
# Today's Webinar

## 2:00 pm ET

# Hydrology, Geology, and Biology of Springs


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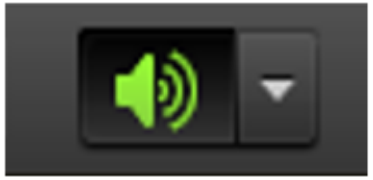

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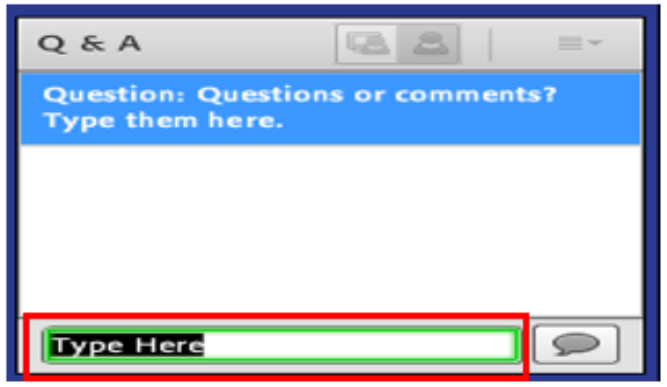
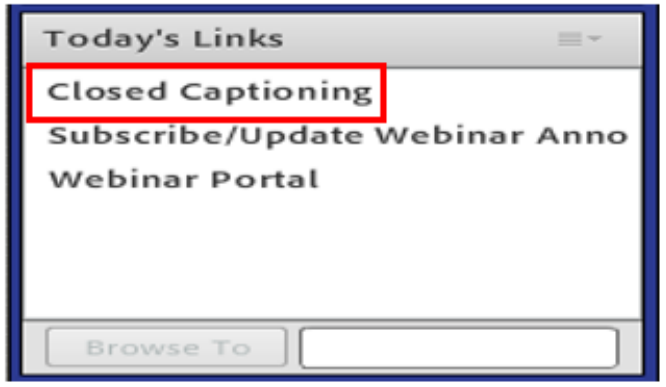
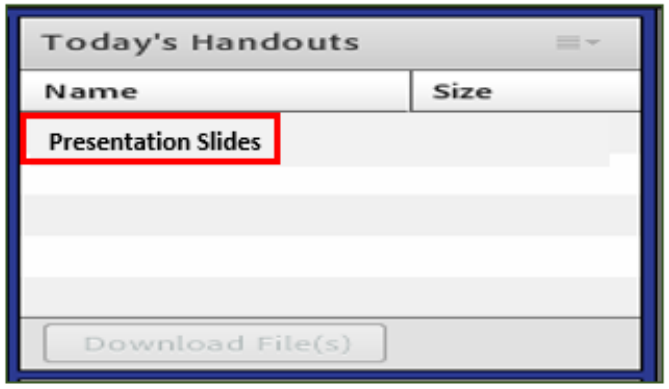



## Today's Links




## Today's Handouts



# Hydrology, Geology, and Biology of Springs

# About the Presenters

Karen Fullen
Ecologist

United States Department of Agriculture NRCS Natural Resources Conservation Service

Jon Fripp
Civil Engineer

United States Department of Agriculture NRCS Natural Resources Conservation Service

Jo Johnson
National Geologist

United States Department of Agriculture NRCS Natural Resources Conservation Service

Zach Freed
Hydrologist

The Nature Conservancy
Protecting nature. Preserving life.

# Overview

- **Hydrology**
  - Jon Fripp, NRCS National Design Center Civil Engineer
- **Geology**
  - Jo Johnson, NRCS National Geologist and Geological Services Unit (GSU) Coordinator
- **Biology**
  - Zach Freed, Hydrologist, The Nature Conservancy – Oregon
- **Environmental Laws, Regulations, and Policy Related to Springs**
  - Karen Fullen, NRCS Environmental Compliance Specialist

# Why a Springs Webinar?

- Request from State Biologist
- Conservation Practice Standard (CPS) for Spring Development (Code 574) criteria:
  - Conduct an evaluation of the site to determine -
    - Water quantity and quality needed for the intended purpose.
    - Suitability of the spring location.
    - Soil and geologic suitability.
    - Impacts to existing ecological functions benefiting from the spring and potential losses caused by the spring development, including impacts to local wildlife and wildlife habitat….
    - Effects of consumptive use on riparian health and function, stream flow, water temperature, and local aquifer recharge.
    - Impacts to wetlands.

# Wetlands and Springs

JON FRIPP, NRCS CIVIL ENGINEER

# Conservation Practice Standards (CPS)

The conservation practice standard contains information on:

- why the practice is applied,
- where the practice is applied,
- and it sets forth the minimum quality criteria that must be met during the application of that practice in order for it to achieve its intended purpose(s).

***CPS – as with the NEM, they are policy***

***BUT – they are not construction specifications***

USDA United States Department of Agriculture

574-CPS-1

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

**CPS 574 is commonly used**

# SPRING DEVELOPMENT

CODE 574

(no)

## DEFINITION

**What**

The collection and use of water from seeps or springs.

## PURPOSE

**Why**

This practice is used to accomplish one or more of the following purposes:

- Improve water quantity for livestock and wildlife
- Improve water quality for livestock and wildlife

## CONDITIONS WHERE PRACTICE APPLIES

**Where**

This practice applies to a site having a spring or seep with a dependable supply of suitable water for the planned use. Identify and evaluate alternative water sources before considering the development of a spring.

## CRITERIA

**How**

### General Criteria Applicable to All Purposes

Plan, design, and construct the practice to comply with all Federal, State, Tribal, and local laws and regulations. The landowner is required to obtain all necessary permits prior to construction. The landowner/contractor is responsible for locating all buried utilities in the project area including drainage tile and other structural measures.

Design the spring development to collect sufficient water for the intended purpose while protecting ecological functions of the site. Design the spring development to minimize the risk of damage and water contamination caused by freezing, flooding, livestock, sediment, and vehicular traffic.

Developing a spring for livestock water use may cause adverse impacts to fish and wildlife habitat. Develop only the necessary water for the planned purpose. Place a screen over open pipe vents to prevent wildlife entrapment and potential water contamination.

**The Conservation Practice Standard addresses the question: *"what guidelines do we need to follow for this design in the field?"***

**Note some of the general guidelines**

Design the spring development to collect sufficient water for the intended purpose while protecting ecological functions of the site. Design the spring development to minimize the risk of damage and water contamination caused by freezing, flooding, livestock, sediment, and vehicular traffic.

Developing a spring for livestock water use may cause adverse impacts to fish and wildlife habitat. Develop only the necessary water for the planned purpose. Place a screen over open pipe vents to prevent wildlife entrapment and potential water contamination.

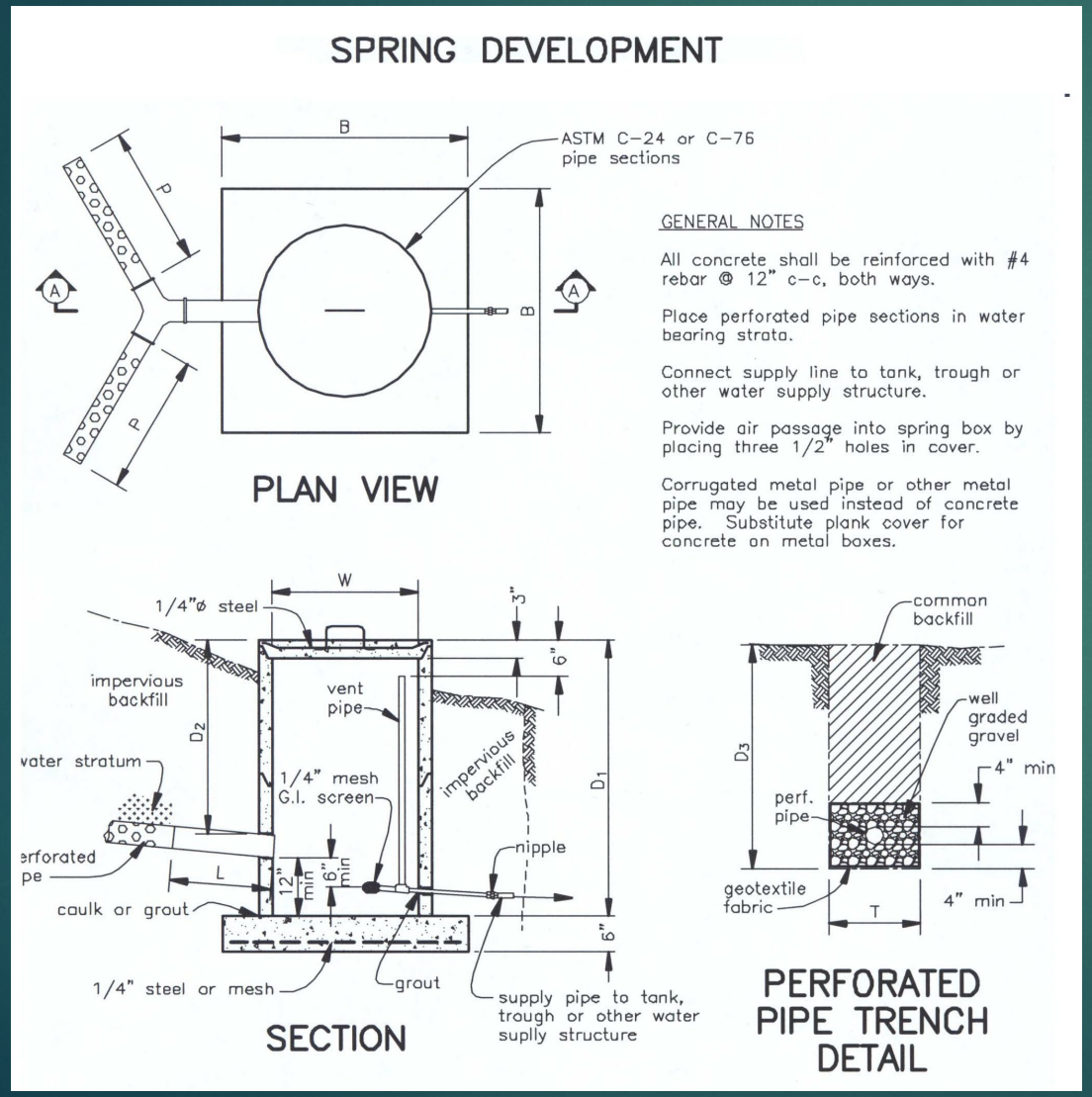
A spring development is the collection and use of water from seeps or springs.

