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Brooklyn College
The City University of New York

Soil Profiles in Bioswales: Implications on Soil Development and Bioswale Management

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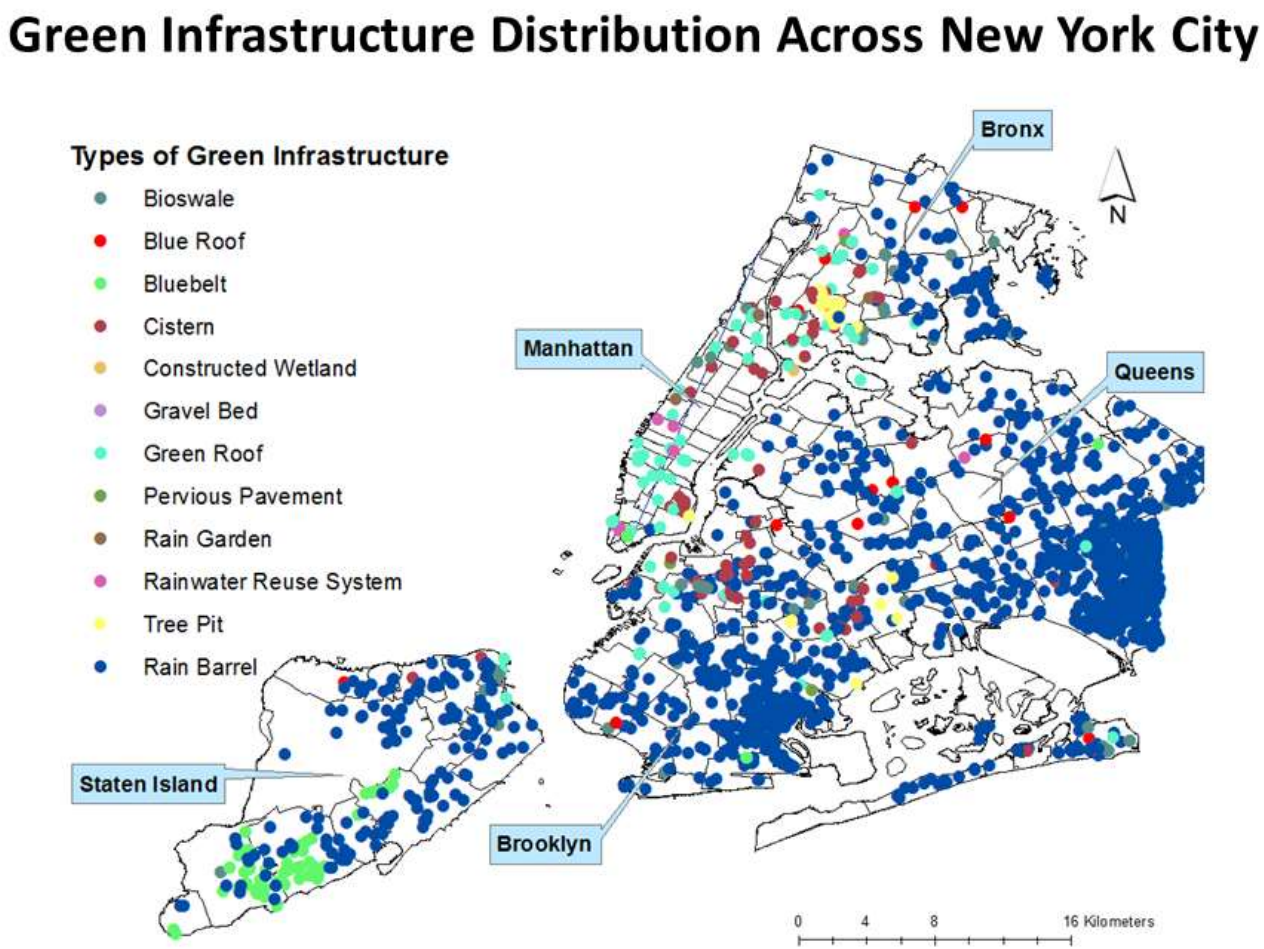
GREEN INFRASTURE IN NYC



Soil Development and Pedogenesis in Green Infrastructure

- The nature of a soil, soil profile build-up and specific properties are the direct result of several pedogenetic processes linked to the soil forming factors. Soils, soil properties and soil formation are affected by climate, parent material, vegetation, man, topography and time.

- Environmental and structural features of GI characteristics, particularly soil texture greatly impacts local microclimatic conditions by regulating the availability of surface water films for soil microbes and water retention for plants and meso-macrofauna. Numerous soil properties are influenced by soil texture including drainage, water holding capacity, aeration, organic matter content, CEC, and soil pH.

Research Objectives

To established the general characteristics of the soils relative to other soils in the area and relative to the intended characteristics specified a decade ago

To understand the potential effects of soil design parameters to the rate and process of soil development

Research Methods

Four green infrastructure sites studied in the Borough of Brooklyn of New York City.

