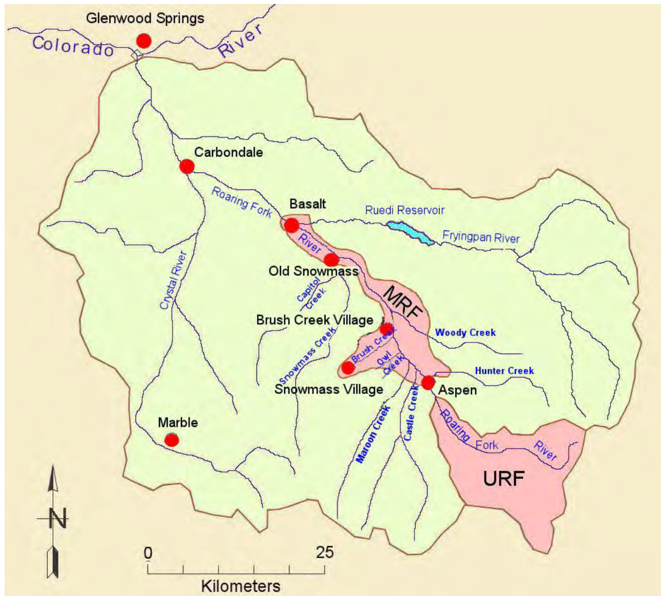
UPPER & MIDDLE ROARING FORK VALLEY

Background: In 2006, Hydrologic Systems Analysis, LLC completed a GIS-based ground water resources evaluation of the Upper and Middle Roaring Fork Valley.[1] This study area is depicted below:



Upper Roaring Fork (URF) and Middle Roaring Fork (MRF) Study Areas

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The ground water resources evaluation completed for Pitkin County provides *only a general overview* of the factors influencing groundwater availability, sustainability, and vulnerability to contamination in the URF/MRF Study Area; it does not provide site-specific evaluations for every individual parcel of land.

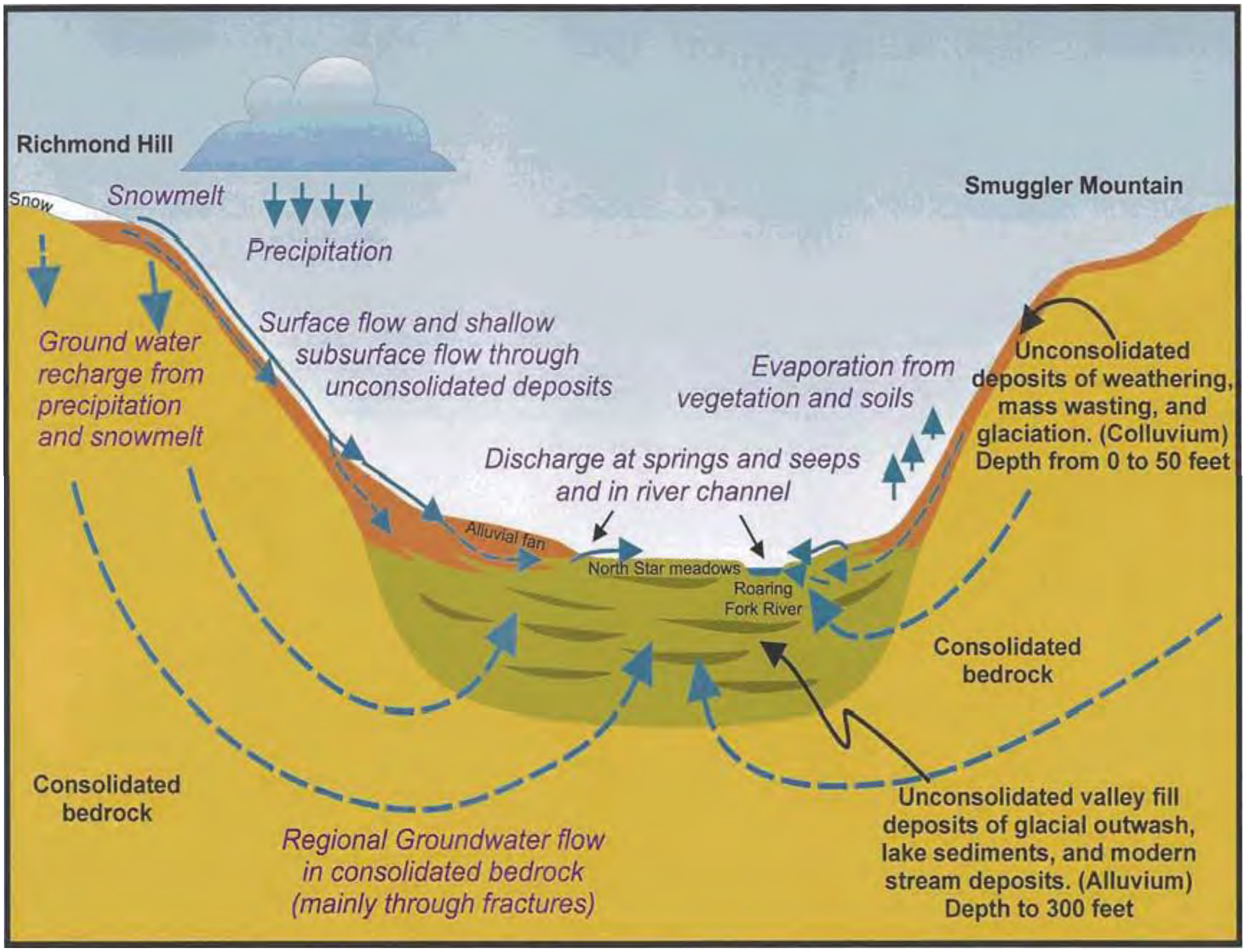
What Are the Key Factors Affecting the Groundwater Supply In the Study Area?