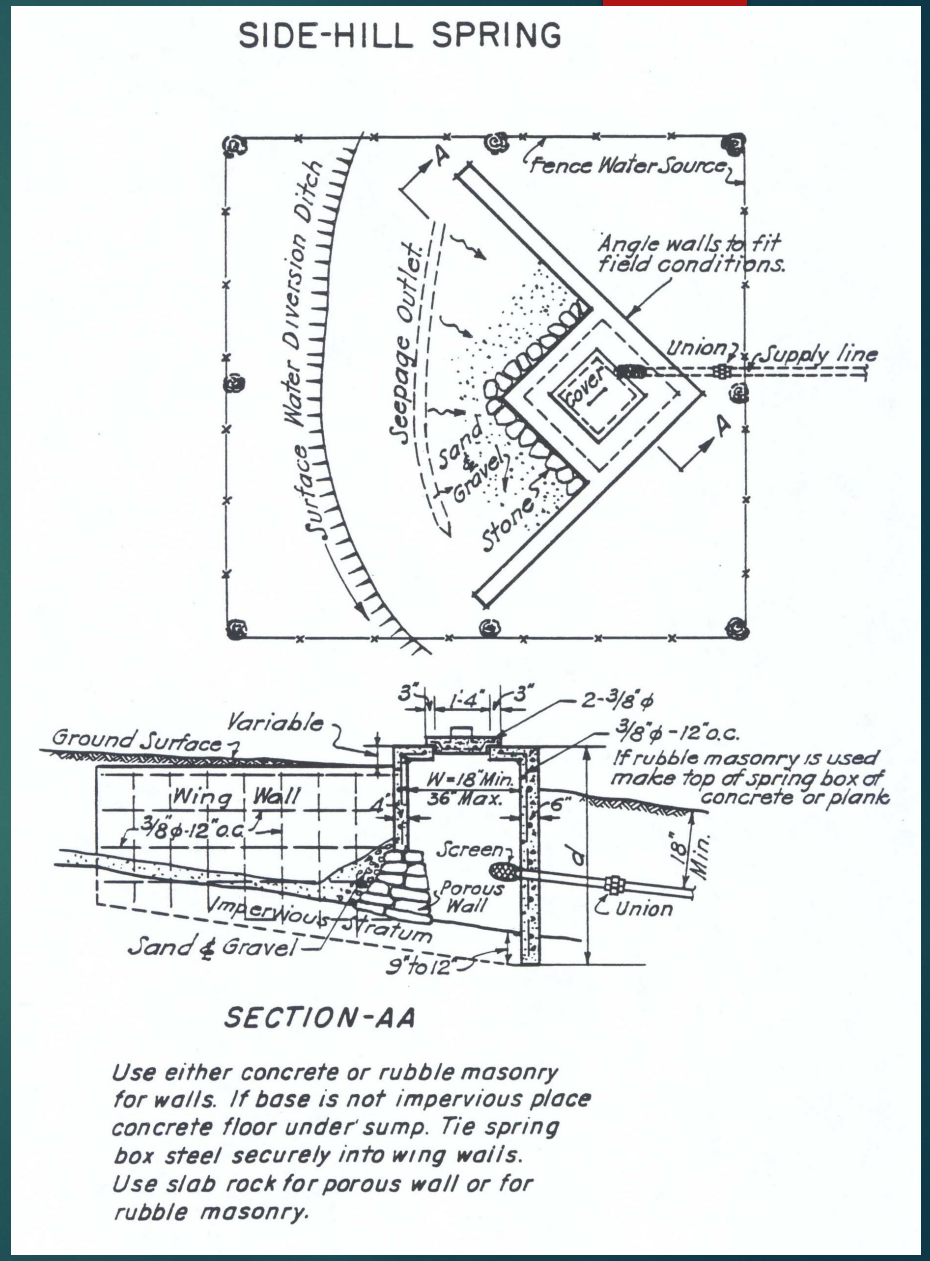


New York

Spring Development (574) is commonly applied with other conservation practices, such as Livestock Pipeline (516) and Watering Facility (614).

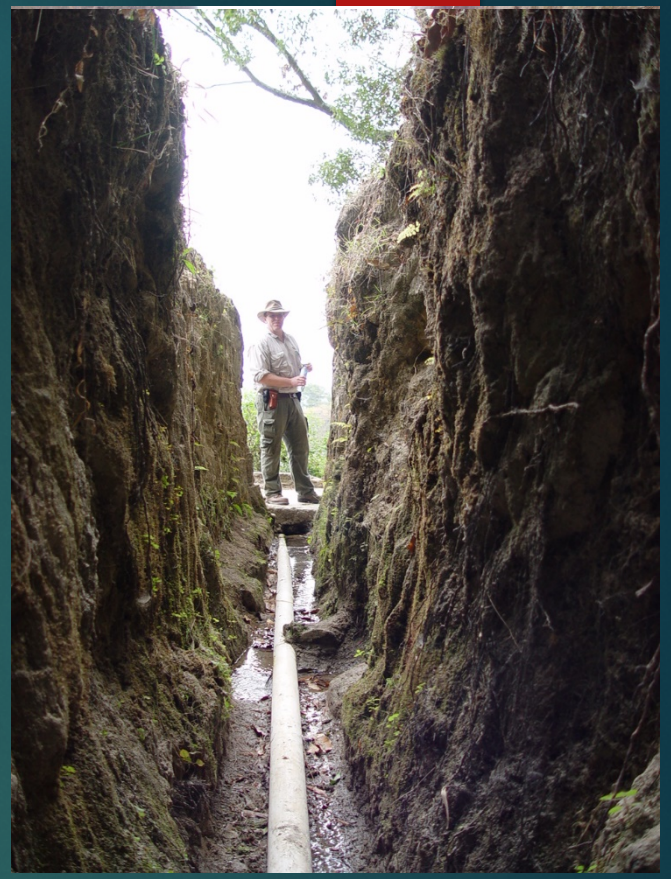
# Lots of designs are available to accomplish this



# All Spring Development Designs Include….

- Source of the water
- Something to collect the water
- An outlet and something to distribute the water
- Something to manage the water



# Water Source....

# Springs viewed from a Hydrogeomorphic Wetland Classification System

HGM is used to develop functional assessments useful in planning, design and monitoring

Originally developed as a classification of wetlands based on hydrologic regime and geomorphic position

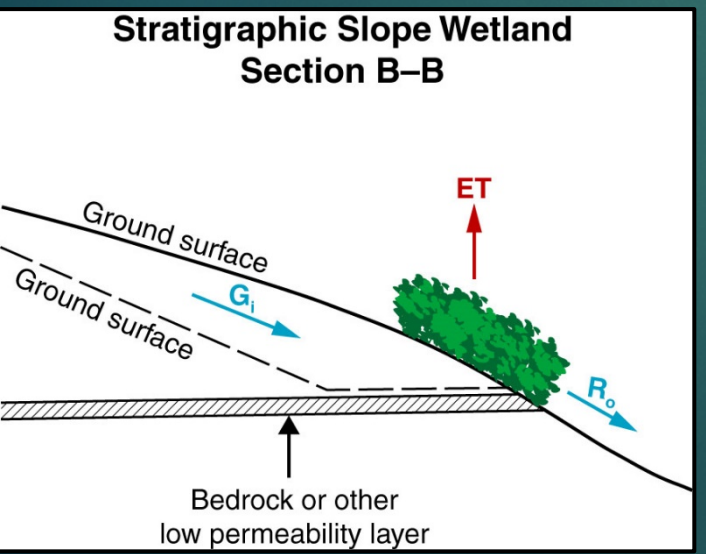
Later it was developed as an approach for assessing wetland functions

