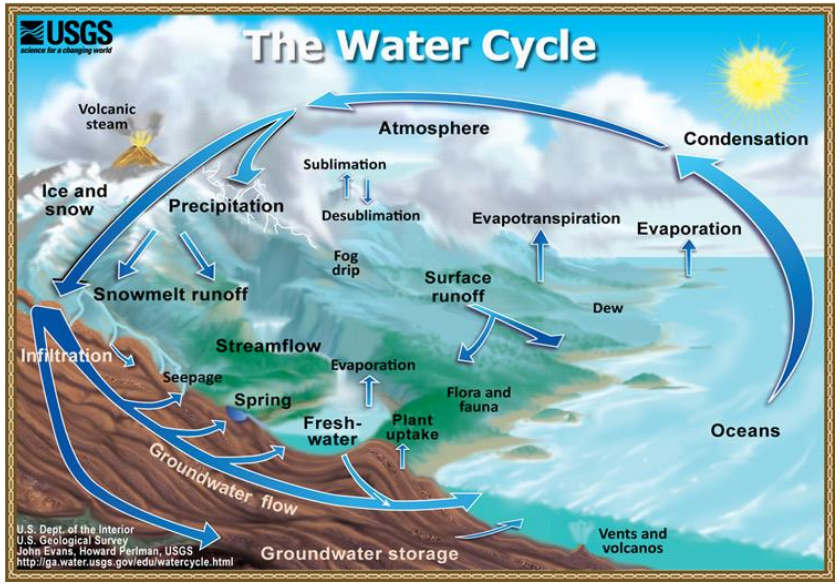
Facilitated by following a Roadmap

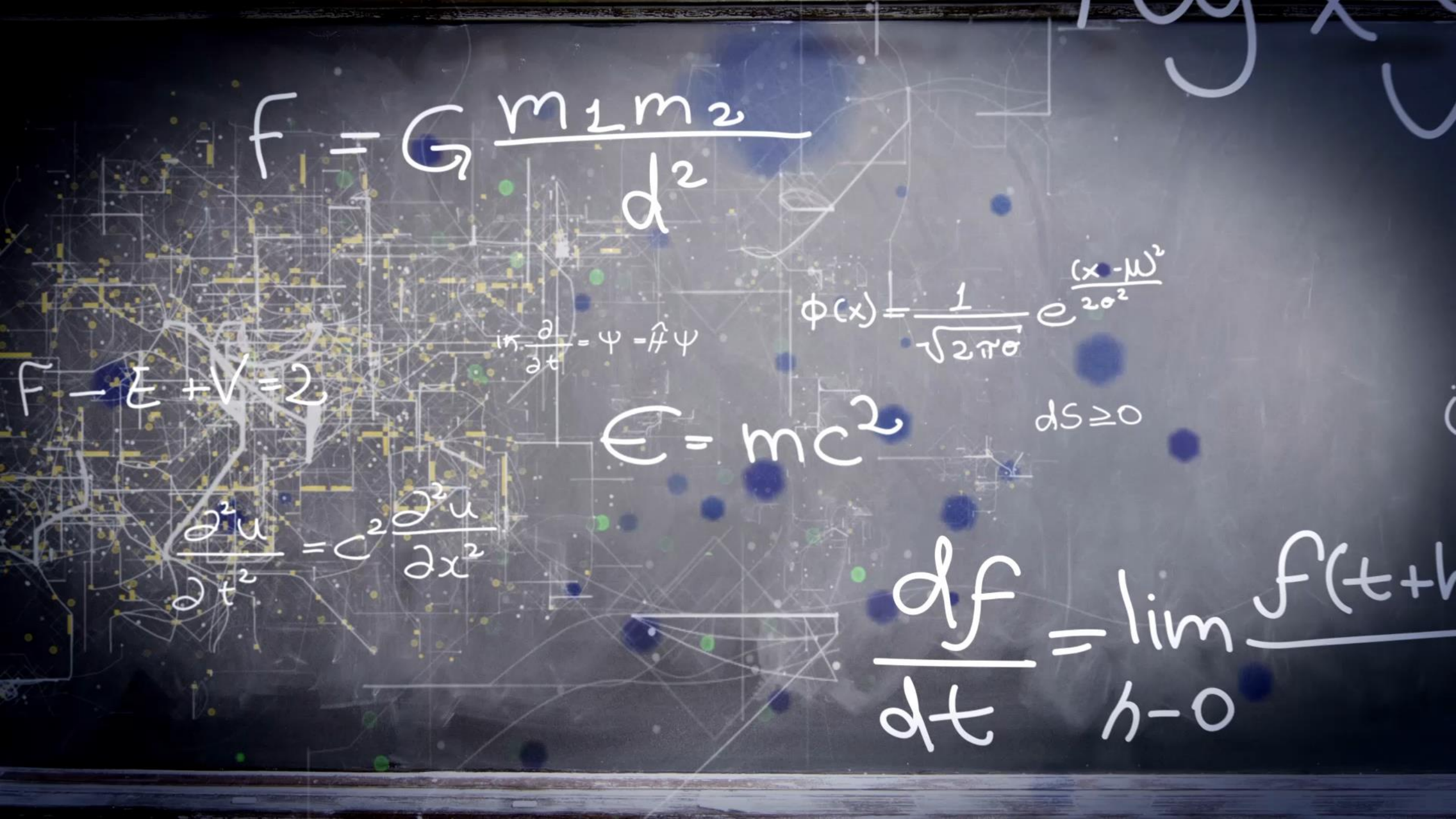
1. ~~Review District Goals & Purpose~~
2. Establish Baseline Knowledge
3. Clarify/Update Rule Language and Criteria
4. Coordination With Other Agencies
5. Establish Procedures/Workflows
6. Stakeholder Review of Proposed Updates
7. Complete Review and Comment Period



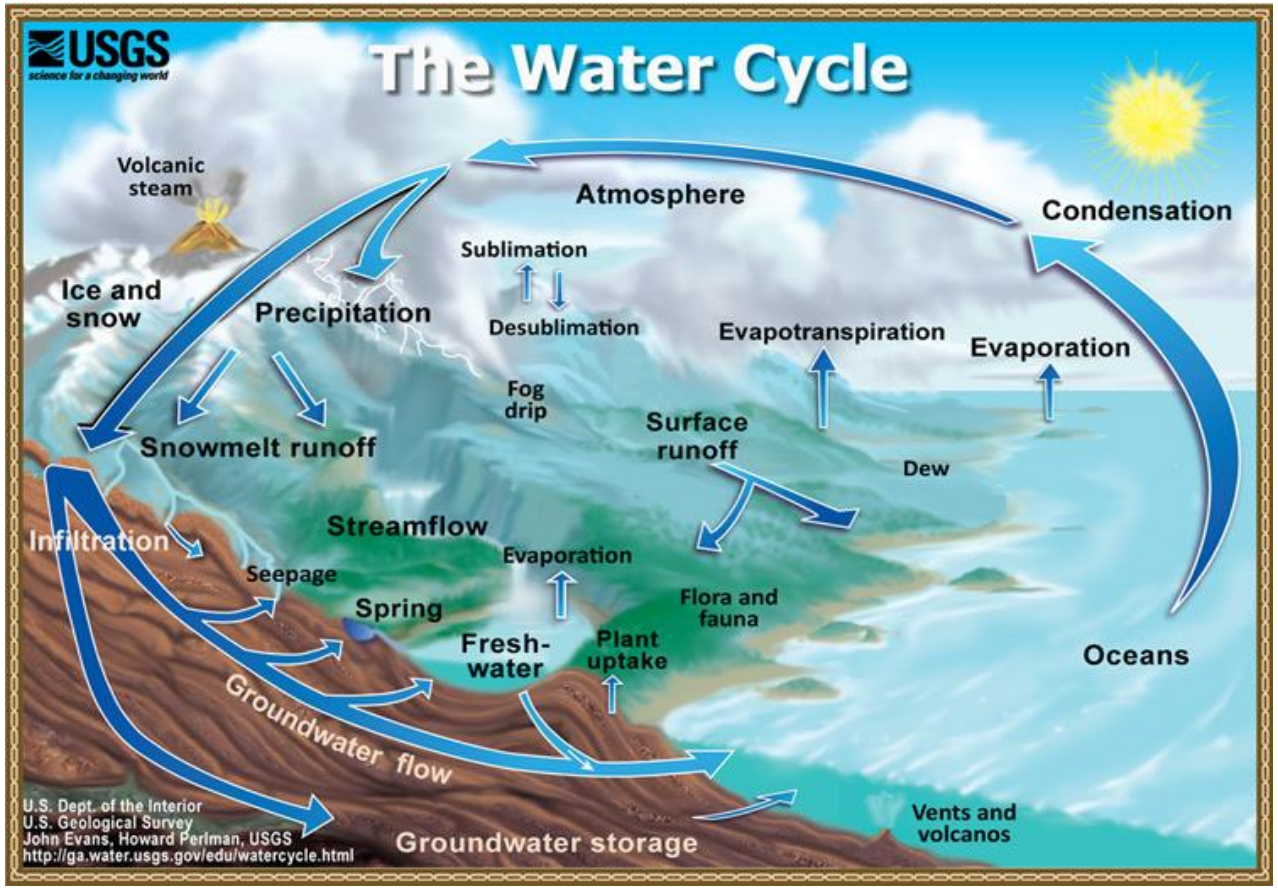
Establish Baseline Knowledge

- Gain common understanding
- Empower informed decision making
- Convey a basic understanding of:
  - Detailed Water Cycle
  - Lake and Stream Health
  - Stormwater and Runoff
  - MIDS
  - Drainage
  - Near Shore Activities

