Chapter 1: Introduction

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Introduction

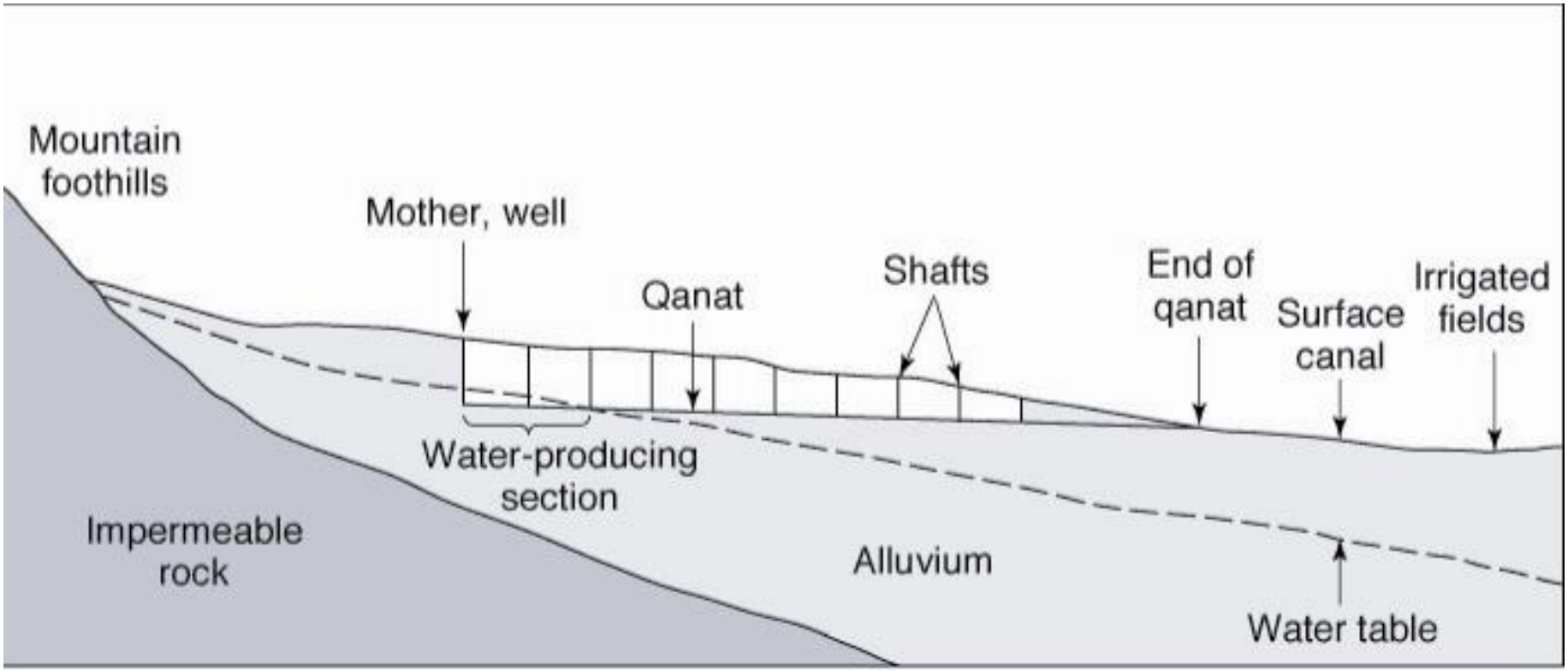
Groundwater:

