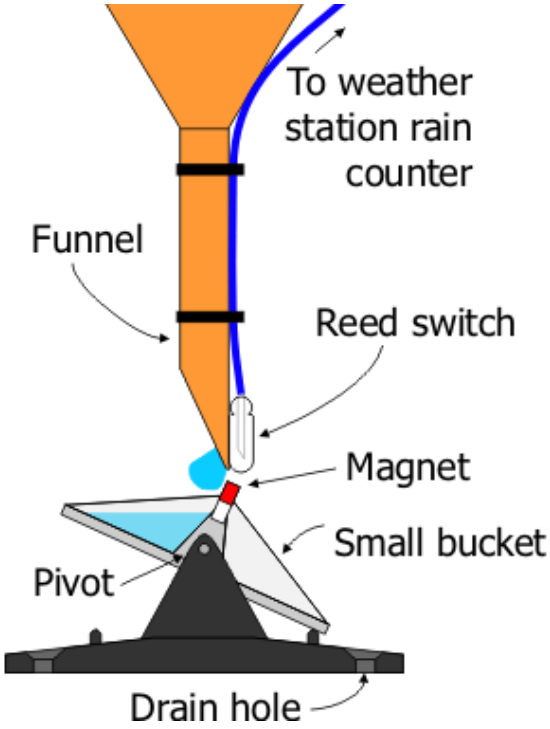
Measuring Water

Measuring water helps us understand the properties of water, and also to help us make predictions about water. In the photo, the field scientist is using a hand-held monitor to measure the amount of dissolved oxygen in the small stream.

The most basic type of measurement is the amount of rain received. We call this Depth. You might have a backyard rain gauge to track how much precipitation has fallen. To get a more accurate measurement, tipping buckets track not only how much rain has fallen, but at what intensity. A gauge in the weather station tracks how frequently the tipping bucket fills up.



Many weather stations are maintained by volunteers. The data can be downloaded from the state climatology office website.

Learning Activity

Visit **http://climate.umn.edu/climatology.htm** to find the weather station nearest you.

How Do We Measure Water?

NOAA maintains a network of even more precise rain gauges throughout the United States. They are automated and use telemetry to send weather data to a central site. NOAA also maintains a network of snowfall monitoring sites. Accurately predicting snowmelt is very important in the mountainous west, which relies on the meltwater stored in reservoirs for their drinking water.