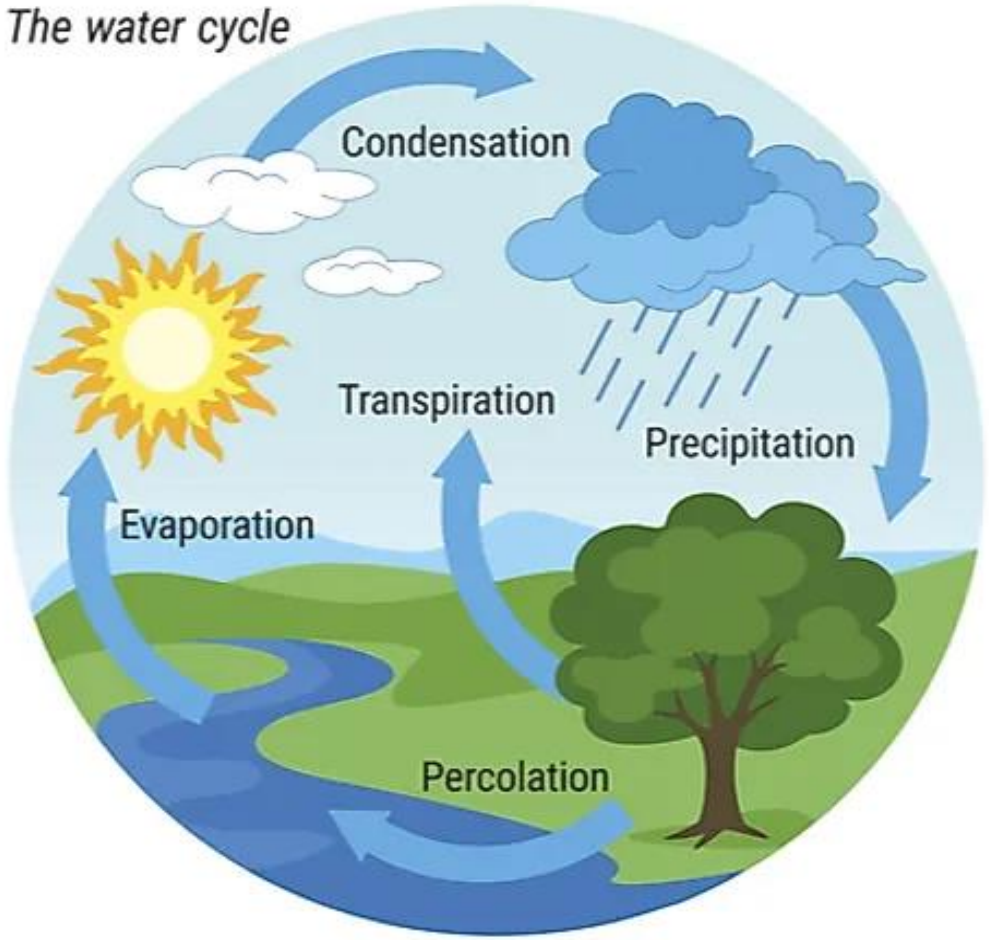



$F = G\frac{m_1 m_2}{d^2}$
$F - E + V = 2$
$i\hbar\frac{\partial}{\partial t}\Psi = \hat{H}\Psi$
$\phi(x) = \frac{1}{\sqrt{2\pi\sigma}} e^{\frac{(x-\mu)^2}{2\sigma^2}}$
$E = mc^2$
$dS \geq 0$
$\frac{\partial^2 u}{\partial t^2} = c^2 \frac{\partial^2 u}{\partial x^2}$
$\frac{df}{dt} = \lim_{h \to 0} \frac{f(t+h}{}$

Water Cycle


USGS
science for a changing world
The Water Cycle
Volcanic steam
Atmosphere
Condensation
Sublimation
Ice and snow
Precipitation
Desublimation
Evapotranspiration
Evaporation
Fog drip
Surface runoff
Snowmelt runoff
Dew
Streamflow
Infiltration
Evaporation
Seepage
Flora and fauna
Spring
Fresh-water
Plant uptake
Oceans
Groundwater flow
U.S. Dept. of the Interior
U.S. Geological Survey
John Evans, Howard Perlman, USGS
http://ga.water.usgs.gov/edu/watercycle.html
Groundwater storage
Vents and volcanos

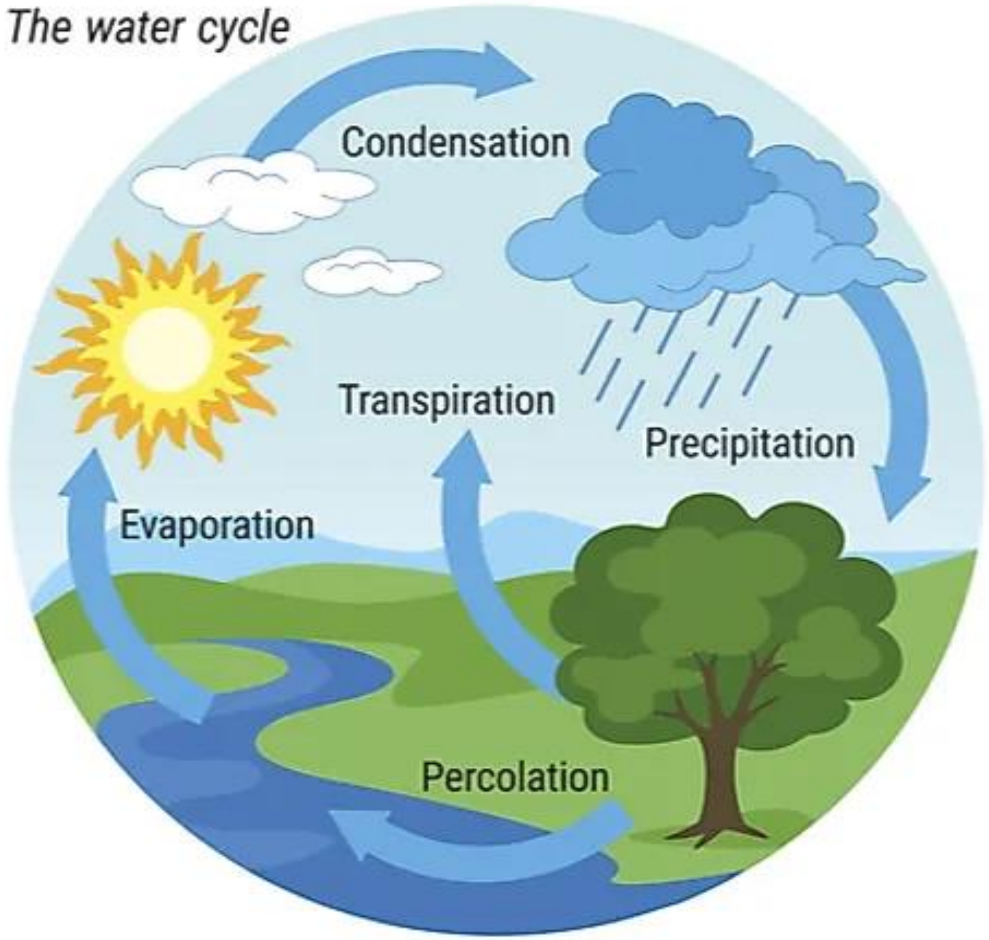
Water Cycle


The water cycle
Condensation
Transpiration
Precipitation
Evaporation
Percolation

Water Cycle

- Evaporation
  - Phase change from liquid to gas
  - Think puddles drying

Water Cycle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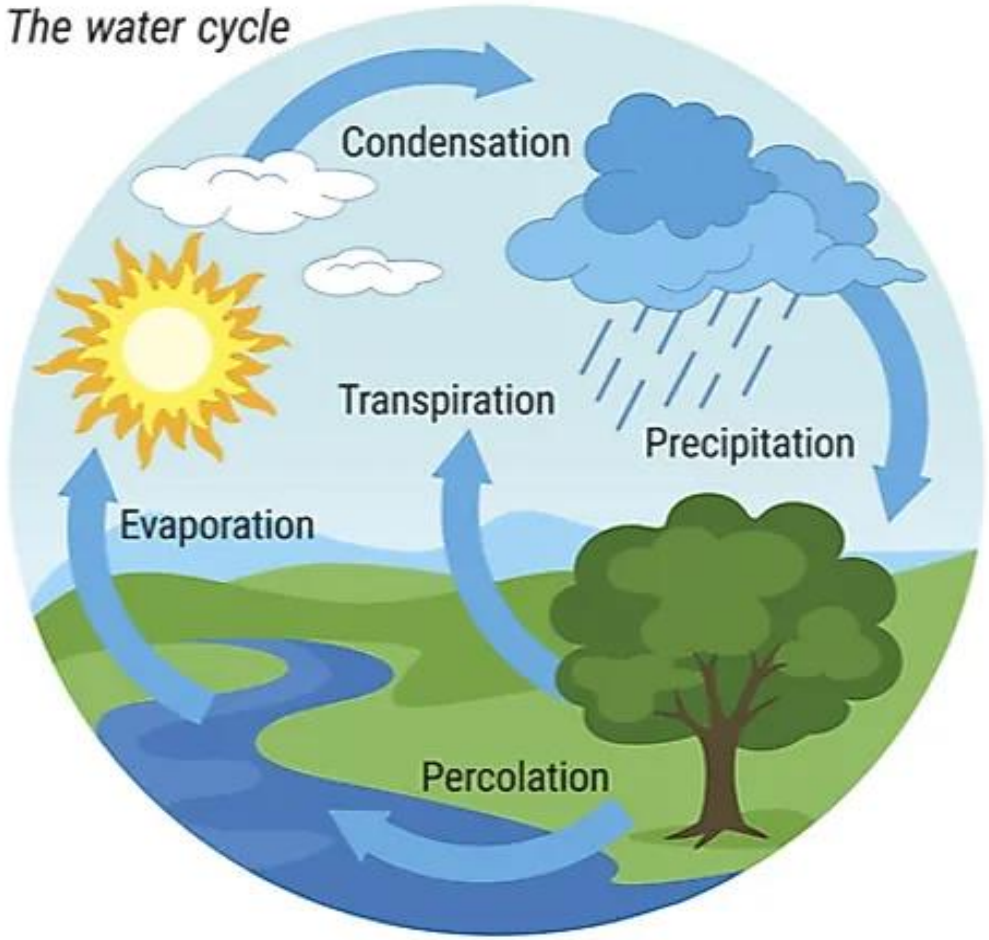
- Transpiration
  - Plants sweating
  - E/T is ~ 90/10

