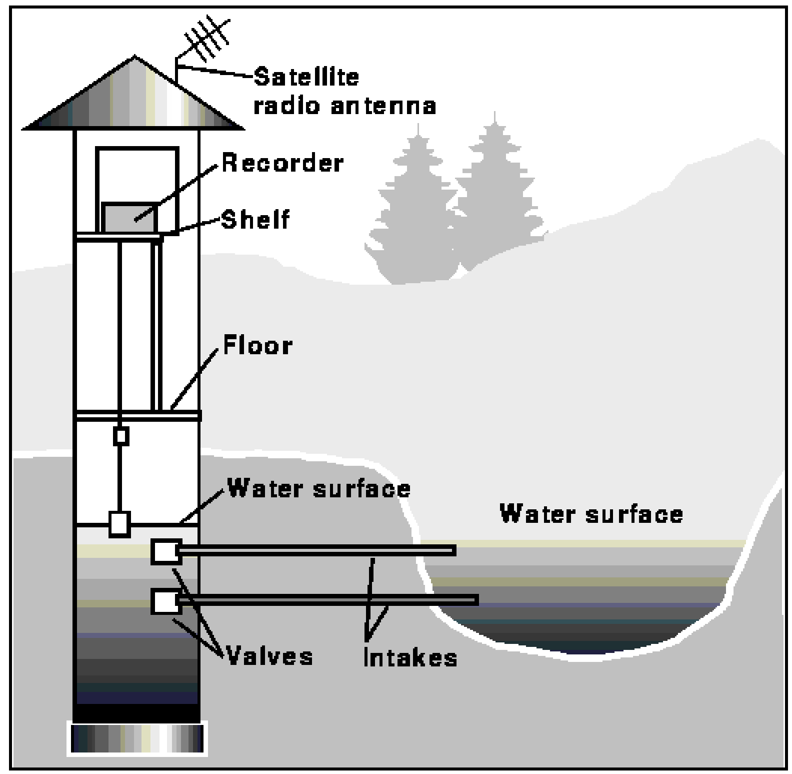
Streamflow

- Streamgages — sites with continuous monitoring of river levels used to obtain discharge estimates
- U. S. Geological Survey (USGS) (http://water.usgs.gov)