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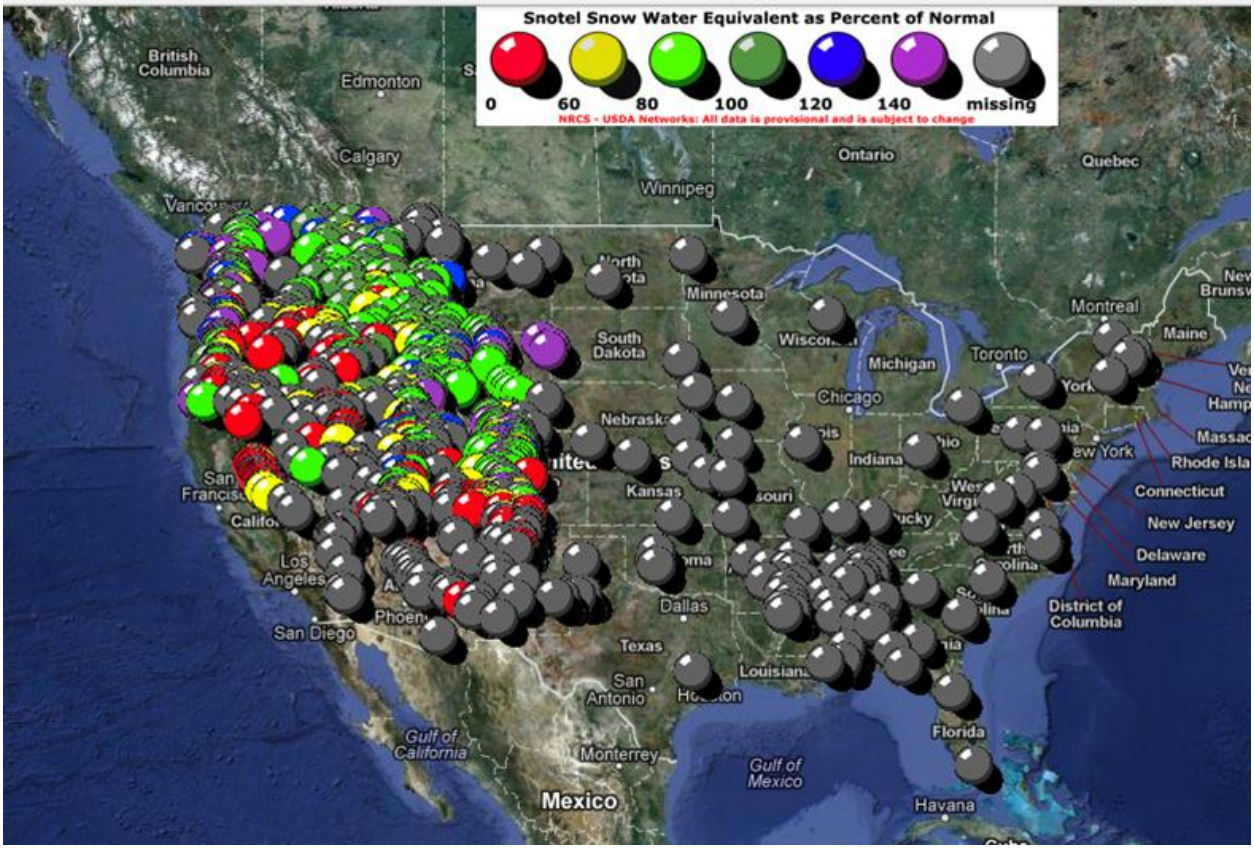
