A Comparison Of Three Residential Soil Profiles

in Bothell, Kirkland, And Seattle

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Introduction

Urban soils tend to be vastly different from what is predicted by soil surveys. The heavy equipment used in urban development can compact the soil and reduce infiltration capacity (Brady & Weil, 2010). Each time housing is taken down and new development put in place, the existing soil may be completely removed and replaced with fill from somewhere else. Urban soils are typically not in place long enough to develop past an Entisol order. However, there are some interesting details that can be gleaned from examining these soils, such as how backyard canopy cover and species choice can influence the soil profile. A primary question I wanted to answer was: "How to suburban and urban soils compare to what is listed in the official soil survey."

Site History | Observations | Soil Survey Results

Site 1

A suburban Bothell residence, built in the 1972, with a two-tiered backyard to the East. Samples were collected from a spot in the flat upper tier, in which coal ashes from a barbeque had been deposited for many years. The resulting surface layer was an inch thick of clayey muck. 40 year old Douglas-firs and Western Red Cedars dominated the canopy and provided quite bit of shade for the area.

Below the inch of ash muck was profile of A at 0 to 4 inches (granular silt loam), Bt1 at 4 to 12 inches (granular silt loam), and Bt2 below 12 inches (granular loam), the depth of the survey hole. The shift from Bt1 to Bt2 was indicated by a shift to a darker brown color and finer texture. The most interesting part of this site was the pH profile, starting at 8.1 in the surface muck, and dropping with depth, but only to pH 6.1 by 12 inches.

The NRCS soil survey lists this site as being AgC, Alderwood gravelly sandy loam (Soil Survey Staff). According to the survey, I should have expected a deep A of 0 to 7 inches. It's possible the leached ash deposit and shallow hole skewed my interpretation.

Site 2

A suburban Kirkland residence, built in 1965, with a slightly sloped backyard to the West with a SW aspect. There was virtually zero canopy cover, with the tallest tree in the area a 30' Holly tree. The soil was incredibly dry and cracked, due to years of neglect and an exposed southern aspect. There was barely any O horizon, but a substantial A horizon, like what I would expect in a grassland, down to 8 inches, after which the soil was impenetrable. Scrapings from the bottom layer revealed grey/orange mottles, so I marked it as Bs. Both A and Bs horizons were extremely hydrophobic, and were at first difficult to mix with water for texture and color analysis.

The soil survey lists the site as AmC, Arents, Alderwood material. It shows an H1 profile to 26 inches, far past where I was able to dig. An H horizon is "dominated by organic material, formed from accumulations of undecomposed or partially decomposed organic material at the soil surface which may be underwater" (Food and Agriculture Organization of the United Nations, 1998). If that organic material happened to be particularly waxy, that would certainly explain the hydrophobicity.

Site 3

An urban residence in the Green Lake neighborhood of Seattle, built in 1998. A very tall Douglas-fir dominates the small backyard, which is on NE side of the building, and very shaded. This site's soil was a very granular, sandy loam, and two A horizons were present, but it was impenetrable below 9 inches.

The soil survey site returned the following for this area: "No Data Available in Web Soil Survey for your Area of Interest." However, as it is fairly recent construction, it's likely that the impenetrable layer was due to heavy machinery compaction.

