For Septic System Service Providers

Presented:

February 1, 2008

- ❑ **Introduction**

  Joe Meek, DEQ Source Water Protection
- ❑ **Groundwater Basics**

  Jeffrey F. Herrick, *same*
- ❑ **Transition**

  Joe Meek, *same*
- ❑ **Septic Systems, New Technology & Maintenance**

  Eric Regensburger, DEQ Subdivisions Section

Groundwater Basics

MT DEQ   Source Water Protection Program

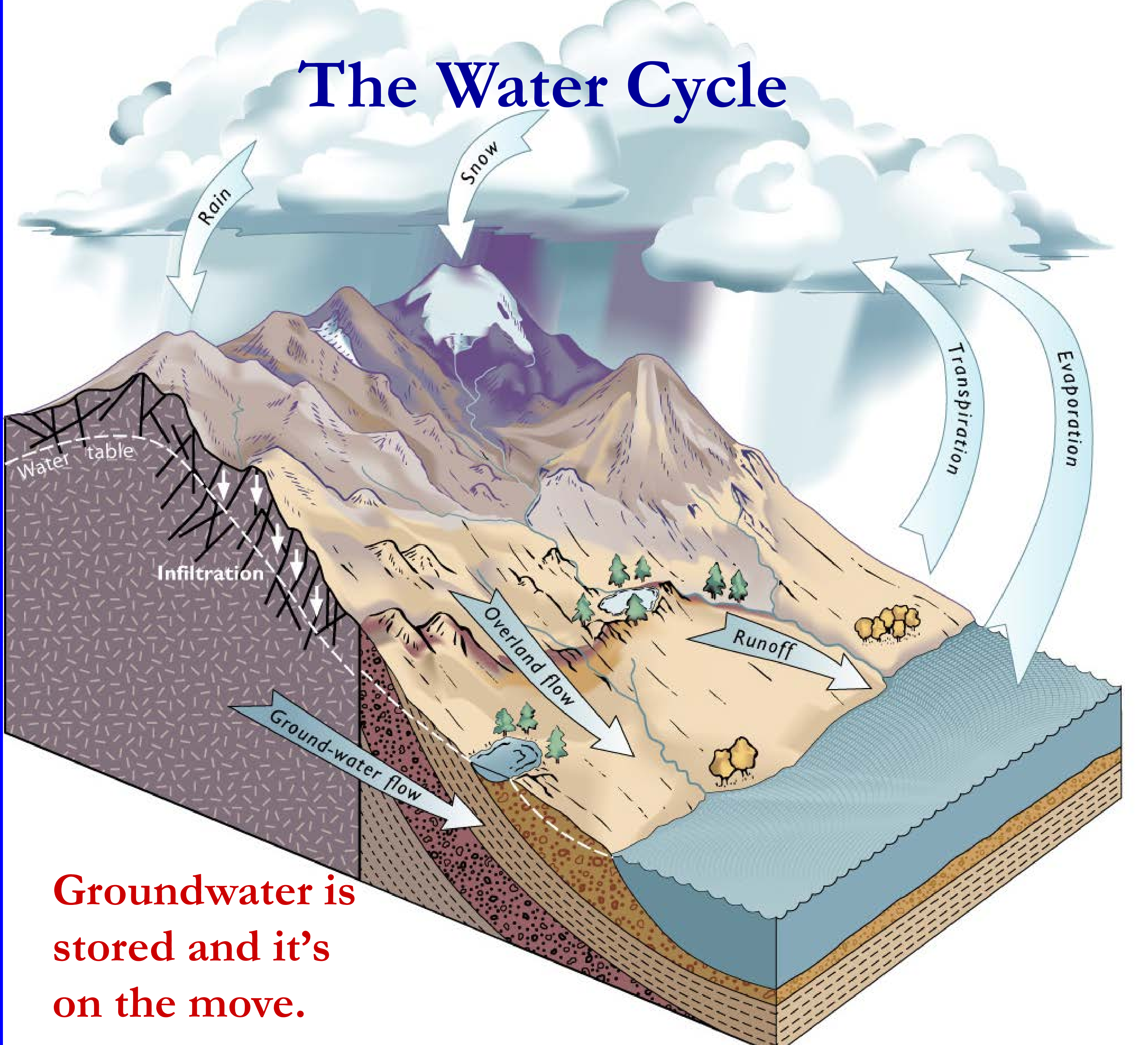
Joe Meek, Supervisor

Jeffrey Frank Herrick   (that’s me!)


Target Audience:
Homeowners, Septic
Professionals, You.

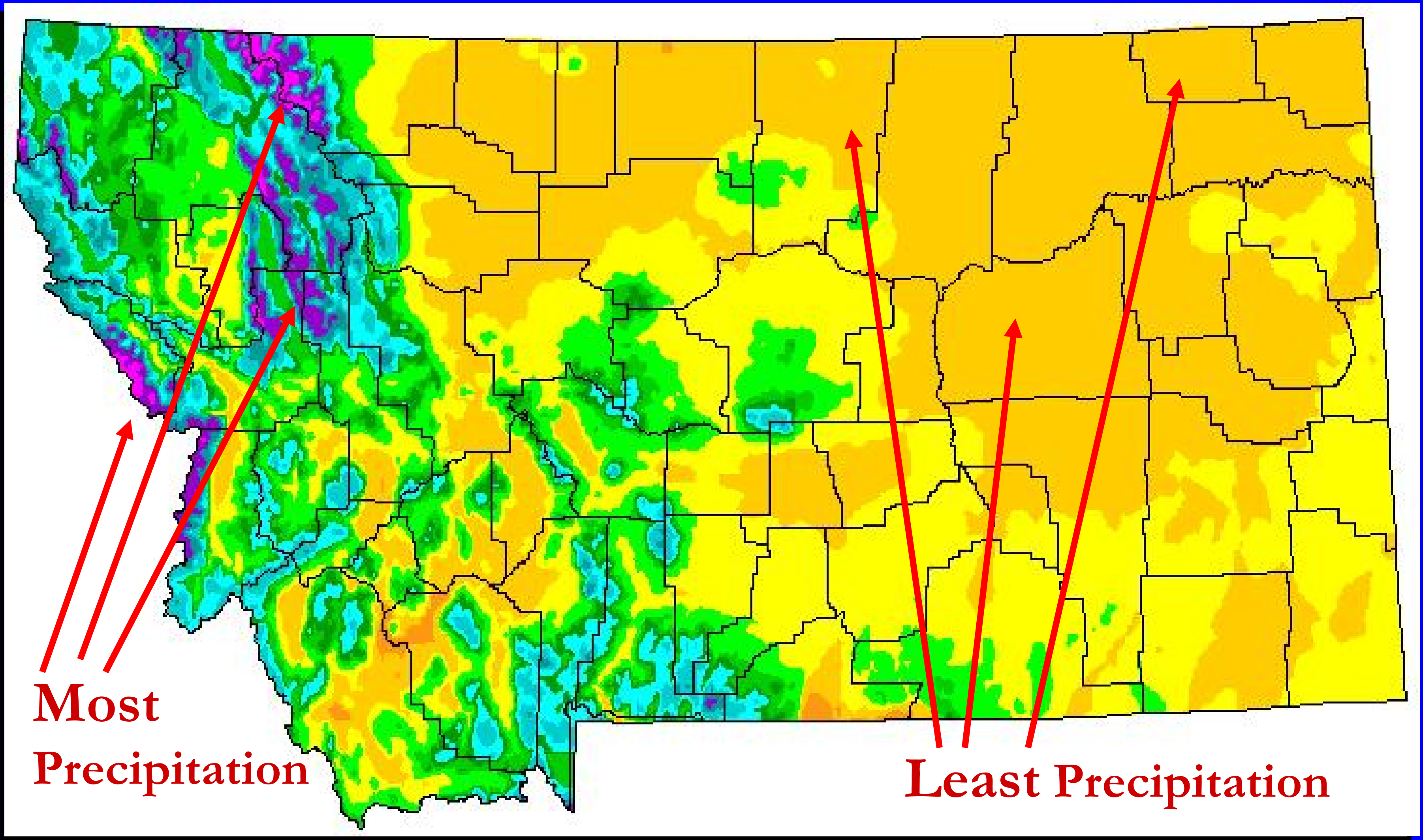

Most of Montana's
Water comes from
the Pacific

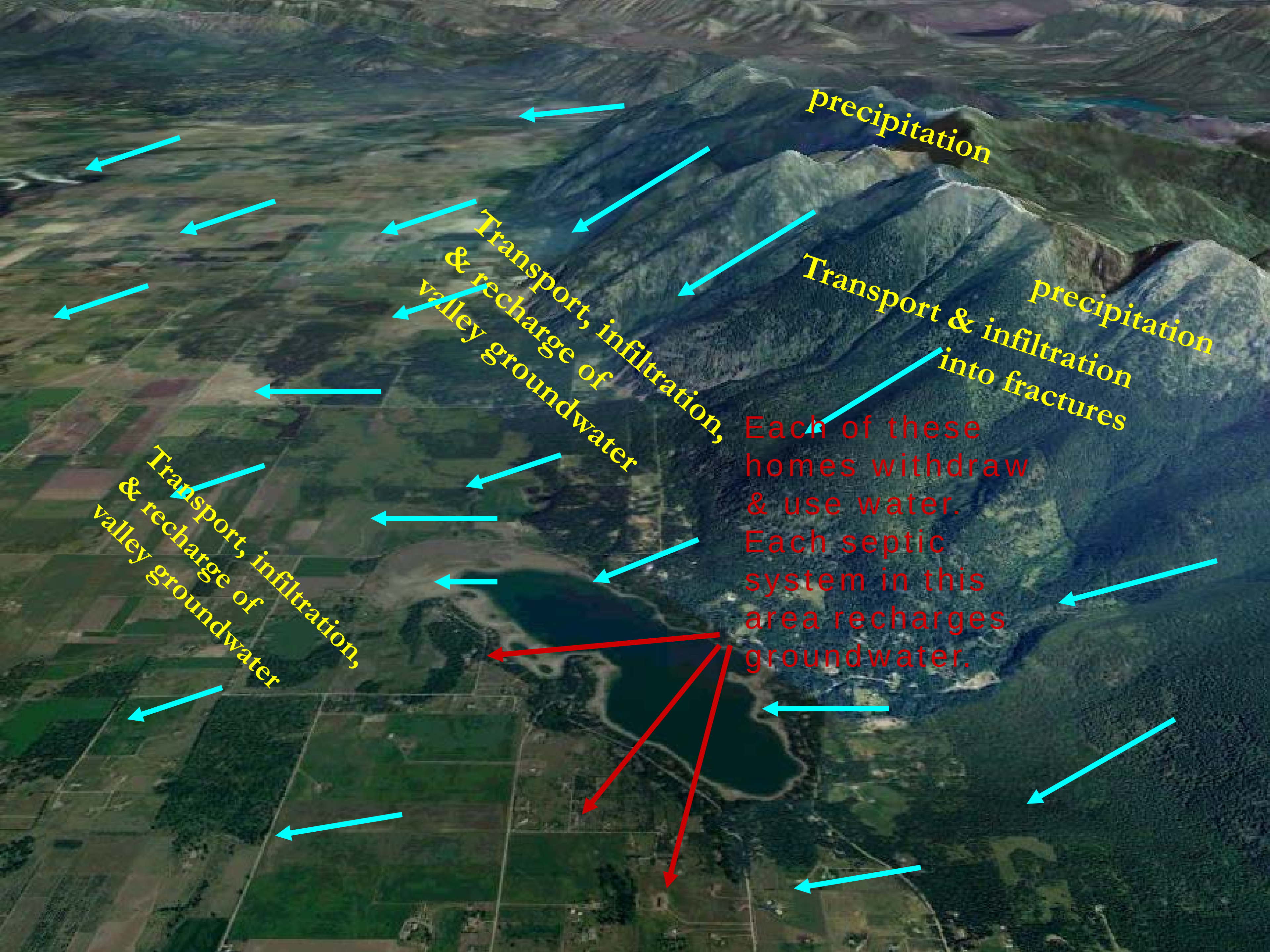
The Water Cycle



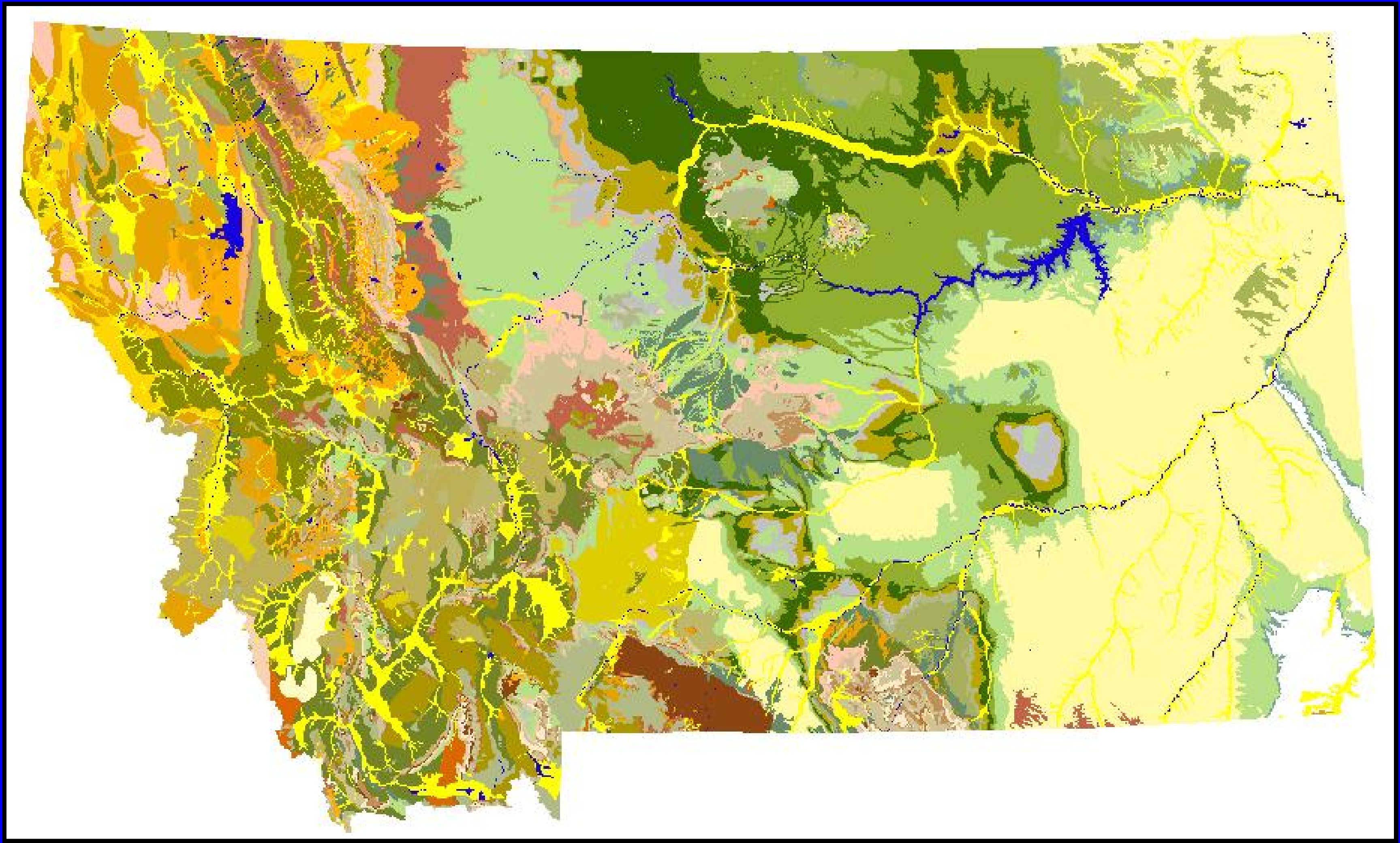
Groundwater is stored and it's on the move.