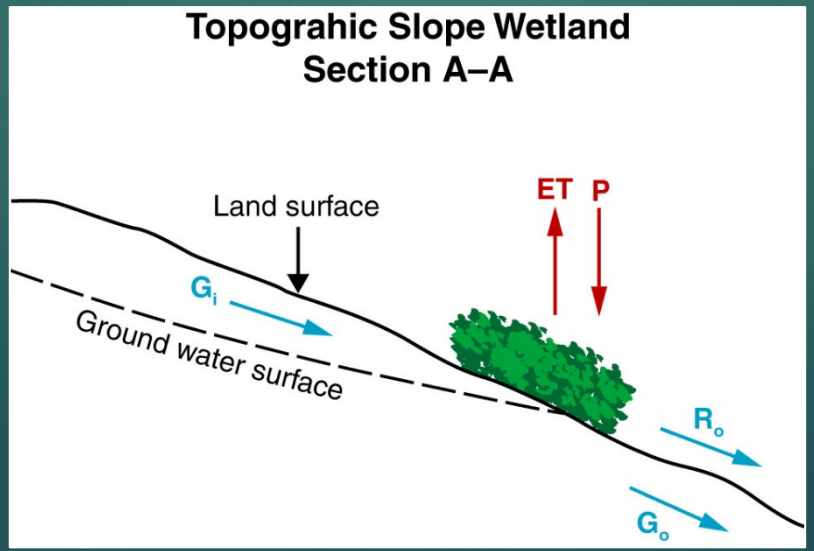
When considering the HGM class, think:

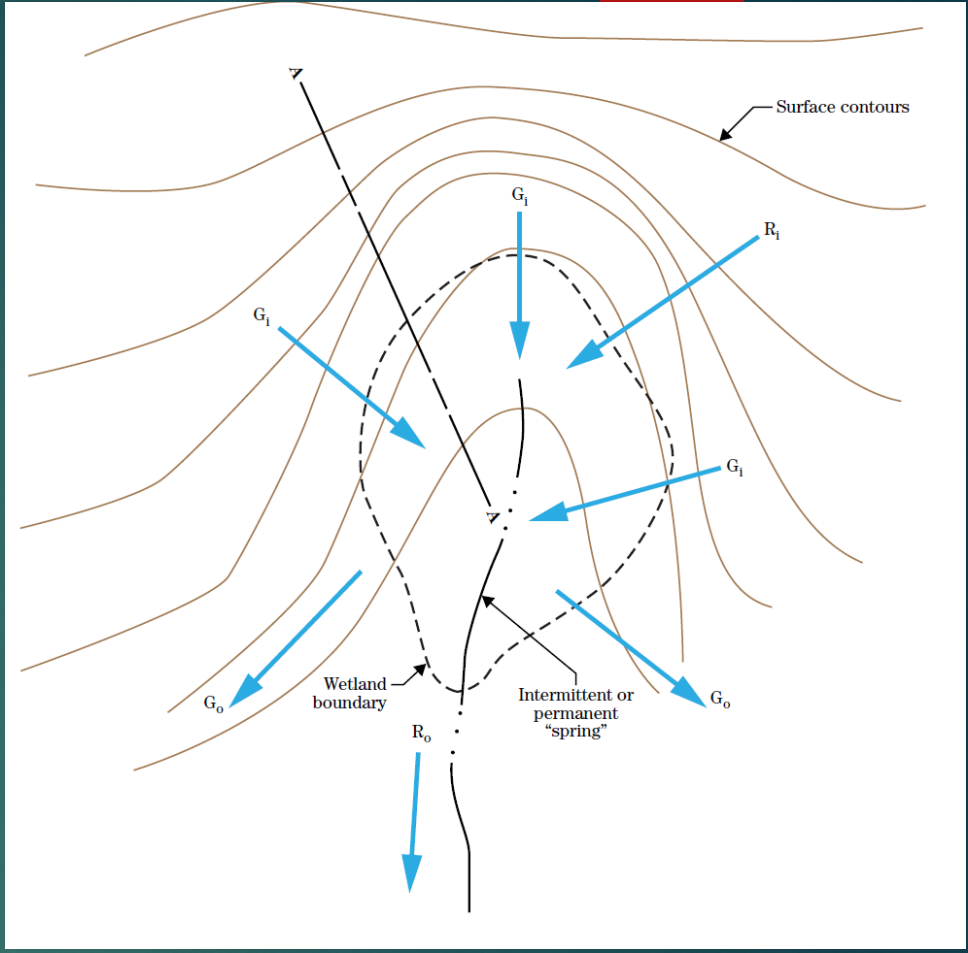
1. Landscape Position *i.e certain wetland types (with specific functions) only exist in certain landscapes*
2. Dominant Water Source *i.e the main, not the only water source*
3. Hydrodynamics *i.e water direction – vertical (groundwater) or horizontal. Uni or bi directional*

# SLOPE Wetland

- Landscape Position –Concave Topographic positions, usually stream headwaters (low stream orders)
- Dominant water source is groundwater which is forced to the surface by restrictive layers, or topography.
- Hydrodynamics is Horizontal, uni-directional




**If the discharge is near continuous, organic soils are formed and maintained.**

# SLOPE Wetlands – Unique Functions

- ***Under Appreciated wetlands***


Kansas Headwater


Idaho Headwater Fen

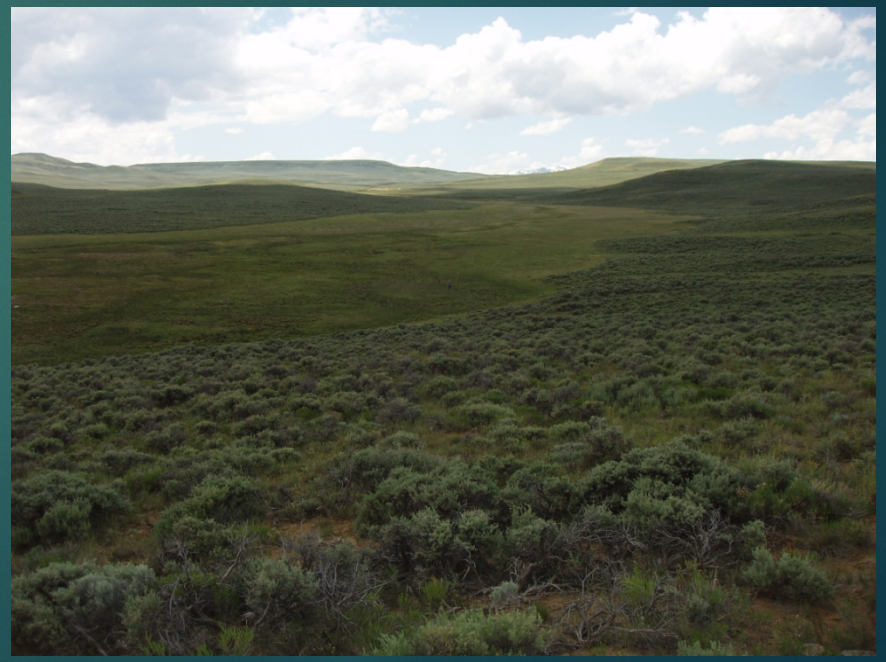

New York Headwater Fen


North Carolina

- HGM SLOPE wetlands occur in all regions and all climates
- Aquifer Storage/groundwater discharge
- Sequestration of Organic Carbon (requires constant inundation)
- Critical Upland Water Sources
- Downstream Baseflow Maintenance

# Slope HGM Class Wetland

- Headwater SLOPE landscapes
- Two separate areas within the same Land Resource Unit in Western Wyoming
- Both are reaches
  - Dominated by groundwater discharge,
  - Organic soils
  - With surface saturation evident by the vegetation and hummocking
  - No Geomorphic Channel




# Often these slope wetlands are targeted for spring development

- Look for low point in slopes
- Look for green, water loving vegetation
- Water being used by vegetation and evaporation can be captured and used for other purposes

# Discussion Question: What are the potential ecological implications of this spring development?


What was using the water before it was collected, transported, and used at another location?
How is its current use different?

Oregon

# Geology of Springs

JO JOHNSON
NRCS NATIONAL GEOLOGIST
AND
GEOLOGICAL SERVICES COORDINATOR (GSU)

# Definition of Key Terms

- Geology – The science that deals with the earth's physical structure and substance, its history, and the processes that act on it.
- Groundwater - A simplistic term that encompasses water in the saturated zone beneath the Earth's surface, water that is under pressure, and the complex movement of groundwater as an integral part of the Earth's hydrologic cycle.
- Aquifer – A zone of saturation in the Earth's crust.
- Springs and Seeps - A place where water from an aquifer discharges naturally into a surface water body or onto the land surface.