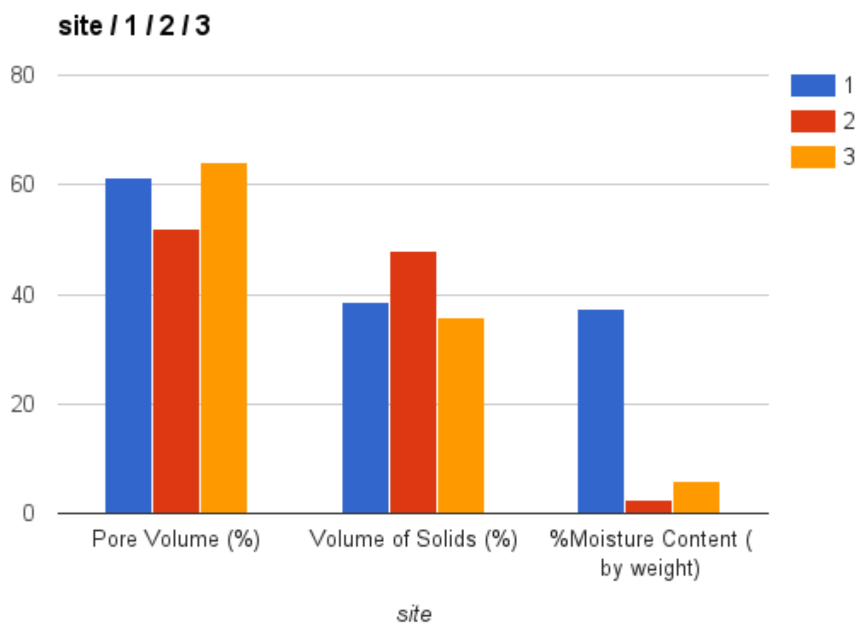
Lab Results

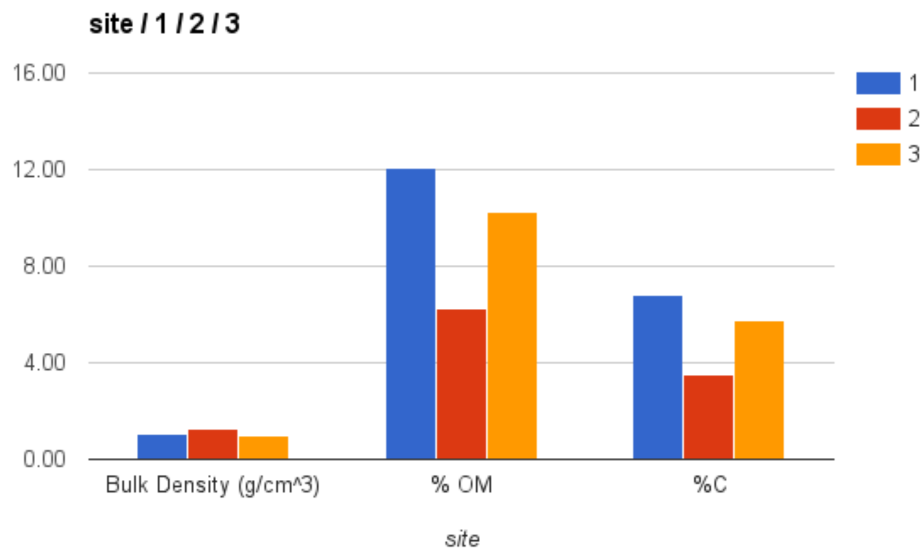
Horizons / pH / color / texture

site	hzn	hzn depth (inches)	sample depth (inches)	pH	color	texture
1	"O"	1 - 0	---	8.1	---	---
	A	0 - 4	2	7.0	10YR2/2 "very dark brown"	VF, F, granular, silt loam
	Bt1	4 - 12	6	6.3	10YR3/3 "dark brown"	VF, granular, silt loam
	Bt2	12+	12	6.1	7.5YR2.5/2 "very dark brown"	VF, granular, loam (finer than Bs1)
2	O	1 - 0	---	5.0	---	---
	A	0 - 8	2	4.9	10YR 3/4 "dark yellowish brown"	VF/F, granular, sandy loam
	Bs	8+	8	4.8	7.5YR2.5/2 "very dark brown"	VF, granular, sandy loam (finer than A)
3	O	.5 - 0	0	5.0	---	---
	A1	0 - 4	2	5.4	10YR3/1 "very dark grey"	VF/F, granular, sandy loam (grainier than site 2)
	A2	4 - 9	9	6.0	7.5YR3/1 "very dark grey"	VF/F, granular, sandy loam (finer than A1)

Calculated Results:

site	Bulk Density (g/cm^3)	Particle Density	Pore Volume (%)	Volume of Solids (%)	%Moisture Content (by weight)	%OM	%C
1	1.03	2.65	61	39	37	12	7
2	1.27	2.65	52	48	3	6	4
3	0.95	2.65	64	36	6	10	6





Conclusions

Site 1 has a remarkably alkaline profile that becomes less so further down, all surely the result of the coal ash and leaching during rain events. I think it would be interesting to plant hydrangeas or some other pH-sensitive plant in that area and the surrounding, less alkaline soil, to have a visual display of the different pH levels in a lateral plane.

The incredible dryness of Site 2's was a surprise, as it is only a few miles from Site 1. The difference in the two sites is a dramatic display of the impact of canopy cover on water retention.

Site 3 is seems like the youngest, newest, least developed soil. The owners intentionally allowed a layer of Douglas-fir needles to build-up, which explains the acidic pH levels at the surface (as the heavy shading would keep the site relatively cool, so decomposition would be slow and organic acids would build).

Bulk Density and Water Content aligned with field observations. The dry, compacted Site 2 was the densest, and the newer, gravelly Site 3 was least dense. Site 1, with its gross ash/clay layer, was over 37% water by weight, while the others were in single digits.

To restore Site 2 to a usable state, I would recommend flipping the top few inches over, to kill the weed/moss layer. A layer of cardboard sprayed with water that's been laced with good soil microbe would help speed things along, and a top layer of wood chip mulch would keep the weeds from taking things back over while the microbes went to work. Shade trees should be strategically planted to keep the moisture just evaporating out of the soil while the microbes are restoring it. Earthworms (none of which were spotted in my survey) would eventually move back in once the site was again hospitable, or could be introduced manually.

The main point of this project was to compare actual soils to what the NRCS had listed in the official soil survey. Although the parent materials of glacial till and/or outwash matched up well, the details of each site were pretty different from what I would have expected had I looked at the surveys first. Most of the differences were due to the different treatments of the soils by each individual homeowner, either by planting shade trees (or not), adding soil amendments (like BBQ ashes), or allowing a layer of conifer needles to develop.

References

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed [07/20/2015].

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