Montana - On The Surface

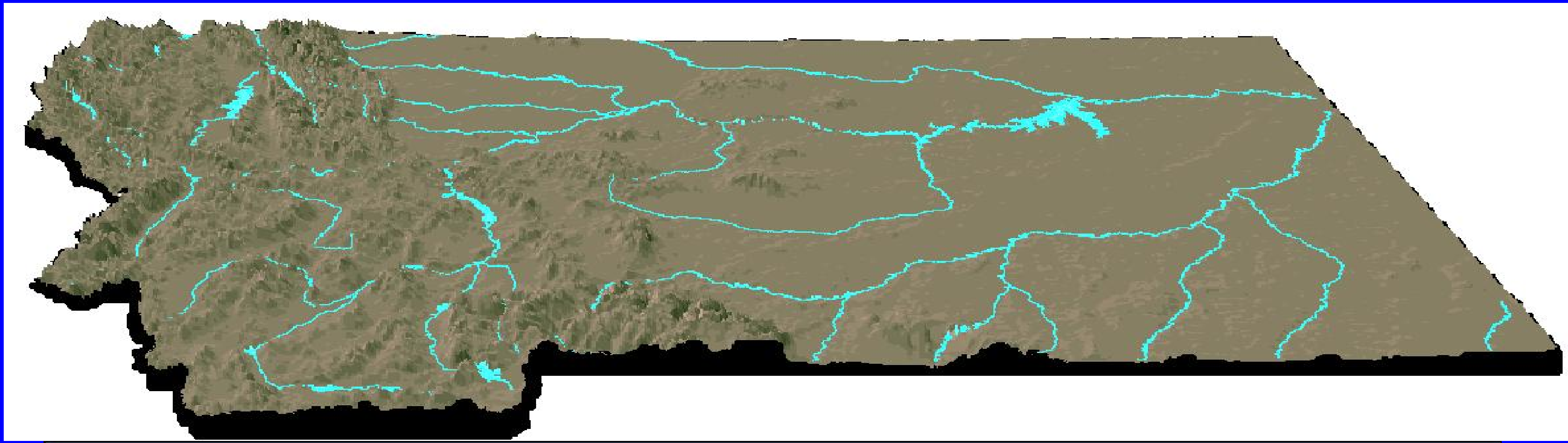


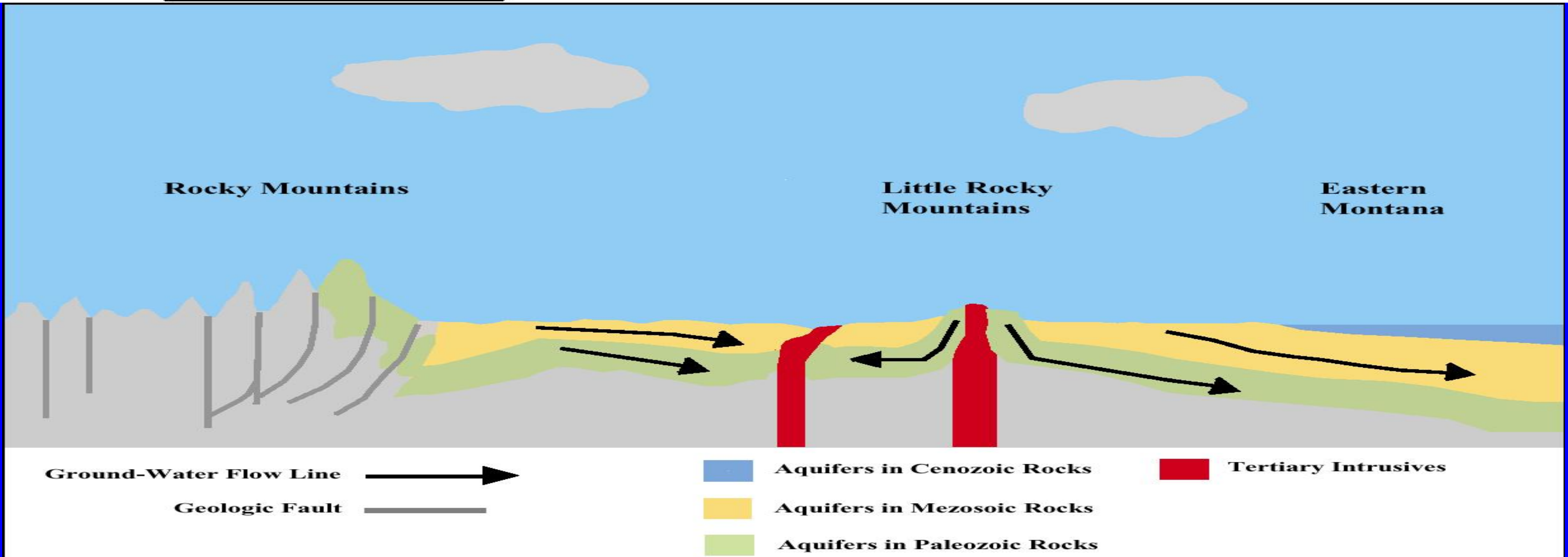

precipitation
precipitation
Transport, infiltration, & recharge of valley groundwater
Transport & infiltration into fractures
Each of these homes withdraw & use water.
Each septic system in this area recharges groundwater.
Transport, infiltration, & recharge of valley groundwater

Montana –Map of Surface Geology



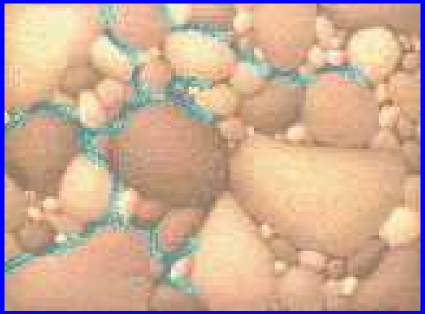
Montana - Beneath The Surface

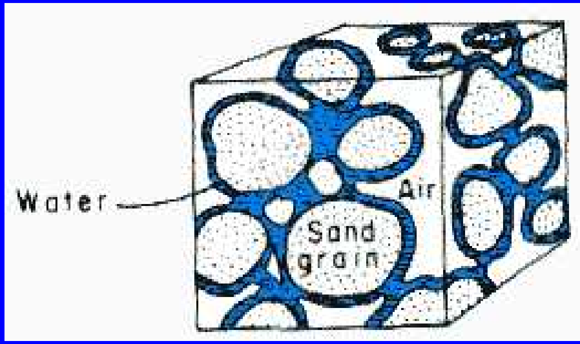




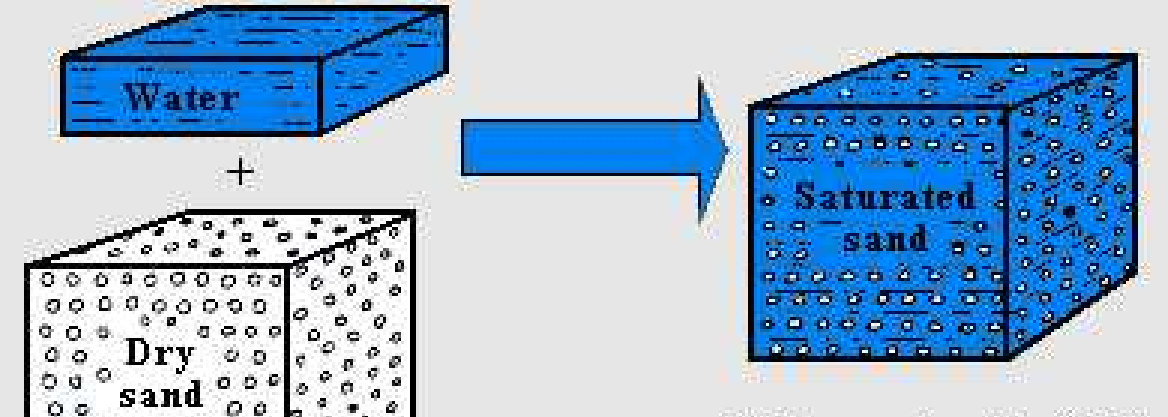
What Makes A Good Aquifer

- Conductivity = Inter-Connected Voids/Fractures



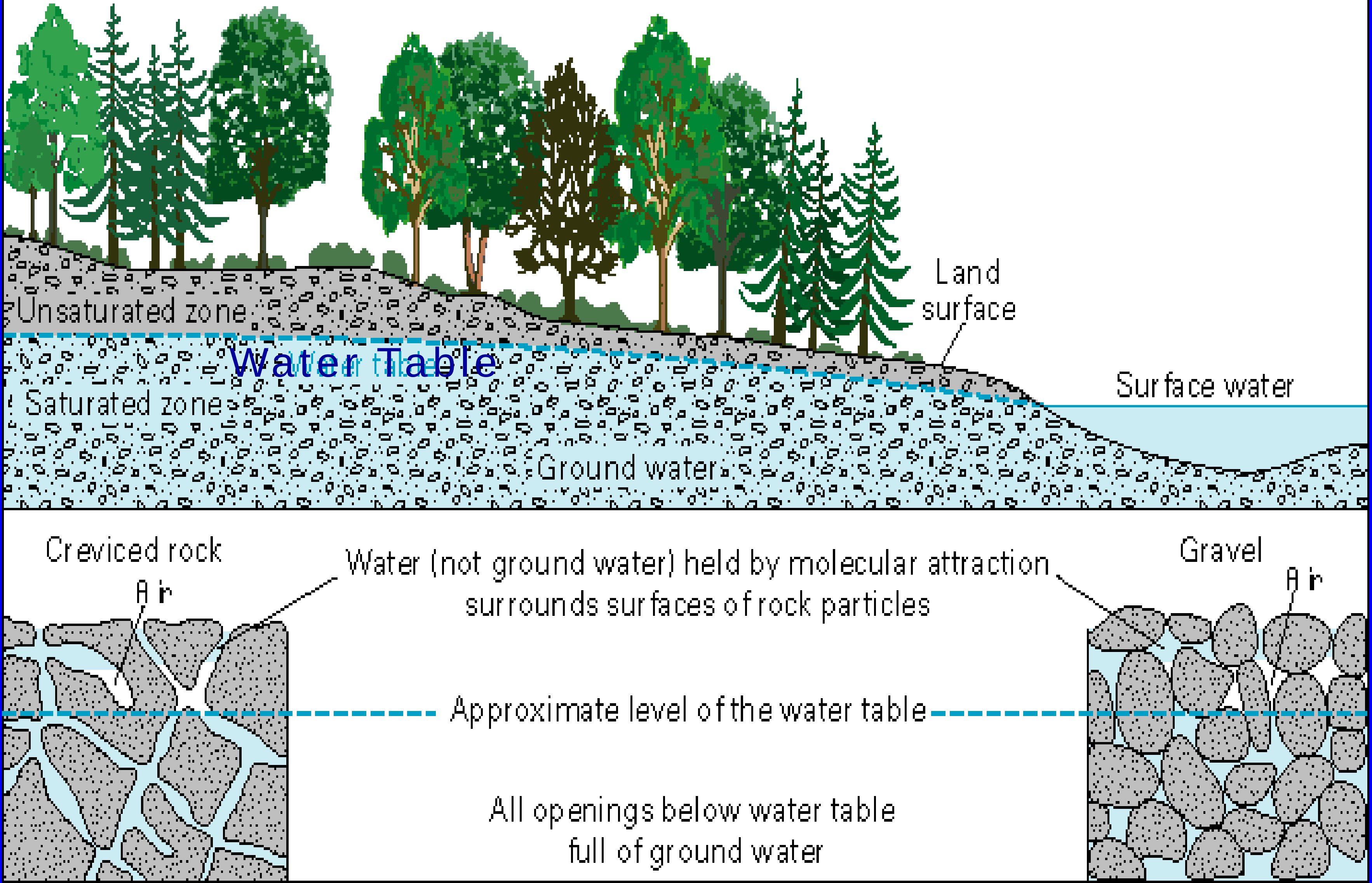


- Effective Porosity = % Void Spaces

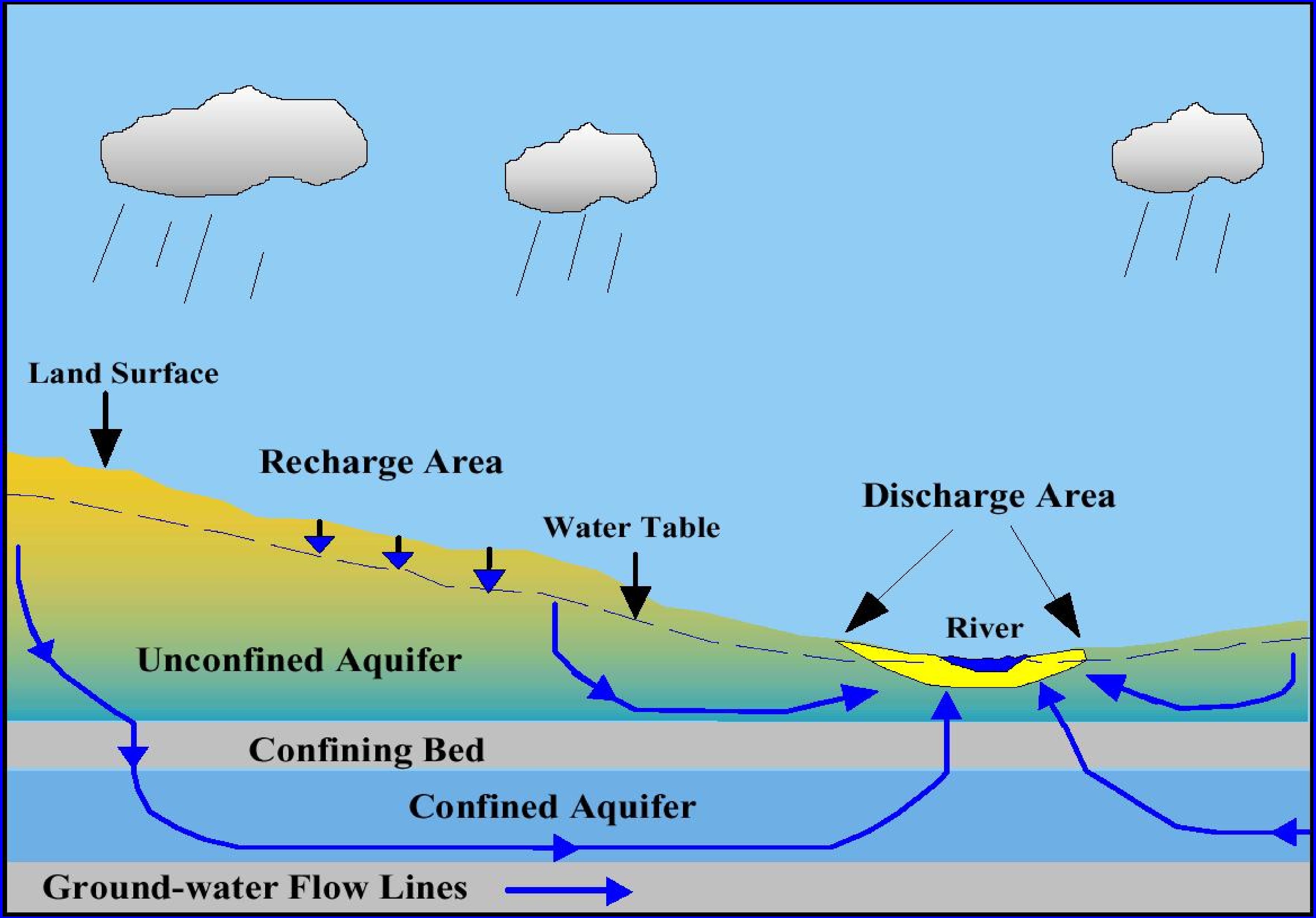


$$\text{Porosity } (n) = \frac{\text{Volume of voids } (V_v)}{\text{Total volume } (V_t)}$$

What is the Water Table?