1. Hydrogeology:

- **Upper Roaring Fork Area:** Regional groundwater movement and storage in the Upper Roaring Fork occurs within a complex three-dimensional framework, as depicted in the following graphic. Groundwater recharge occurring on the hillsides moves through unconsolidated material (e.g., glacial gravel deposits) through a fractured crystalline bedrock aquifer toward the valley floor. Water then moves vertically into thick, highly permeable unconsolidated glacial, colluvial and alluvial deposits. Water surfaces and discharges in hillslope wetlands (which may become dry in late summer and fall when subsurface runoff is exhausted) and those along the

[1] The Development of GIS-Based Ground Water Resources Evaluation of the Upper and Middle Roaring Fork Valley Area, Pitkin County, Colorado is available online at: *http://www.aspenpitkin.com/depts/12/water_res.cfm.* The report draws from a series of previous studies on ground and surface water resources and wetlands hydrology conducted for Pitkin County by Hydrologic Systems Analysis, LLC.

valley floor (such as the critical and extensive wetlands at the North Star Nature Preserve), and to the Roaring Fork River.

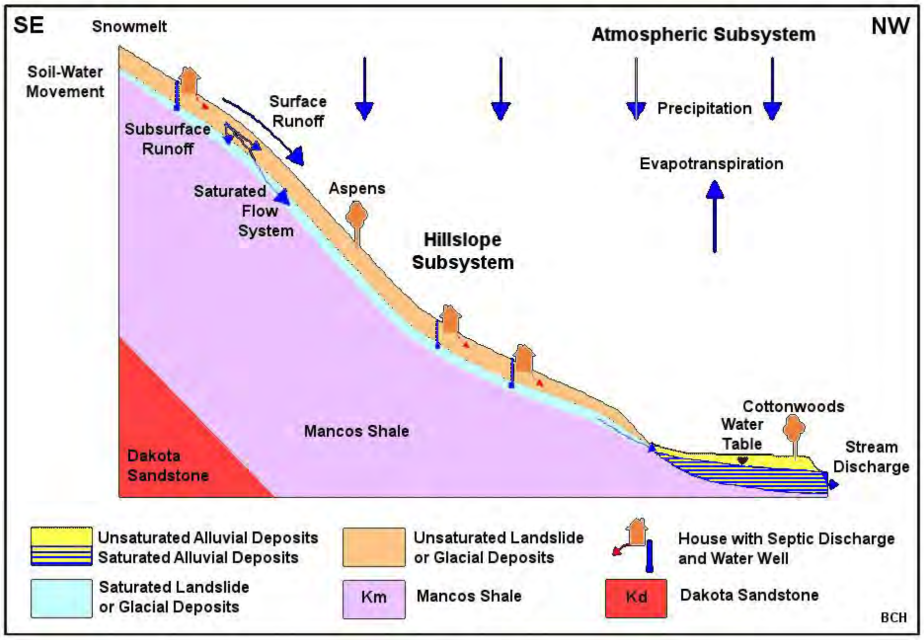


<u>Conceptual Model of the Upper Roaring Fork Hydrologic System</u>