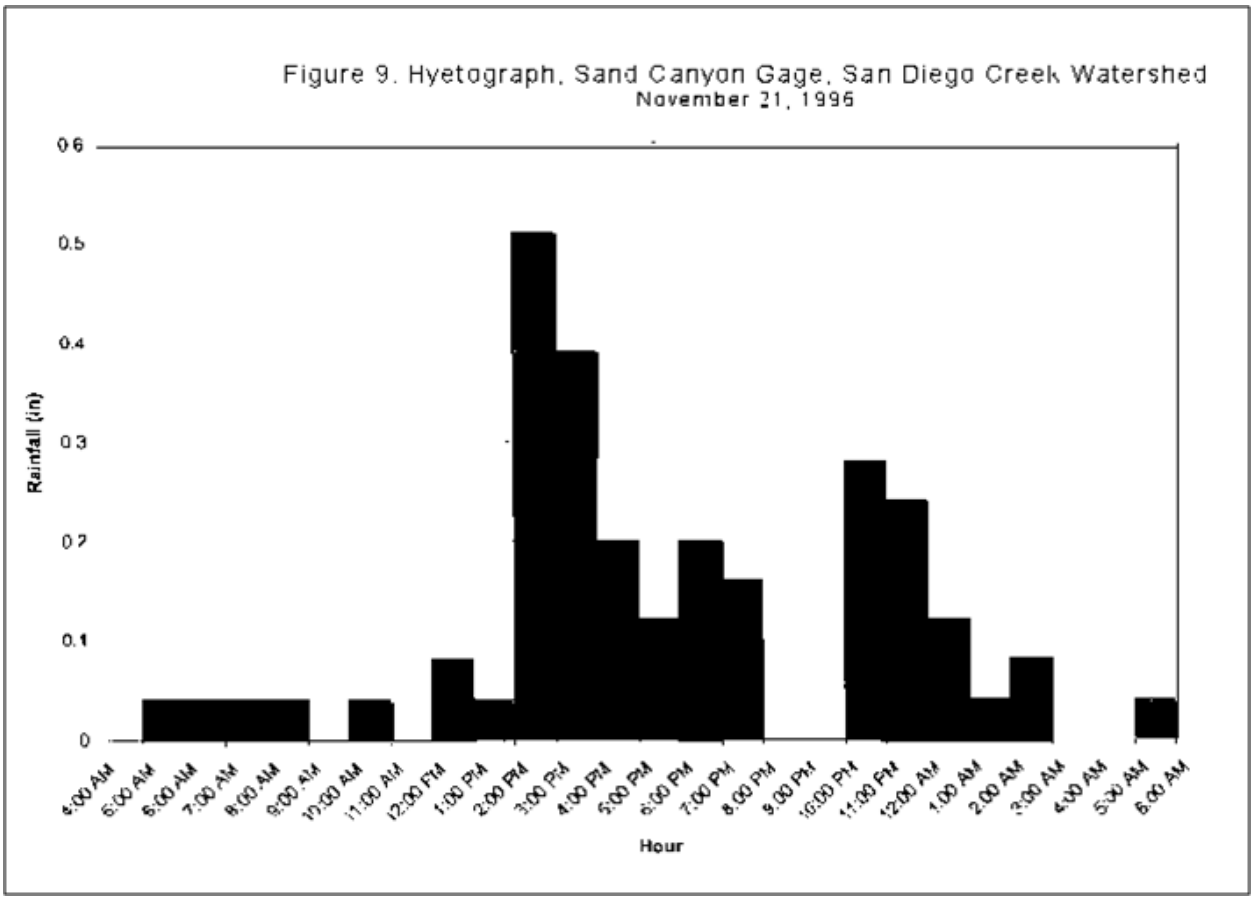
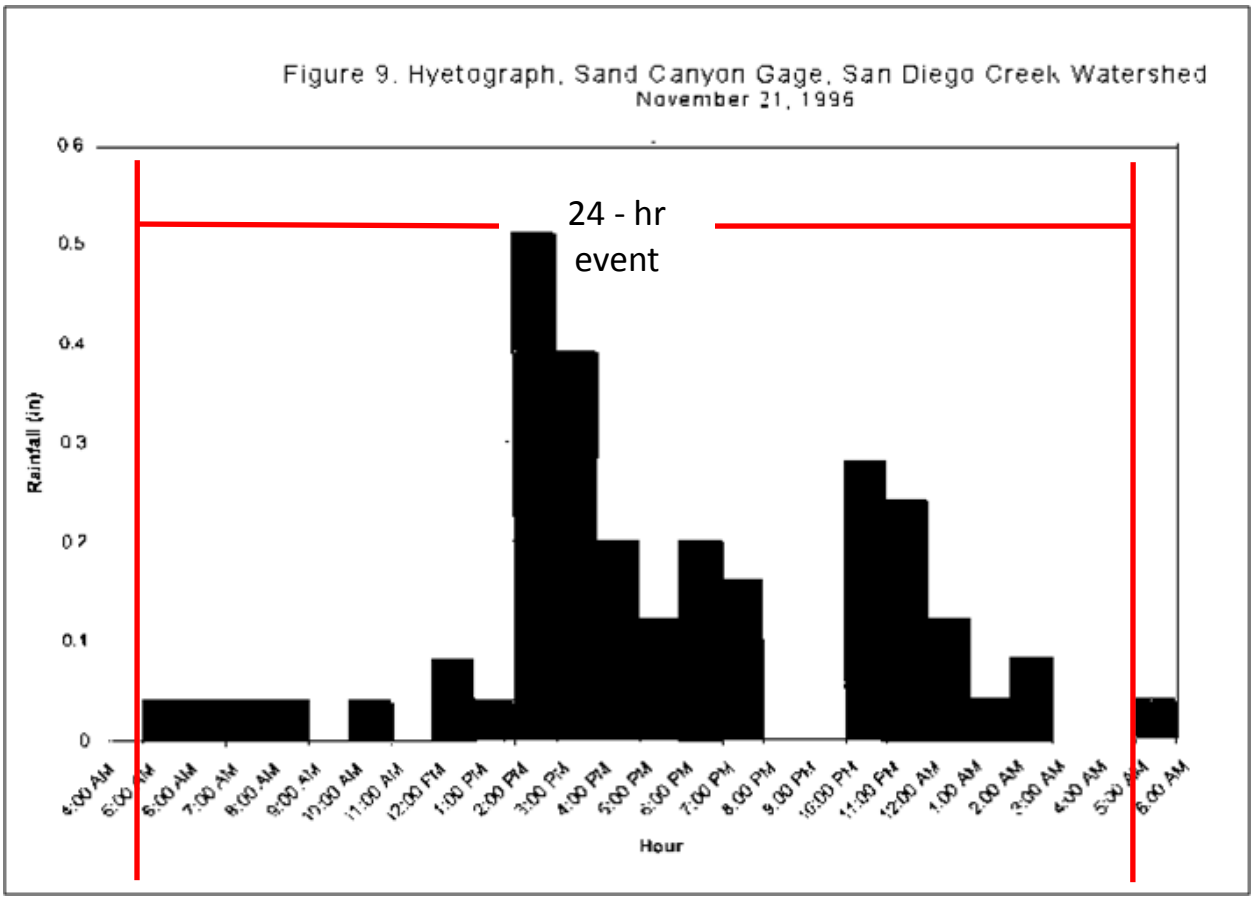