Water Cycle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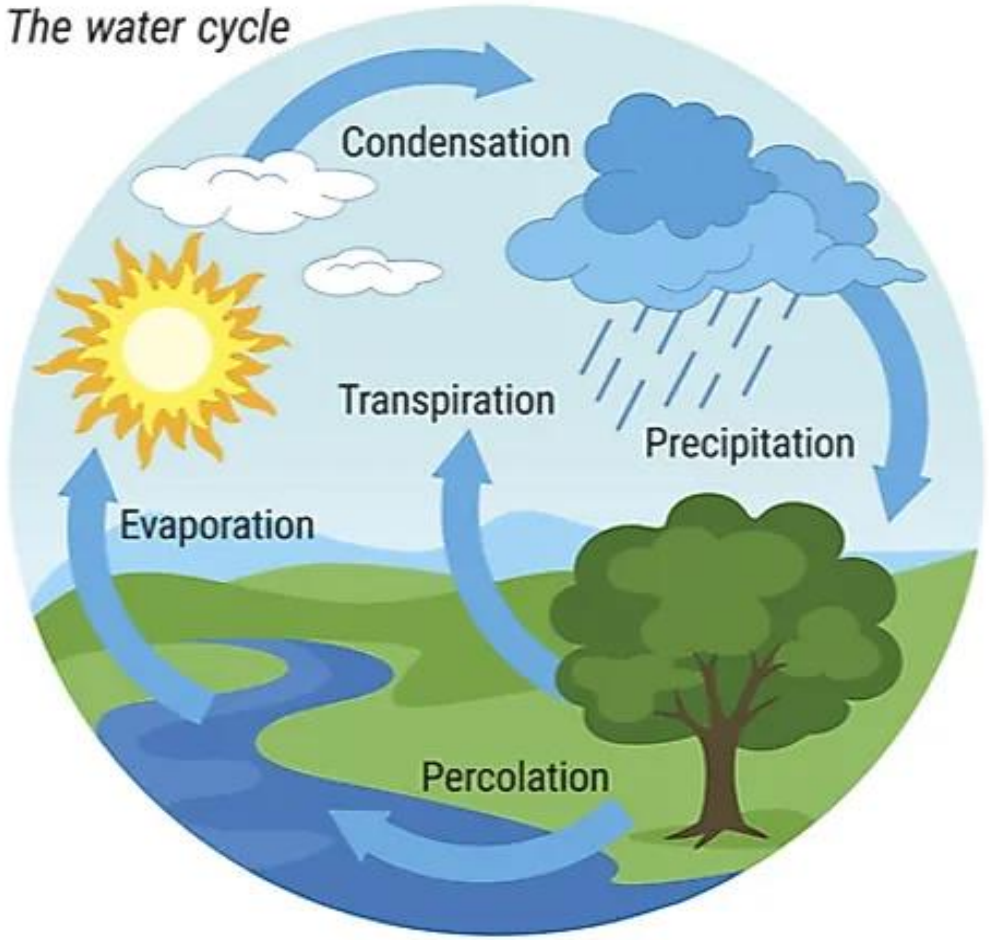
- Condensation
  - Phase Change from gas to liquid
  - Making clouds

Water Cycle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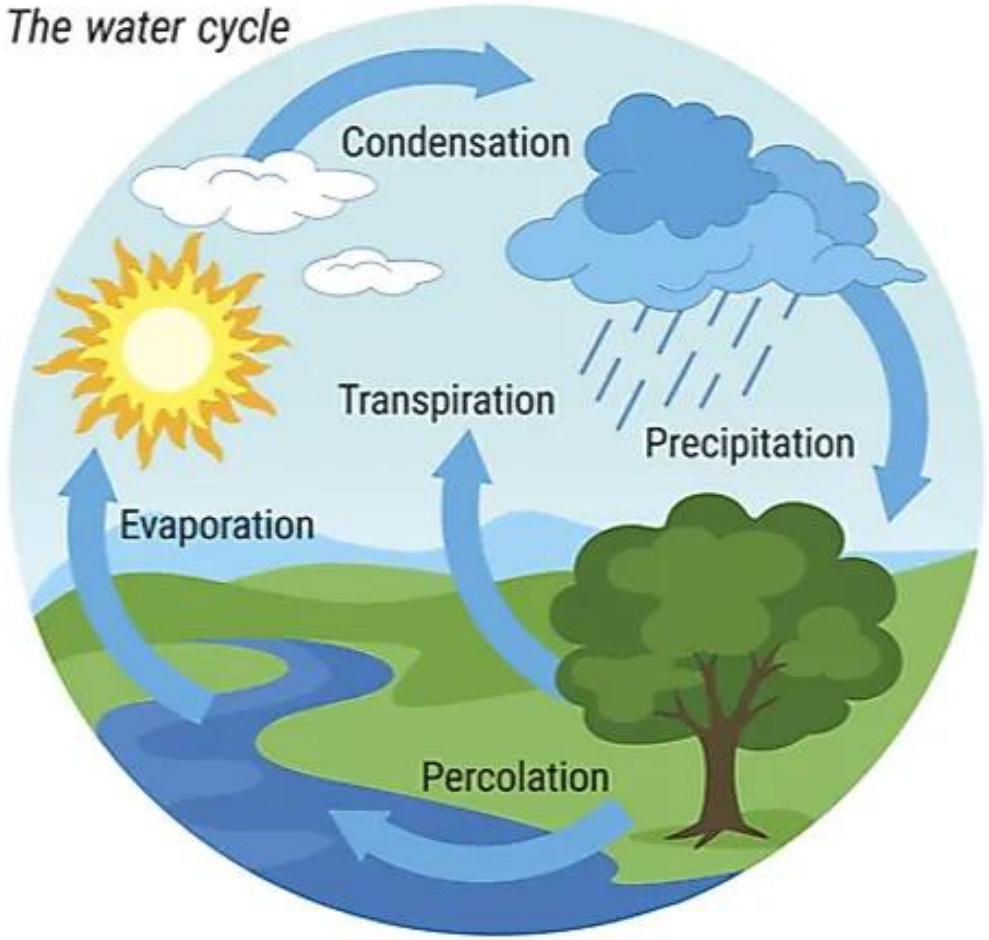
  - Making clouds
- Precipitation
  - Rain
  - Snow
  - Sleet
  - Hail

Water Cycle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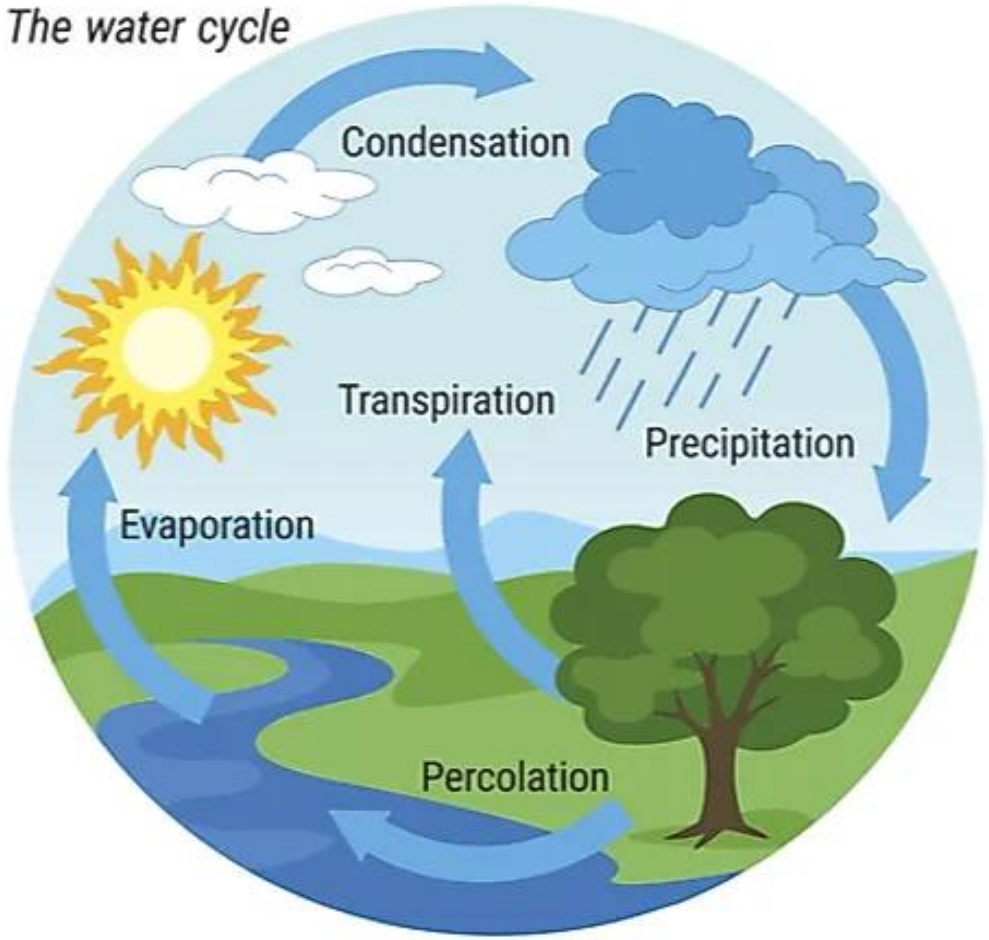
- Percolation
  - Water movement through the voids in soil

Water Cycle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  - Rain
  - Snow
  - Sleet
  - Hail
- Percolation
  - Water movement through the voids in soil
- … Surface Water!

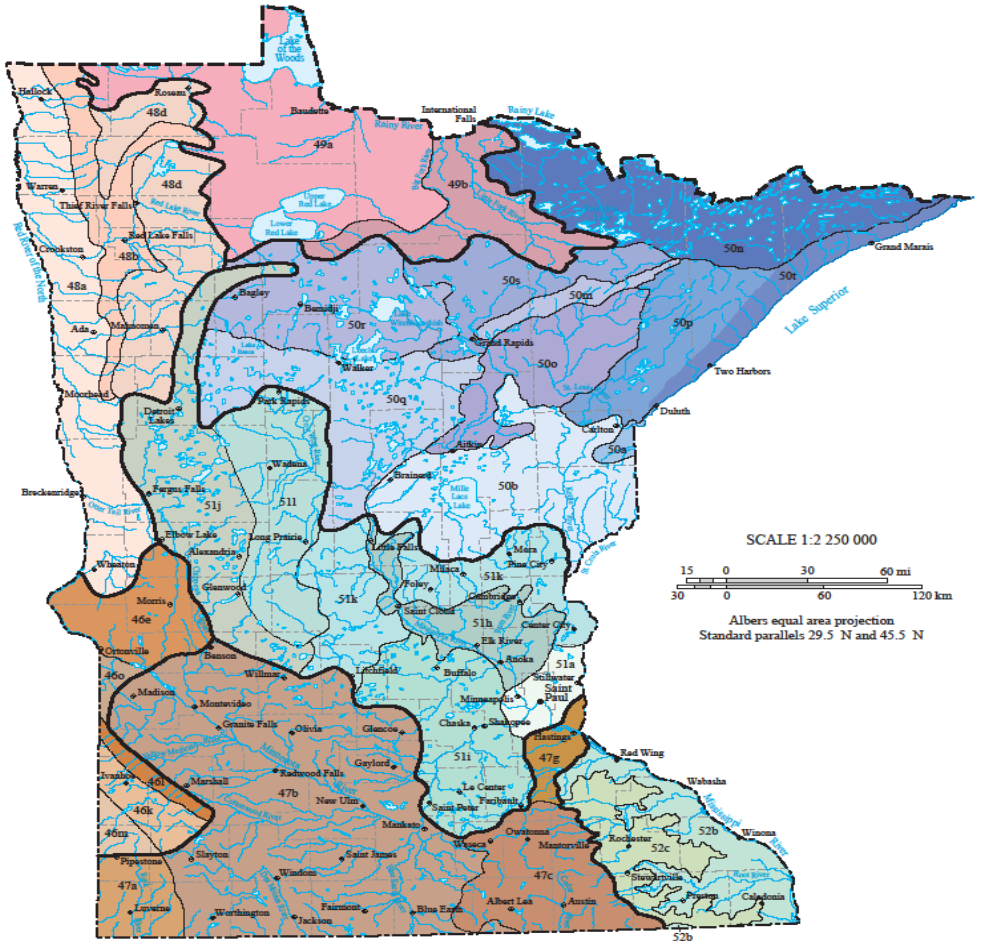
Lakes and Streams

With Jeff!