# The Hydrologic Cycle with a Focus on Groundwater

# Spring vs. Seep

- **Springs have a defined outlet for groundwater to discharge from an aquifer.**
- **Seeps are zones where groundwater seeps onto the land surface from an aquifer.**
- **Note:** Seeps are treated like springs when developing, capturing and funneling the water to a point of use.

# Factors Controlling Aquifer Discharge

- Porosity – An expression of void spaces in earth material
- Permeability - an expression of the ability of the earth material to transmit water through interconnectivity of pore spaces (voids) in earth material
- Aquifer Components
  - Unconsolidated material (sands or gravel)
  - Jointed and permeable sandstone
  - Jointed and soluble (solution channels) limestone
  - Jointed or fractured volcanic material
  - Jointed or fractured dense hard rock
  - Fine-grained material (primarily silts and clays)

# Typical Continuous Yield to Springs Based on Aquifer Components

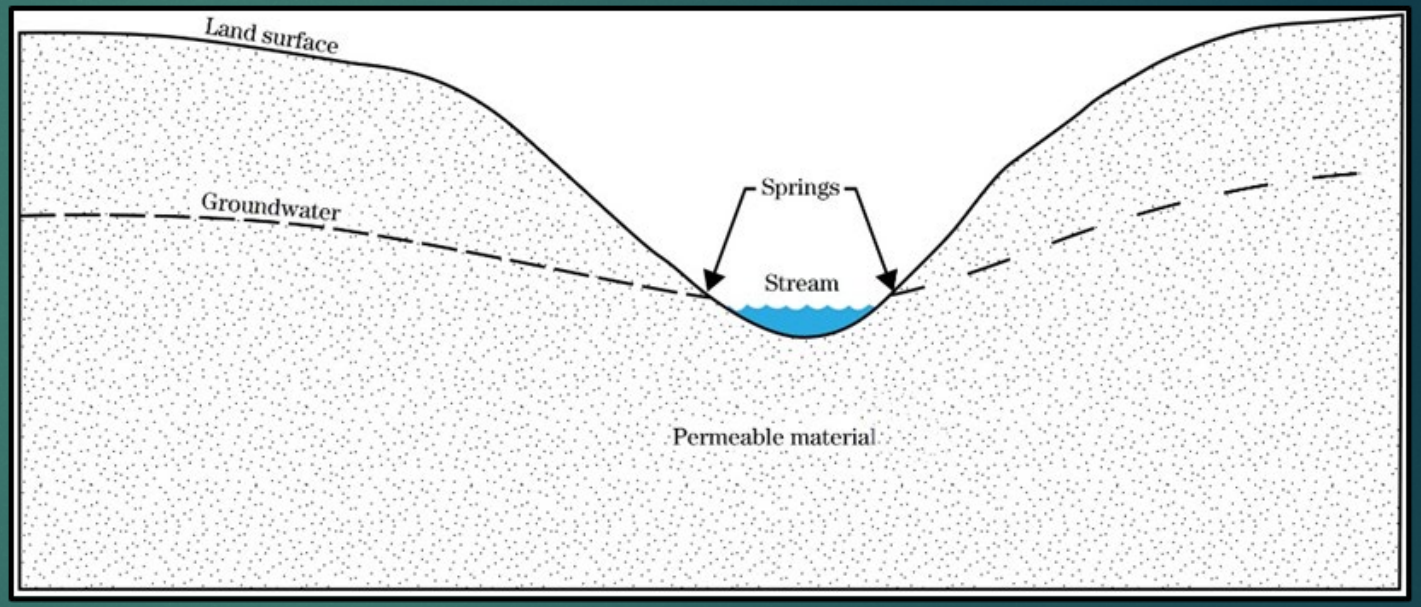
| Aquifer Component | Typical Yield |
|---|---|
| Unconsolidated material (sands or gravels) | High |
| Jointed and permeable sandstone | Variable |
| Jointed and soluble (solution channels) limestone | Variable |
| Jointed or fractured volcanic material | Variable |
| Jointed or fracture dense hard rock | Variable |
| Fine-grained material (primarily silts and clays) | Low |

# Types of Springs and Another Controlling Factor for Flow

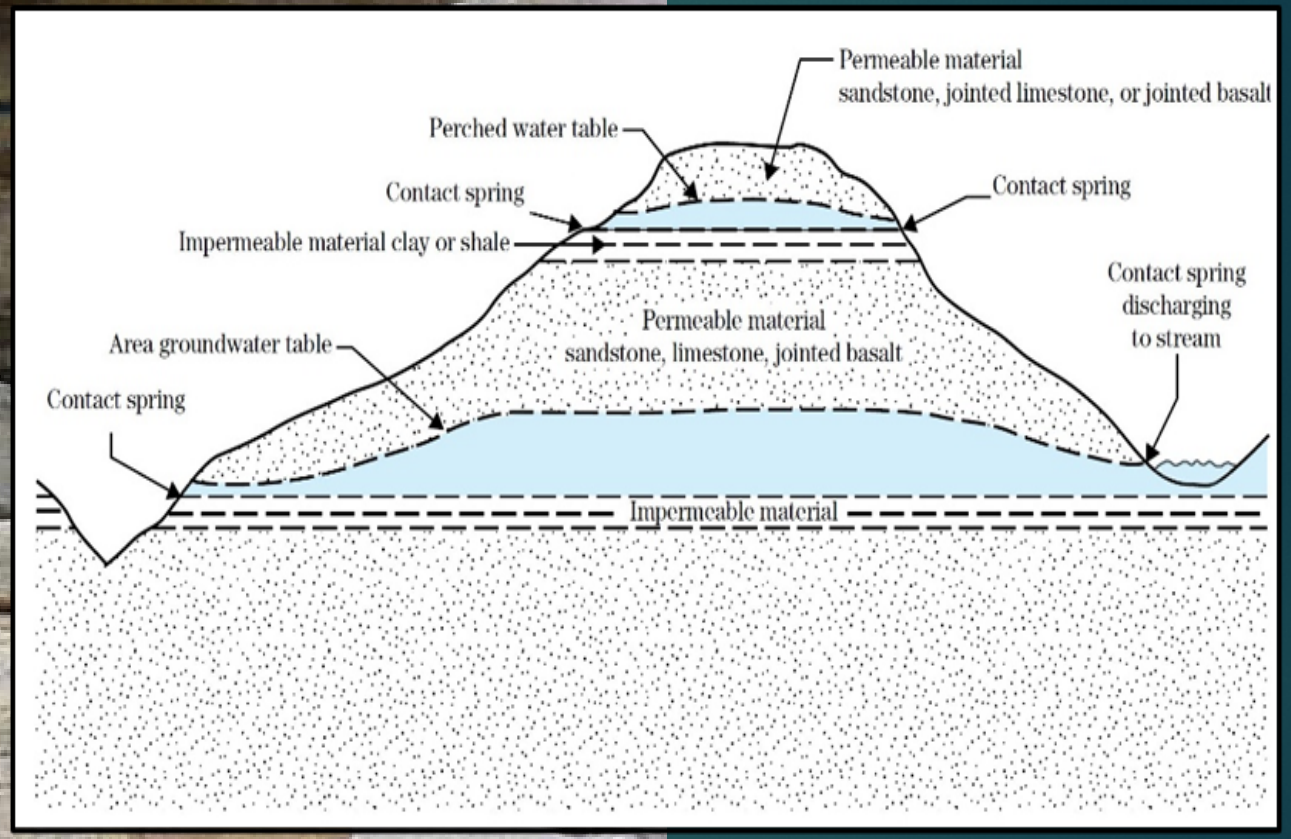
- Gravity Spring – Gravity
  - Depression Spring
  - Contact Spring
  - Fracture/Joint or Tubular Spring
- Artesian Spring - Hydraulic Pressure