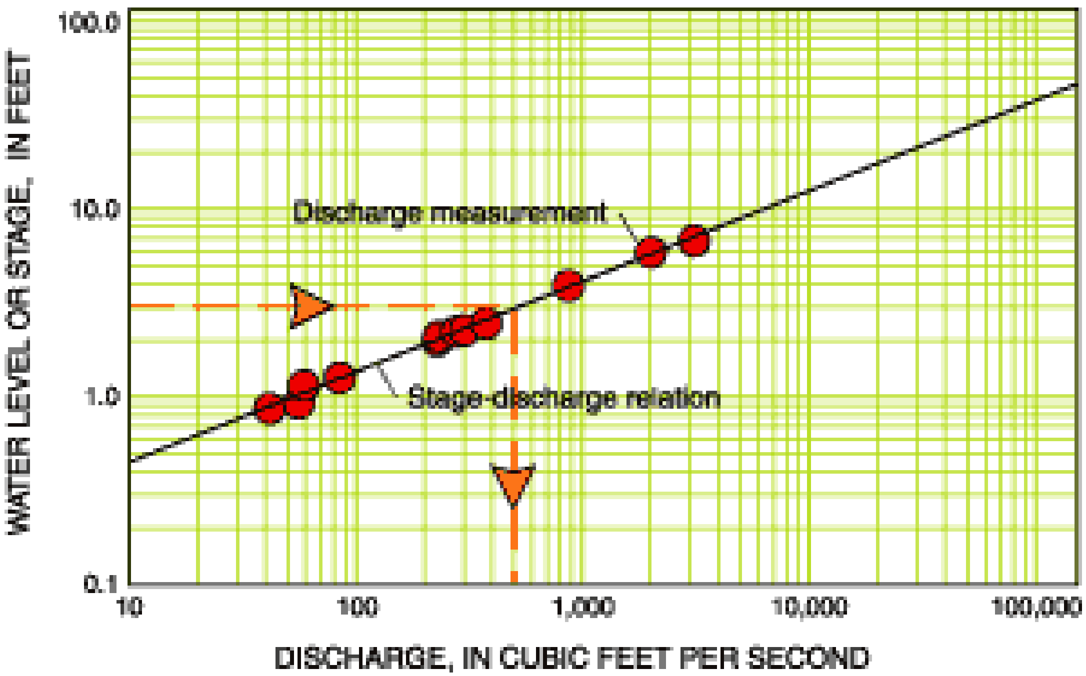
USGS Iowa Streamgages

USGS Streamgage

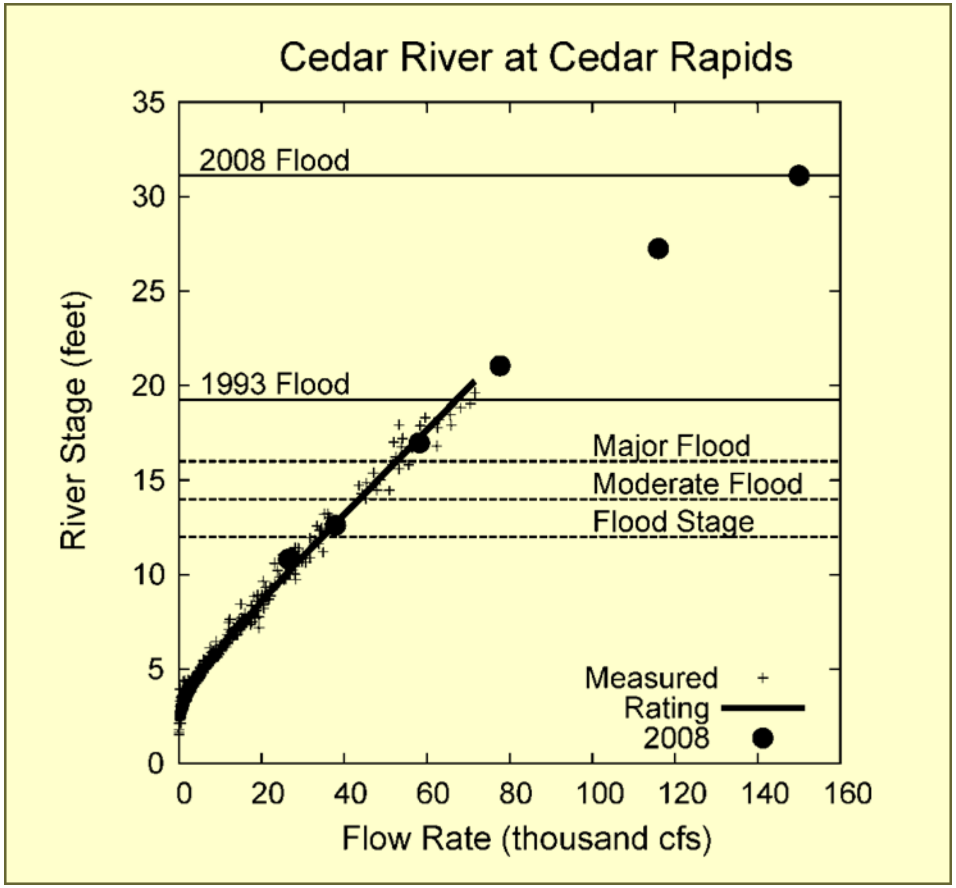


Current Meter Measurements

Rating Curve