Lakes in Minnesota

- What is a lake?
  - Generally, an area of open, relatively deep water that is large enough to produce a wave-swept shore.
  - Minnesota statues says 10-acres in size or greater
  - Lakes are Public Waters in MN : DNR Lake Finder
- Lake Types : Shallow vs Deep
  - Shallow: Most of the lake (>75%) is 15 feet or less
  - Deep: Average depth >15 feet
  - Different water quality and ecological communities in shallow vs deep lakes.
- Minnesota Lake Standards are split out for Shallow vs Deep Lakes
  - Standards also vary by Ecoregion
  - Pelican River is in the North Central Hardwood Forest region
  - Also Coldwater vs Warmwater communities

MINNESOTA LEVEL III AND IV ECOREGIONS



46 Northern Glaciated Plains
- 46e Tewaukon/Big Stone Stagnation Moraine
- 46k Prairie Coteau
- 46l Prairie Coteau Escarpment
- 46m Big Sioux Basin
- 46o Minnesota River Prairie

47 Western Corn Belt Plains
- 47a Loess Prairies
- 47b Des Moines Lobe
- 47c Eastern Iowa and Minnesota Drift Plains
- 47g Lower St. Croix and Vermillion Valleys

48 Lake Agassiz Plain
- 48a Glacial Lake Agassiz Basin
- 48b Beach Ridges and Sand Deltas
- 48d Lake Agassiz Plains

49 Northern Minnesota Wetlands
- 49a Peatlands
- 49b Forested Lake Plains

50 Northern Lakes and Forests
- 50a Lake Superior Lacustrine Clay Plain
- 50b Minnesota/Wisconsin Upland Till Plain
- 50m Mesabi Range
- 50n Boundary Lakes and Hills
- 50o Glacial Lakes Upham and Aitkin
- 50p Toimi Drumlins
- 50q Itasca and St. Louis Moraines
- 50r Chippewa Plains
- 50s Nashwauk/Marcell Moraines and Uplands
- 50t North Shore Highlands

51 North Central Hardwoods
- 51a St. Croix Outwash Plain and Stagnation Plains
- 51h Anoka Sand Plain and Mississippi Valley Outwash
- 51i Big Woods
- 51j Alexandria Moraines and Detroit Lakes Outwash Plain
- 51k McGrath Till Plain and Drumlins
- 511 Wadena/Todd Drumlins and Osakis Till Plain

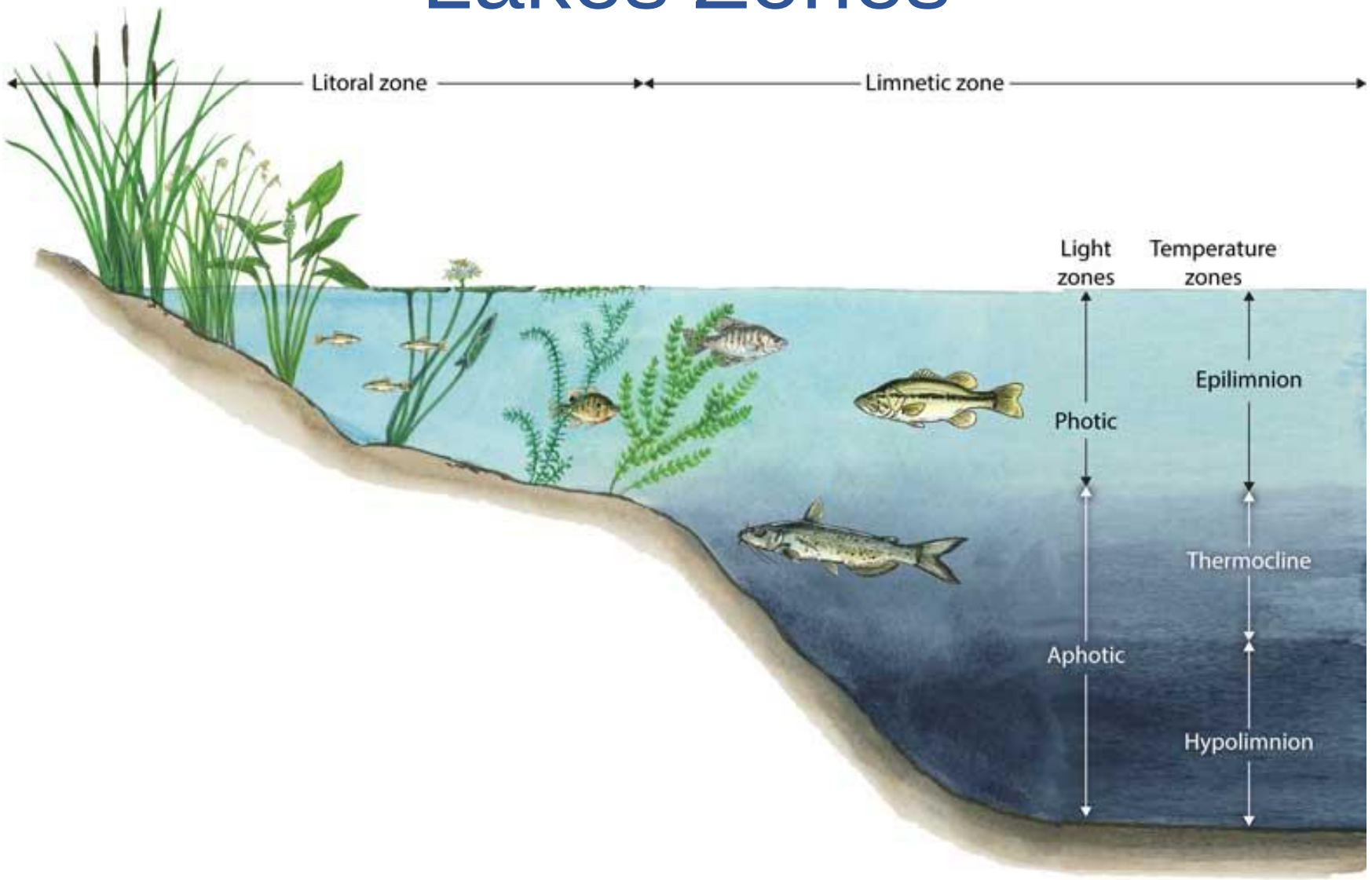
52 Driftless Area
- 52b Blufflands and Coulees
- 52c Rochester/Paleozoic Plateau Upland

2015-0629

Lakes – Water Quality Standards

Ecoregion	Total Phosphorus (ug/L)	Chlorophyll-a (ug/L)	Secchi Depth (M)
NLF – Class 2A (coldwater)	20	6	2.5
NLF – Class 2B	30	6	2.0
NCHF – Class 2A (coldwater)	20	6	2.5
NCHF – Class 2B	40	14	1.4
NCHF – Shallow Lakes	60	20	1.0
WCBP/NGP	65	22	0.9
WCBP/ NGP – Shallow Lakes	90	30	0.7

Lakes Zones

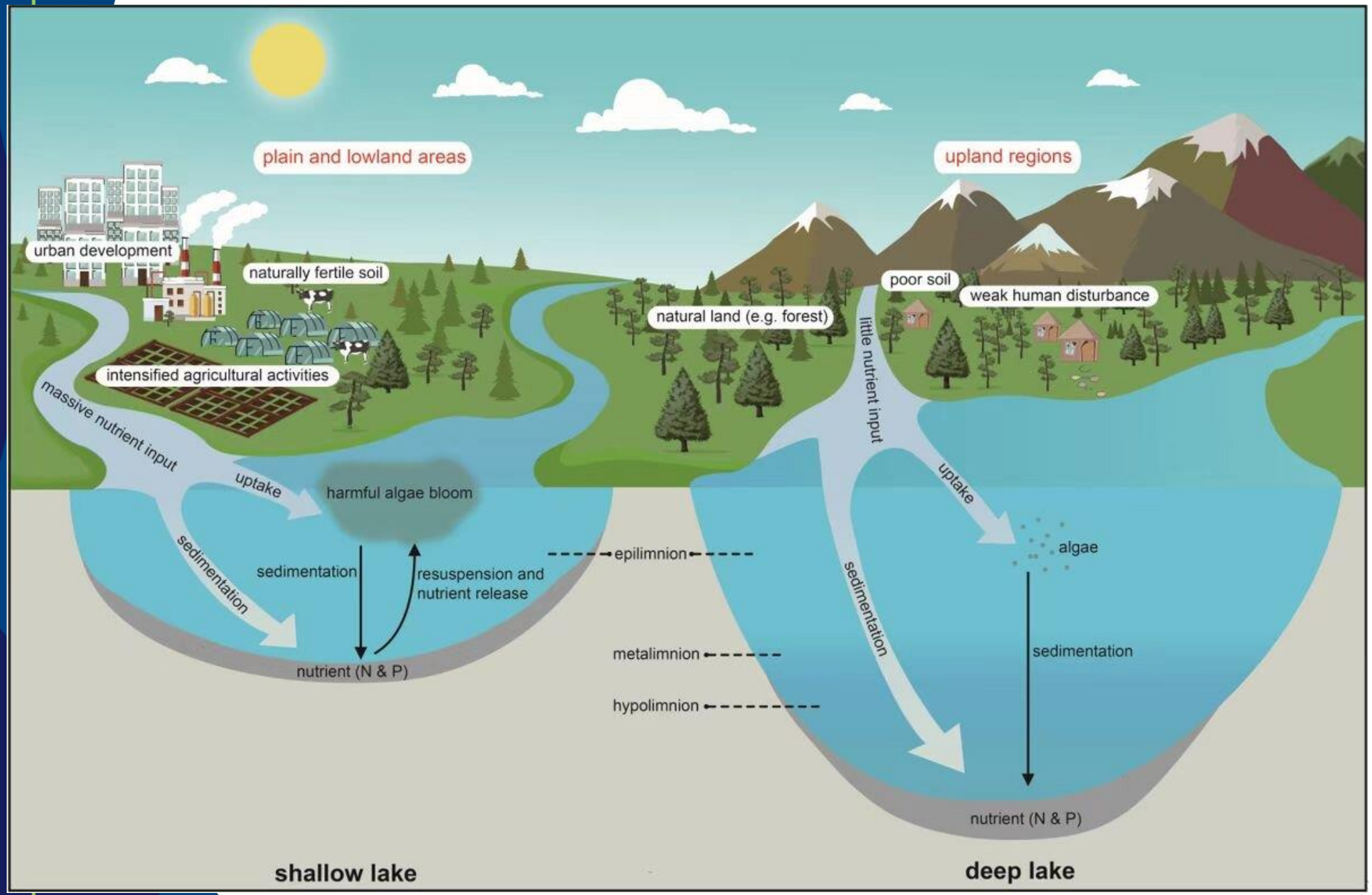

Litoral zone
Limnetic zone
Light zones
Temperature zones
Photic
Epilimnion
Thermocline
Aphotic
Hypolimnion