Groundwater/Aquifer Recharge Areas



Potential

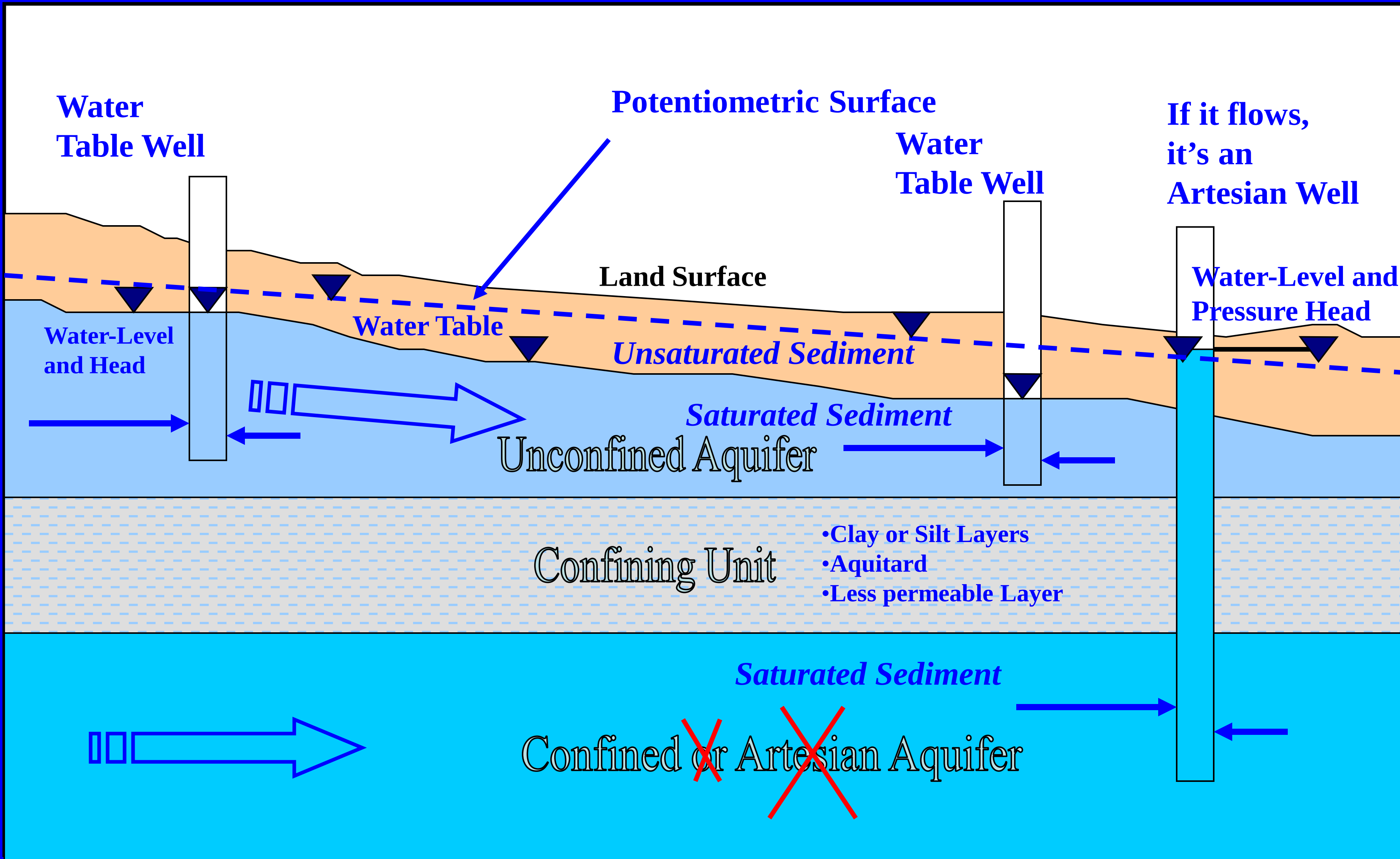
For <u>all aquifers</u>:

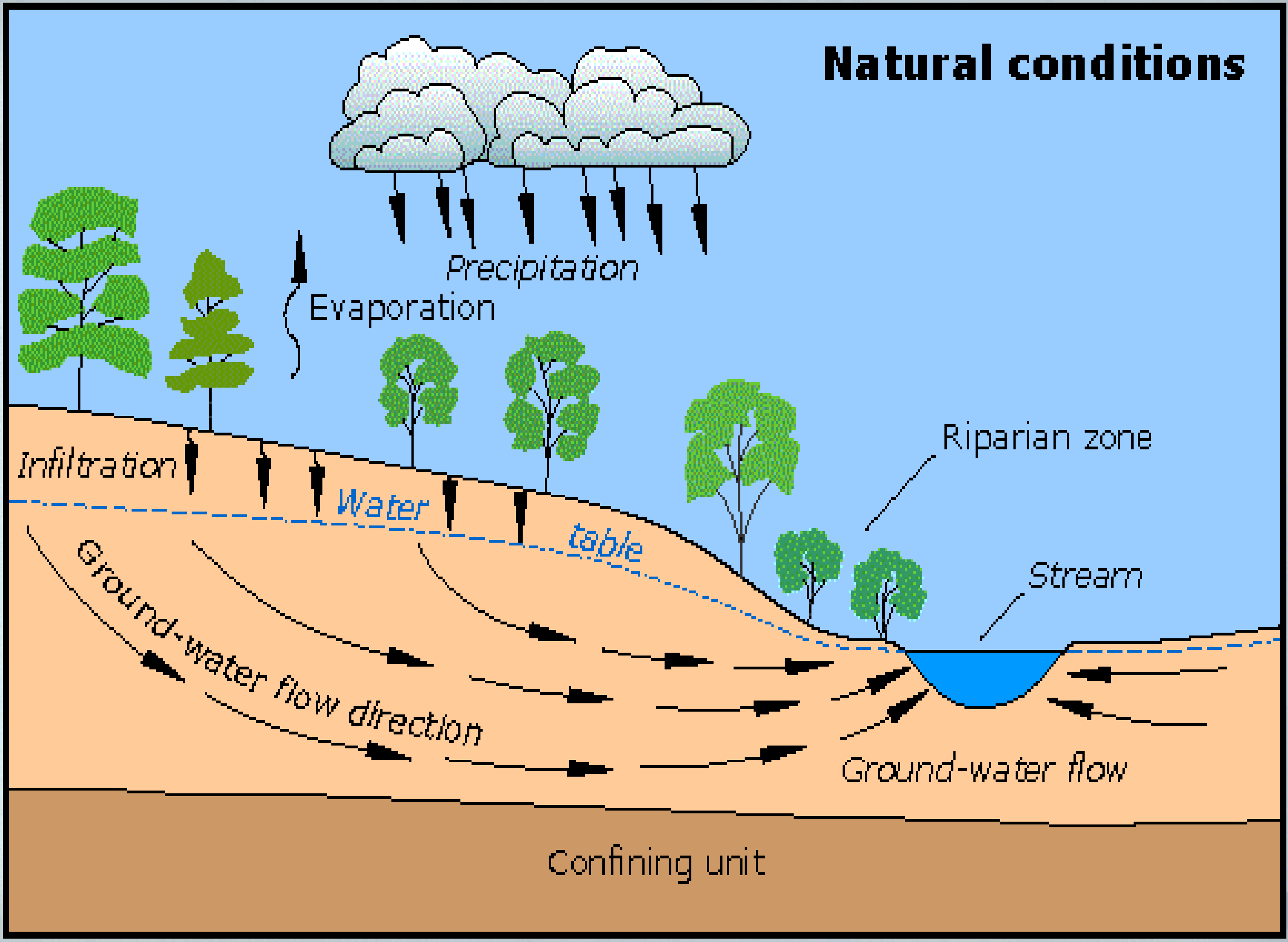
- **Water moves from areas of higher potential (~elevation) to areas of lower potential (~elevation).**

For <u>unconfined aquifers</u> (water table aquifers), it's pretty safe to say:

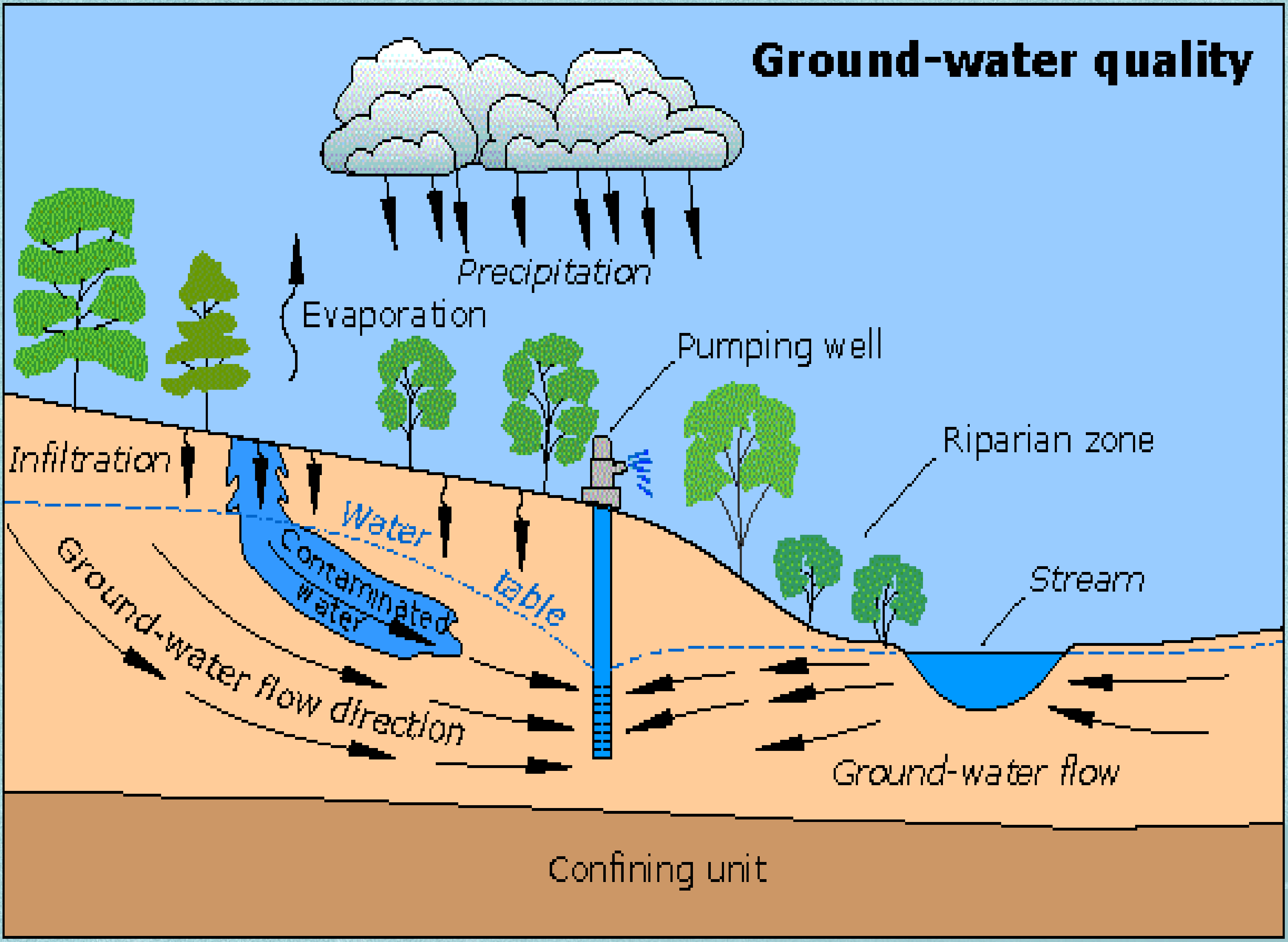
- **The slope of the water table often mimics the slope of the surface topography.**
- **Water flows downhill. This is imprecise, but an easy to remember rule-of-thumb.**

Groundwater Terms



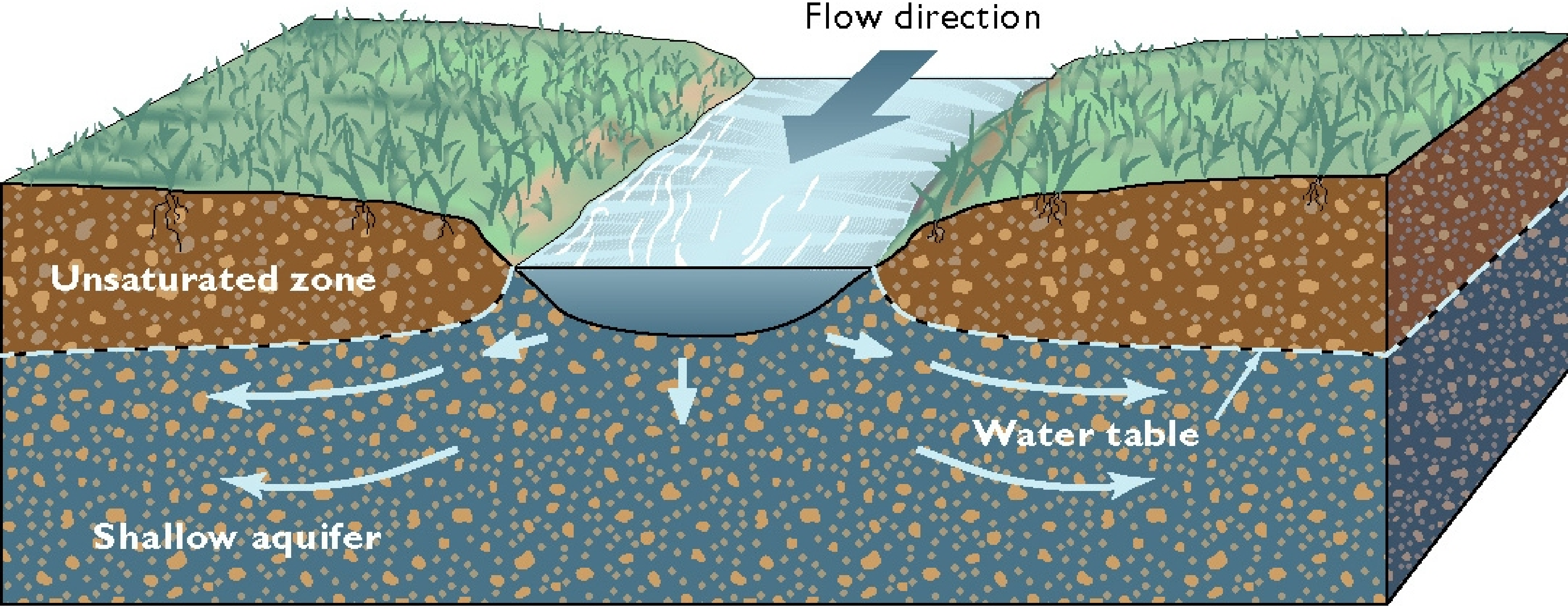


Natural conditions
Precipitation
Evaporation
Infiltration
Water table
Riparian zone
Stream
Ground-water flow direction
Ground-water flow
Confining unit



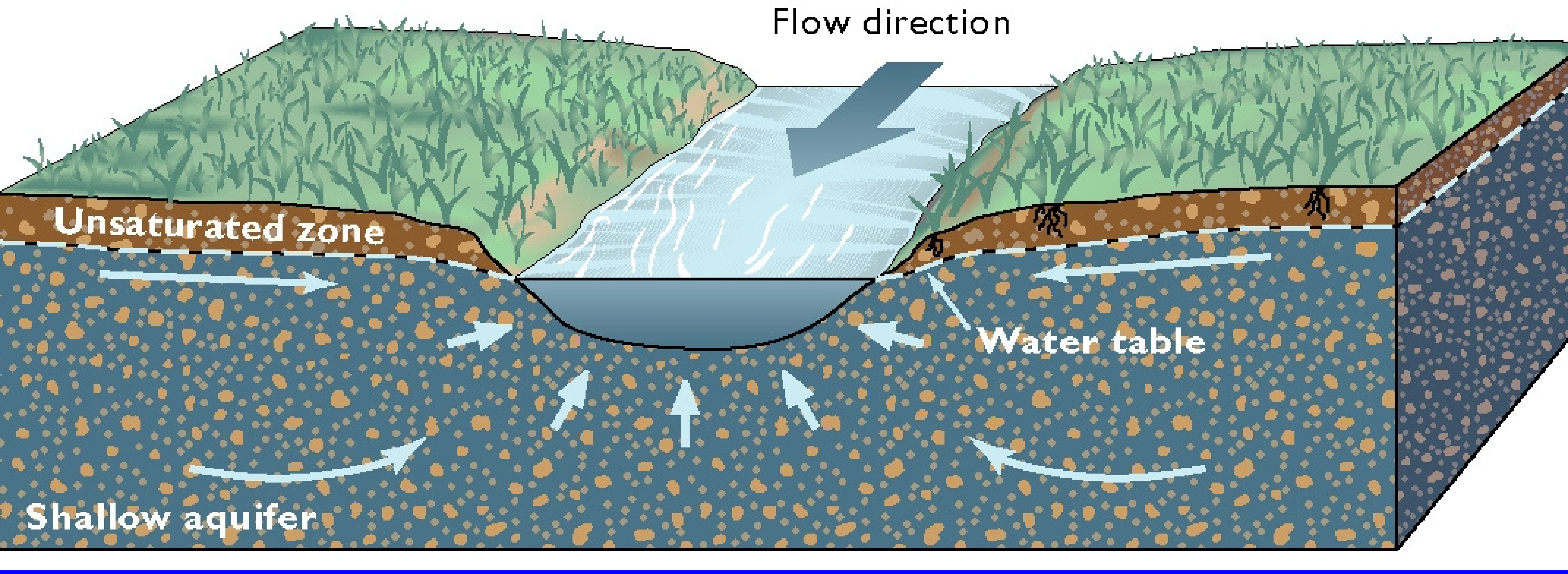
Ground-water quality
Precipitation
Evaporation
Pumping well
Riparian zone
Infiltration
Water table
Contaminated water
Ground-water flow direction
Stream
Ground-water flow
Confining unit