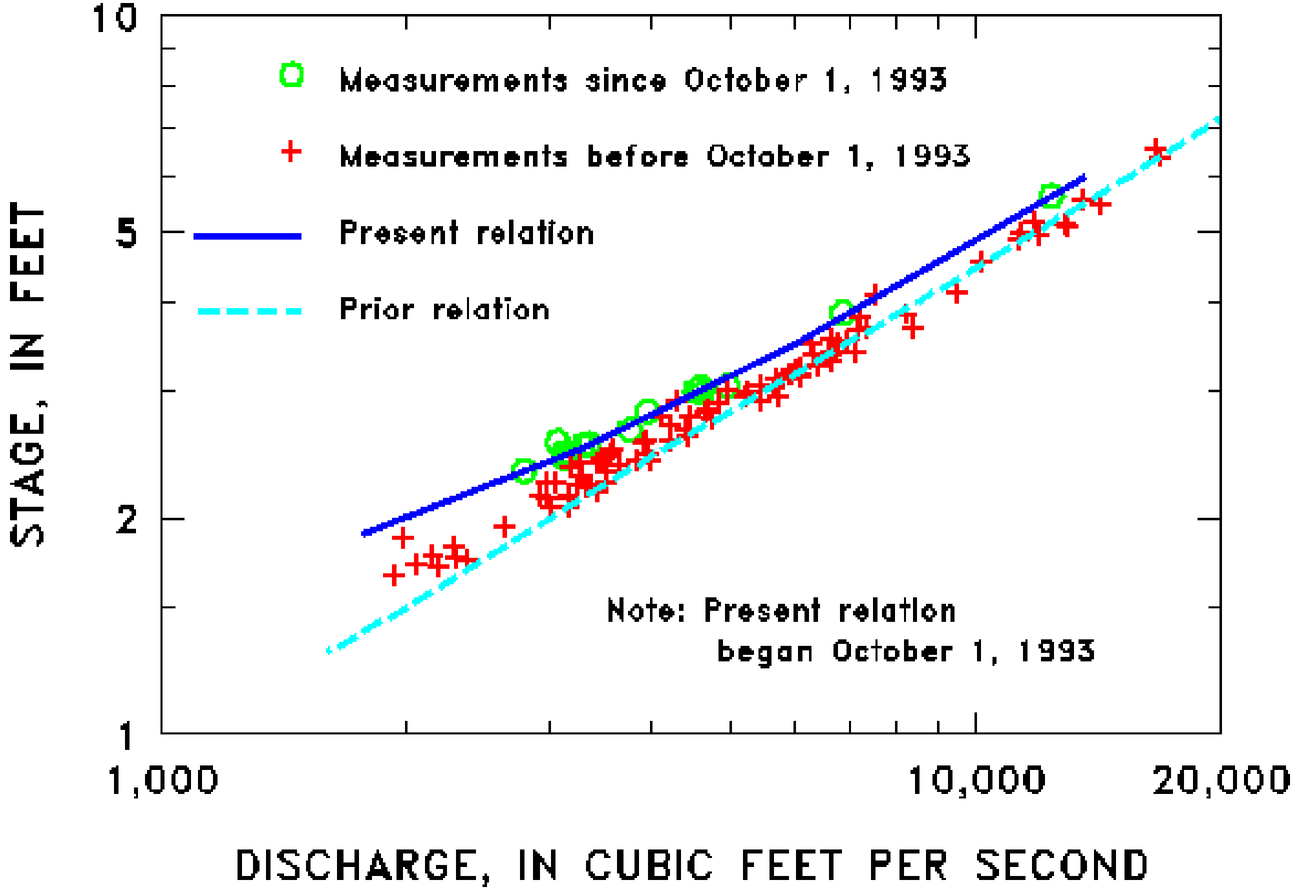


Rating Curve



Stage-discharge relationship established from many current meter (or other) flow measurements

Rating Curve



Acoustic Measurement (ADCP)