- **<u>Middle Roaring Fork Area</u>:** The hydrogeologic framework of the Middle Roaring Fork portion of the study area has four distinct areas – three bedrock units (e.g., Mancos Shale) and one unit of unconsolidated material (i.e., glacial, alluvial and colluvial deposits). No regional groundwater system has been identified for this area; it is characterized by a series of sub-regional and local systems, as described in the four general conceptual models below.

  - **<u>West Roaring Fork Valley Hillslope Subsystem</u>:** This area is characterized by unconsolidated materials (primarily alluvium and colluvium) overlying a confining bedrock layer of Mancos Shale. The unconsolidated materials vary in saturation, depending upon location and seasonal precipitation events. Here, as elsewhere in the Roaring Fork Valley, the Mancos Shale has minimal water transmissivity and storage capacity. It acts as a confining hydrogeologic unit for the ground water flow system.

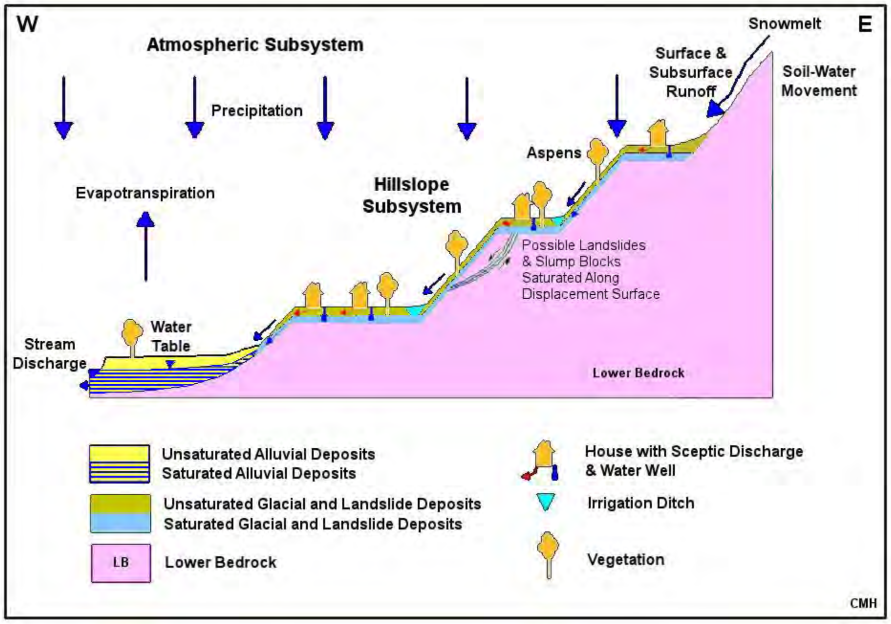
  - **<u>Brush Creek Valley Hillslope Subsystem</u>:** This area is also characterized by unconsolidated materials overlying a confining bedrock layer of Mancos Shale. The unconsolidated materials vary in saturation, depending upon location and seasonal precipitation events. It is possible that the Dakota Sandstone bedrock aquifer, which underlies the Mancos Shale in this area, may be hydraulically connected by faults to some areas of unconsolidated materials. Otherwise, the Mancos Shale prohibits the upward or lateral movement of groundwater to the unconsolidated materials.