Shallow Lakes

- More than 5,000 shallow lakes over 50 acres in size in Minnesota
- Aquatic vegetation is a critical component of the ecosystem.
  - Invasive species can dominate when nutrient concentrations are elevated.
- Have a combination of submerged, floating leaf, and emergent vegetation
  - Clear vs Turbid state (if turbidity gets too high then conditions can prevent aquatic vegetation growth; negatively impacts water quality and lake health)
- Fish species can include:
  - Sensitive to water quality and habitat changes: bluegill, pumpkinseed, northern pike, largemouth bass, certain shiner and darter species
  - Tolerant of water quality and habitat changes: common carp, black bullhead, green sunfish, fathead minnow

Deep Lakes

- Plants provide crucial habitat but cover varying amount of the lake that is typically 5 – 15 feet.
- Desirable for recreation and residences which often leads to significant shoreline alteration and public use.
  - Buffer and riparian habitat are important for lake health
- Many deep lakes are naturally Oligotrpohic (low in nutrients)
- OHW – Ordinary High Water : Where DNR has regulatory authority of a lake
- Fish community can be more diverse ranging from 20 - 28+ species, including:
  - Sensitive to water quality and habitat changes: bluegill, pumpkinseed, rock bass, cisco, northern pike, small & largemouth bass, walleye, muskellunge, certain shiner and darter species
  - Tolerant of water quality and habitat changes: common carp, black bullhead, green sunfish


plain and lowland areas
upland regions
urban development
naturally fertile soil
intensified agricultural activities
natural land (e.g. forest)
poor soil
weak human disturbance
massive nutrient input
uptake
harmful algae bloom
sedimentation
resuspension and nutrient release
nutrient (N & P)
epilimnion
metalimnion
hypolimnion
little nutrient input
uptake
algae
sedimentation
sedimentation
nutrient (N & P)
shallow lake
deep lake

Becker County Lakes

Top 10 Counties by Percent of Lake Area

1. Lake of the Woods (37%)
2. Mille Lacs 36%
3. Beltrami (22%)
4. Cass (22%)
5. Crow Wing (15%)
6. Douglas (14%)
7. Otter Tail (13%)
8. Becker (10%)
9. Cook (10%)
10. Hennepin (9%)

Top 7 Counties With the Most Lakes

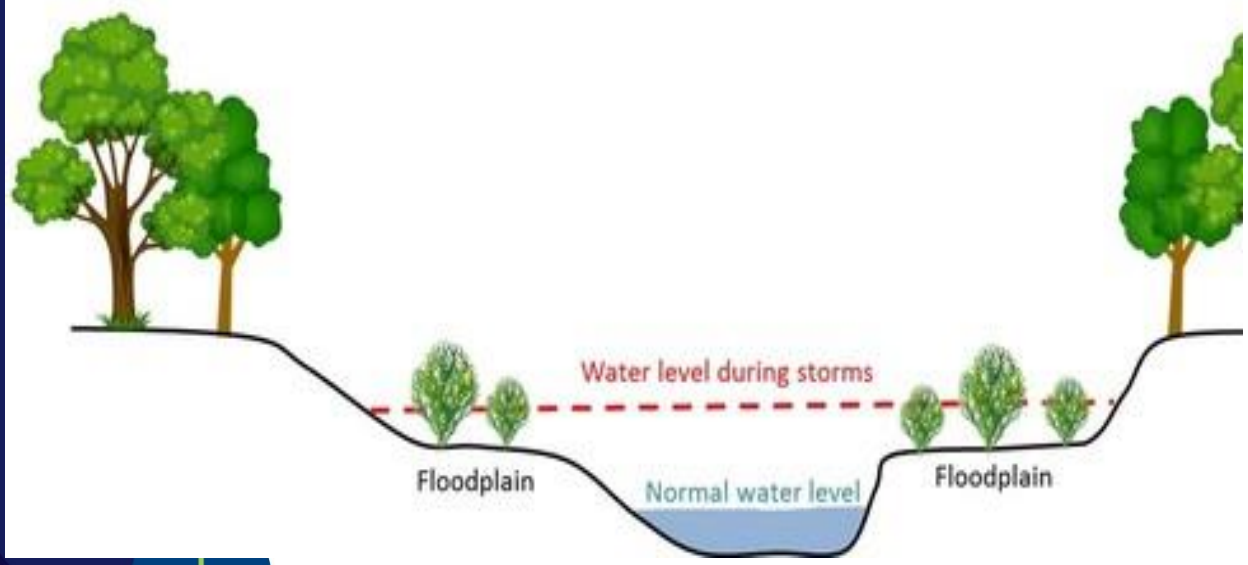
1. Otter Tail (1073)
2. St. Louis (969)
3. Itasca (897)
4. Cass (758)
5. Lake (742)
6. Becker (701)
7. Cook (698)

(From Downing 2021: Minnesota: Land of How Many Lakes?

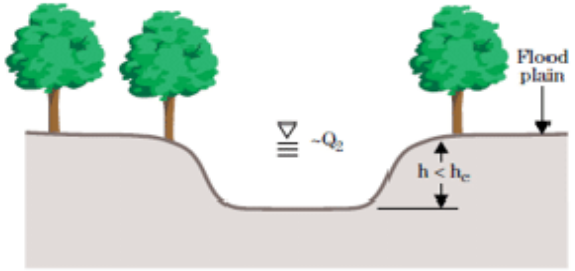
Streams

- Hydrology and Channel Shape
  - The amount of water that flows in the stream shapes the channel. The natural process is for a 2-yr event to shape the channel.
  - Changes to the landscape and fluctuating weather patterns are impacting channel stability.
- Aquatic Habitat
  - Combination of woody structure, rocky surfaces, in channel substrate, and bank vegetation.
  - Diversity of habitat is important for healthy fish and aquatic invertebrate communities
- Alteration of Hydrology ultimately impacts habitat.
- Streams have water quality and aquatic health standards that vary by stream type and region.