Sensors

Current
Meter

ADCP

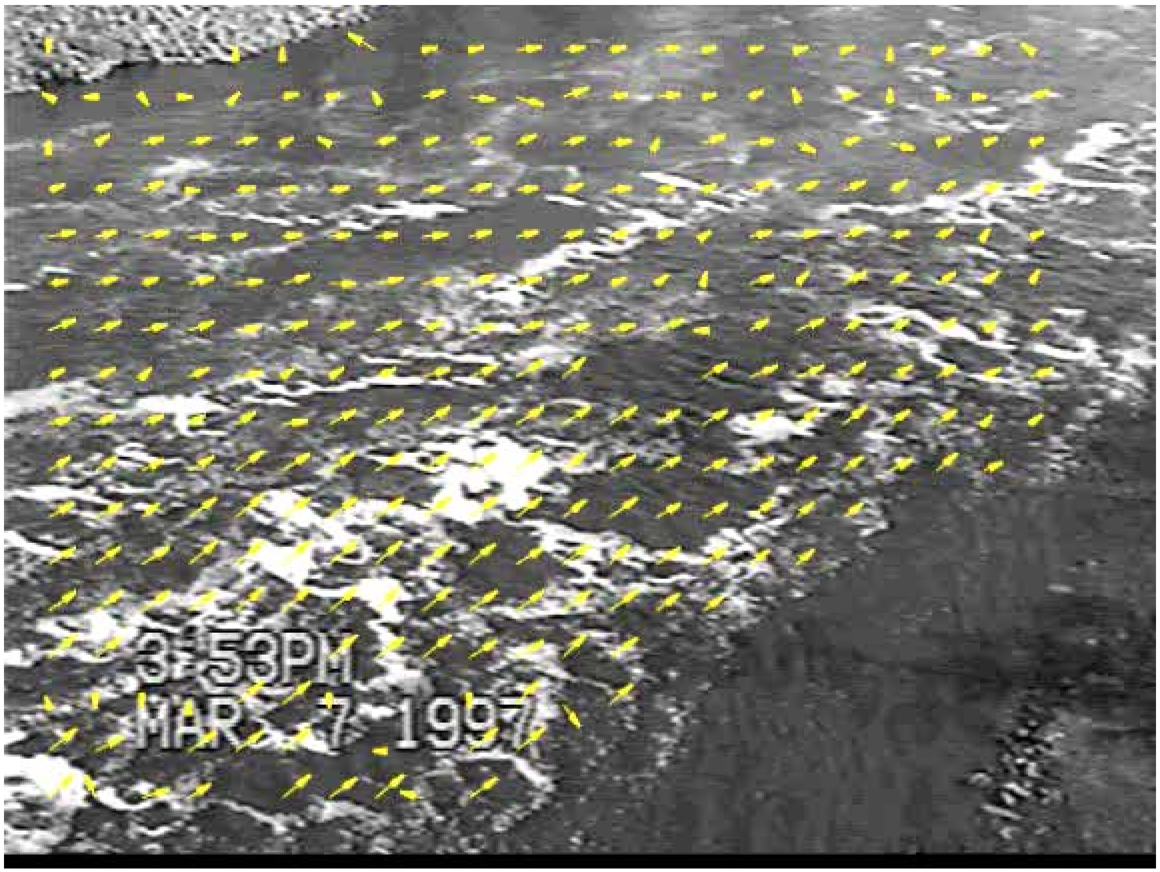
Non-Contact Approaches

Helicopter-mounted radar experiment. Two microwave antennas are located just below the cabin on each side. The radar antenna is the large white structure below the helicopter.

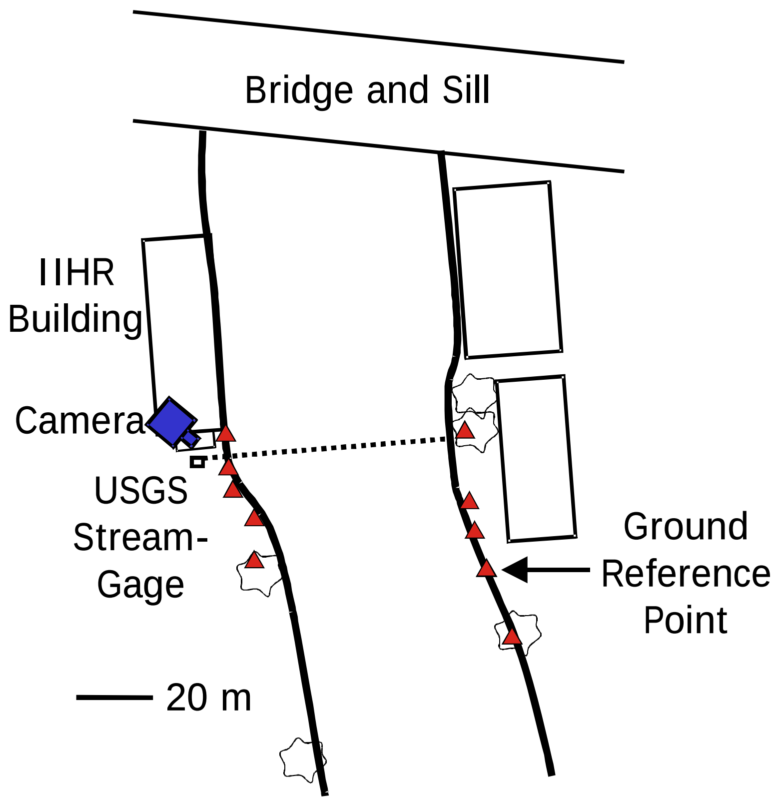
GPR and radar
(helicopter platform)

Radar

Measurements from Images



Iowa River Gaging Experiment

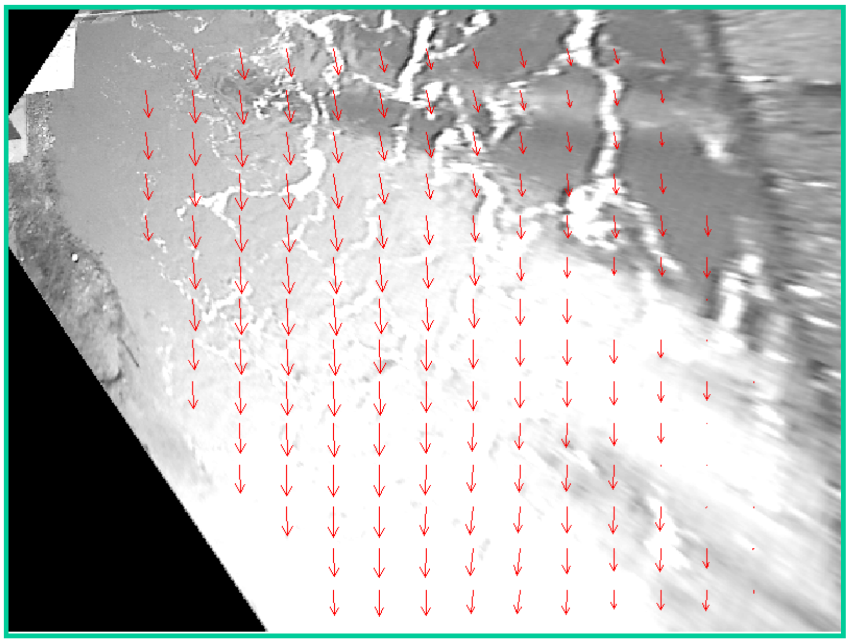


- 10 measurements over a 20 day period
- Discharge varied from 50 to 300 m^3/s
- 600 images (1 sec)
- Unseeded
- Depth-averaged velocity estimated from surface velocities

