Article 36

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The Compaction of Urban Soils

Many professionals have an interest in the compaction of urban soils. For example, a structural engineer may need to increase compaction to provide a stable foundation for a road or building. Conversely, an urban forester or landscaper may want to decrease or prevent compaction in order to improve root growth and plant survival. A stormwater engineer must understand soil compaction to accurately model the runoff from lawns and landscaped areas, to identify suitable locations for stormwater treatment practices, or to stabilize an embankment or slope. Soil compaction is also an important issue for managers involved in land conservation, erosion and sediment control, watershed education and watershed planning. In this note, we examine how soil compaction increases in response to watershed development and the implications it has for watershed professionals.

What distinguishes soil from dirt? One of the major factors is the amount of "fluff" within a soil. Undisturbed soils have a lot of pore space. Indeed, air comprises from 40 to 55% of the soil volume (unless it has recently rained, in which case the pore spaces are filled up with water). Scientists and engineers frequently measure bulk density to indicate how much fluff is present in a particular soil. Bulk density is defined as the mass of dry soil divided by its volume, and is expressed in units of grams per cubic centimeter (gms/cc). Bulk density is a useful indicator of the structure of a soil, and can help predict its porosity, permeability, infiltration rate and water holding capacity. In general, as the bulk density of a given soil increases, it will produce more surface runoff and allow less infiltration.

The surface bulk density of most undisturbed soils ranges from 1.1 to 1.4 gms/cc, depending on the type of soil present (Table 1). Soils that are predominately sands or clays are on the lower end of the range, whereas silts and silt loams are on the high end of the range. Glacial tills, which were compressed by thousands of feet of ice in the last ice age, can have a bulk density ranging as high as 1.6 to 2.0 gms/cc, depending on how much they have weathered. Highly organic soils, like peat, can be as low as 0.3 gms/cc. In general, bulk density increases with soil depth, reflecting the compression by the overlying soil, and the decline in the abundance of soil fauna and organic matter.

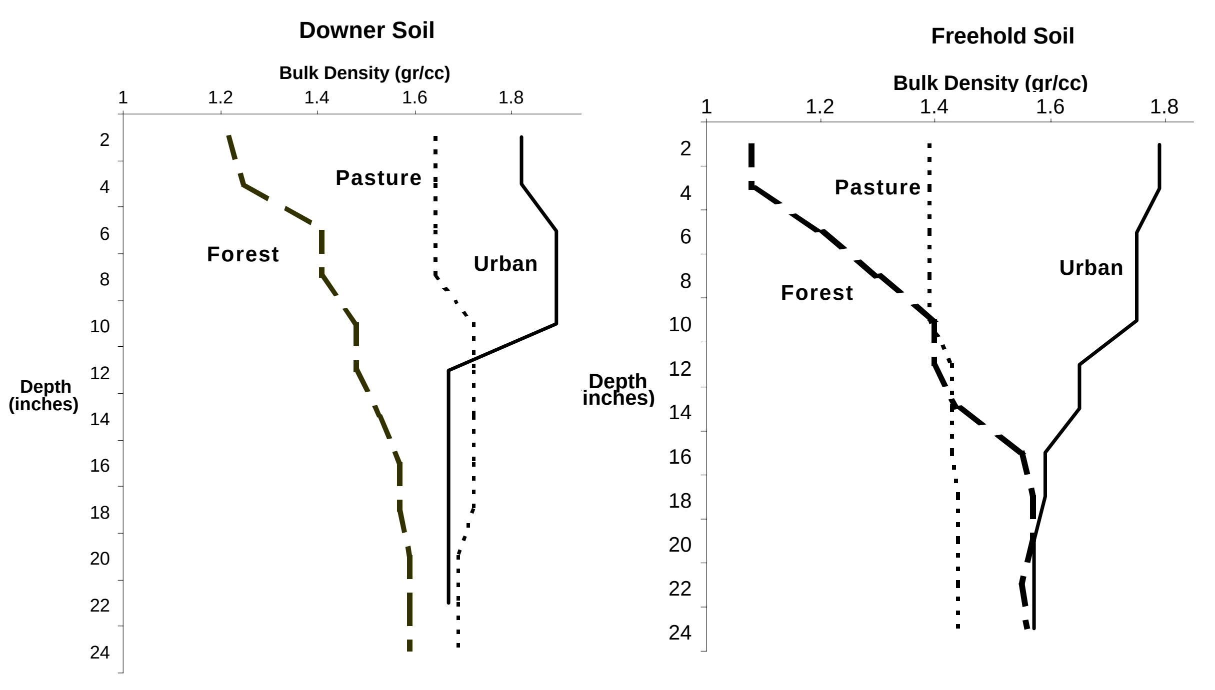

Figure 1: Change in Bulk Density in the Soil Profile as a Function of Land Use