- Saturated zone
- Unsaturated zones

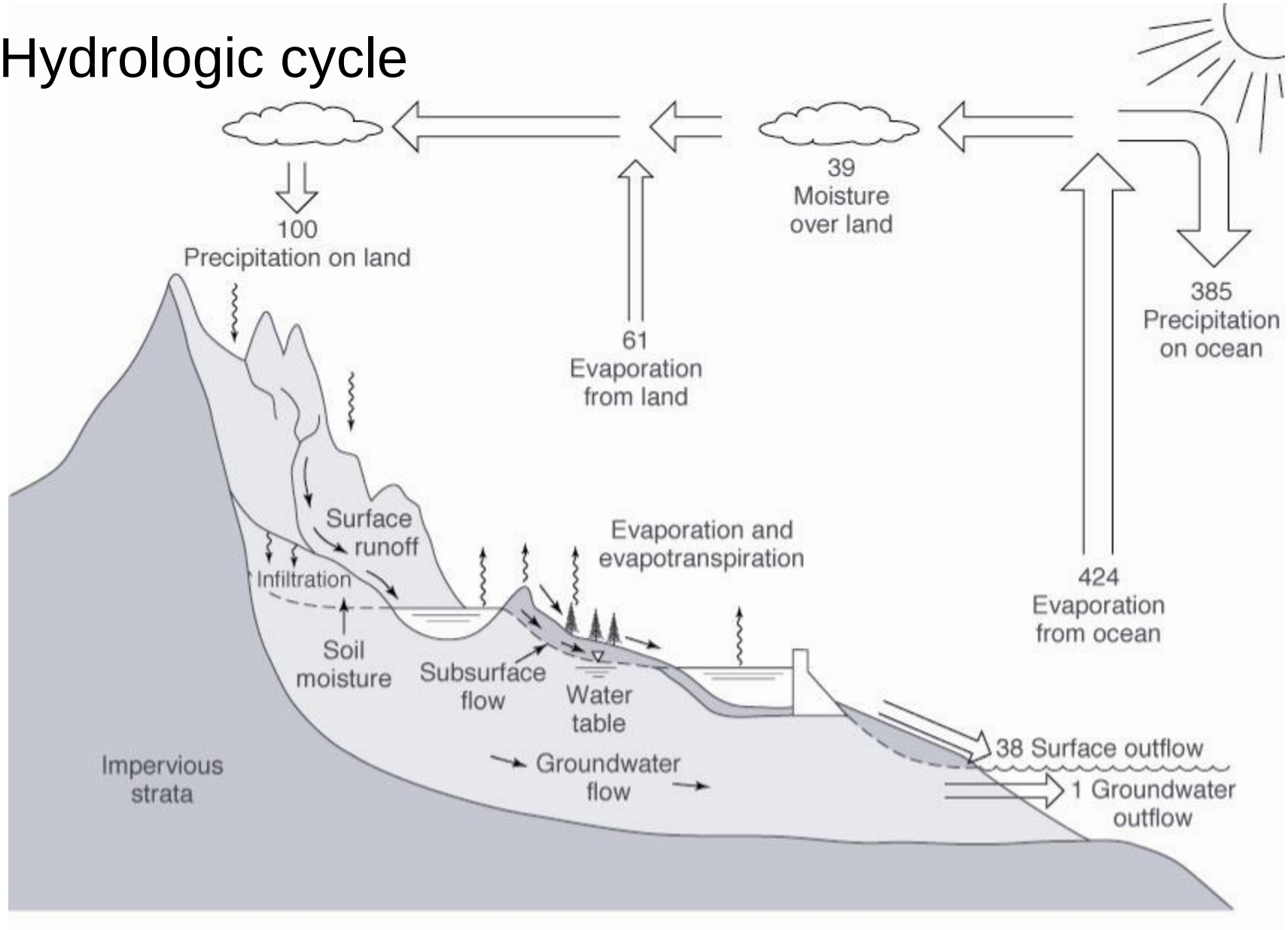
Aflaj (plural), Falaj (singular):

- Ainy falaj (Source of water: water spring)
- Dawoodi falaj (Source: Man-made horizontal well)
- Ghaily falaj (Source: surface water)