Iowa River Video Imagery

Camera Image

Transformed Image



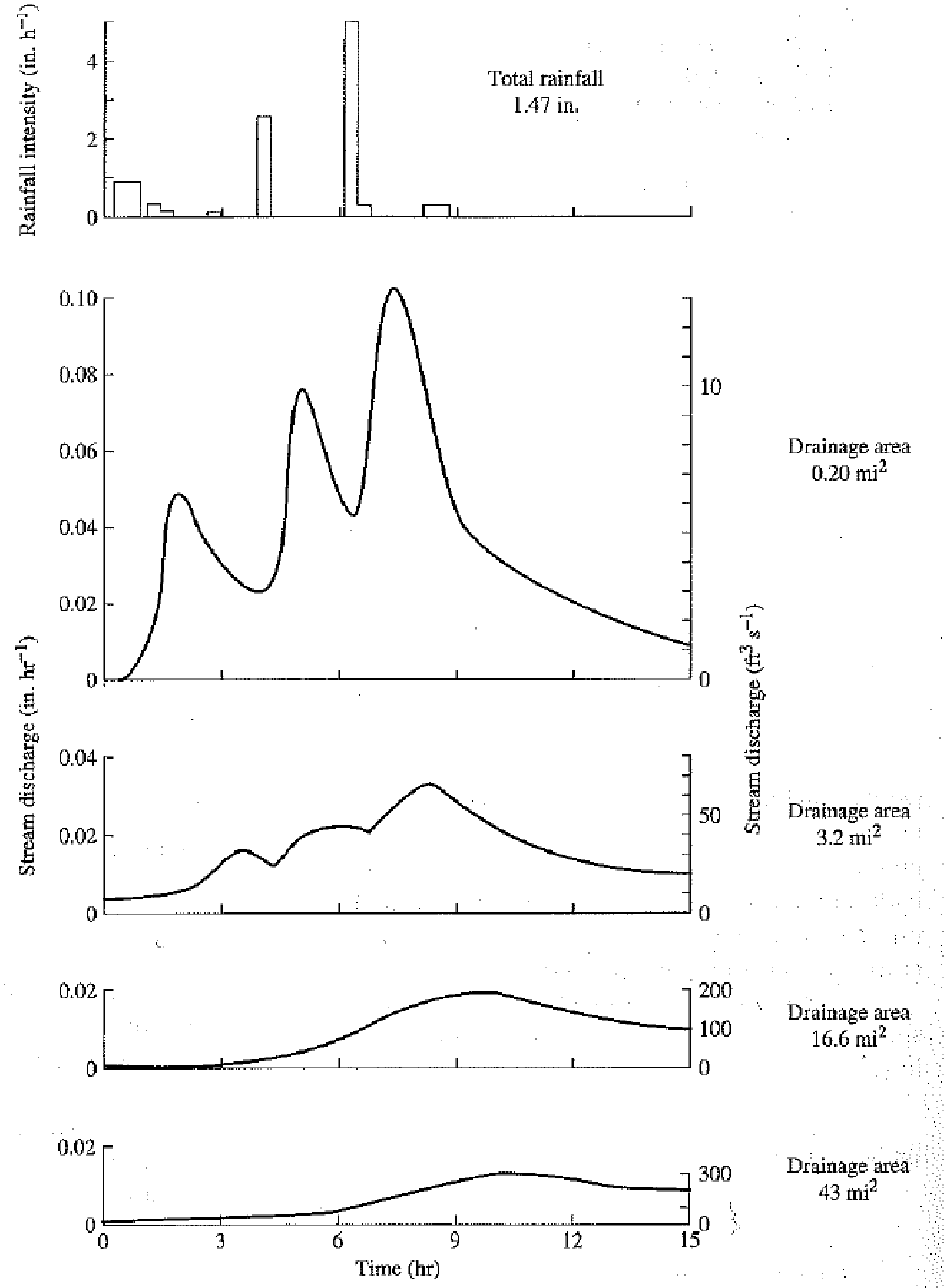
Streamgaging

- Make periodic field measurements of discharge and water levels
- Estimate the relationship between river stage and discharge (rating curve)
- Make continuous measurements of river stage at the streamgage
- Estimate continuous discharge using the rating curve