The Water Table / Unconfined Aquifer - Losing Reach of Stream

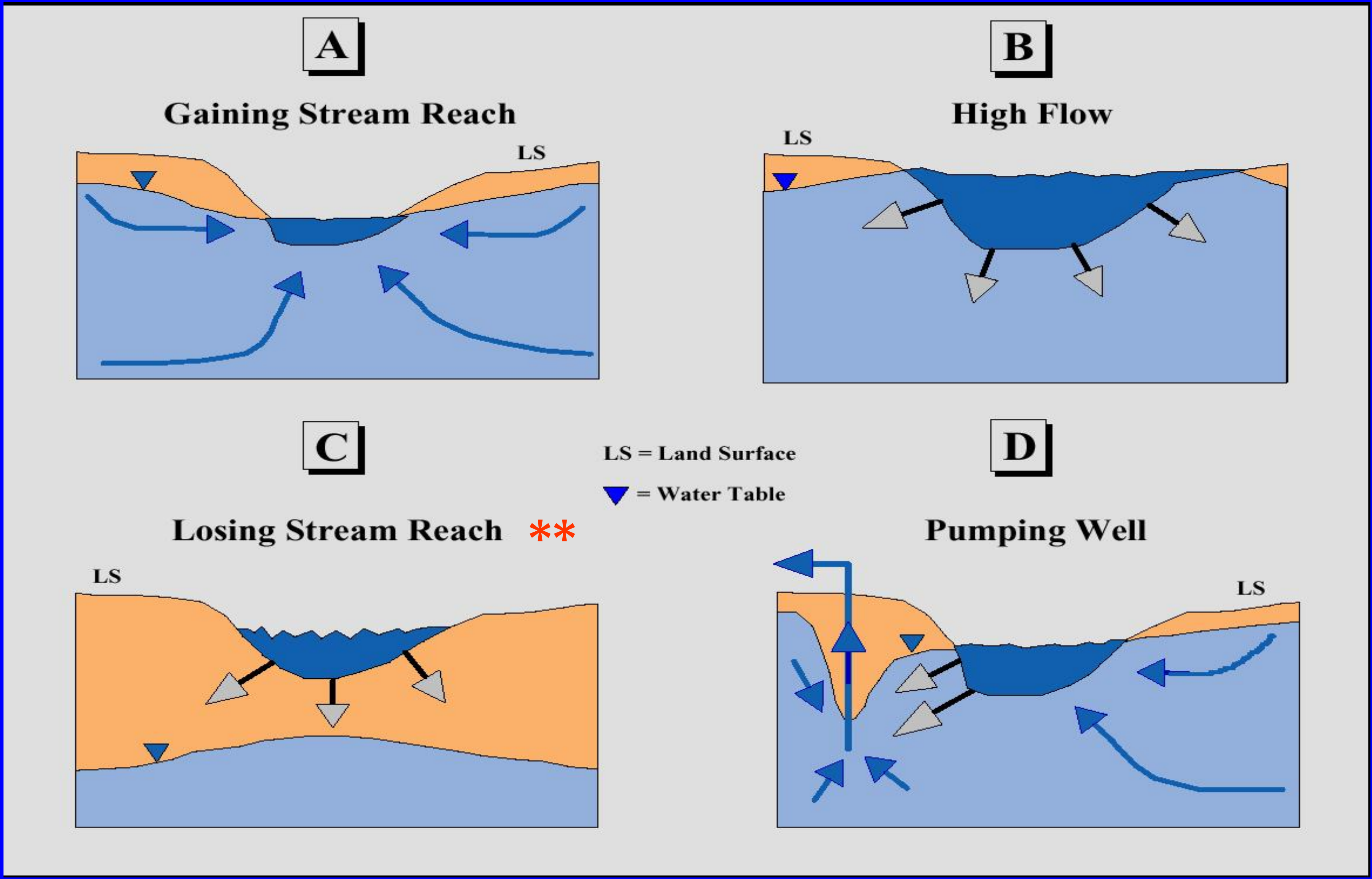


From Winter and others, 1999

The Water Table / Unconfined Aquifer - Gaining Reach of Stream



Surface Water - Ground Water Interactions



Example of a quickly losing stream

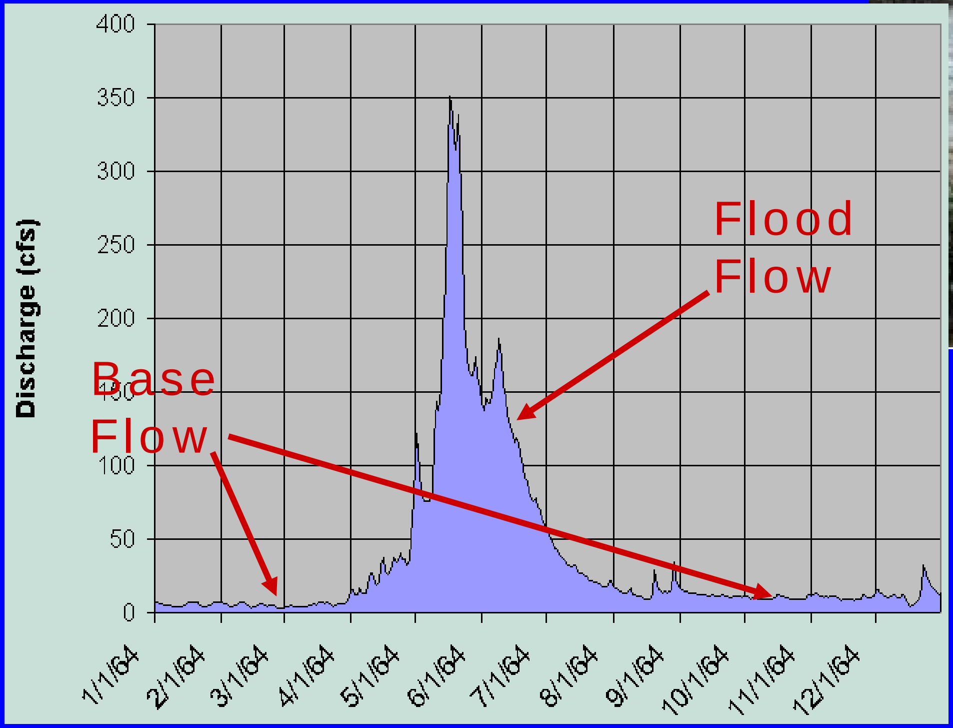
Water level in the stream

**


King'S

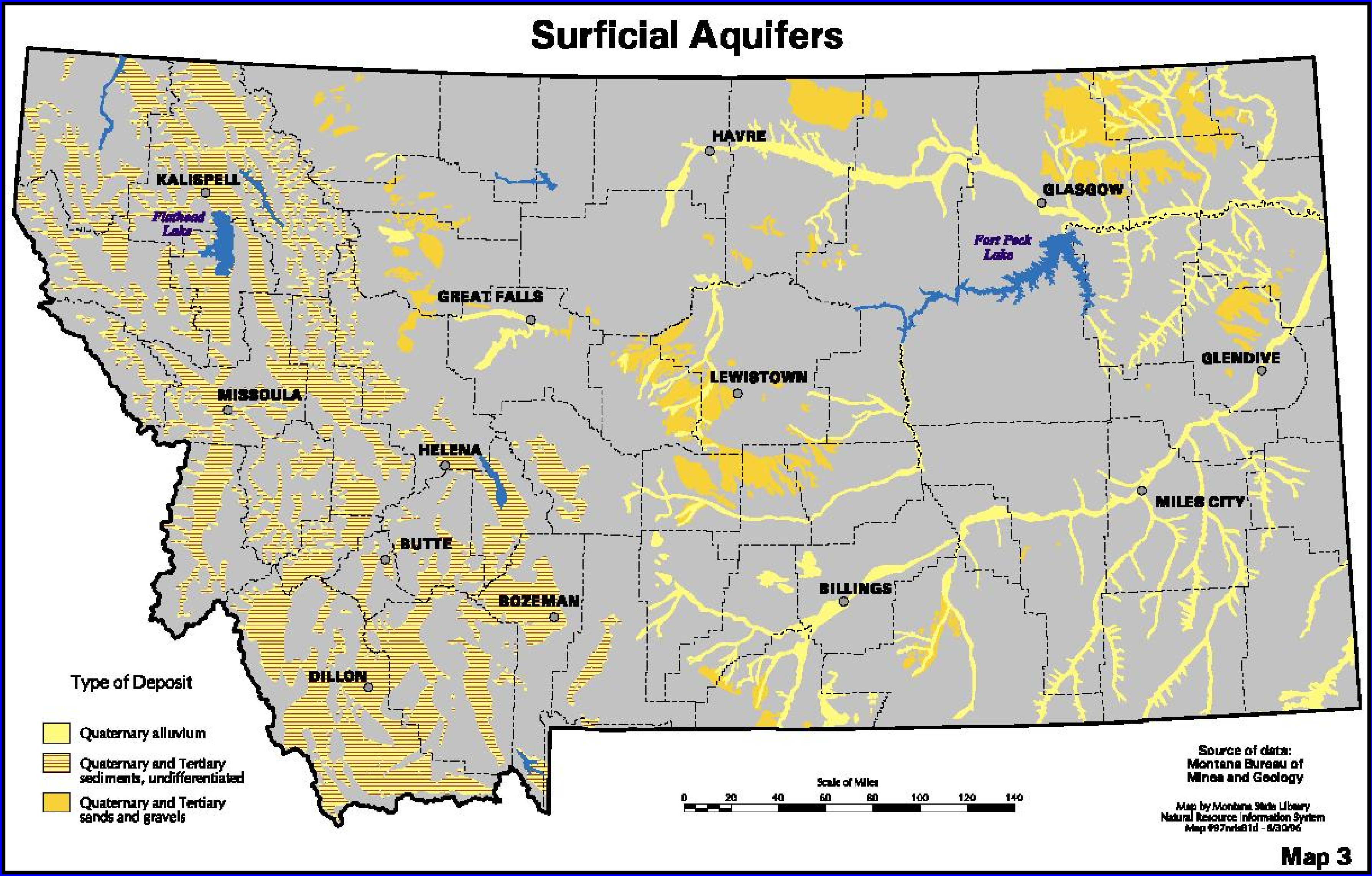
Snowmelt, rainfall, and flooding

Snowmelt and rain produce a dramatic peak in discharge (flow) of a river or stream, as shown on a *hydrograph*.