# Depression Gravity Springs, Seepage or Filtration

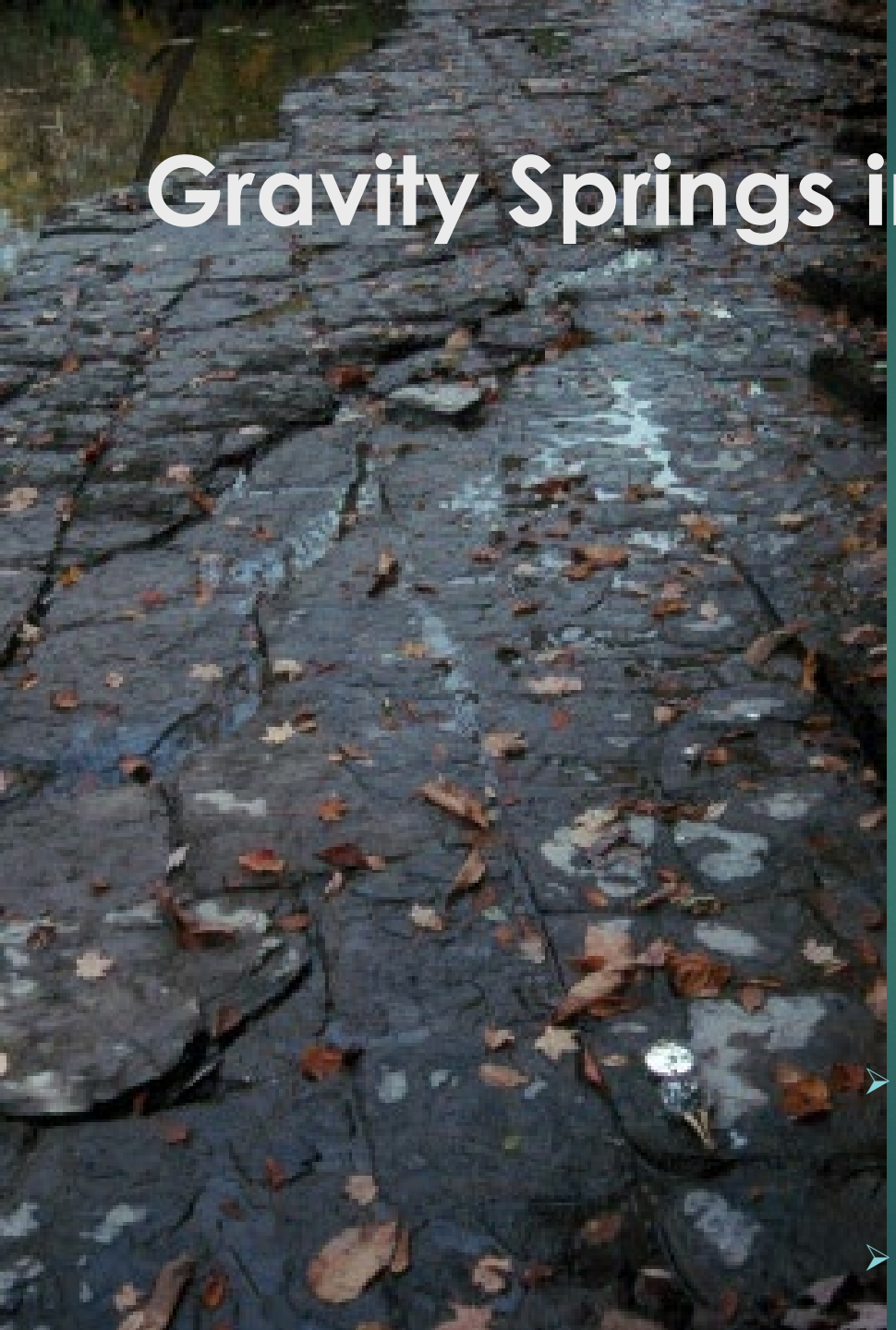
- Cause – Land surface intersects the water table
- Yield – Typically low but probably enough for livestock needs



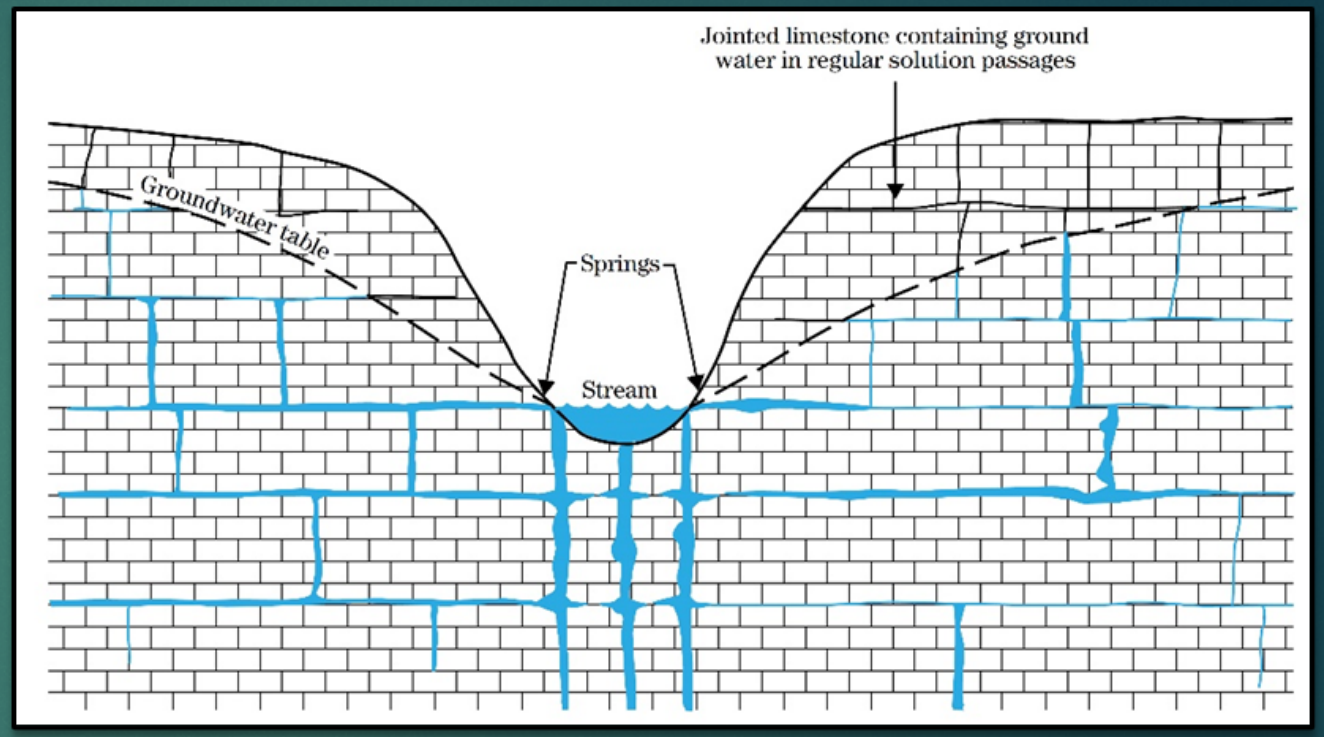
# Contact Gravity Springs




- Cause – A layer of impervious material (ex. outcrop of a perched water table)deflects groundwater movement laterally to the surface.
- Yield – Typically low but probably enough for livestock needs



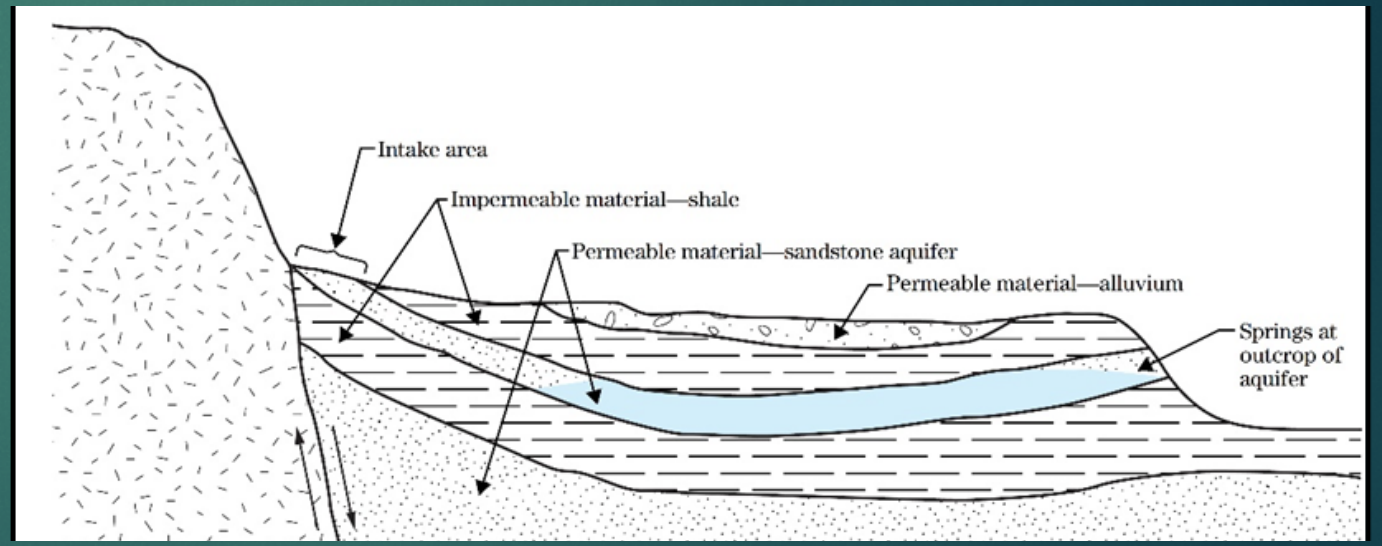
# Gravity Springs in Jointed Limestone




- Cause – Water emerges from fractures or joints in rock, from solution channels in limestone or gypsum, or from natural tunnels in volcanic rock
- Yield – Typically low but probably enough for livestock needs

# Artesian Springs at Aquifer Outcrop

- Cause – Relatively impervious strata confines water introduced to permeable strata exposed near the surface at higher elevations
- Yield – Varies depending on the difference in the recharge and discharge elevations of the aquifer and the size of the openings transmitting the water.