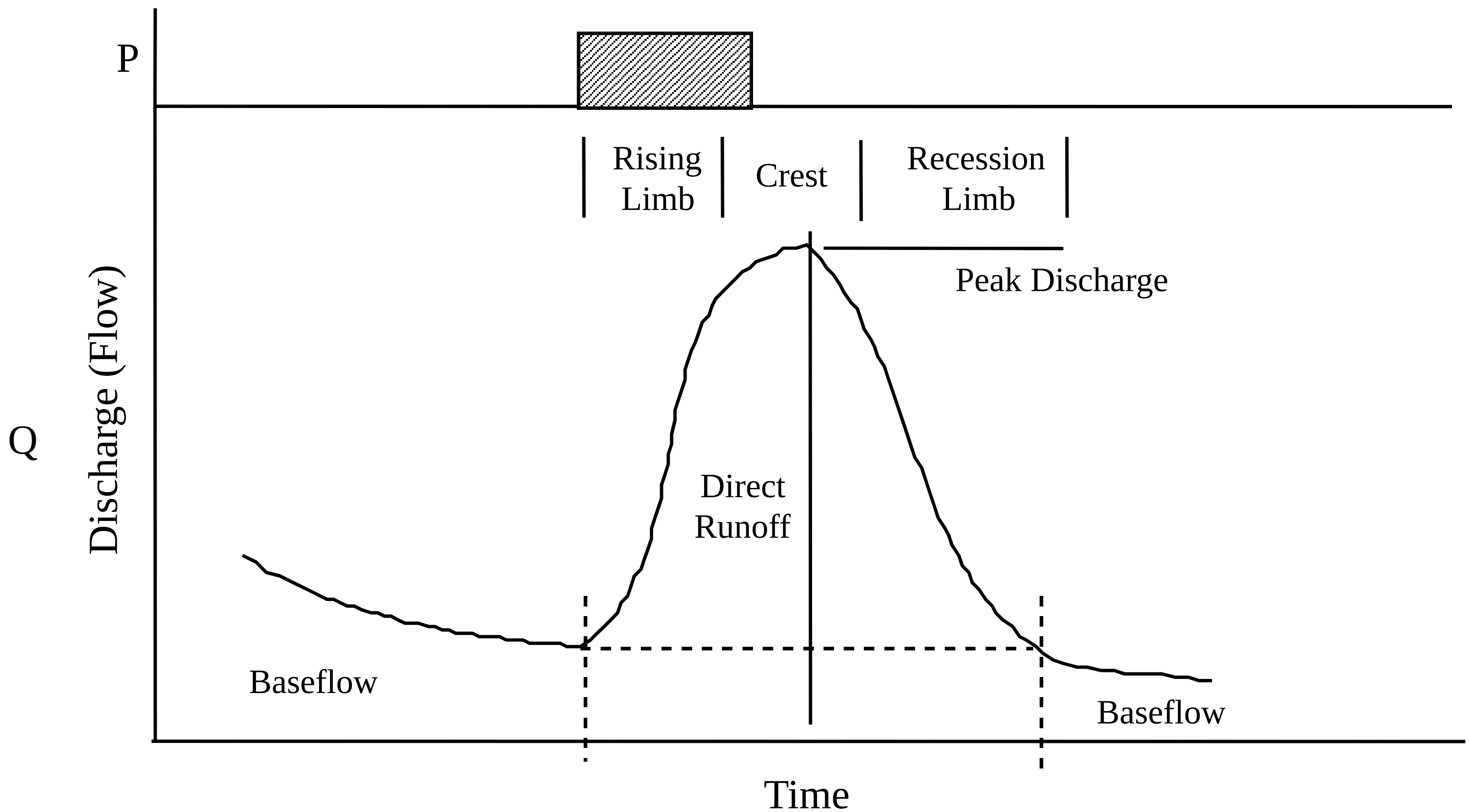
Streamflow Hydrograph

- Hydrograph
  - A graph (or a table) showing the discharge rate (or river stage) versus time for a point on a stream.