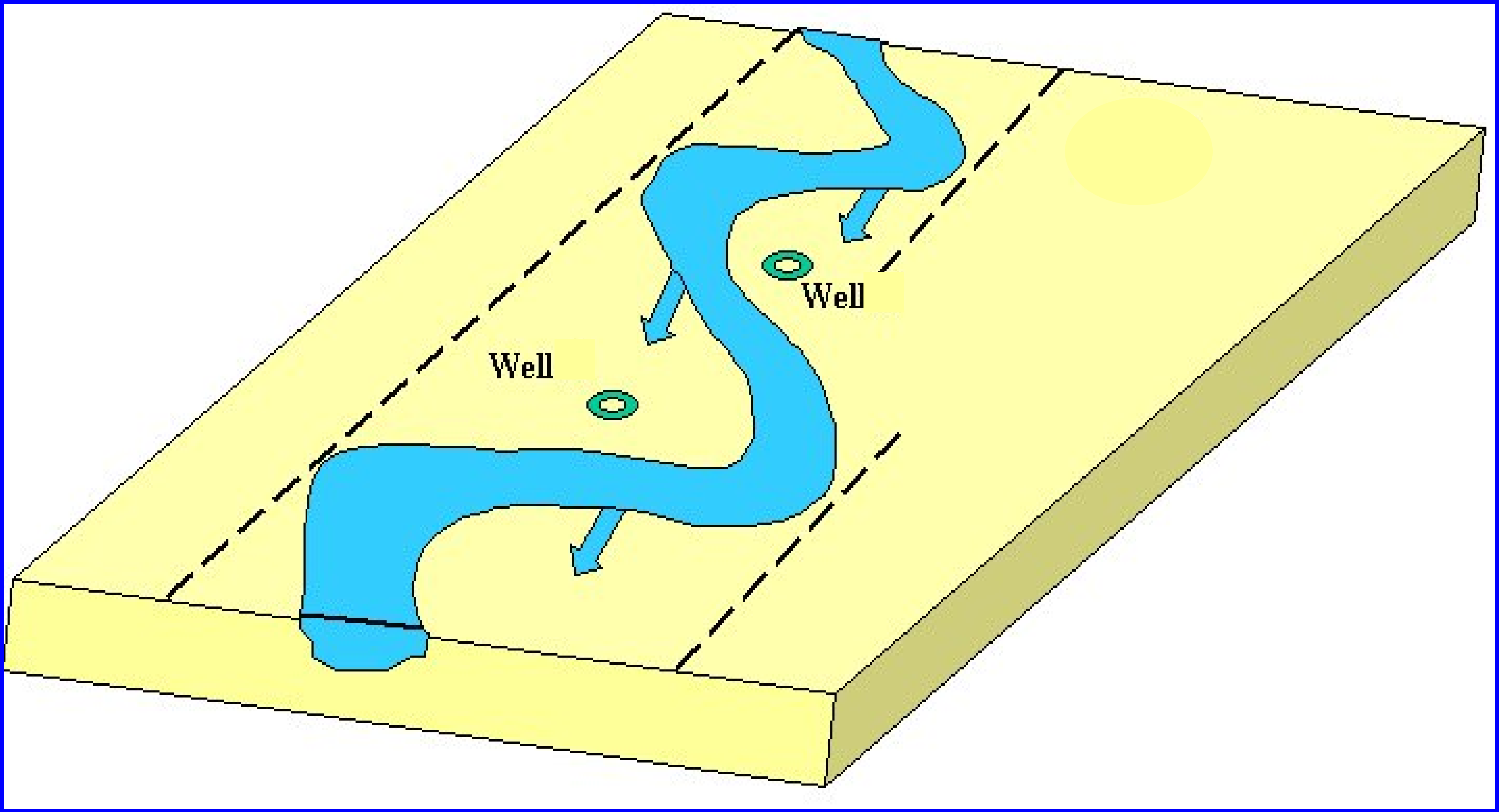


Point: **Stream base flow is derived completely from groundwater.**

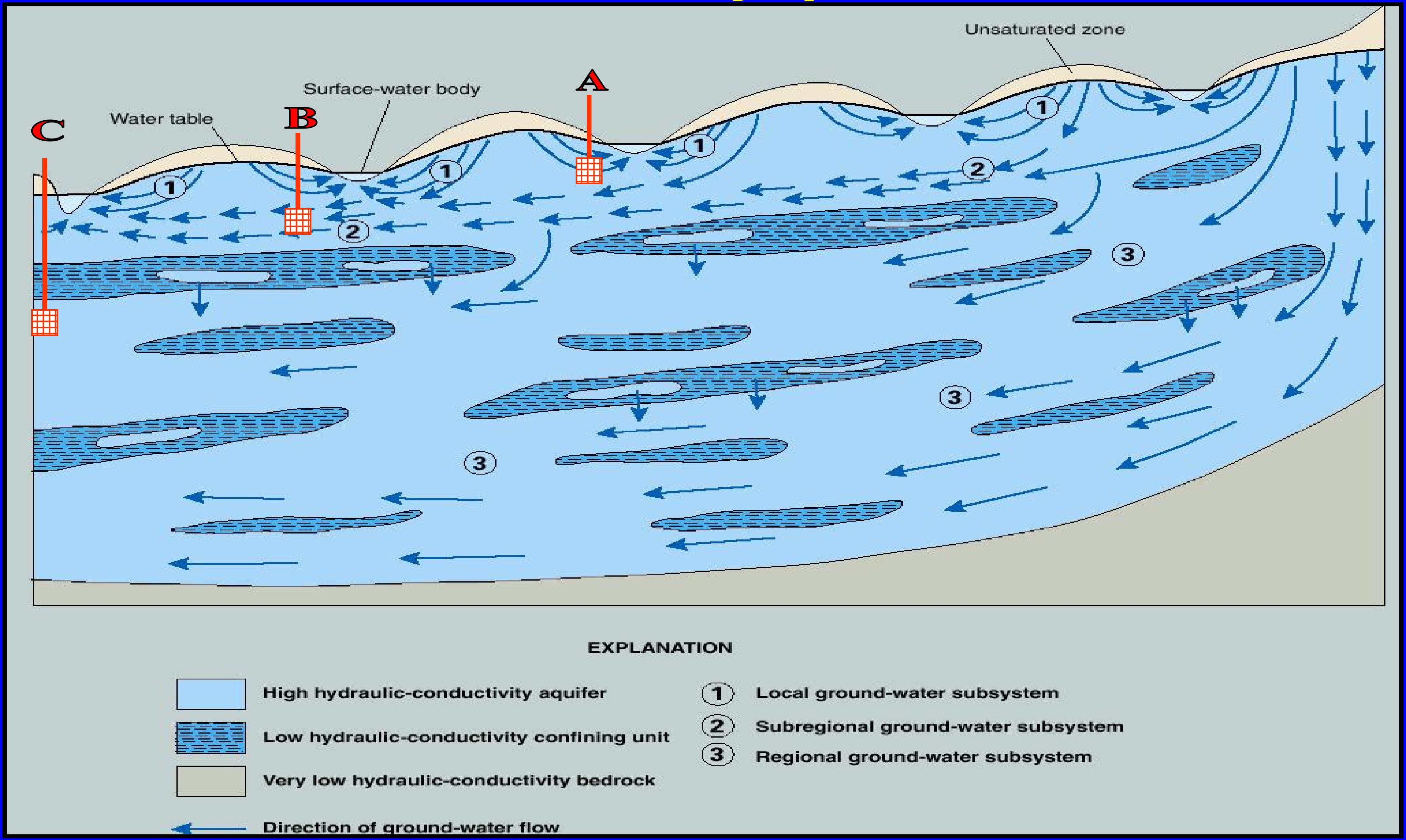
Shallow Aquifers in Montana



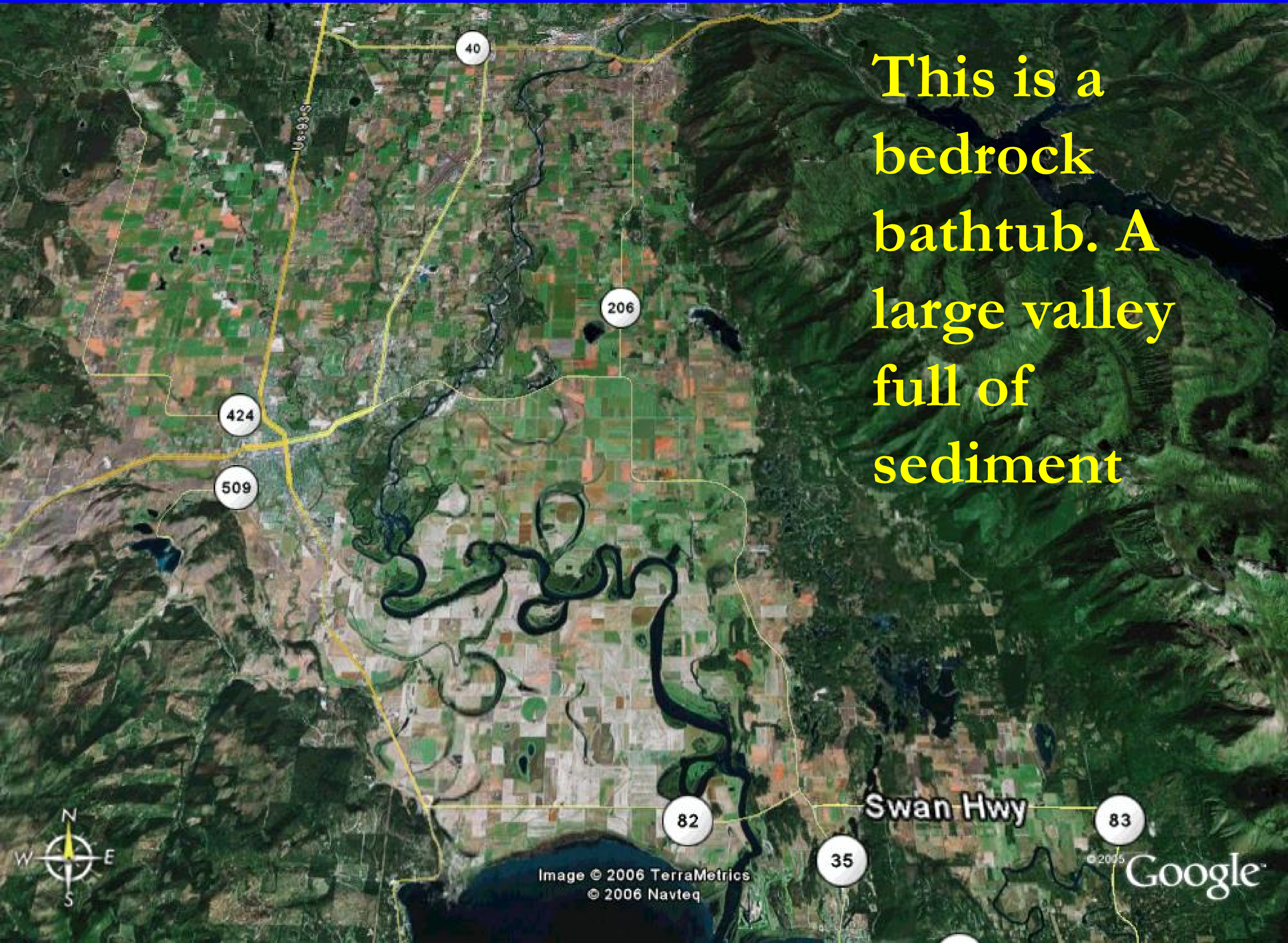
A meandering stream / river.

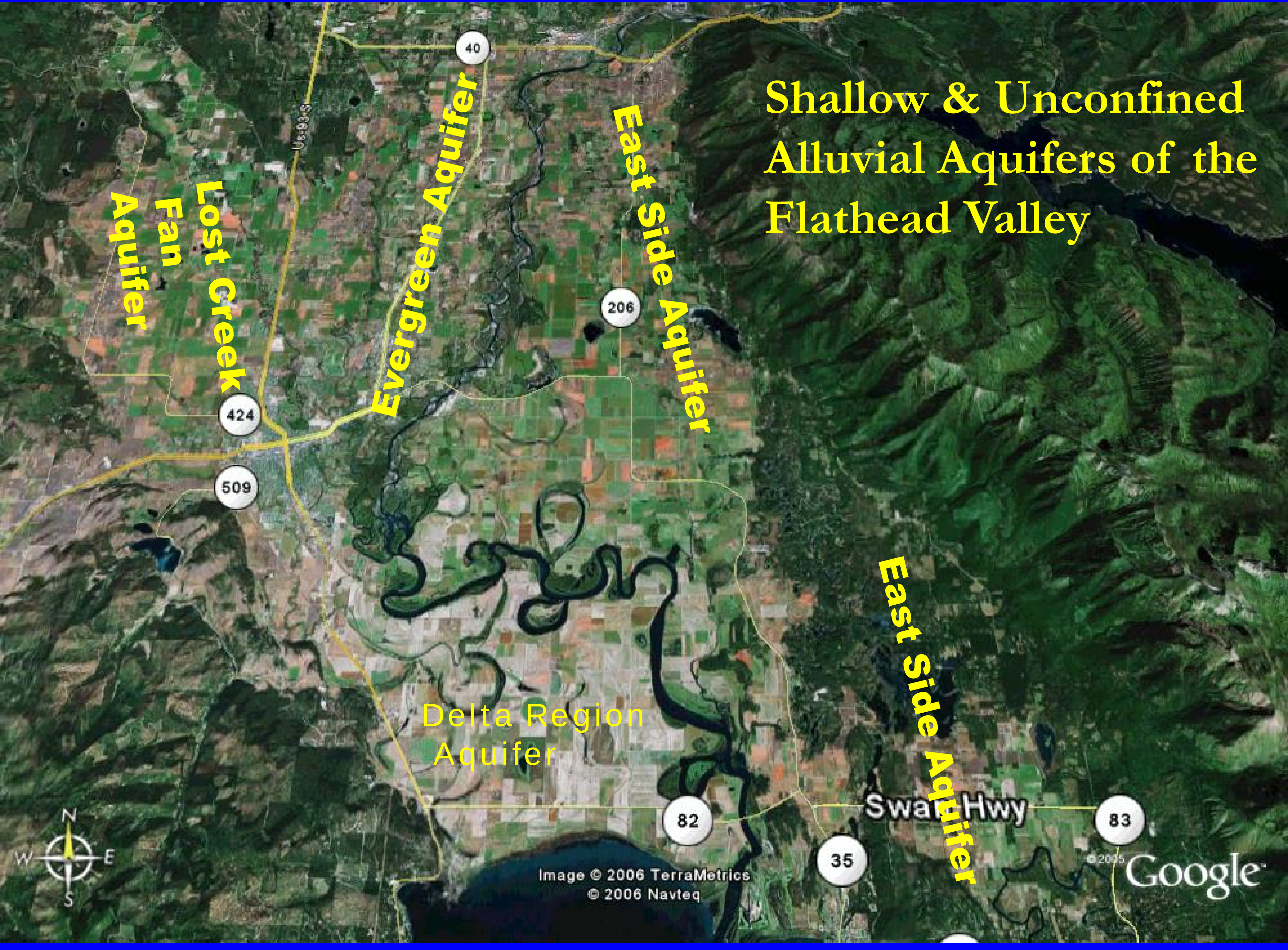


Groundwater Flow Systems (Note that this is similar to most river valleys)

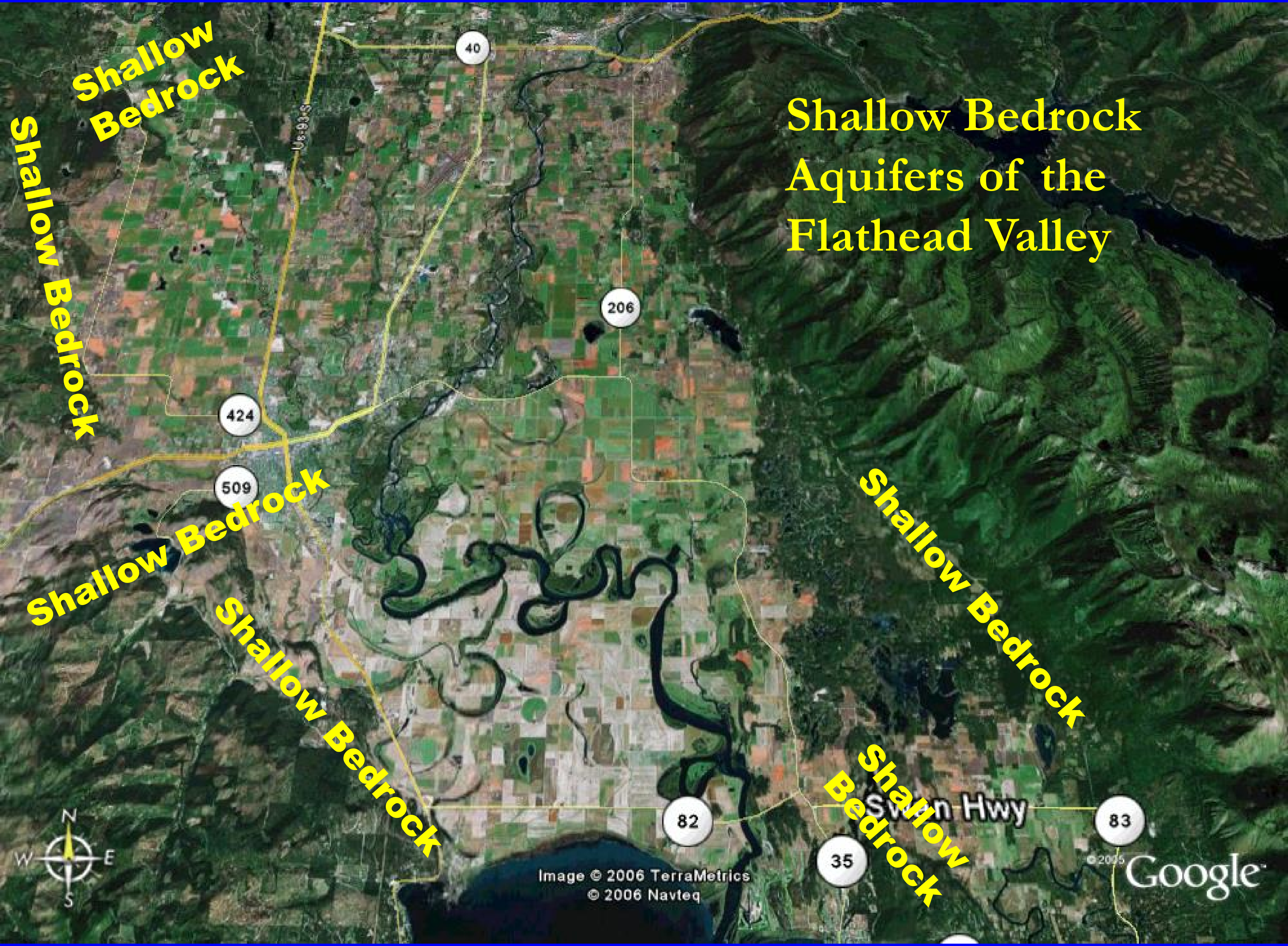


This is a bedrock bathtub. A large valley full of sediment





Shallow & Unconfined Alluvial Aquifers of the Flathead Valley
Lost Creek Fan Aquifer
Evergreen Aquifer
East Side Aquifer
East Side Aquifer
Delta Region Aquifer
40
206
424
509
82
35
83
Swan Hwy
Image © 2006 TerraMetrics
© 2006 Navteq
Google
N
S
E
W