# Spring Selection for Adequate Water Source

- Existing spring and well locations and yields
- Current hydrologic conditions (precipitation and departure from normal)
- USGS and State geological survey investigative reports
- Copies of well drillers' logs for wells in the vicinity or in aquifers of interest
- Interviews with well drillers who have done work in the area
- County soil survey report and interpretation data, and general description of geologic conditions
- Map showing groundwater development sites and including the geologic situation of each site
- Groundwater contour maps or structural contour maps of known aquifers
- Geology reports from previous investigations

# Methods of Increasing Flow from Springs

- Gravity Spring
  - Removal of obstructions
    - Sand, silt, or clay) brought to the outlet by ground water
    - Slope wash material
    - Vegetation
  - Collection of flow
  - Drainage of more of the water-bearing formation (aquifer)
- Artesian Spring
  - All of the above
  - Lowering the outlet elevation

# Spring Protection

Springs are frequently at locations susceptible to flooding. Design the spring appurtenant structures to permit use without continual maintenance, use diversions if needed. Develop the spring so that flood flows passing over the top do not cause damage.

# Biology of Springs

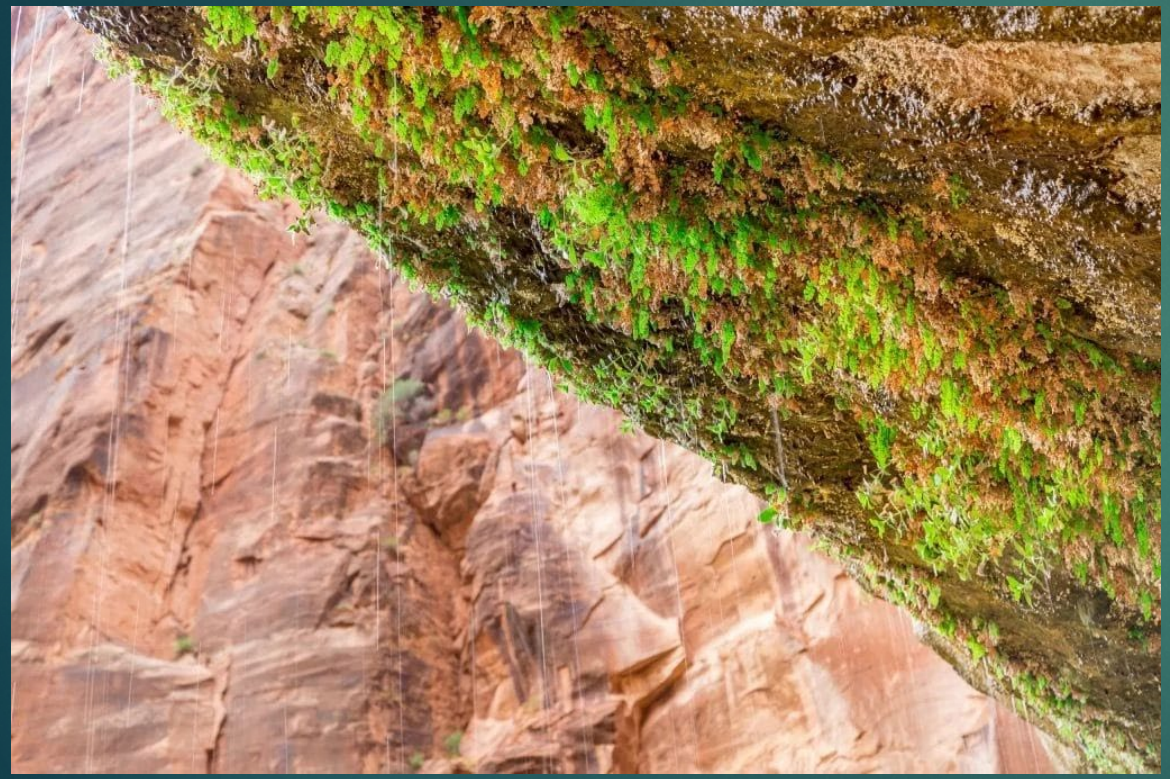
ZACH FREED, HYDROLOGIST

# Spring Habitats

- Wide variety of habitat types
- Ecologically-important characteristics differ by type
- Dependent upon hydrogeologic setting

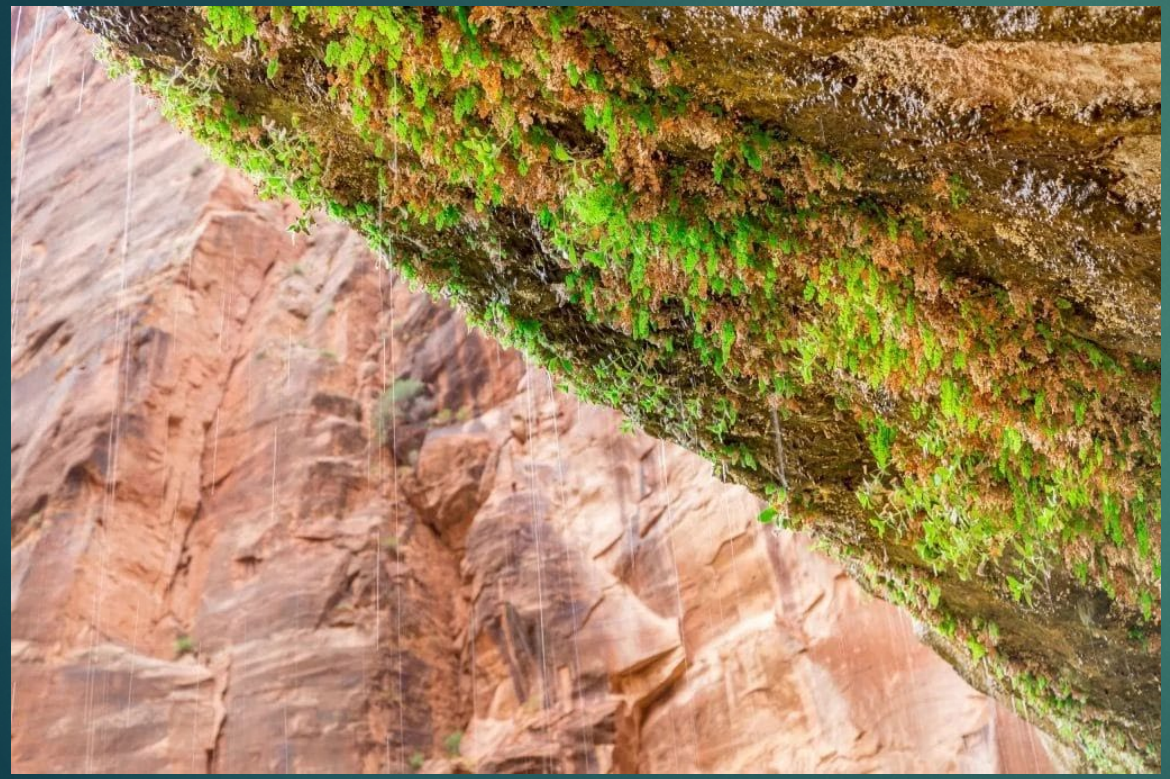
# Spring Habitats

# Spring Habitats



Source: www.nps.gov/zion

# Spring Habitats



Source: www.nps.gov/zion

# Spring Habitats

- Patchy distribution in space and time
- Watershed position affects habitat types
- Flora and fauna depend on temporal dynamics

# Keystone ecosystems

(Springer and Stevens 2008)

Ecological characteristics:

1) **Flow**
2) **Temperature**
3) Saturated soil area & depth
4) pH, turbidity, dissolved oxygen, other QW

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# Keystone ecosystems

(Springer and Stevens 2008)

Spring-dependent species

- **Obligate** spp. require springs for all or part of their lifecycle
- Facultative spp. commonly utilize springs, but can survive elsewhere