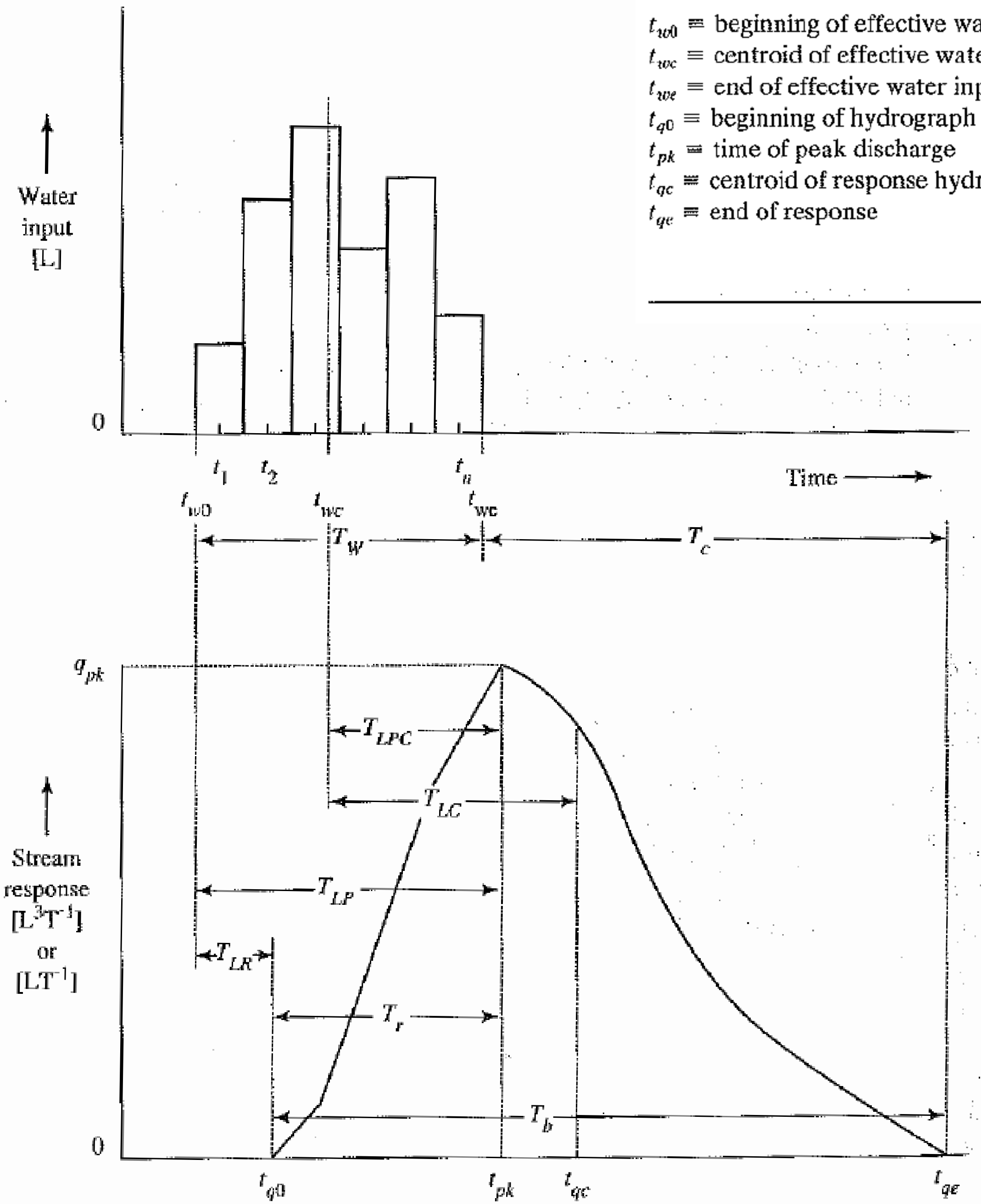
Streamflow response to rain events



Streamflow Hydrograph



Time Instants	Time Durations
$t_{w0} \equiv$ beginning of effective water input	$T_w \equiv$ duration of effective water input $= t_{w0} - t_{we}$
$t_{wc} \equiv$ centroid of effective water input	$T_{LR} \equiv$ response lag $= t_{q0} - t_{w0}$
$t_{we} \equiv$ end of effective water input	$T_r \equiv$ time of rise $= t_{pk} - t_{q0}$
$t_{q0} \equiv$ beginning of hydrograph rise	$T_{LP} \equiv$ lag-to-peak $= t_{pk} - t_{w0}$
$t_{pk} \equiv$ time of peak discharge	$T_{LPC} \equiv$ centroid lag-to-peak $= t_{pk} - t_{wc}$
$t_{qc} \equiv$ centroid of response hydrograph	$T_{LC} \equiv$ centroid lag $= t_{qc} - t_{wc}$
$t_{qe} \equiv$ end of response	$T_b \equiv$ time base $= t_{qe} - t_{q0}$
	$T_c \equiv$ time of concentration $= t_{qe} - t_{we}$
	$T_{eq} \equiv$ time to equilibrium $\approx T_c$



Streamflow Hydrograph

- Components of streamflow:
  - Direct runoff (overland and subsurface flow) is water that travels quickly (over the ground or in the upper soil layers) to the channel (fast)
  - Baseflow (groundwater flow) is water that reaches the water table and moves to the stream (slow)

