Groundwater and Surface Water—A Single Resource in New England

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Jones River, Kingston
Take Home Messages-Answer to Questions

• Why/How is that water flowing?
• How did that water get there, and
  • what pathway did the water follow?
• How does this system vary naturally?
• How do human activities affect this system?
Why/How is that water flowing?
Precipitation

Average Annual Snowfall (inches)

Annual Mean Total Precipitation

USGS
Runoff

The volume of water to pass the watershed outlet over a given time period, per unit area, includes groundwater and surface runoff.

HERRING RIVER AT NORTH HARWICH, MA

Photo by USGS, MA office
The Difference Between Precipitation and Runoff

In a natural system much of the long term average difference is due to ET; short term differences reflect changes in groundwater storage.

Streamflow data may be provisional, and subject to revision. Precipitation data from: https://daymet.ornl.gov/
Effective Recharge - how much water reaches the water table

https://pubs.er.usgs.gov/publication/sir20185080
Ground-water recharge in any location during a given time period depends on many factors:

- Precipitation
- Geology
- Temperature/Season
- Soil type (also soil moisture)
- Vegetative Cover
- Slope
- The amount of channeled runoff
- Degree of urbanization
Glacial Stratified Deposits (Coarse Sand and Gravel) Have the Largest Recharge Rates
Groundwater Recharge

- Occurs mainly in the non-growing season, due to evapotranspiration during the growing season.

Well MA-HGW 76
HANSON MA

Groundwater-level data may be provisional, and subject to revision
Precipitation data from: https://daymet.ornl.gov/
The reason streams are flowing when there has not been any precipitation

Almost all streams in New England are gaining streams
The Groundwater Component of Streamflow

Images from infrared camera
c/o Janet Barclay USGS
Baseflow - the groundwater component of streamflow

Hunt River near E. Greenwich, RI

Can range from about 35 – 95 percent of streamflow in New England

Simulated Recharge Age of Discharge

Implications for water quality related to the time lag for groundwater discharge from different parts of the watershed

Example from Broad Brook, Connecticut

https://pubs.er.usgs.gov/publication/sir20065278
Groundwater Evapotranspiration

Transpiration

Surface water

Land surface

Water table during dormant season

Water table during growing season

Recharge, and the question of using recharge volume to size groundwater supply development

Long-Term Groundwater Availability =

- (Average annual precipitation) -
- (the amount of overland runoff) -
- (the amount of evapotranspiration) -
- (current or projected consumptive use) -
- (the amount required in streams for habitat sustainability, fire protection, effluent dilution, public-water supply etc.)
Changes to the Groundwater/Surface Water System due to Human Activities

- Urbanization
  - Surface water impoundments, withdrawals, and diversions
  - Large groundwater withdrawals
  - Private well use and return flow
  - Impervious surfaces
  - Changes to land cover
  - Return flows- wastewater facilities
Changes to the Groundwater/Surface Water System due to Human Activities

- Groundwater withdrawals

Interception of groundwater in the flowpath to a stream

Induced infiltration of water from a stream

Effects of pumping on inflow, outflow, and change in storage

- Decreased outflow
- Increased inflow
- Change in storage

Percent of water pumped vs. Time
Changes to the Groundwater/Surface Water System due to Human Activities

Increase in recharge could be from induced infiltration or from pulling water from over the groundwater divide.
Urbanization increases overland runoff, bypassing the groundwater system

https://pubs.usgs.gov/wri/wri034300/
Changes to minimum flows over time due to augmentation of streamflow from wastewater discharge, and possibly changes in regulation.
Possible Changes to the Groundwater/Surface water System Under Changing Climate

• Greater precipitation, more variable
  • Extreme events (wet, dry)?
• Smaller proportion as snow
  • Changes in volume and timing of recharge and runoff
• Warmer temperatures/longer growing season
  • Greater evapotranspiration?
  • Greater water demand?
• Sea level rise
  • High groundwater levels in coastal areas, rising salinity, inundation of water supplies during storm surge