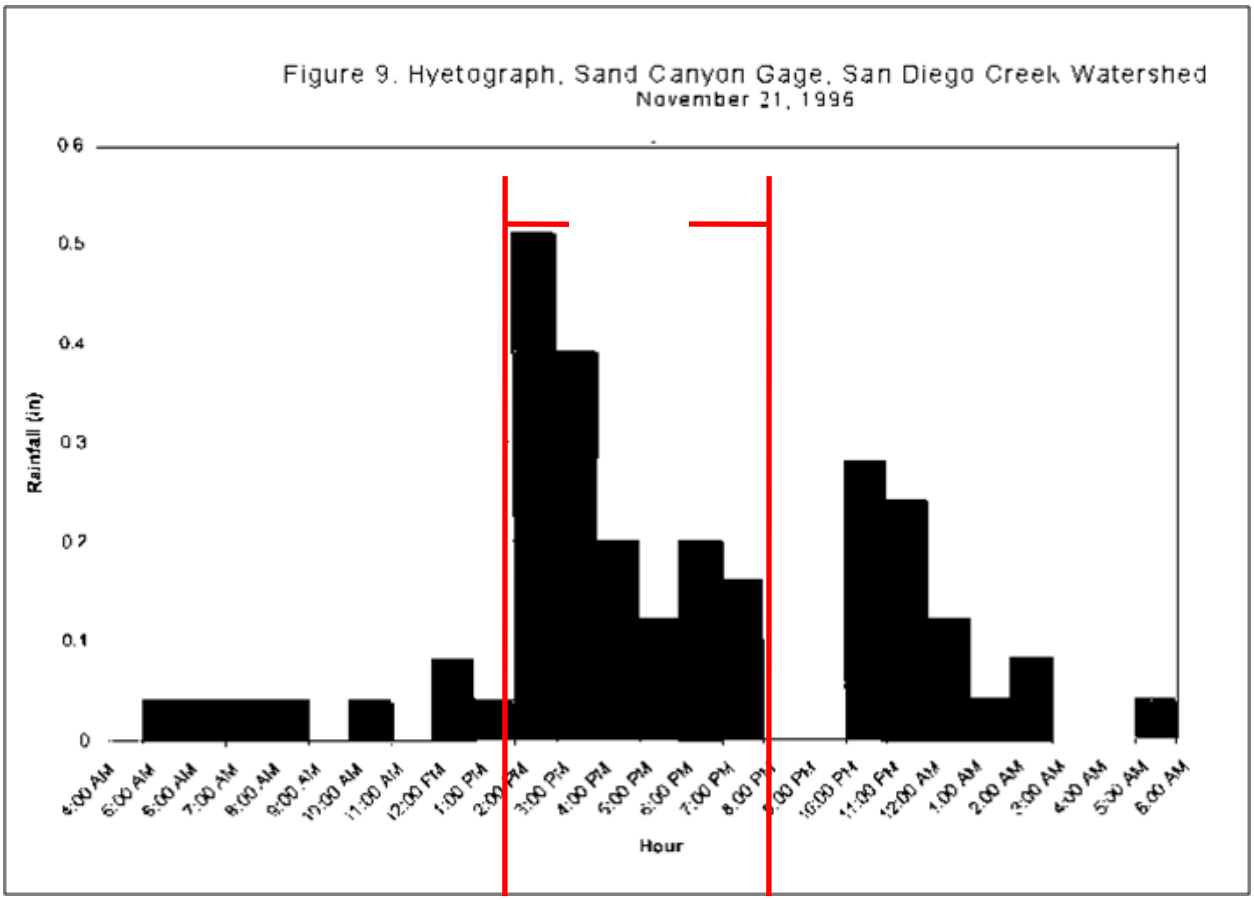
This is a hyetograph. A hyetograph shows distribution of precipitation, whether rain or snow, over time. The X axis shows the time interval of interest, in this case each interval is one hour. The Y axis shows the amount of precipitation received during that interval. In this case each bar shows the fraction of an inch received per hour.