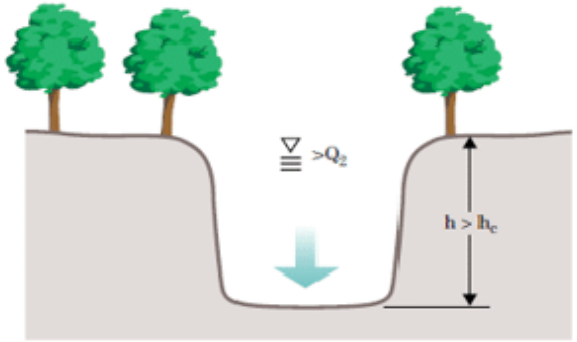
Natural Stream Channel



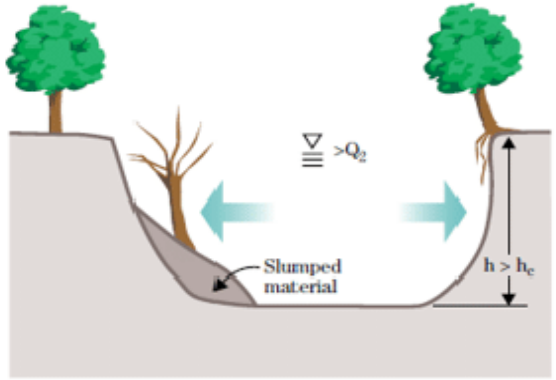
Stage 1: Stable



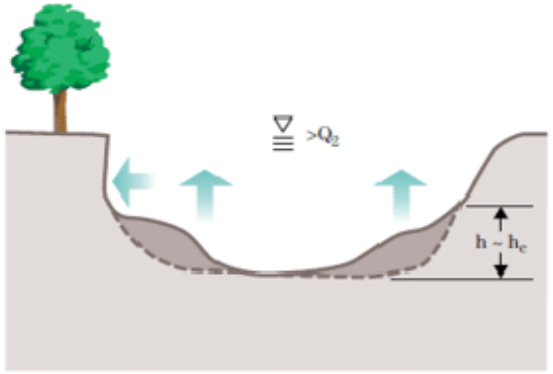
Stage 2: Incision



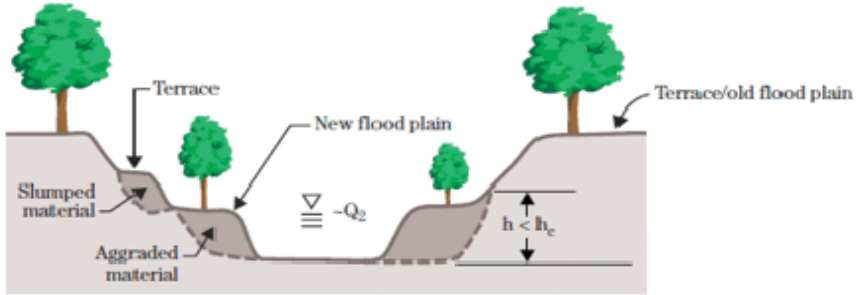
Stage 3: Widening



Stage 4: Deposition and Stabilization



Stage 5: Quasi-Equilibrium Stable



Streams – Channel Restoration Example

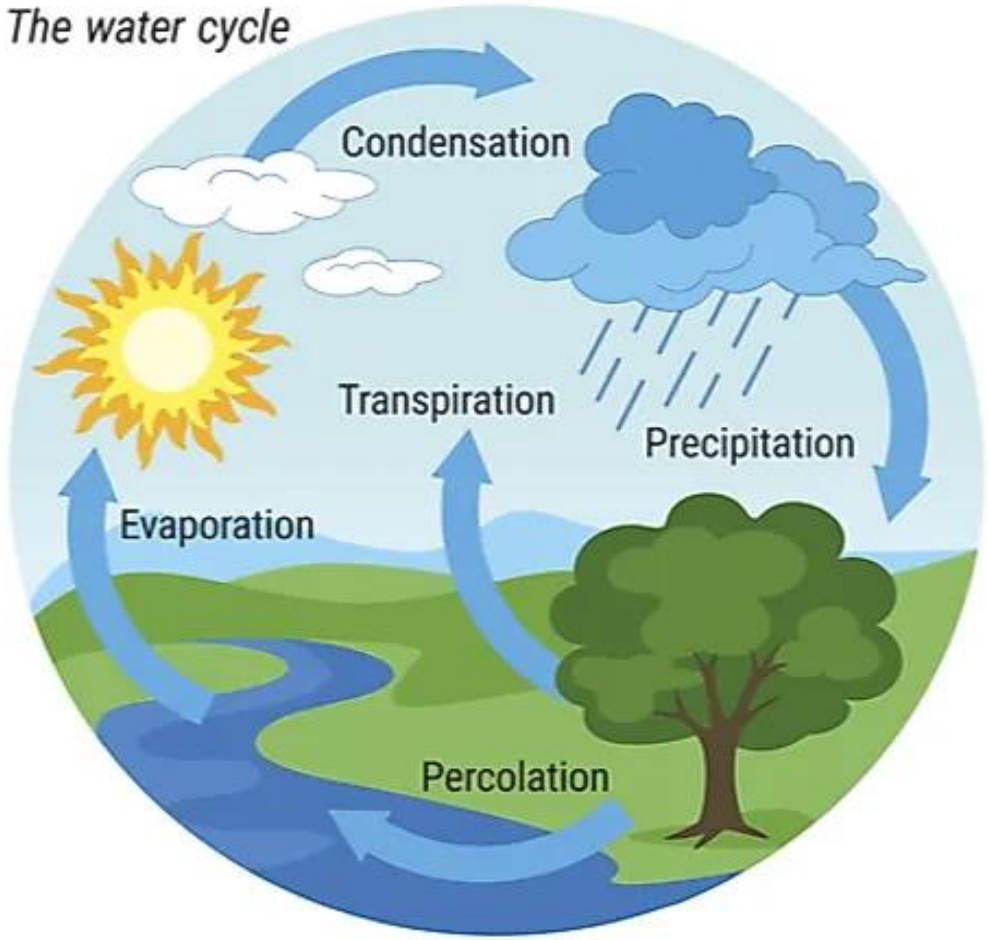
Before : Erosion & Failing Banks

After : Stabilized Channel & Improved Vegetation

Lakes & Streams – Common Issues

- Problems facing our lakes:
  - Development along shorelines
  - Elevated nutrient levels (phosphorus and nitrogen) along with decreased water clarity (Eutrophication)
  - Algal blooms
  - Invasive species
  - Altered habitat and loss of aquatic plants
  - Water level management
- Problems facing our streams
  - Altered hydrograph
  - Elevated sediment, nutrient, and bacteria concentrations
  - Altered habitat from erosion, failing banks, loss of floodplain connectivity
  - Loss of riparian buffer
  - Low head dams or other structures that act as fish barriers

Water Cycle


The water cycle
Condensation
Transpiration
Precipitation
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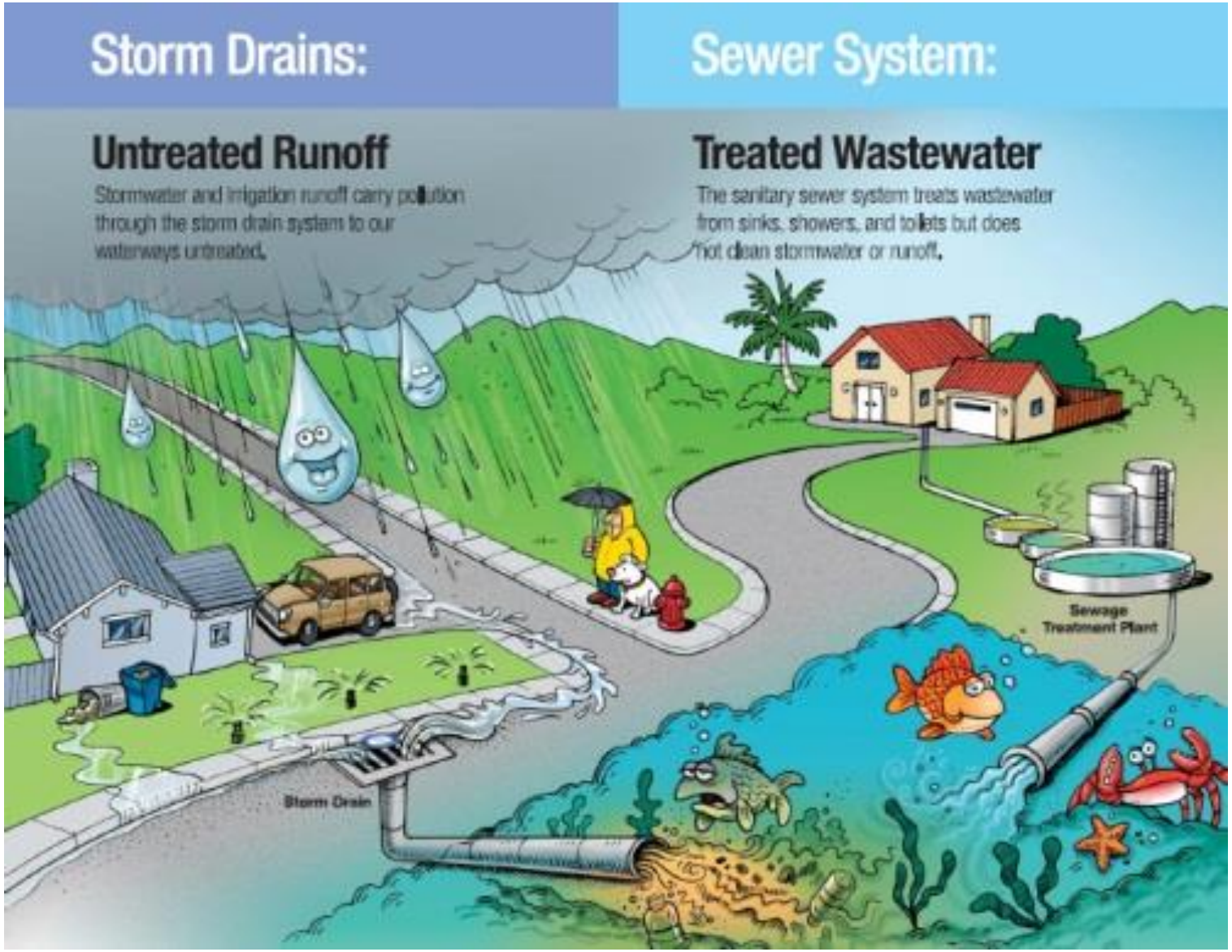
Water Cycle

Runoff

Stormwater Management



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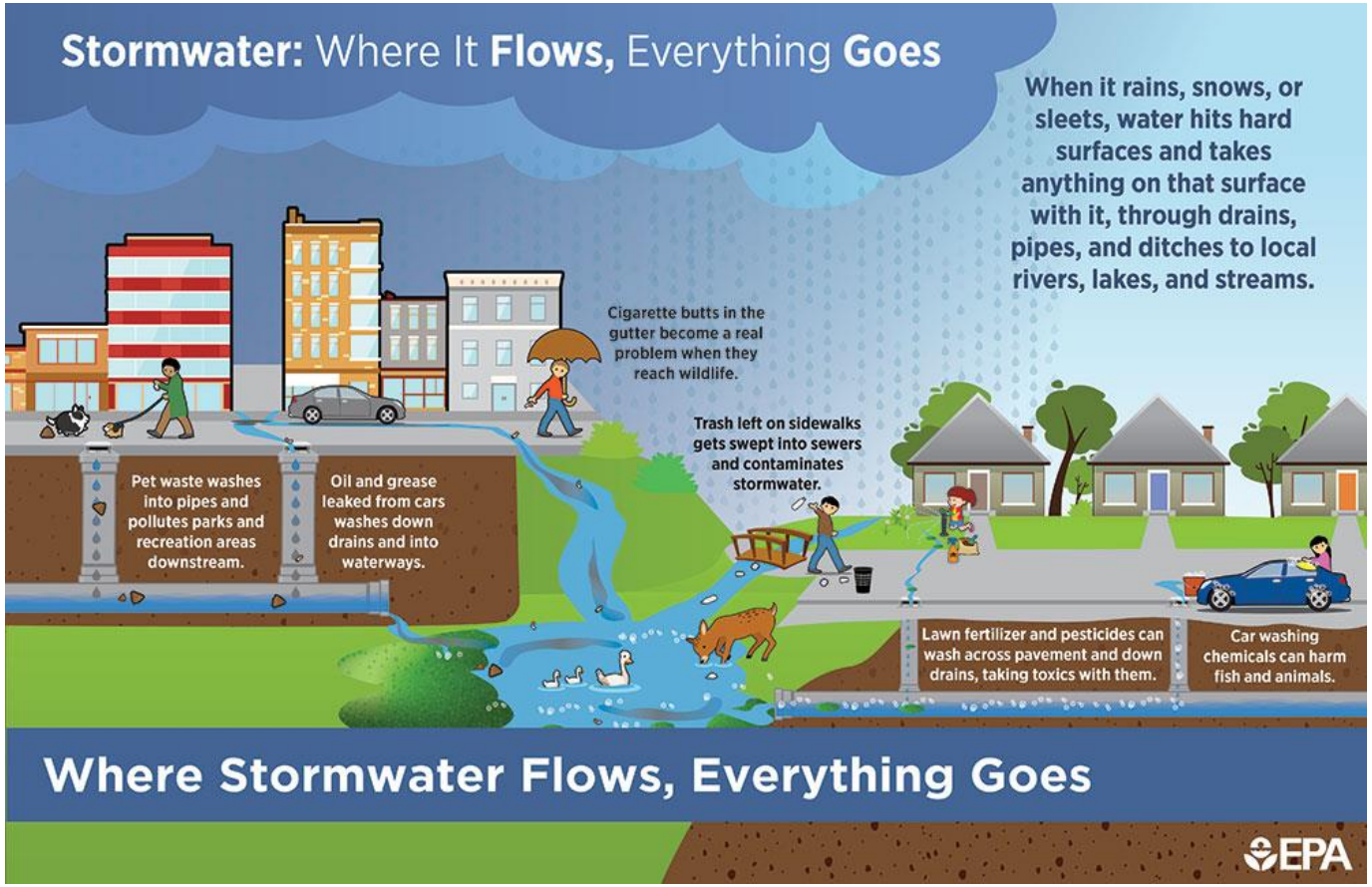


BMPs

Pages in category "Level 3 - Best management practices/Specifications and details/Design criteria"

The following 44 pages are in this category, out of 44 total.