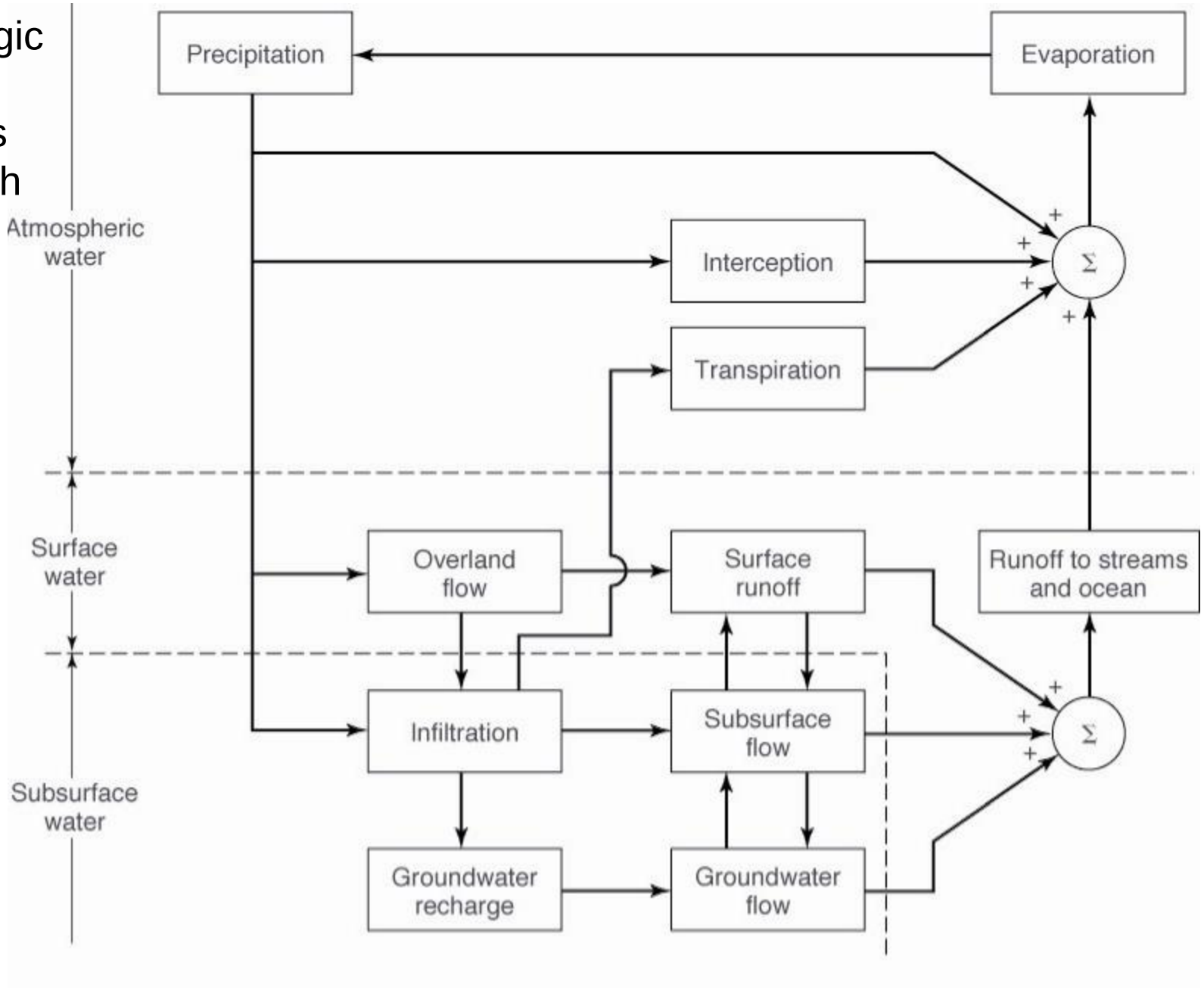
Dawoodi falaj (Qanat)