We often refer to Precipitation Events. An event might be from the start to the finish of a rainfall, or it might be a certain interval. We call this Duration. For example, we might be interested in the amount of precipitation received in a 24 hour period, or a 24-hour event. In this case, 3.85 inches were received over 24 hours.



Rain falls at different rates during an event. We call this Intensity. In our example 3.85 inches of rain fell over 24 hours, which averages 0.16 inches per hour. However, during the six hours of maximum intensity, 1.55 inches fell, for an average intensity of 0.26 inches per hour. The storm's peak intensity occurred during the two hours where the most rain was received, 0.9 inches over two hours, which is 0.45 inches per hour. In hydrology, we look at all the different intensities that occur during rain events as we design storm sewers, ponds, and other drainage systems.



INTENSITY. 3.85" / 24 hrs = 0.16"/hr 1.55" / 6 hrs = 0.26"/hr 0.9" / 2 hours = 0.45"/hr

Learning Activity

In the Discussion Forum, write the definitions of the three things we need to know about a rainfall event: Depth. Duration, Intensity

What does it mean when we say "that was a 100-year event?" That it is an event that occurs once every 100 years – or which has a 1% probability of happening. We call this the Return Frequency. It also generally refers to a 24 hour event.

- *Return period* = 1/probability
- An event that has a 1% chance of occurring is a 1/.01 = 100 year return event
- An event that has a 50% chance of occurring is a 1/.50 = 2 year return event

NOAA uses precipitation records from across the US to mathematically establish the probability that rain events of various depths will happen. NOAA recently reanalyzed Midwest precipitation data going back a century, and published the new return frequency depths in a publication called Atlas 14. Atlas 14 is much more accurate than the previous standards, which were published in the late 1950s. Atlas 14 is available on an interactive map, so the user can zoom in and get return frequency data down to the neighborhood scale.

Learning Activity

Visit the NOAA Atlas 14 data server to zoom in on your area. Drag the red crosshairs to your location. IN the Discussion Forums, tell us what is the 24-hour, 100-year storm event depth for your location?
http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=mn

The following table shows data for the Minnehaha Creek District office in Minnetonka. When we talk about a "100-year storm" for that site, the 100-year, 24-hour event is 7.4 inches of rain.

Return Frequency	24-hour	12-hour	6-hour	3-hour	2-hour	1-hour	30-min	15-min
2-year (50% chance)	2.9	2.5	2.2	1.9	1.7	1.4	1.1	0.7
10-year (10% chance)	4.3	4.0	3.5	3.0	2.7	2.1	1.6	1.1
100-year (1% chance)	7.4	7.0	6.4	5.4	4.7	3.7	2.6	1.8

In hydrology, it is important to look at the larger, less frequent events. When we are managing stormwater for water quality, we often look at smaller, more frequent events. Dr. Robert Pitt and others

have researched small storms and found that most rain events are less than one inch in depth, and somewhere around 70 percent of the total annual volume of rain comes in the first one inch of rain.

