# V. STREAM DISCHARGE MEASUREMENTS

## A. Methods for Flow Measurement

Determination of stream flow involves two steps: continuous measurement of stage (water level above a datum) at some cross-section and establishment of a mathematical relationship for converting that stage record to discharge. Ideally a structure with known hydraulic properties is constructed in the channel to standard specifications [e.g., Bos, 1985]. Structures such as weirs and flumes have advantages of a consistent, precalibrated stage-discharge relationship and accurate results [e.g. Herschy, 1985], but because of logistical considerations we chose to use dilution gaging techniques.

Water level of the lake at a point immediately above the outlet has been recorded by the U.S. Geological Survey (USGS) since October 1983. Water level in the stream a few meters below the outlet has been recorded by this project since August 1985. A second sensor, which was recorded independently, was installed in June 1986. Staff gages near both water level sensors were read manually and served as a permanent reference. The USGS sensor was a nitrogen-gas bubble gage with a precision of about 1 cm in stage. Because of the location of the USGS sensor in the lake, stage changes of a centimeter over the large surface area of the lake can mask considerable fluctuations in outflow discharge. This project's sensors were rugged pressure transducers (Montedero-Whitney Model 140 PC) of the differential type. The standard (1 psi) transducer is accurate to within 1.3 cm change in water level over the range of water temperatures occurring in the gaged streams (manufacturer's specifications). The transducers convert water pressure (which is a function of water depth) into voltage when an excitation voltage is applied. The transducers were mounted inside a short section of pipe to avoid influences of velocity on measured pressure [Herschy, 1985]. Transducer output was recorded by solid-state data loggers (Omni Data Easy Loggers). The loggers were programmed to record averages of 5 minute interval scans every 15 minutes.

Stream discharge (volume per unit time) was calculated from the stage records with an empirical stage-discharge relationship (rating curve). The development of a rating curve requires dozens of manual measurements of discharge over the complete range of expected stages. Conventional discharge measurement relies on measurement of mean velocity and the cross-sectional area of the channel. The product of velocity and area is discharge. Generally, velocity is measured at several points across a channel with a current meter and averaged to obtain a mean velocity for a measured cross-sectional area. Standard velocity measurements with a current meter tend to be unreliable in mountain streams. Velocity at a cross-section can fluctuate widely in turbulent high-gradient streams. At high flow, there may be air entrainment. At low flow, water depths can be so small that the size of even pygmy-type cup meters are on the order of the channel depth in many locations. Flow