# Keystone ecosystems

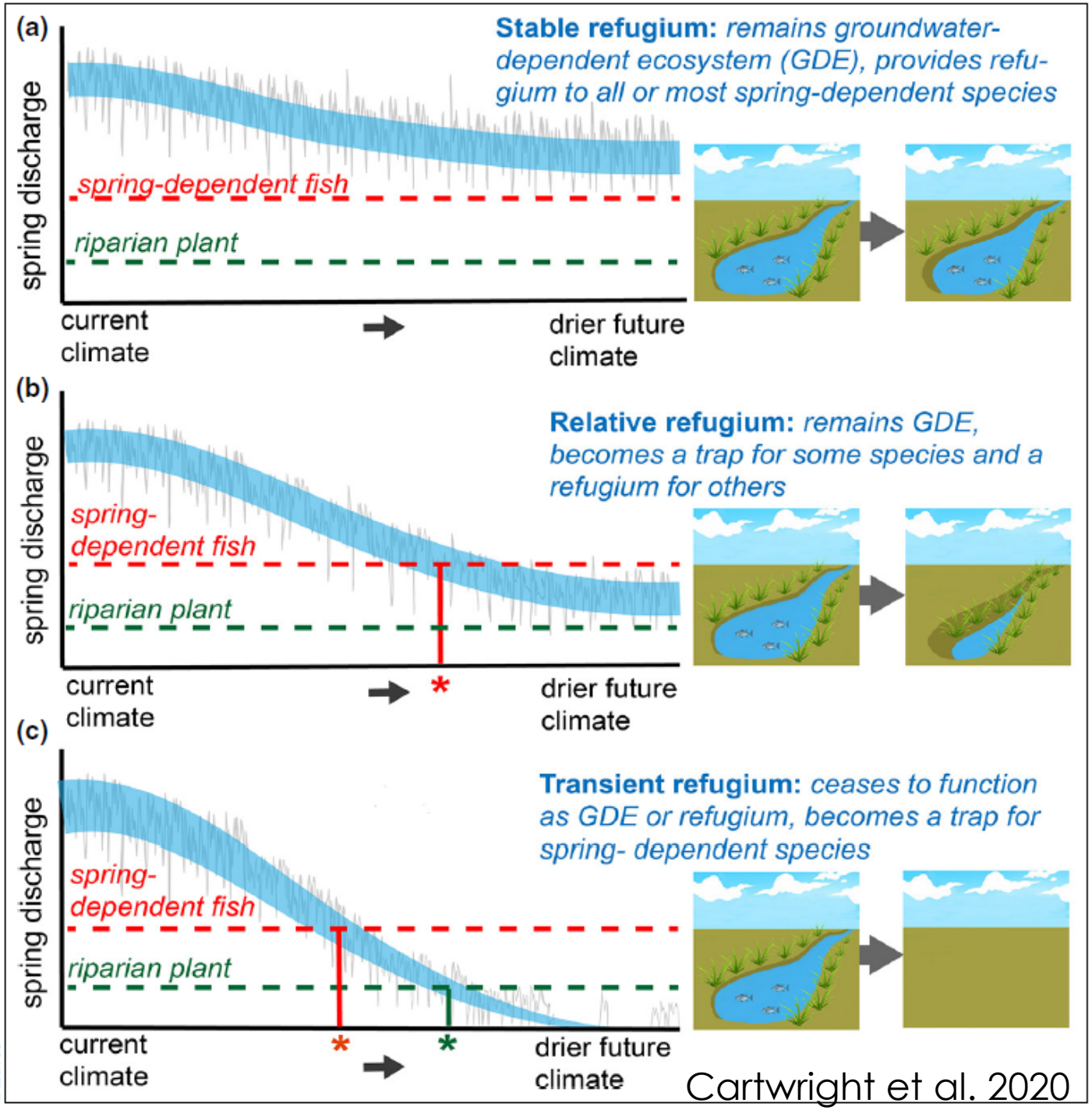
(Springer and Stevens 2008)

Spring-dependent species

- Obligate spp. require springs for all or part of their lifecycle
- **Facultative** spp. commonly utilize springs, but can survive elsewhere

# Climate Refuge

- **Hydrologic** refuge: provides saturated, inundated, and/or flowing habitat during drought
- **Thermal** refuge: provides microhabitats of cool water during low flows and/or high heat




Cartwright et al. 2020

# Climate Refuge

- Springs as **"museums of biodiversity"** (Murphy *et al.* 2015)
- Relict species and phylogeography
- Human paleo-evolutionary history

Cartwright et al. 2020

# Climate Refuge

<u>Discussion question</u>: What data would contribute to understanding a spring's refugial potential?

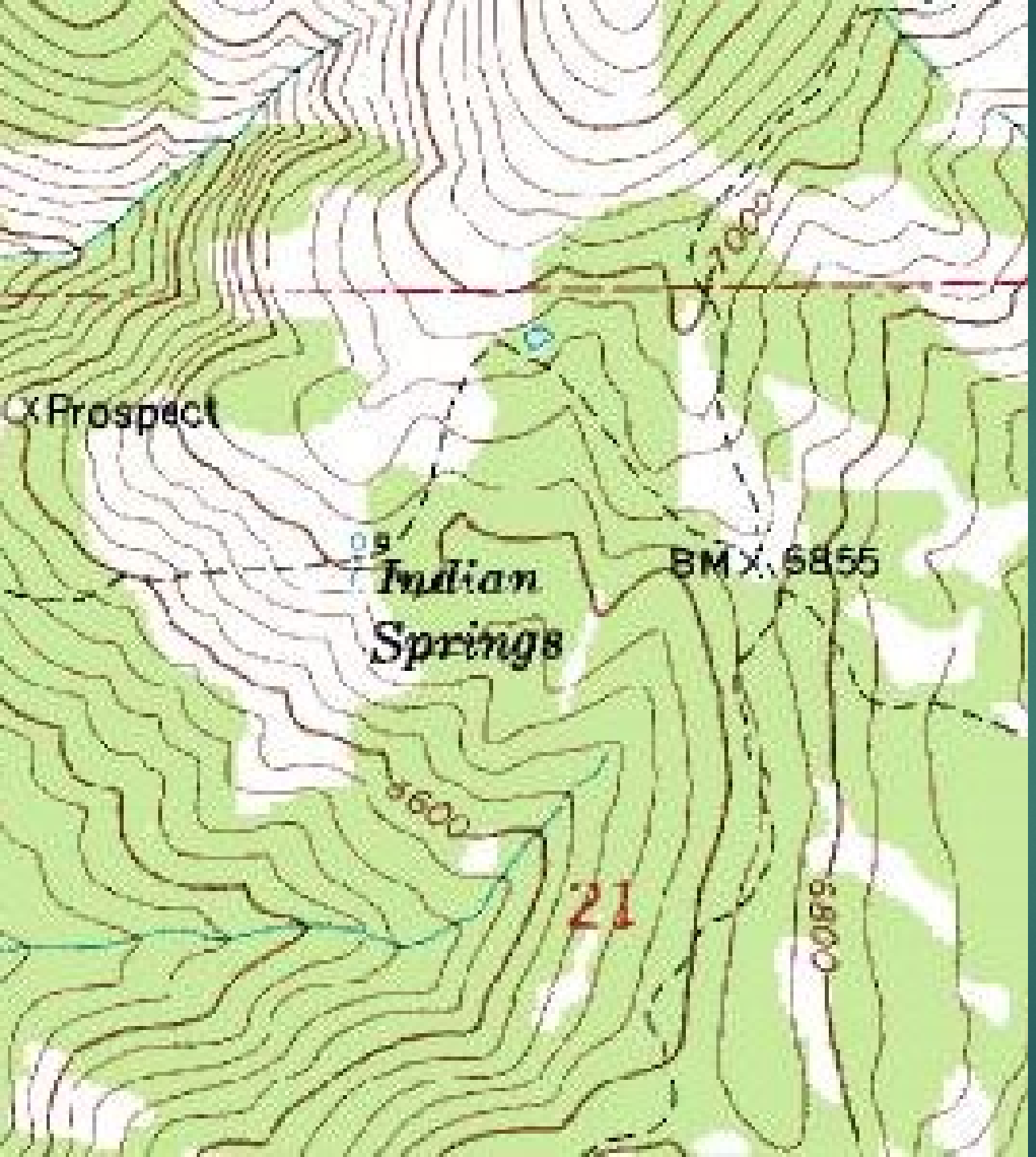
2020

# Related Environmental Laws, Regulations, and Policy

KAREN FULLEN, NRCS ECOLOGIST

# National Environmental Policy Act

- NRCS NEPA Compliance is based on:
  - CPS published in Federal Register for public comment
  - Network Effects Diagram
  - NRCS' Conservation Planning Process with its concurrent environmental evaluation, documented on the NRCS-CPA-52
- NRCS' NEPA regulations [7 CFR Part 650.3 b)(4)] and policy (190-GM-410) require NRCS to minimize adverse effects of planned actions




# Cultural Resources [GM Title 420, Part 401]

- NRCS Policy: protect cultural resources in situ to the fullest extent possible
- Avoid, minimize, mitigate

# National Cultural Resources Procedures Handbook (190-601-H)

- **601.70 Resources of Scientific Value Other Than Cultural Resources**
  - Geological resources of local or regional significance
  - Caves

# Endangered and Threatened Species and Species of Concern [GM 190, Part 410.22]

- NRCS is committed to supporting its clients and partners by providing technical assistance and NRCS actions to conserve and improve natural resources on private lands. Within this framework, and consistent with legal requirements, the implementation of conservation programs through planning and application of conservation practices and measures must provide for the conservation of—
- (i) Federally listed species (endangered and threatened).
- (ii) Species proposed for Federal listing.
- (iii) Federal candidate species.
- (iv) Federally designated and proposed critical habitat.
- (v) State and Tribal species of concern and their habitats.