A

- Adapting stormwater criteria for receiving waters

C

- Channel protection criteria (Vcp)

D

- Design considerations for constructed stormwater ponds used for harvest and irrigation use/reuse
- Design criteria for bioretention
- Design criteria for dry swale (grass swale)
- Design criteria for filtration
- Design criteria for green roofs
- Design criteria for high-gradient stormwater step-pool swale
- Design criteria for infiltration
- *Design criteria for Infiltration basin*
- *Design criteria for Infiltration trench*
- Design criteria for iron enhanced sand filter
- Design criteria for permeable pavement
- Design criteria for stormwater and rainwater harvest and use/reuse
- Design criteria for stormwater ponds
- Design criteria for stormwater wetlands
- *Design criteria for swales*
- Design criteria for wet swale (wetland channel)
- Design guidelines for soil characteristics - tree trenches and tree boxes
- Design guidelines for tree quality and planting - tree trenches and tree boxes

E

- Extreme flood control criteria (Vp100)

I

- Infiltration design guideline - confirming design criteria and applicability
- Infiltration design guideline - determining site infiltration rates
- Infiltration design guideline - drawdown time
- Infiltration design guideline - field verification of site suitability
- Infiltration design guideline - landscaping
- Infiltration design guideline - maximum flow path
- Infiltration design guideline - Observation well
- Infiltration design guideline - perform groundwater mounding analysis
- Infiltration design guideline - preliminary judgement on suitability of a site for infiltration
- Infiltration design guideline - sizing outlet structure and/or flow diversion structure
- Infiltration design guideline - underdrains
- Infiltration design guideline - use of multiple cells

L

- Linear Permanent Stormwater Management Design Flow Chart
- Literature review summary for Unified Sizing Criteria

O

- Overbank flood protection criteria (Vp10)

R

- Recharge and infiltration criterion (Vre)
- References for Unified Sizing Criteria

S

- Stormwater Design Recommendations to Enhance Phosphorus Removal
- Stormwater sizing for redevelopment projects

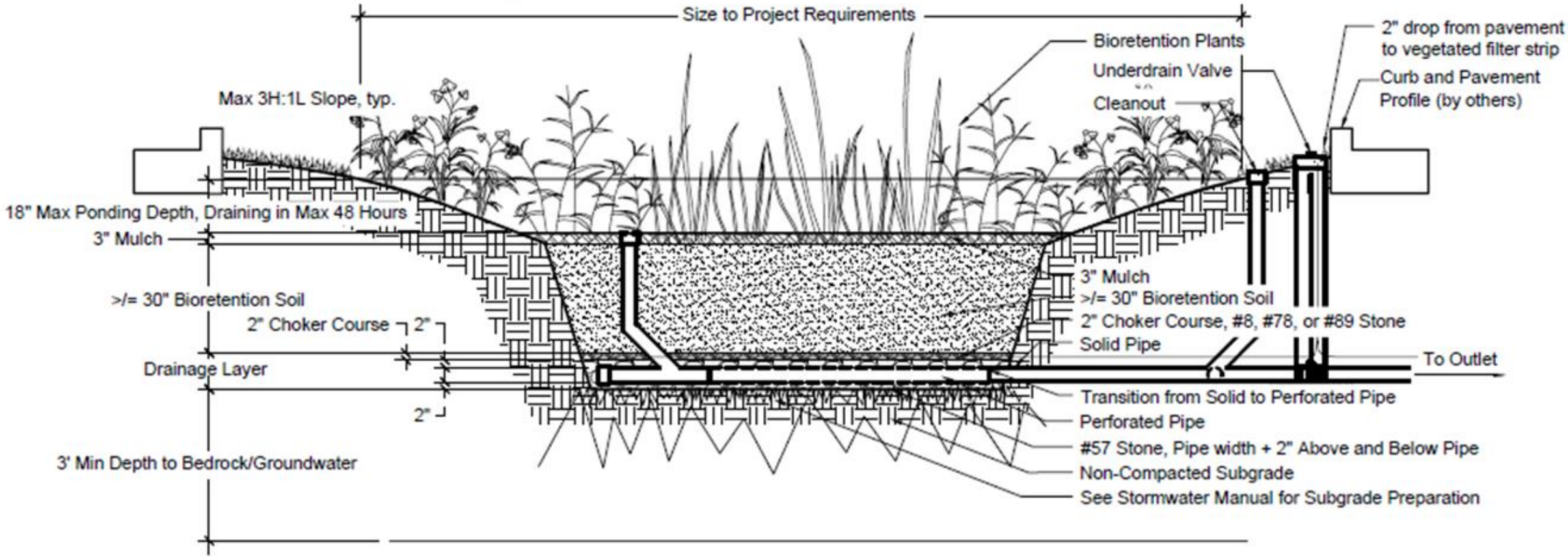
U

- Unified sizing criteria
- Unified sizing criteria combined
- Unified sizing criteria section

W

- Water quality criteria

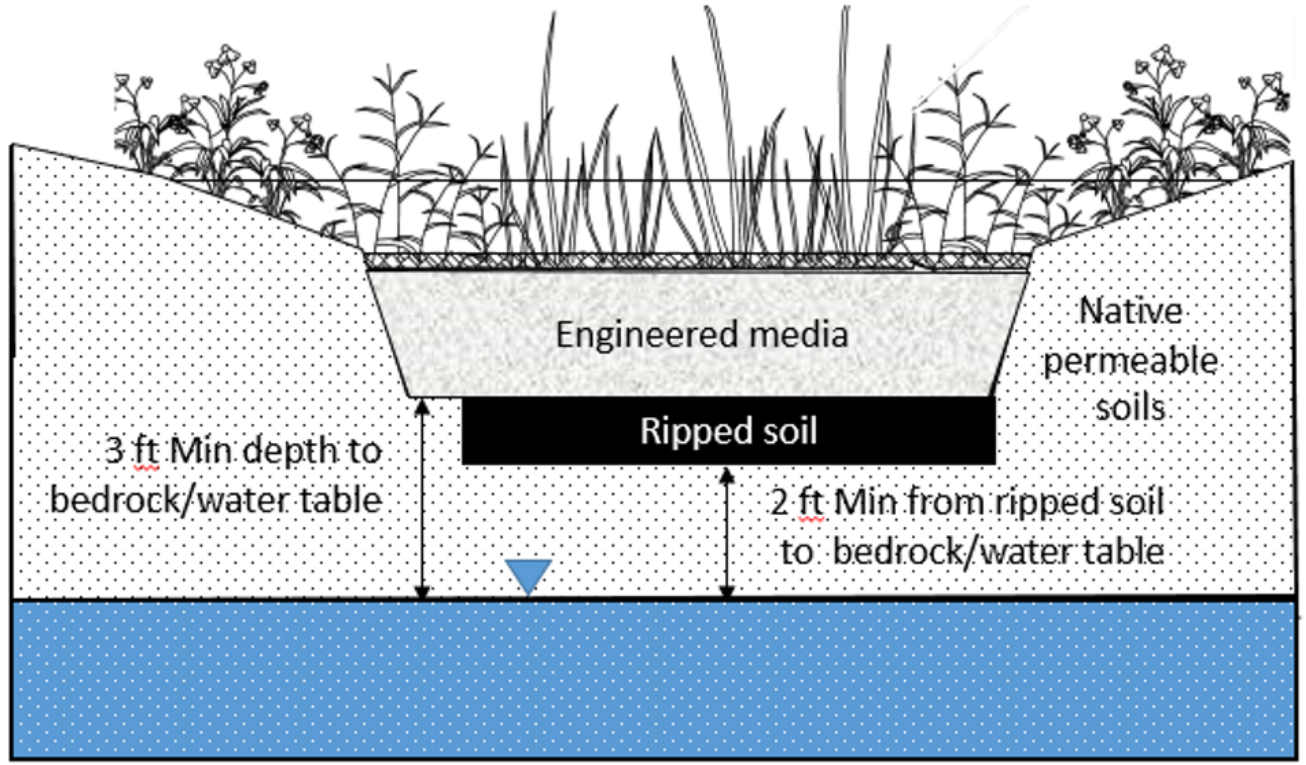
Note: this detail shows and off line system. To show an on line system,this detail should be modified to include an overflow structure, set at the maximum ponding elevation.