Shallow Bedrock Aquifers of the Flathead Valley
Shallow Bedrock
Shallow Bedrock
Shallow Bedrock
Shallow Bedrock
Shallow Bedrock
Shallow Bedrock
40
206
424
509
82
35
83
Swan Hwy
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Image © 2006 TerraMetrics
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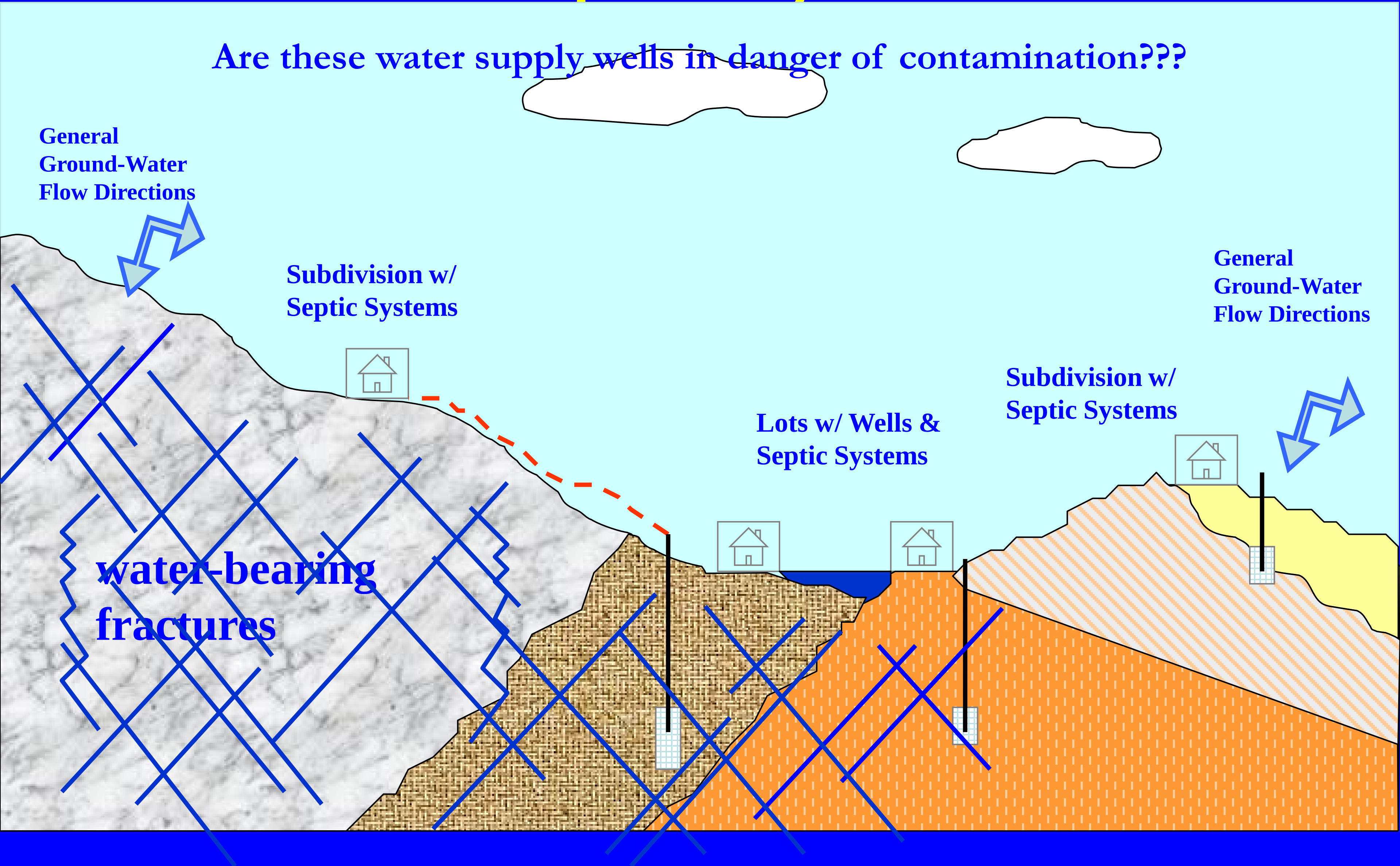
Google

Conceptual Model For Bedrock Aquifer System



Take-Home Messages

- Groundwater comes from somewhere else.
- Understanding where groundwater comes from helps you preserve your water quality.
- Septic Systems recharge groundwater.
- You can make a big difference in the water quality of an aquifer.
- There's no such thing as a free lunch.

Oh, and don’t build on the floodplain

WELL TERMS

Well Casing

Well Screen

Annular Seal (grout)

Pitless Adapter

Drop Pipe

Discharge Pipe

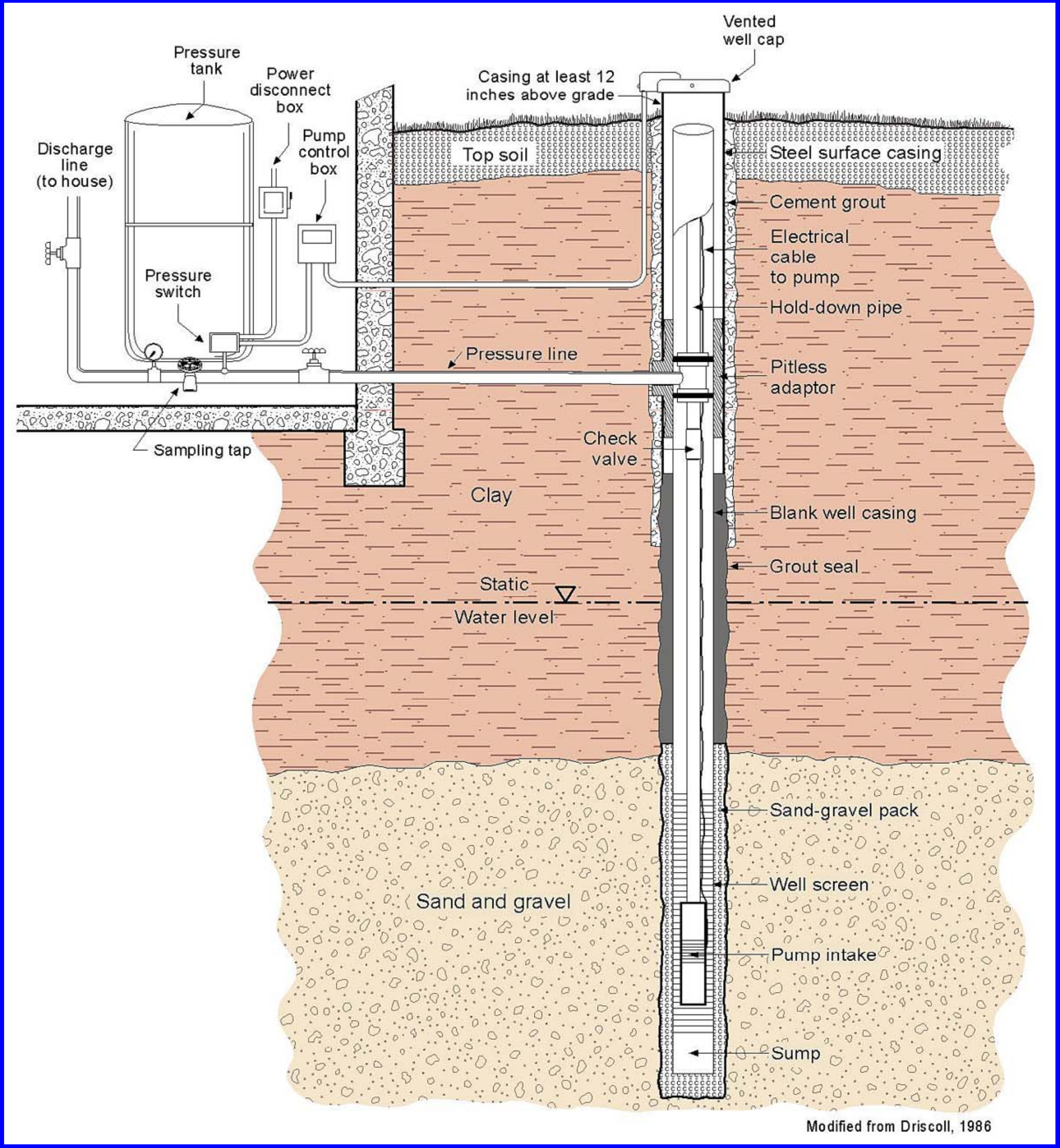
Pump

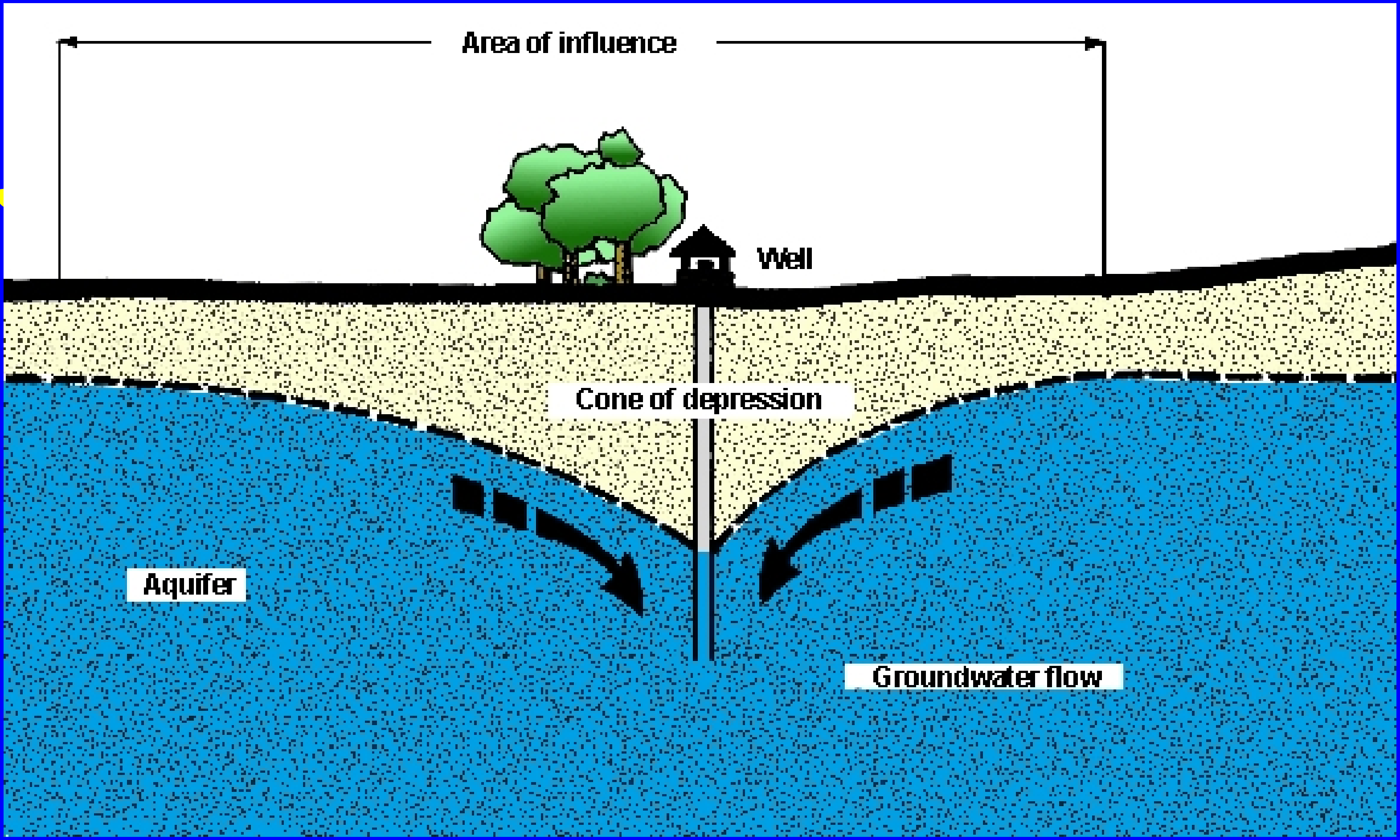
Well Cap

Static Water Level

Water Table

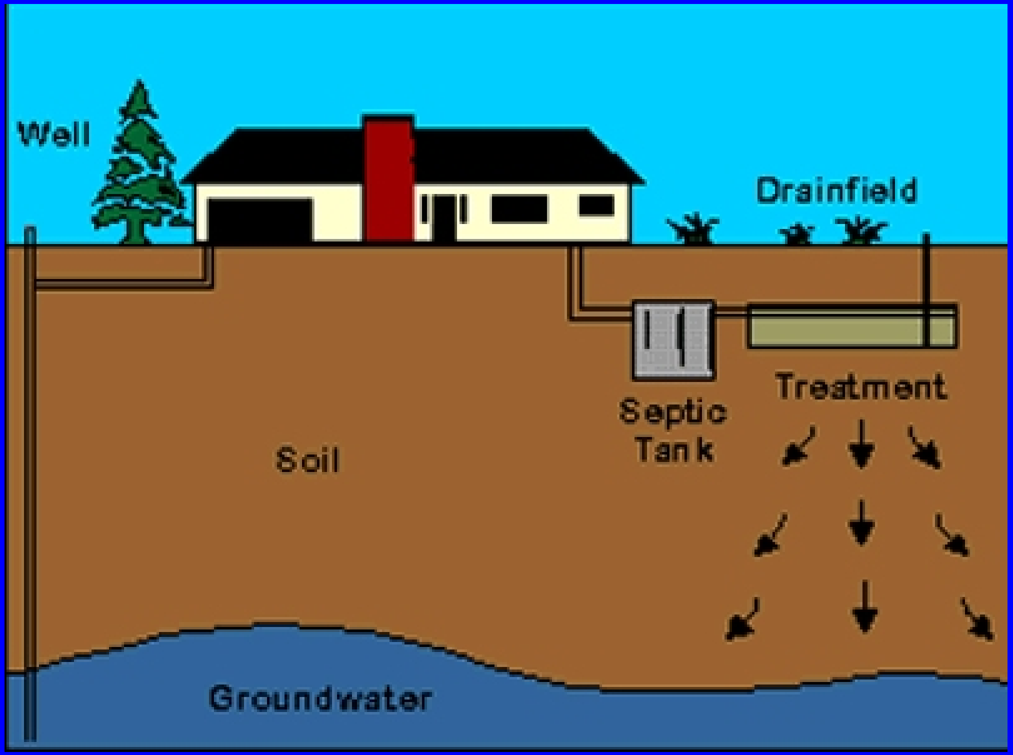
Aquifer





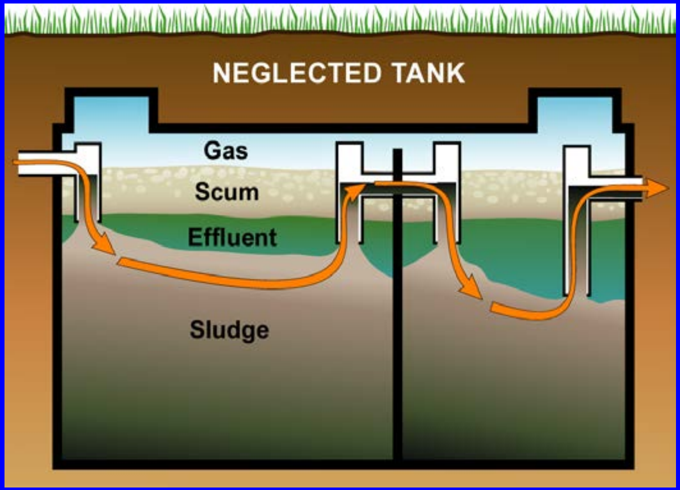
Area of influence
Well
Cone of depression
Aquifer
Groundwater flow

Main Point –Septic Systems Recharge Aquifers



Main Point – Protecting Water Quality Protects Health

Main Point –Wells & Septics Need Maintenance



Main Point -Septic Systems Treat Sewage

Parameter	Raw Sewage	3' Below Drainfield
Viruses	unknown (high)	0
Fecal Coliform	1 million-100 million	0
Nitrogen	50 to 100	50-60
BOD (mg/L)	270-400	0
Phosphrous (mg/L)	10 to 40	0-1

NEW TECHNOLOGIES & MAINTENANCE FOR ON-SITE WASTEWATER SYSTEMS

Presented:
February 1, 2008

Presented by:
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Topics

- Level 2 Treatment
- Types of Systems
- Maintenance Requirements
- Types of Failures
- Effluent Filters

Level 2 Information

- Defined by nitrogen removal:
  - Remove 60% of total nitrogen (TN) , OR
  - Reduce TN (in residential strength wastewater) from 50 to 24 mg/L or less
  - Some systems reduce TN to as low as 7.5 mg/L
- Rules include other classes of TN removal
- Nitrogen removal typically reduces other pollutants [BOD, TSS … pathogens(?)]