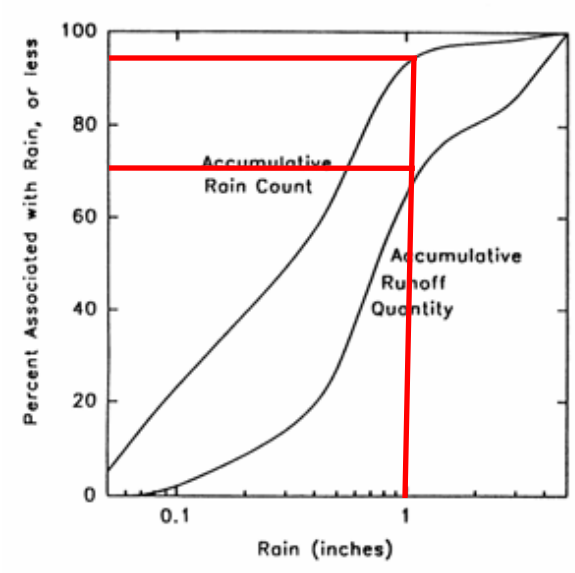


Figure 3. Milwaukee rainfall and runoff probability distributions.

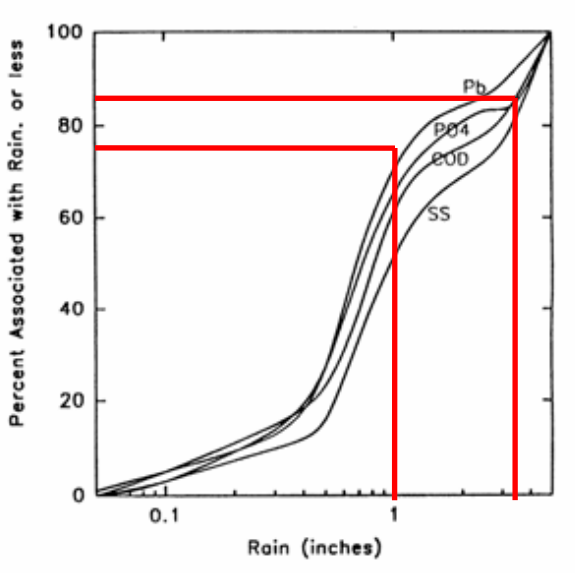


Figure 4. Milwaukee pollutant mass probability distributions.

About 70 percent of the annual load of pollutants in stormwater runoff is associated with those up to one inch storms. About 90 percent of pollutants are conveyed by rains of up to 1.3 inches in depth. We call this the Water Quality Event.

- ⊡ 1" event- ~ 70% of pollutant load
- ⊡ "Water Quality Event" = 1.25-1.3"= ~90% of pollutant load

A key concept in hydrology is Runoff Volume, or the amount of rain that falls on a site and then leaves as runoff. Calculating this volume can be very complex. A simple way to calculate this volume is just multiplying the site area times the runoff depth to get volume. Make sure to check your units of measurement; you may need to include a conversion factor in your calculations.

Learning Activity

Visit your county website's property map (in Hennepin County, http://gis.hennepin.us/property/map/default.aspx) and zoom in on your property. You may need to select some menu options to display annotation such as the parcel dimensions. Turn on the aerial photo. Print this and trace or freehand sketch a diagram of your property showing the house, driveway, garage, and any other impervious areas such as outbuildings, patios or decks, alleys, etc.

Runoff volume from the 100-year event is over seven times the runoff volume from the one inch event.

Learning Activity

Using the 100-year depth for your site you looked up earlier, calculate how much runoff your property would generate from a 1" storm and a 100-year storm. Post that number in the Discussion Forum for this module. Write a short summary of where on your property you think most of that water is generated.