2. On the other side of the size spectrum, less than 7 percent very coarse sand and less than 3 percent gravel should be present. These two figures combined should not exceed 10 percent. If these limits are exceeded then the following may occur:

a) these large fractions may cut or bruise the creeping stems (stolons) of the putting surface grass,
b) these tend to accumulate over time near the soil surface which results in hard greens,
c) they dull mower blades when brought to the surface by core verification,
d) they make cup-setting and core aerification difficult, and
e) the soil will not hold adequate water or nutrients.

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3. The principal characteristic of the sand should be a narrow particle-size distribution with the majority (>80 percent combined) of the particles falling in the fine, medium, and coarse sand (0.1 to 1.0 mm) fractions. Within this range, the medium-sized particles (with a diameter of 0.5 to 0.25 mm) should comprise at least 50 to 70-percent.

**Infiltration and percolation rates**

Even though they may fall within the particle size ranges listed in Table 3, it is possible to have sands that have unacceptable infiltration or water retention values. Therefore, it is essential that the chosen sand have a compacted infiltration test before use. This will help identify any questionable sands.

Several considerations should be made before choosing a sand. First, is the infiltration and percolation rate acceptable to the golf club. For most bermudagrass putting greens, the initial percolation rate should be 10 to 15 inches per hour. Over time, this initial rate will be reduced by an average of 1/3 leaving these numbers well above the minimum of 2 inches per hour required for bermudagrass. If the club decides on the upper drainage rate (15 inches per hour), then a sand that has a major component (minimum 65 percent total) in the coarse (0.5 mm) and medium sand (0.25 mm) range should be considered or, alternatively, a minimum amount of soil or organic matter should be added to the root zone mix. Ideally, to obtain this higher drainage rate, 75 percent of the sand mixture should fall in the medium (0.25 mm) sand range and as much as possible of the remaining 25 percent should fall in the coarse (0.5 mm) sand range.

For those clubs desiring a slower infiltration and percolation rate, then up to 15 of the remaining 25 percent should fall in the fine sand range (0.10 mm). For those desiring still a little slower draining root zone (therefore, requiring less water and fertilizer frequency), a minimum of 65 percent of the sand should fall in the fine to medium sand categories.

Many times, sands in these rigid categories can not be found. In these cases, it is suggested that at least 80 percent of the sample fall in the fine, medium, and coarse sand fractions. Soils predominated by larger sizes such as very coarse sand and gravel, will drain too quickly and have low nutrient holding capacity. On the other hand, root zone soil dominated by smaller sizes such as fine sand, very fine sand, silt and/or clay will become water-logged, low in soil aeration, and conducive to algae and moss occurrence. Sometimes a sand washed over a number 140 or 200 screen will reduce the very fine sand, silt, and clay to the point of being acceptable.

The addition of well-decomposed organic matter to the root zone mix helps improve the characteristics of sands that are lacking such as improved nutrient retention and water holding capacity. There is a vast array of opinions of the use of soil amendments for golf greens. A trend in the 1970's and 1980's was to use pure sand with no additional amendments added. However, in the 1990's, concerns about pure sand greens and the environment have many courses reconsidering using some amendments in this root zone mixture. As Florida's natural resources become more limited and pesticide use contingent on root zone percolation and water holding capacity, golf greens in the south should have some component of organic matter and/or soil added to help improve their moisture and nutrient retention capabilities. Without this added organic matter or soil, greens generally do not adequately retain water or nutrients. Under these conditions, the superintendent must apply water and nutrients more frequently, but, perhaps at lower rates. Table 4 lists general cation exchange capacity levels in relation to the soil textural properties. Table 5 lists several currently used organic sources for golf green root zone mixtures while Table 6 lists specific characteristics of some commonly used peats for modifying root zone mixtures.