# Invasive Species [GM 190, Part 414]

- Executive Order 13112 (1999)
- Federal agencies must
  - Prevent introduction
  - Provide for control
  - Minimize ecological, economic, and human health impacts

# Riparian Areas [GM 190, Part 411]

- NRCS assistance must "maintain or improve" riparian benefits
- RMS alternative must be provided on entire CTU
- If action negatively impacts riparian benefits, planners must modify the action.

# Protection of Wetlands (GM Title 190, Part 410.26)

- Develop practicable alternatives to
  1. Avoid adverse impacts to wetlands
  2. If avoidance is not possible, minimize adverse impacts to wetlands
  3. As a last resort, compensate for lost wetland functions and acres



# Other Relevant Policy

- National Biology Manual 510.11 Biological resources objectives
- National Planning Procedures Handbook Part 600.26 H. (2)
- National Environmental Compliance Handbook Part 610.73 E.

# Spring Development Site Evaluation

- Water quantity and quality needed for the intended purpose.
- Suitability of the spring location.
- Soil and geologic suitability.
- Impacts to existing ecological functions benefiting from the spring and potential losses caused by the spring development, including impacts to local wildlife and wildlife habitat….
- Effects of consumptive use on riparian health and function, stream flow, water temperature, and local aquifer recharge.
- Impacts to wetlands.

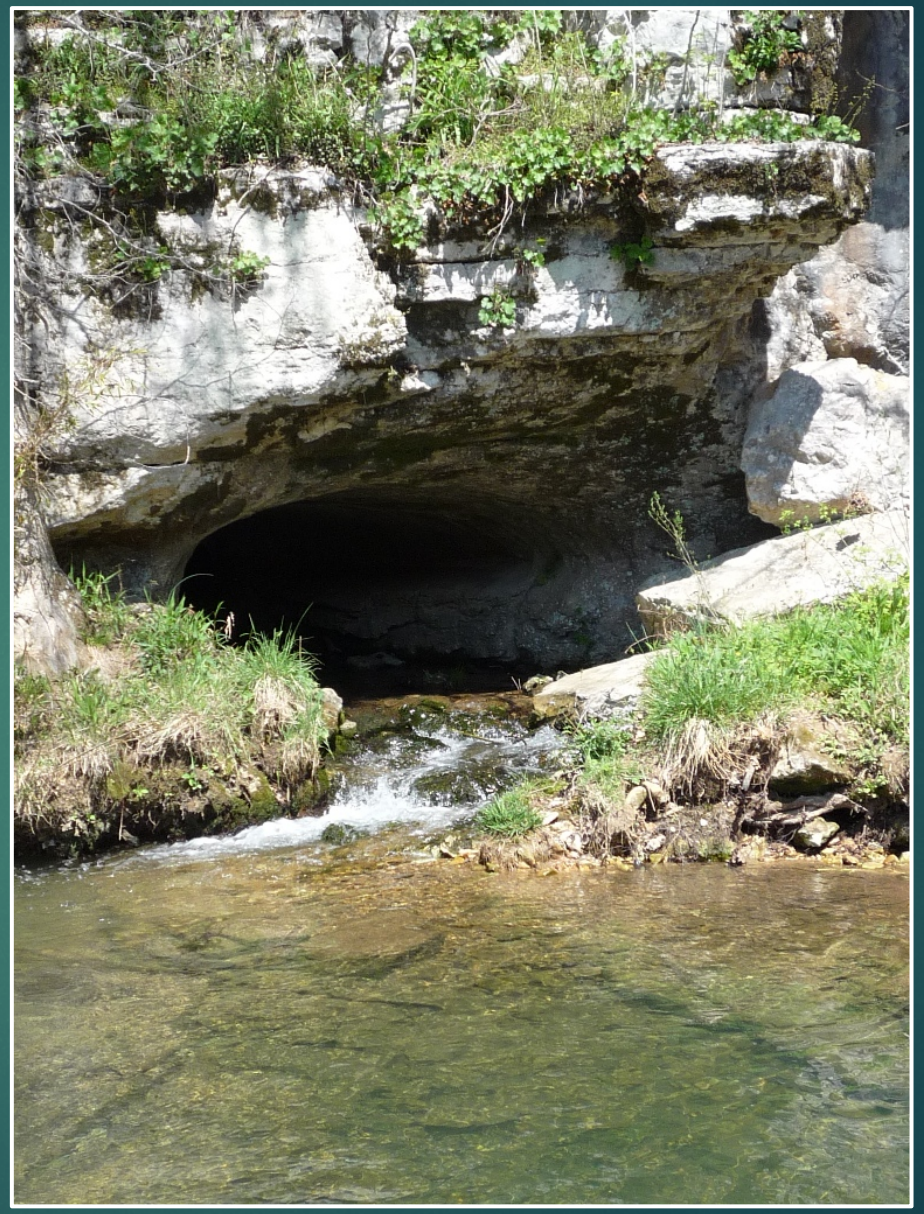
# Discussion Question: What are the potential ecological implications of this spring development?


What was using the water before it was collected, transported, and used at another location?
How is its current use different?

Oregon

## Discussion question:

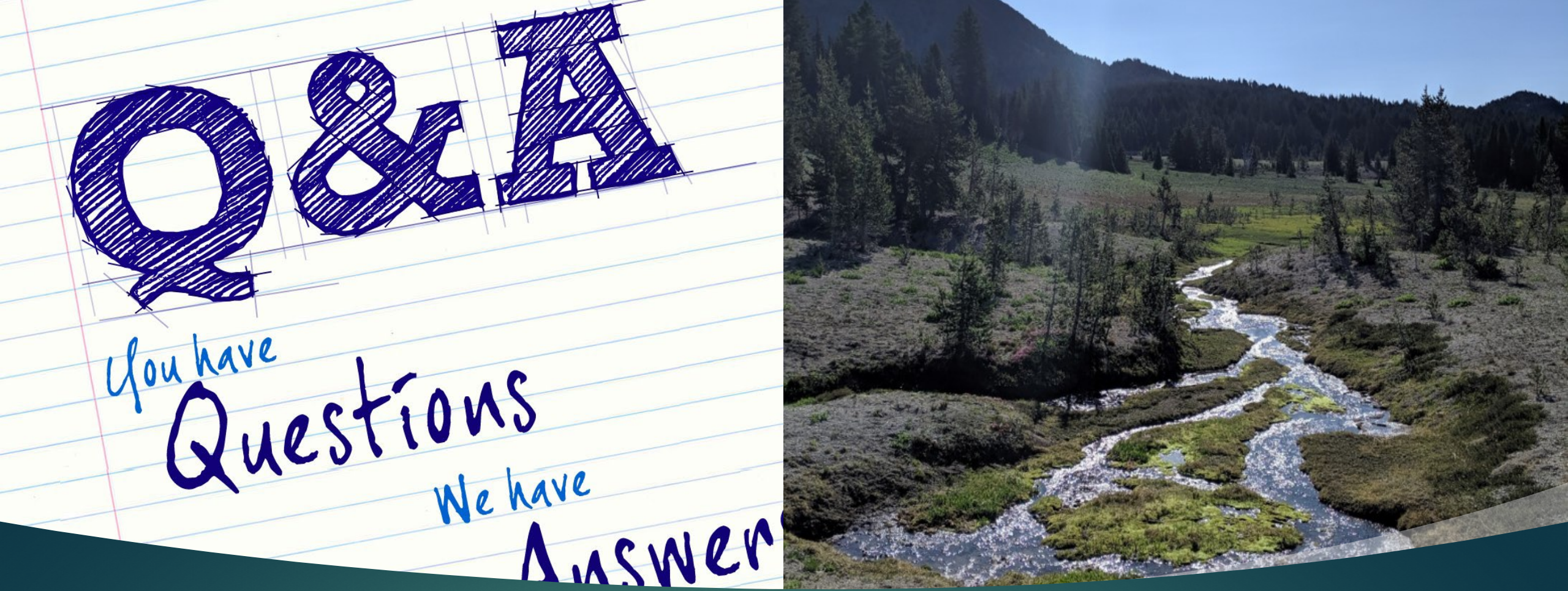
What are the controlling factors for aquifer discharge?



# Climate Refuge

<u>Discussion question</u>: What data would contribute to understanding a spring's refugial potential?

2020




# Ask the Expert!

# Contact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- Jon Fripp, 817-509-3771, jon.fripp@usda.gov
- Jo Johnson, 202-720-0115, jo.johnson@usda.gov
- Zach Freed, (503) 802-8151, zach.freed@tnc.org