Nitrogen Cycle

- Raw wastewater

  = ammonia
- Treatment

  is by naturally occurring bacteria
- Require an aerobic AND anaerobic period:
  - Aerobic (in the presence of air):

    ammonia converts to nitrite/nitrate
  - Anaerobic (without air):

    nitrate converts to nitrogen gas

Nitrogen Cycle
(continued)

- Requires proper pH, temperature and alkalinity
  - pH:

    6.5 to 8.0
  - Temperature:

    optimal around 70 degrees – bacteria less active as temperature drops
  - Alkalinity:

    7 times the amount of nitrogen
  - Explanation of N cycle in wastewater treatment:

    www.onsiteconsortium.org/files/nitrogen.htm

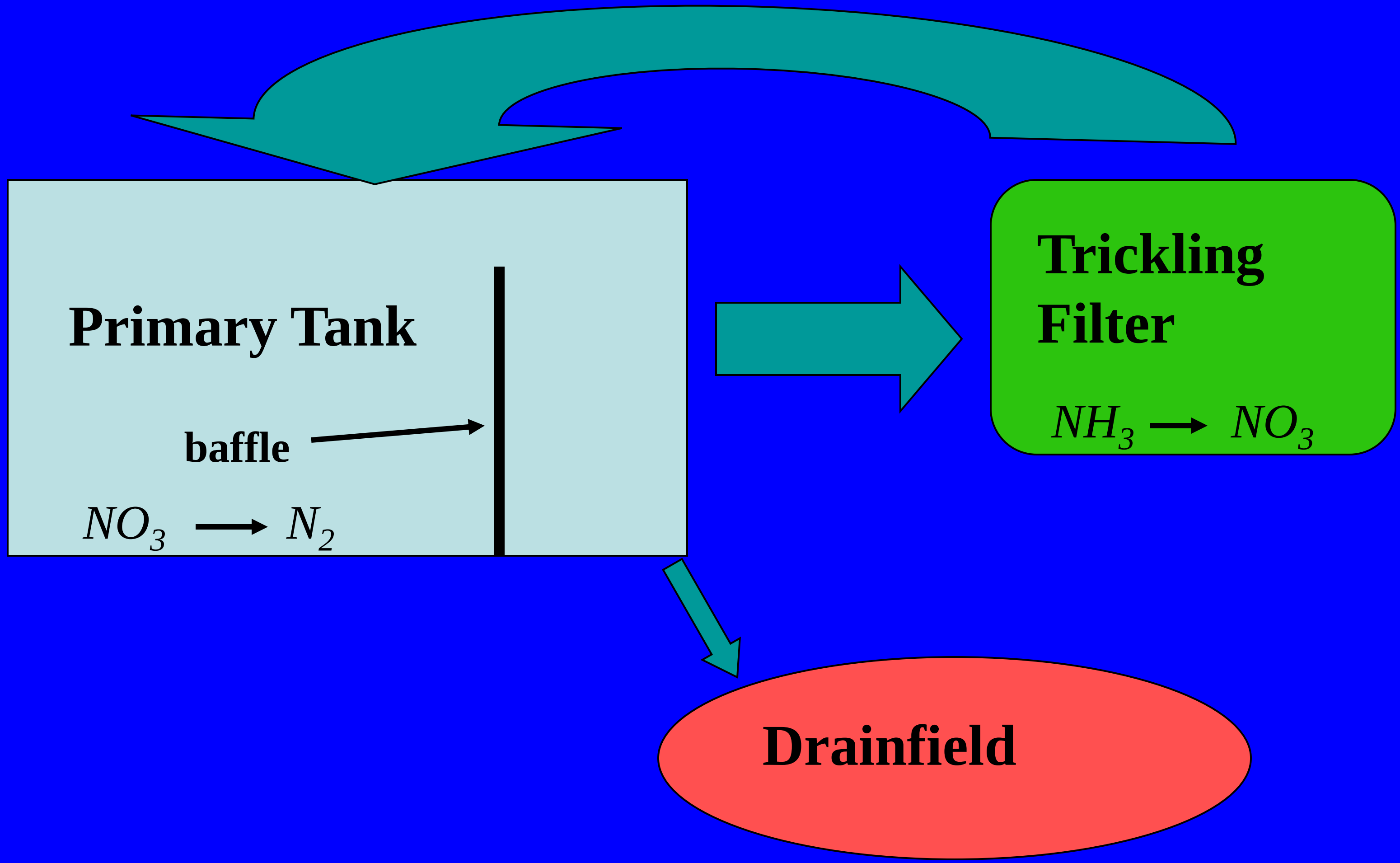
Approved Level 2 Systems

- Level 2 for single family homes (and larger systems)
  - Recirculating Sand Filter (generic)
  - Orenco Advantex Recirc. Trickling Filter
  - Eliminite Recirc. Trickling Filter
  - Bio-Microbics aerobic treatment unit
  - Norweco Singulair aerobic treatment unit
- Level 2 for larger systems (>5,000 gpd)
  - Several aerobic and activated sludge systems
- List updated on internet site as necessary
  - http://www.deq.mt.gov/wqinfo/Nondeg/Index.asp

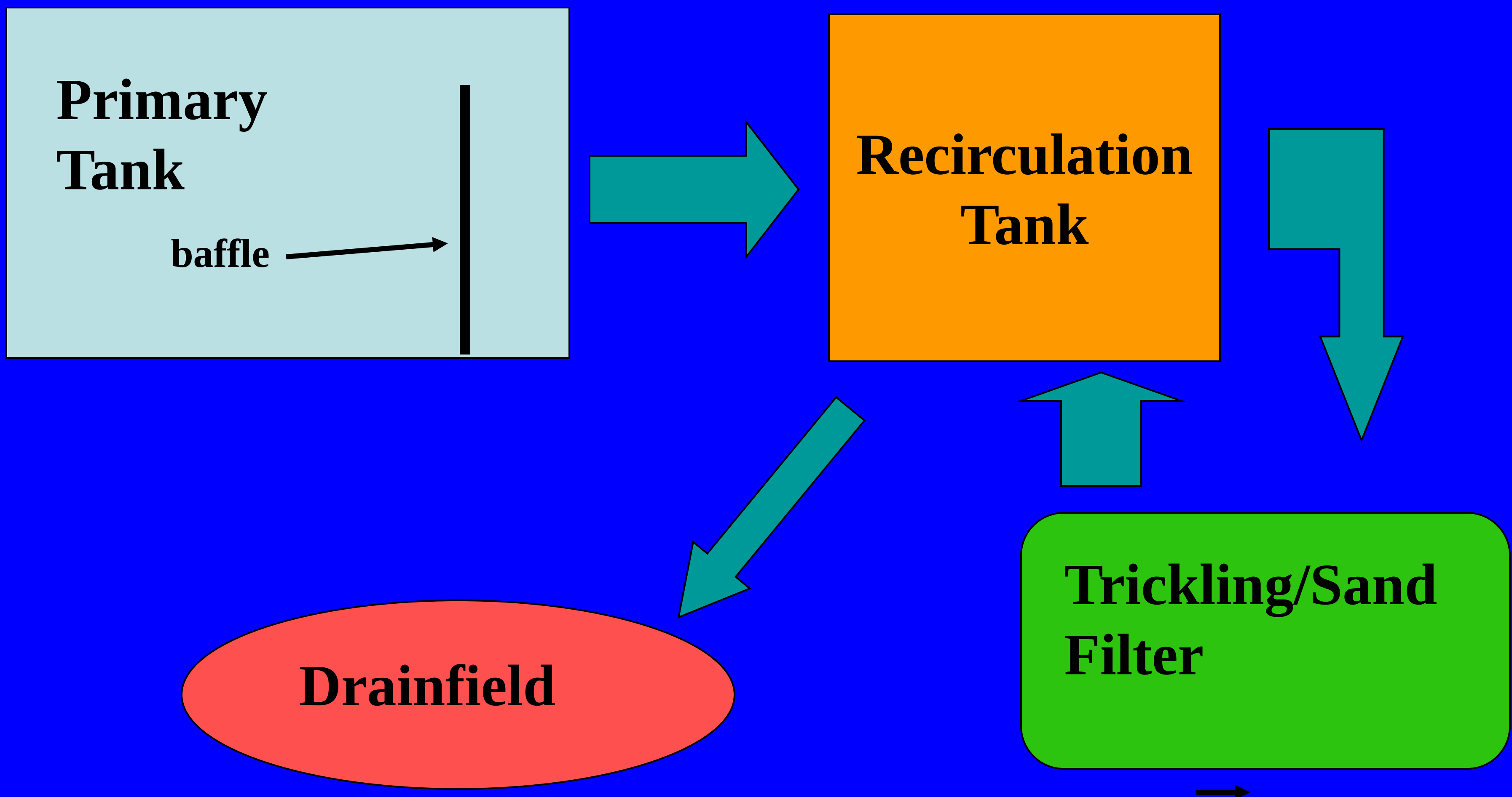
Nitrogen Removal Processes

- Recirculating Trickling/Sand Filter (RTF)
  - Aerobic zone in the trickling/sand filter
  - Anaerobic zone in the septic tank (or separate recirculating tank)
  - Trickling filters have proprietary materials
- Aerobic Treatment Units
  - Aerobic zone and anaerobic zone in same tank
  - Use external air to create aerobic conditions
  - Turn off blower to create anaerobic conditions

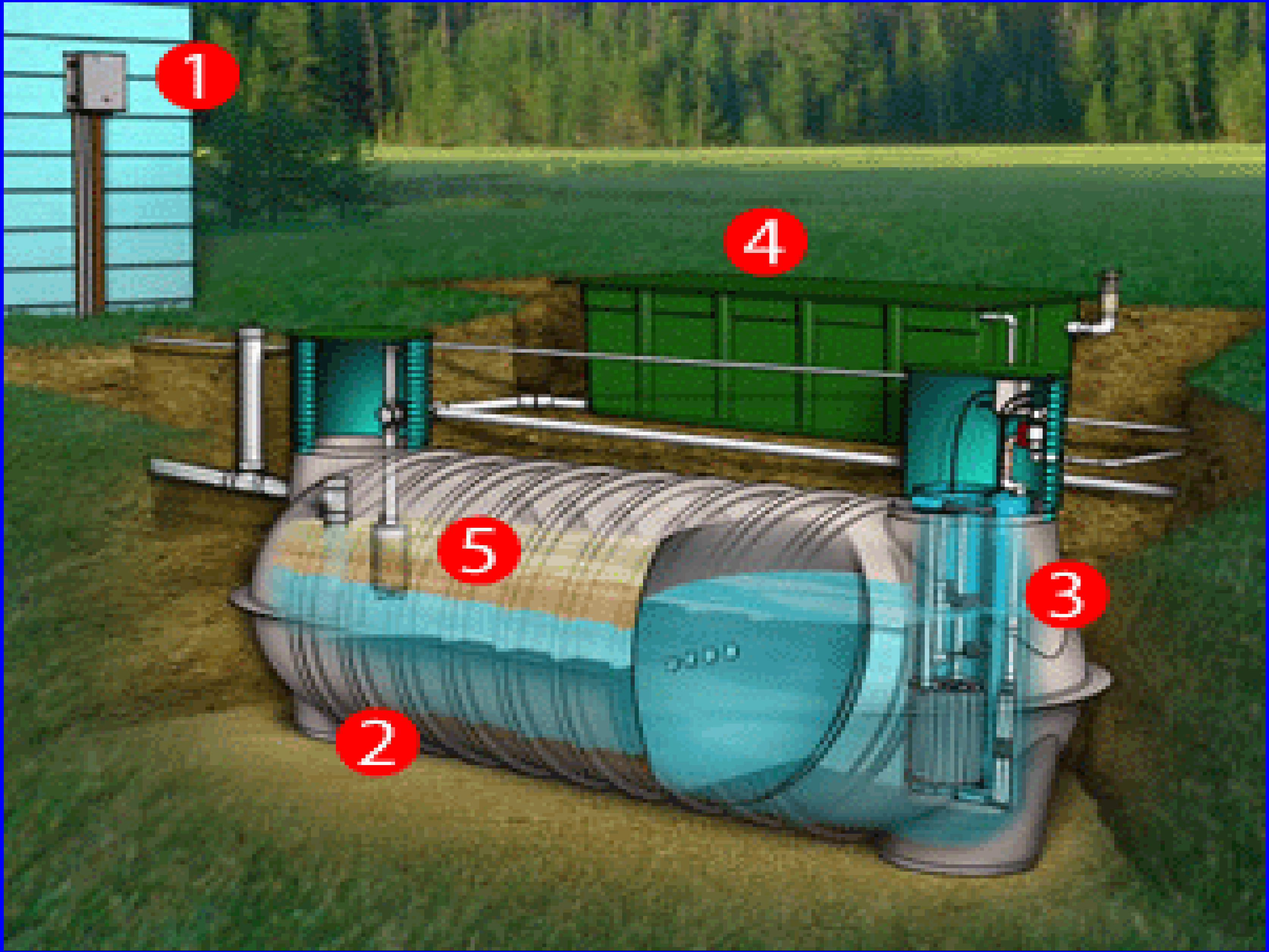
Recirculating Sand & Trickling Filters



Recirculating Sand & Trickling Filters



RTF Schematic (Orenco)

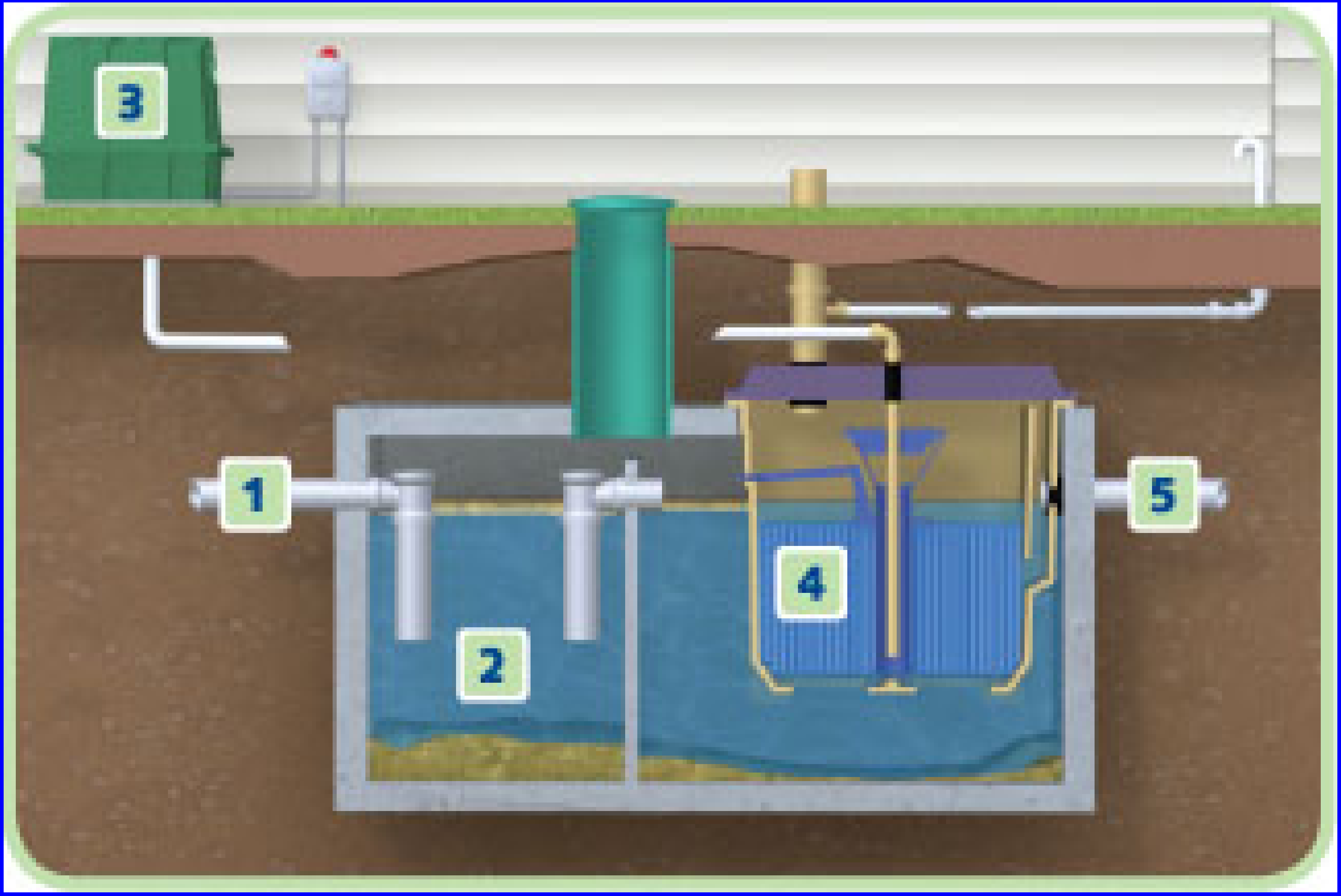


Self Contained RTF (Eliminite)

RTF Media (Orenco)

RTF Media (Eliminite)

Bio-Microbics



DEQ Maintenance Requirements

- DEQ-4 Appendix D
  - All systems in DEQ-4 required to meet O&M (except septic tank/drainfield system)
  - Requires service contract for life of the system
  - First two years requires at least four onsite inspections (frequency not specified after that)
- Nondegradation Rules (ARM 17.30.718)
  - Any system approved for nutrient reduction
  - Twice a year inspections for first 2 years and annually afterwards (double for aerobic systems)
  - Annual effluent sample/analysis (nitrate, nitrite, ammonia, TKN, BOD, TSS, fecal coliform bacteria, specific conductance, temperature)
- Manufacturers Requirements …

What About Additives?