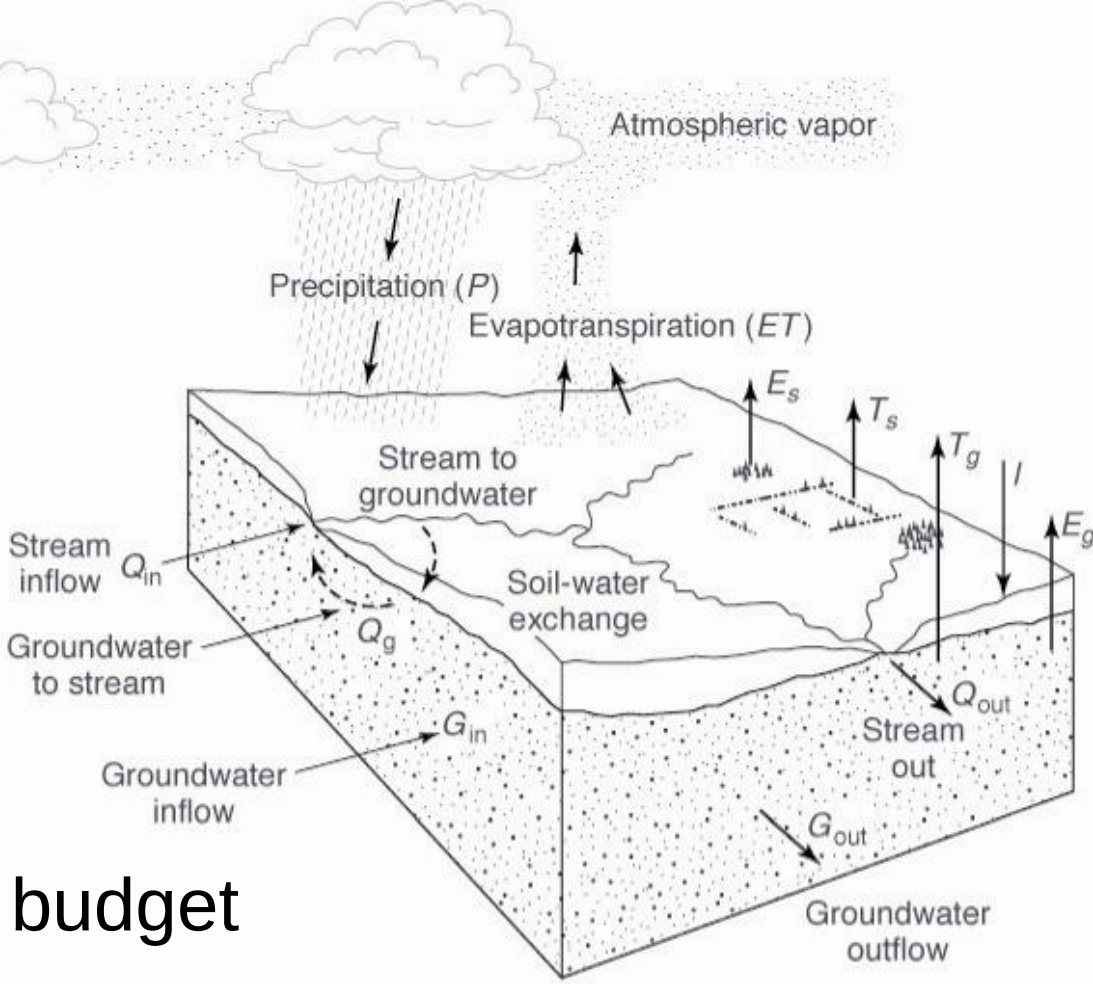
Hydrologic cycle



Hydrologic cycle- Systems approach



Hydrologic budget



Surface water system budget

$$P + Q_{in} - Q_{out} + Q_g - E_s - T_s - I = \Delta S_s$$

Ground water system budget

$$I + G_{in} - G_{out} + Q_g - E_g - T_g = \Delta S_g$$

System hydrologic budget

$$P-(Q_{out}-Q_{in})-(E_s+E_g)-(T_s+T_g)-(G_{out}-G_{in})$$
$$=\Delta(S_s+S_g)$$

Using net mass exchanges, the above budget can be expressed as:

$$P-Q-E-T-G=\Delta S$$

Example 1.6.1

During 1996, the water budget terms for Lake Annie in Florida[60] included precipitation (P) of 43 inch/yr, evaporation (E) of 53 inch/yr, surface water inflow (Q_{in}) of 1 inch/yr, surface outflow (Q_{out}) of 173 inch/yr, and change in lake volume (ΔS) of –2 inch/yr. Determine the net groundwater flow (the groundwater inflow minus the groundwater outflow).

Assuming $T_g = 0$, the water budget equation (1.6.4) to define the net groundwater flow for the lake is

$$G = \Delta S - P + E - Q_{in} + Q_{out}$$

$$= -2 - 43 + 53 - 1 + 173$$

$$= 180 \text{ inch/yr}$$

■

Table 1.7.1 Types of U.S. Geological Survey Reports

Circulars—Purpose: To present to general or scientific audiences short summaries or articles of short-term, popular, or local interest.