Conceptual Model of the Brush Creek Valley Hillslope Subsystem Near Snowmass Village

- **Disconnected Glacial Terrace East Roaring Fork Valley Hillslope (DTH) Subsystem:** This portion of the study area is distinguished by unconsolidated materials (consisting primarily of alluvium and glacial terrace gravels) overlying a confining layer of Mancos Shale bedrock. The unconsolidated materials vary in saturation, depending upon location and seasonal precipitation events; there is negligible lateral and upward movement of ground water from the underlying bedrock. Ground water in unconsolidated materials on the higher terraces is recharging the unconsolidated materials in the lower terraces, and the lower terraces are recharging the alluvium below. Ground water is also discharging into streams cutting through the terraces.

- **Connected Glacial Terrace/Mass Wasting East Roaring Fork Valley Hillslope (CMH) Subsystem:** Unconsolidated materials overly a confining layer of Mancos Shale bedrock in this area. The unconsolidated materials consist primarily of glacial terrace gravels and mass wasting deposits (from landslides and slumping). The unconsolidated materials vary in saturation, depending upon location and seasonal precipitation events; there is negligible lateral and upward movement of ground water from the underlying bedrock in most locations. Ground water in the higher terraces is recharging the lower terraces by ground water flow through the mass wasting deposits. The lower terraces and areas of mass wasting are recharging the alluvium below. Ground water is also discharging into streams cutting through the terraces.



Conceptual Model of the CMH Subsystem

2. Climate/Topography/Vegetation/Geomorphology: Elevation and the steepness and orientation of a slope with respect to sunshine and prevailing winds affect the amount of rain and snow available for ground water recharge. Typically, south and west facing hill slopes are hotter and drier and have less winter moisture and snow pack available for ground water recharge during the spring melt and will have higher evapotranspiration by plant life during the growing seasons. The amount of vegetative cover influences the amount of water loss from evapotranspiration and affects the relative humidity in an area; it also reduces solar radiation reaching and melting the snowpack and modifies heat gain/loss to the snowpack from wind.

3. Land Use:

- **Irrigation:** In the URF/MRF Study Area (such as along Brush Creek, and on the terraces in the DTH and CMH Subsystems) ditches are leaking water and recharging the unconsolidated materials they run through. Many of the terraces have water-loving plants (e.g., willows), seeps and springs along them – indicating places where leakage is occurring. Taking irrigated land out of production may result in lowering of the water table and reduction in ground water flow velocities.

- **Onsite Wastewater Treatment Systems (OWTSs); Wells:** The study area includes residences with OWTSs and wells. It would be expected that the return flows from OWTSs are also having some local effect on recharge of the ground water system. Increasing demand for domestic water supply or local irrigation will increase the usage of wells which may already be drawing from a localized groundwater system, particularly in the Middle Roaring Fork portion of the study area.

How Do You Put All Of This Information Together?

Generally, modeling a ground water system consists of identifying and quantifying all the inputs and outputs from climate (precipitation and snowmelt), stream functions (water gains/losses), vegetation (loss to evapotranspiration), topography (e.g., slope steepness and aspect), soils and geomorphology, geology, and human activity (e.g., ditches, wells, irrigation). Over time, even on a large scale, it is easy to see how difficult this process can be – as we go through periods of drought, water rights are bought and sold, and land uses change.

The study conducted for Pitkin County provides only a very "high-level" overview of a very complex system, as the following illustration shows. However, it is a good starting point for every land owner concerned about their water supply. Certainly the study demonstrates how tenuous some local water supplies may be in the URF/MRF Study Area.