

ingly, we arranged to carry out an investigation under Dr. Bower's guidance. During 1962 and 1963, chemical data from West Pakistan were sent to Riverside, and also to Cambridge, Massachusetts, for statistical analysis and evaluation. Dr. Bower carried forward a theoretical analysis of the various chemical processes at the soil-water interface that govern the uptake of sodium ions upon the clay lattice. This analysis was published by Bower and Maasland [8]. Maasland, Priest, and Malik [9] have summarized the results of the field and laboratory tests as well as the analytical studies.

In the water budget presented in Chapter 7 of the Panel Report, the predicated constraints pertaining to limiting mixing ratios of groundwater to surface water in the saline and non-saline areas were based on analyses of water from tubewells in the SCARP I project area and of water samples from elsewhere in the Northern Zone, made by the Water and Soils Investigation Division of WAPDA. The results are contained in items I C 7(a) and 7(c)(1)(2)(3) and (6) of the water budget. We estimated that in the non-saline areas of the former Punjab and former Bahawalpur the dilution ratio for one-third of the wells must be at least 1:1, while in the saline areas one-half the wells must have a dilution ratio of 2:1. These degrees of dilution were adequate to reduce the ESP to the range of 15 to 20 which we considered as generally safe for the soil types of the Northern Zone. As Maasland, Priest, and Malik show, reduction of the ESP to the commonly accepted "safe" range of 10-15 would require much higher dilution ratios. For example, in 40 per cent of the wells in the non-saline area, 2.5 parts of canal water would be needed for 1 part of tubewell water. However, a reduction to this extent is probably not necessary with the mica-type clays of former Punjab and Bahawalpur.

The Panel Report states the mixing ratios of canal to tubewell waters, as well as other design constraints based on groundwater salinity, in the form of inequalities, rather than equalities. In the final solution (IC 7(e)) for the water budget, several of these constraints were not binding. For example, if 77 per cent of the canal water is used in the non-saline area (*see*, Table III), the ratio of canal water to tubewell water at the water courses in the non-saline area is 70 per cent greater than that specified in the Report as a lower limit. In the saline area, if "skimming" wells can be used to recover canal seepage before it has become mixed with the salty underlying groundwaters, the salinities of the tubewell water may be lower than the calculated values.

The Panel Report contemplated that only 75 per cent of the area in the non-saline zone and 50 per cent of the area in the saline zone were to be cultivated. It should be possible to "pick and choose" favorable locations. In the non-saline zone, the groundwater over the best 75 per cent of the area may