Digital Data Series—The Digital Data Series encompasses a broad range of digital data, including computer programs, interpreted results of investigations, comprehensive reviewed databases, spatial data sets, digital images and animation, and multimedia presentations that are not intended for printed release. Scientific reports in this series cover a wide variety of subjects and facets of U.S. Geological Survey investigations and research that are of lasting scientific interest and value. Releases in the Digital Data Series offer access to scientific information that is available in digital form; the information is primarily for viewing, processing, and (or) analyzing by computer.

Fact Sheets—Purpose: To describe Water Resources Division (WRD) programs, projects, products, and water-resources topics to either a general or professional audience. Water Fact Sheets are concise and timely publications that increase the understanding and visibility of WRD activities and accomplishments.

Hydrologic Atlases—Purpose: To present reports on hydrology or geohydrology in map format to a wide range of hydrologically oriented audiences.

Open-File Reports—Purpose: To make available (1) data reports, (2) reports preliminary findings that would be of interest to few persons other than the cooperating agency, (3) reports and maps pending publication elsewhere but requiring immediate release, and (4) timely information describing programs, projects, products, and water-resources topics.

Professional Papers—Purpose: To present comprehensive or topical reports on any field in the earth sciences. This series is commonly used for summaries of wide popular, scientific, or geographic interest, and for significant scientific contributions—generally on topics other than hydrology.

Techniques of Water-Resources—Purpose: To present to technically oriented audiences reports on methods and techniques used in collecting, analyzing, and processing hydrologic data.

Water Data Reports—A series of annual reports that document hydrologic data gathered from the U.S. Geological Survey's and cooperating agencies' surface and groundwater data-collection networks in each state, Puerto Rico, and Trust Territories. These records of streamflow, groundwater levels, and water quality provide the hydrologic information needed by state, local, and federal agencies, and the private sector for developing and managing our Nation's land and water resources.

Water-Resources Investigations Reports—Purpose: To (a) present to interdisciplinary audiences comprehensive or topical interpretive reports and maps that are mainly of local or short-term interest; (b) provide a medium of release for reports and maps that would not be feasible in any other series or journal or that would be published quickly.

Water-Supply Papers—Purpose: To present significant interpretive results of hydrologic investigations of broader than local interests.

Water Errata Sheets—Changes made to reports after publication.

Source: http://water.usgs.gov/pub.html

Table 1.8.1 Principal Types of Data and Data Compilations Required for Analysis of Groundwater Systems

Physical framework
Topographic maps showing the stream drainage network, surface-water bodies, landforms, cultural features, and locations of structures and activities related to water
Geologic maps of surficial deposits and bedrock
Hydrogeologic maps showing extent and boundaries of aquifers and confining units
Maps of tops and bottoms of aquifers and confining units
Saturated-thickness maps of unconfined (water-table) and confined aquifers
Average hydraulic conductivity maps for aquifers and confining units and transmissivity maps for aquifers
Maps showing variations in storage coefficient for aquifers
Estimates of age of groundwater at selected locations in aquifers
Hydrologic budgets and stresses
Precipitation data
Evaporation data
Streamflow data, including measurements of gain and loss of streamflow between gaging stations
Maps of the stream drainage network showing extent of normally perennial flow, normally dry channels, and normally seasonal flow
Estimates of total groundwater discharge to streams
Measurements of spring discharge
Measurements of surface-water diversions and return flows
Quantities and locations of interbasin diversions
History and spatial distribution of pumping rates in aquifers
Amount of groundwater consumed for each type of use and spatial distribution of return flows
Well hydrographs and historical head (water-level) maps for aquifers
Location of recharge areas (areal recharge from precipitation, losing streams, irrigated areas, recharge basins and recharge wells), and estimates of recharge
Chemical framework
Geochemical characteristics of earth materials and naturally occurring groundwater in aquifers and confining units
Spatial distribution of water quality in aquifers, both areally and with depth
Temporal changes in water quality, particularly for contaminated or potentially vulnerable unconfined aquifers
Sources and types of potential contaminants
Chemical characteristics of artificially introduced waters or waste liquids
Maps of land cover/land use at different scales, depending on study needs
Streamflow quality (water-quality sampling in space and time), particularly during periods of low flow

Source: Alley et al.[3]