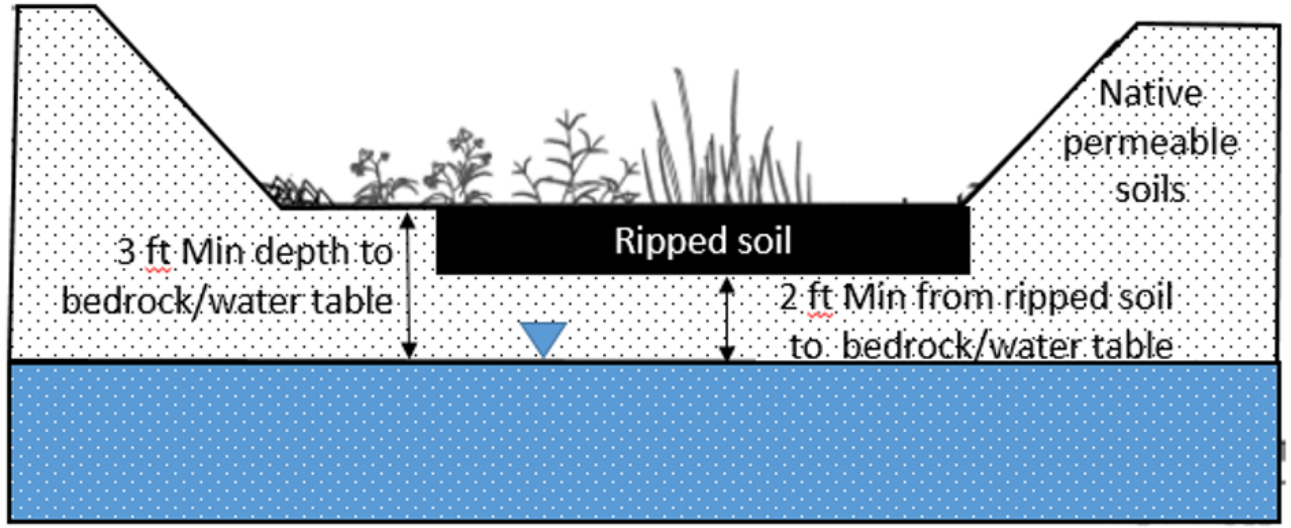


Bioretention Parking Median-Section

Not To Scale

NOT FOR CONSTRUCTION PURPOSES


Engineered media
Native permeable soils
Ripped soil
3 ft Min depth to bedrock/water table
2 ft Min from ripped soil to bedrock/water table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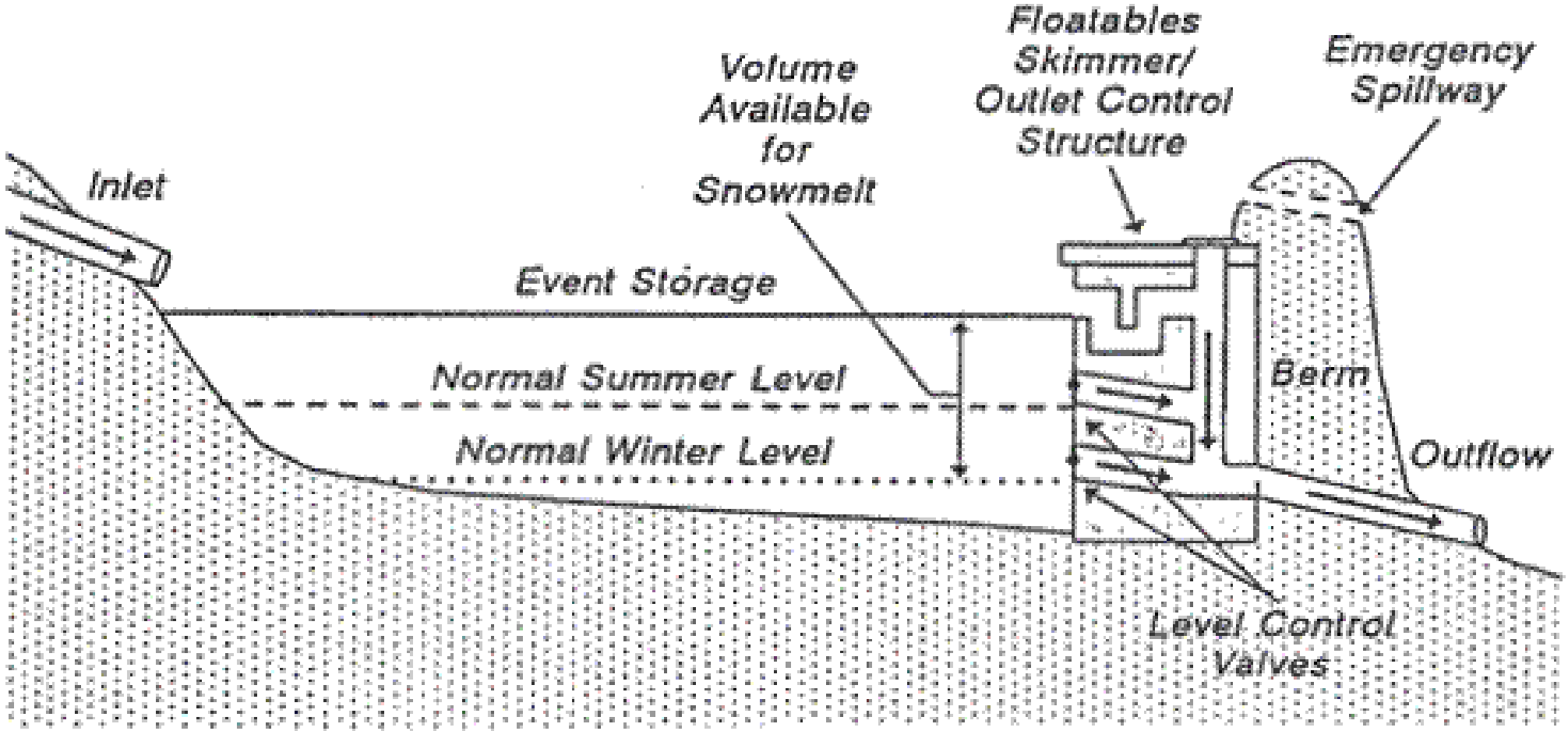

Floatables
Skimmer/
Outlet Control
Structure
Emergency
Spillway
Volume
Available
for
Snowmelt
Inlet
Event Storage
Normal Summer Level
Normal Winter Level
Berm
Outflow
Level Control
Valves

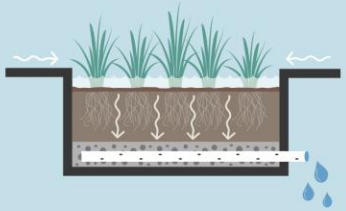
STORMWATER BEST MANAGEMENT PRACTICES

OUTFALL PROTECTION

A storm drain outfall is where a storm drain pipe or channel discharges stormwater runoff to a natural waterbody. Increased urbanization can damage outfalls by increasing the volume, frequency and intensity of stormwater runoff from impervious surfaces. Erosion from unstable outfalls can release sediment and other pollutants into nearby waterbodies. These outfalls can be stabilized or improved through the use of rip-rap, bioengineering techniques and/or vegetation.

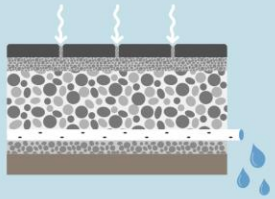
MICRO-BIORETENTION

A micro-bioretention cell is a small-scale practice that captures and treats stormwater runoff from buildings, roads or parking lots. It works by collecting stormwater from impervious surfaces and allowing it to pond temporarily. Plants in micro-bioretention include native species that are adaptable to wet and dry soil conditions.



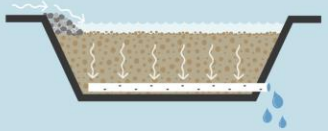
PERMEABLE PAVEMENT

Permeable pavement is an alternative to conventional pavement systems. The pavement surface allows stormwater to flow through to a gravel storage area underneath. The stormwater infiltrates into the ground or discharges to the storm drain system by an underdrain. Permeable pavement can be found in different applications such as parking spaces, alleys, sidewalks or pedestrian plaza areas.



POCKET SAND FILTER

A pocket sand filter is a small depression in the ground filled with sand. It is designed to remove pollutants by filtering water through a bed of sand. It often looks like a small volleyball court or sandbox. After flowing through the BMP, the treated water is either absorbed by the soil under the sand filter or is conveyed into the storm drain system by an underdrain.



POND RETROFIT

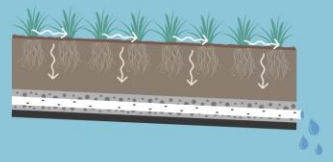
The County has a large number of existing stormwater management ponds that do not meet the current water quality standards for stormwater BMPs. Pond retrofits include reconfiguring and re-grading the ponds so that they provide a permanent pool of water. Water flows into a forebay that captures and settles out pollutants such as sediment and nutrients.

TREE PLANTING

Trees are one of the greenest and most economical stormwater BMPs. When it rains, trees intercept rainwater and allow it to evaporate or slowly soak into the ground. The roots help to remove pollutants by absorbing nutrients as water moves through the soil. Trees provide soil stabilization, improve air quality and help keep communities within a healthy temperature range in the summer.

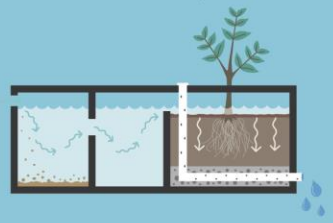
BIOSWALE

A bioswale uses plants and an engineered soil mix to treat stormwater runoff. Water is not ponded in a bioswale. It flows across the plants and engineered soil in the swale where runoff is infiltrated or filtered out. The shape of a bioswale can be linear or it can meander along roads or parking lots.



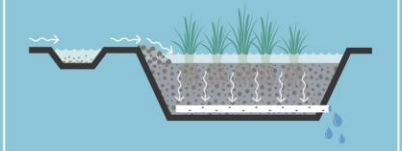
TREE BOX FILTER

A tree box filter is a concrete box filled with an engineered soil mix that can filter out pollutants from stormwater. The soil mix is designed to handle a large flow of water; this allows the device to treat a large impervious area with only a small footprint. This BMP is often used in areas where there is limited space.



SUBMERGED GRAVEL WETLAND

A submerged gravel wetland is a large-scale practice that can be placed in poor-draining soil areas. The wetland is filled with gravel and covered with a layer of soil. Plants in the wetland include native emergent species that help remove nutrients such as nitrogen, phosphorus and sediment. A submerged gravel wetland will stay wet at all times so it must be located in larger drainage areas to sustain the plants and ecosystem.



WET SWALE

A wet swale safely conveys stormwater to a natural outfall such as a wetland or stream. The wetland in the bottom of the swale reduces flow velocity and filters out pollutants. A wet swale can be used along roadways or parking lots where the groundwater table is high and the soil is damp. A wet swale will often have large piles of stone or check dams where water will pond to help slow and maintain the water flow.

STREAM RESTORATION

Stream restoration is a major construction project that stabilizes an eroded stream. This is done by installing grade controls such as adding rocks at the bottom of the stream bed, re-grading the side slopes and stabilizing the banks with rocks and vegetation. The overall condition of the stream can be improved through the proper management of a healthy riparian buffer.

REGENERATIVE STEP POOL CONVEYANCE

Regenerative Step Pool Storm Conveyance (SPSC) is designed to stabilize and restore eroded outfalls. A series of small pools and riffles help to remove sediment and control downstream erosion. A sand and woodchip stream bed filters pollutants and promotes infiltration into the natural groundwater system.


Doing it right
hazardous household waste to waste depot
rooftop storm water into rain barrel
rooftop storm water onto gardens
water wise plants require less water
wash your car at car wash
rainwater infiltrates thick soil
rainwater infiltrates gravel
Doing it wrong
excessive use of herbicides and pesticides
rooftop runoff directed to street drain
thin soil stores little water
city runoff is not treated
click to enlarge

MIDS

Minnesota Minimal Impact Design Standards

MIDS contains four main elements :

- A stormwater volume performance goal for new development, redevelopment and linear that will provide enhanced protection for Minnesota's water resources.
- New credit calculations that will standardize the use of a range of innovative structural stormwater techniques.
- Design specifications for a variety of green infrastructure best management practices (BMPs).
- A model MIDS ordinance package that will help developers and communities implement MIDS.

*1.1-inch event represents ~90% of all MN rainfall events. Rainfalls between 0.5 and 1.5 inches contribute ~75% of runoff pollutants.


moore
engineering, inc.