- Enough bacteria are present in the tank from normal bodily wastes

- Additives cost $$$

- Typically the people who recommend additives are those who sell them

- Chemical additives may end up in groundwater

- There is no substitute for maintenance!

Types of Failures

- Hydraulic Failure (e.g. squishy soil)
- Treatment Failure (harder to identify)
- Drainfield Treatment Failure (without hydraulic failure, very difficult to identify)

Hydraulic Failure

- Poor maintenance (don’t pump tank)
- Hydraulic or organic overload
- Poor siting (undersized for soils)
- Poor construction (poor distribution, too shallow)
- Excessive grease, garbage disposal, chemicals
- Tree roots
- Driving over the drainfield

Surfacing Effluent

Surfacing Effluent

Surfacing Effluent

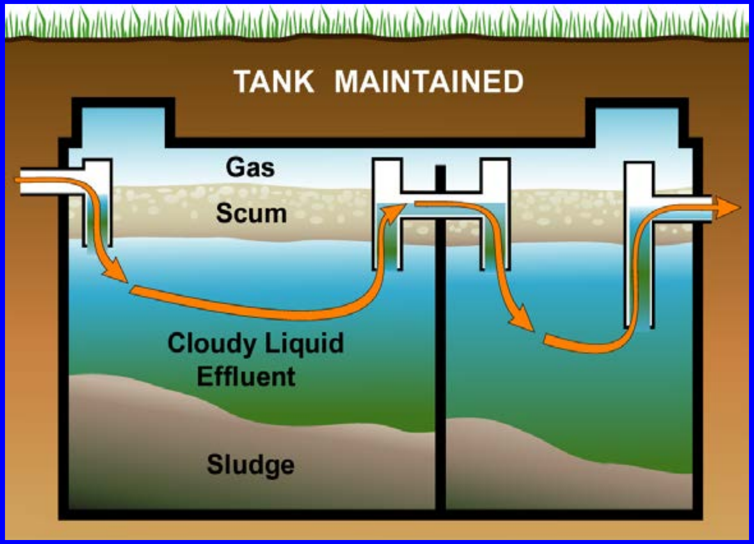
Surfacing Effluent

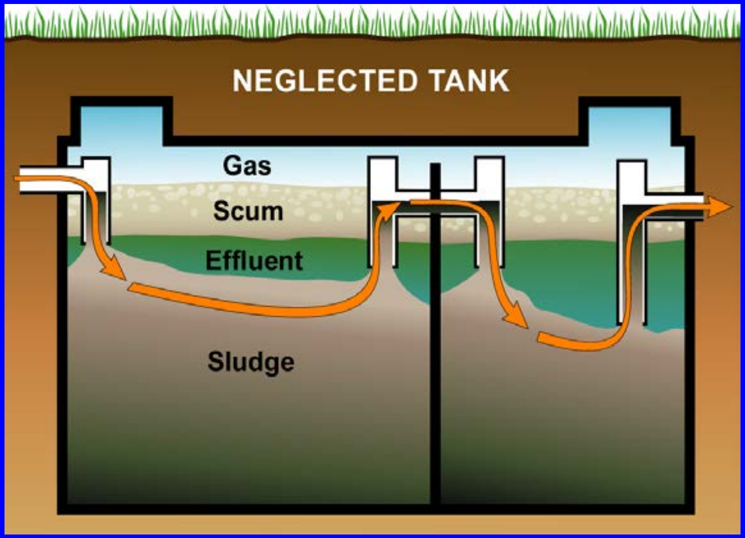
Failed Septic Tank

Treatment Failure

- Inadequate nitrogen treatment (excessive chemicals, too cold, system malfunction)
  - Look at nitrogen components
    - Ammonia vs. nitrate
  - Look at temperature/pH/alkalinity
- Inadequate settling of organics in septic tank (inadequate retention time)
  - Results in high BOD/TSS levels
  - Check sludge layer in tank
  - Chemical use could upset balance
  - Excessive salts from water softener(???)
- Inadequate pathogen treatment in soil (poor distribution)

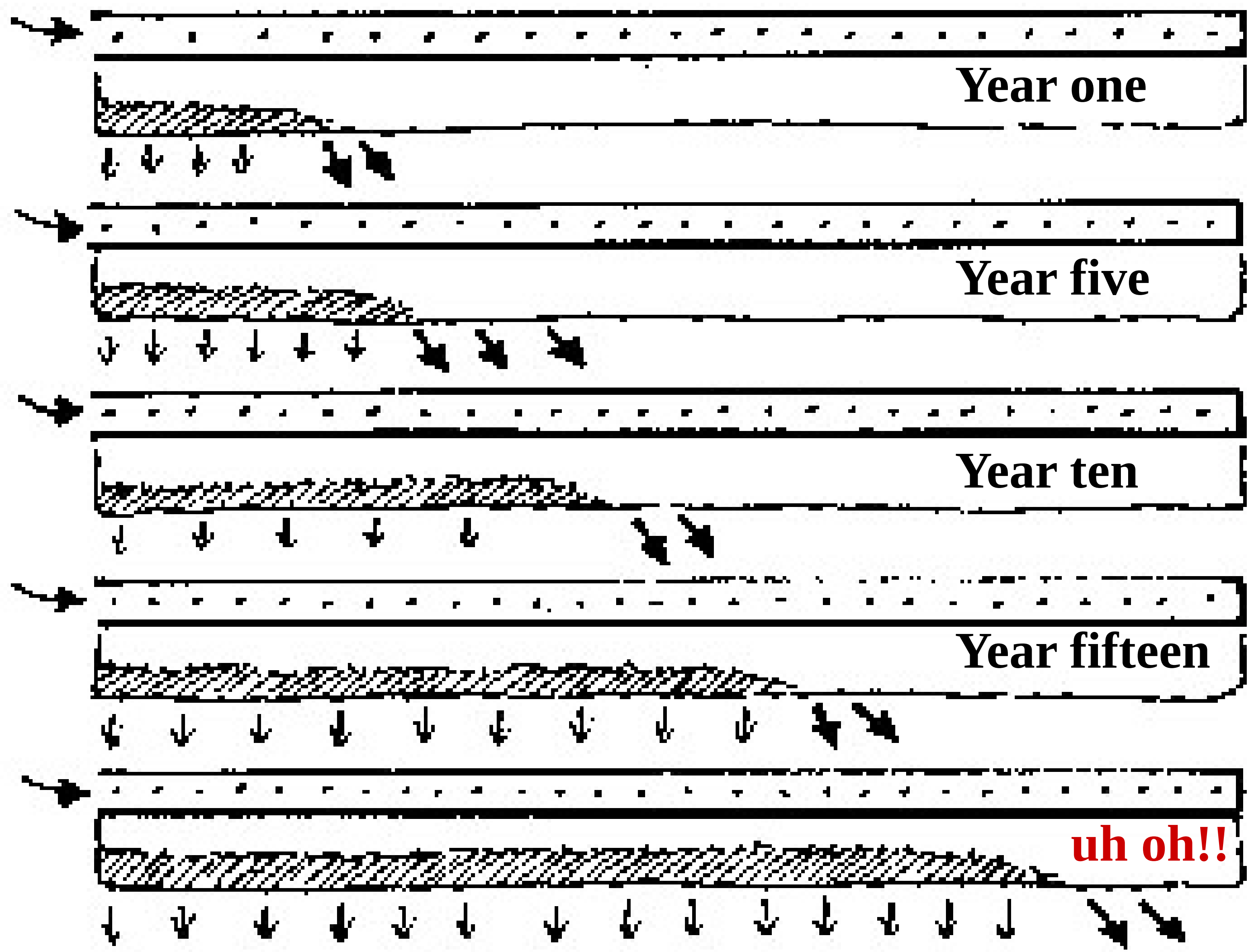
Main Point –Septic system failure is not just a soggy spot in the lawn





It is also a failure to properly treat wastewater!

Progressive Development of a Biomat- localized hydraulic overloading



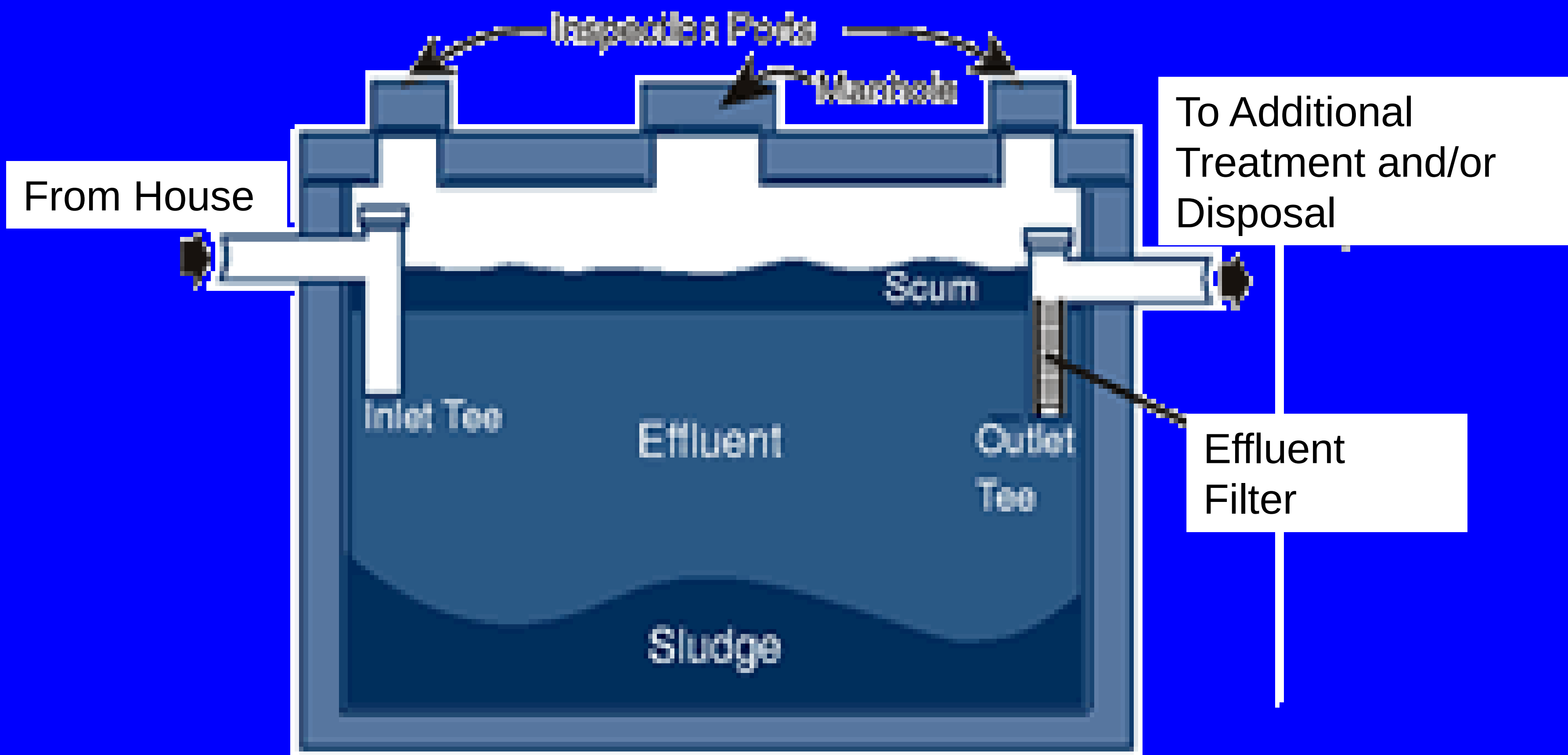
Effluent Filters

- Filter out TSS and BOD to minimize clogging in the drainfield
  - BOD = biological oxygen demand
  - TSS = total suspended solids
- Installed in septic tank outlet “t”
- Required in all new systems (DEQ-4)
  - *www.deq.mt.gov/wqinfo/Circulars.asp* (sect. 7.2.7)
  - Can propose alternate filter (screened pump vault)
  - Alarm system recommended but not required
  - Requires ANSI/NSF Standard 46 approval
- Cost: $50 - $300

Effluent Filters

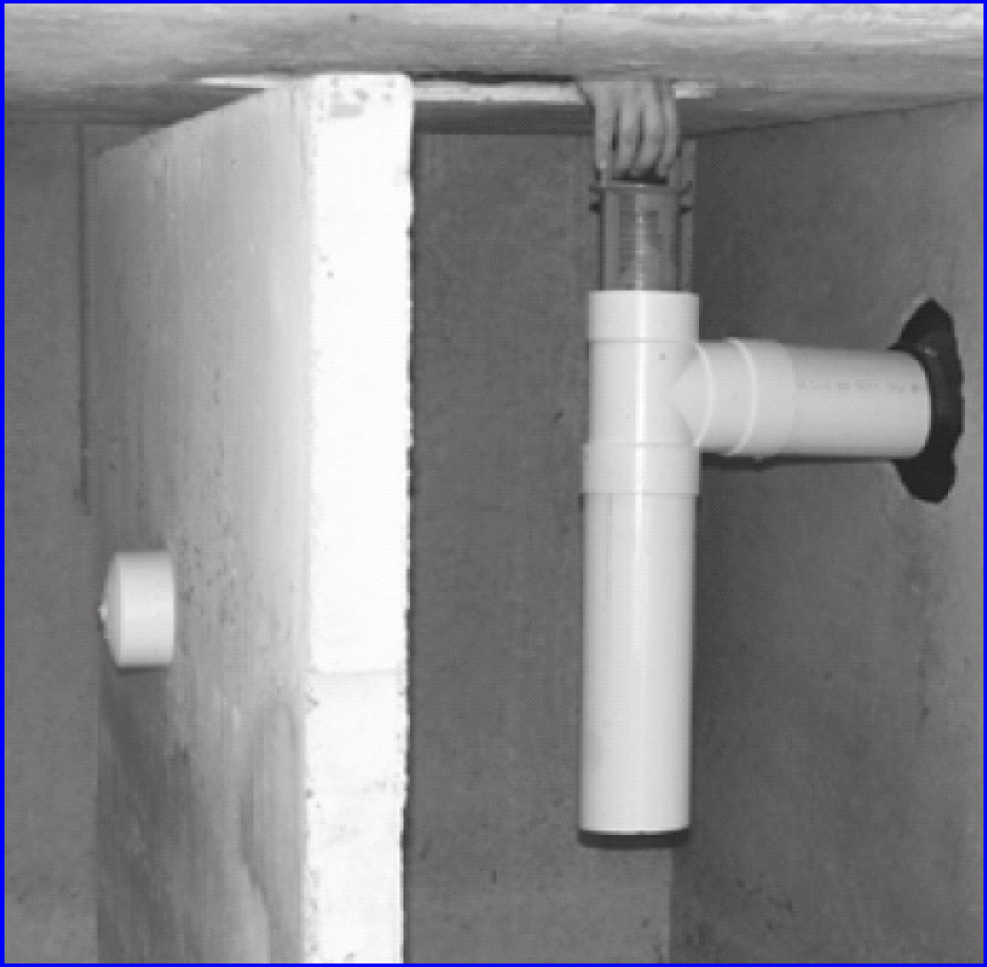
- Cleaning interval varies based on size/use
  - 6 to 12 months(?) – longer (?)
  - Pull and rinse(?)
  - Frequent clogging = time to pump
- Two chamber septic tank will further reduce BOD/TSS in drainfield
  - But will require more frequent pumping for similar sized as single chamber
- Over sizing = less frequent maintenance
- Can be retrofitted to existing units

Septic Tank Cross Section



Single Compartment Septic Tank

Effluent Filter Maintenance



Message for clients- What is in Your Septic System Effluent?

Parameter	Raw Sewage	3' Below Drainfield
Viruses	unknown (high)	0
Fecal Coliform	1 million- 100 million	0
Nitrogen	50 to 100	50-60
BOD (mg/L)	270-400	0
Phosphorus (mg/L)	10 to 40	0-1

Whatever you flush