Base-flow separation

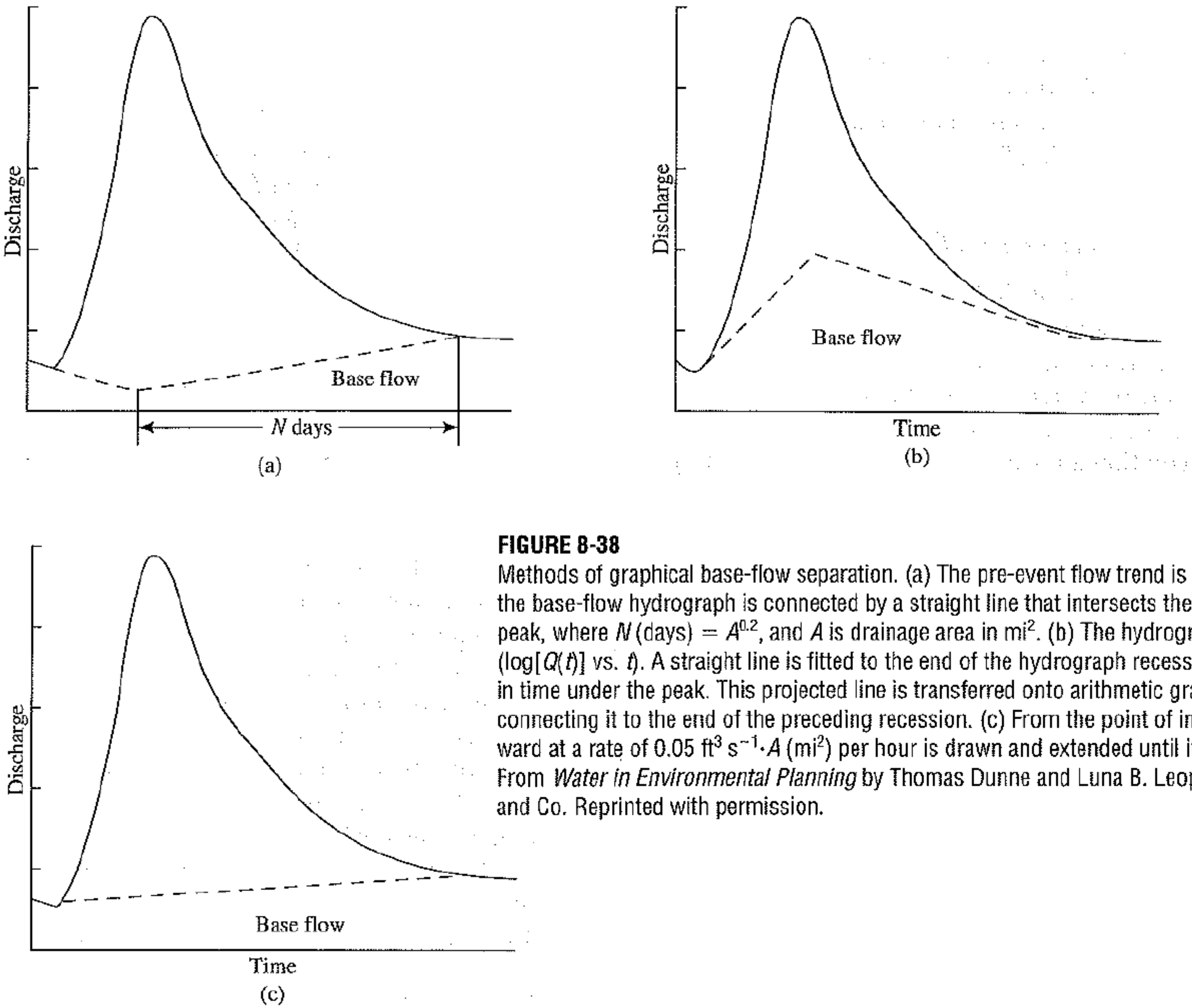


FIGURE 8-38
Methods of graphical base-flow separation. (a) The pre-event flow trend is projected until the time of peak, after which the base-flow hydrograph is connected by a straight line that intersects the total-flow hydrograph *N* days after the peak, where *N* (days) = $A^{0.2}$, and *A* is drainage area in mi^2. (b) The hydrograph is plotted on semi-logarithmic paper ($\log[Q(t)]$ vs. *t*). A straight line is fitted to the end of the hydrograph recession on this graph and projected backward in time under the peak. This projected line is transferred onto arithmetic graph paper and a smooth line is sketched connecting it to the end of the preceding recession. (c) From the point of initial hydrograph rise, a line that slopes upward at a rate of 0.05 $ft^3\ s^{-1} \cdot A\ (mi^2)$ per hour is drawn and extended until it intercepts the hydrograph ($A < 20\ mi^2$). From *Water in Environmental Planning* by Thomas Dunne and Luna B. Leopold. Copyright © 1978 by W. H. Freeman and Co. Reprinted with permission.