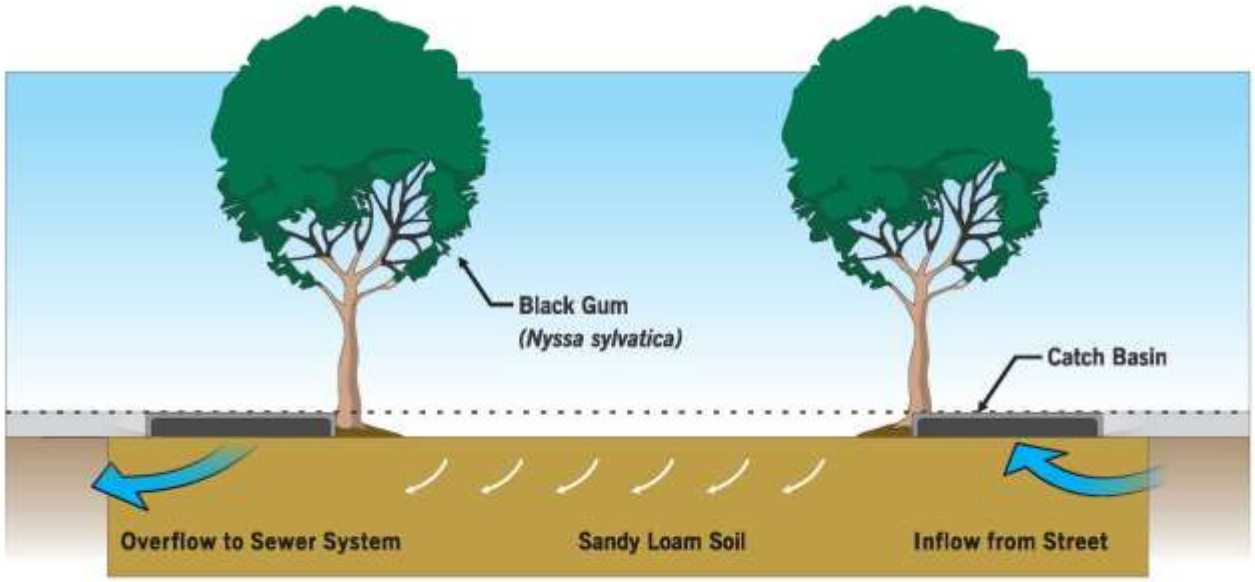
This sites were established between 2010-2011. They were three Right-of-way bioswales and one vegetated swales in a parking lot.

Site Characteristics

Location	Latitude	Longitude	Design	Area (m2)	Impervious contributing area (m)	Watershed area Ratio (WAR)
Union ETP	40”39’ 49.9”N	73” 55’ 16.1W	ETP	9.3	156	17
Union Street SSIS	40”39’ 49.9N	73” 55’ 16.1W	SSIS	19	207	11
Ridge wood	40” 40’ 56.9N	73” 53’ 14.7W	SSIS	19	512	27
Canarsie parking lot	40” 38’ 45.7N	73” 54’ 09.4W	VS	111	3252	29

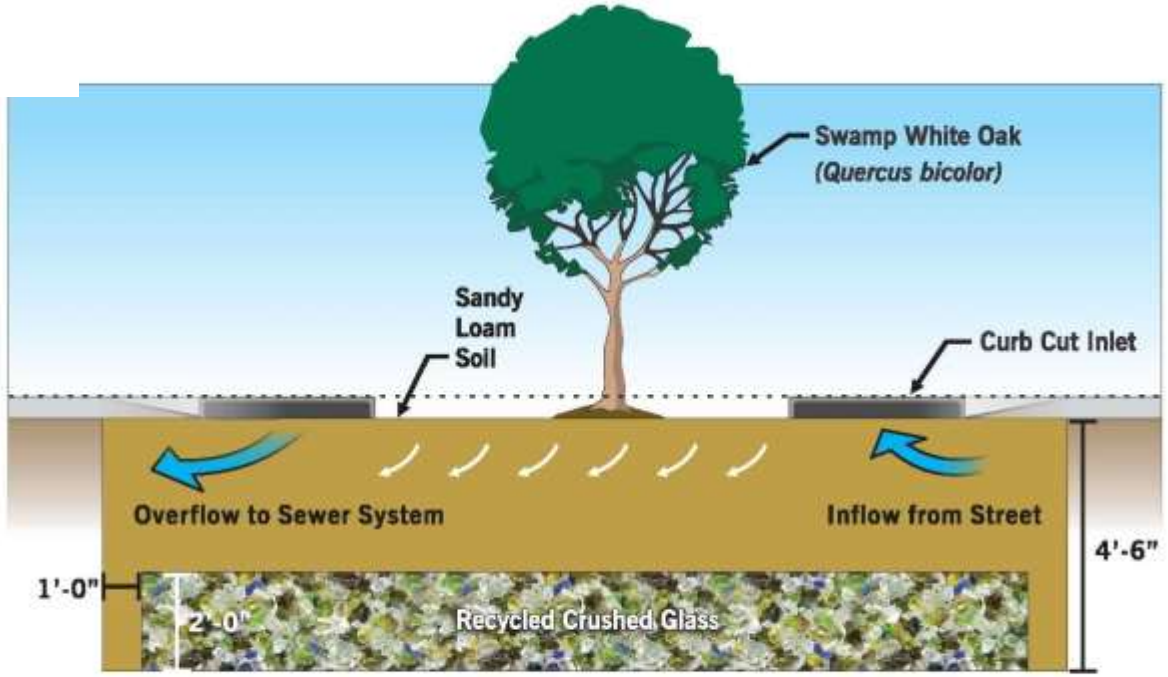
Typical Bioswales in NYC

Prototype designs in Early Pilots



Streetside Infiltration Swales

Enhanced Tree Pits
Rain garden in parking lot



Site Characteristics

The plant cover for all designs is a combination of

- Herbaceous perennials- e.g. American boneset, New England aster, oxeye sunflower.
- Grasses- e.g. Switch grass, virginia wild rye.
- Trees- e.g. Black gum, sweet gum, shadblow, swamp white oak.






Soil Profiles

(extracted soils using an auger, field described)

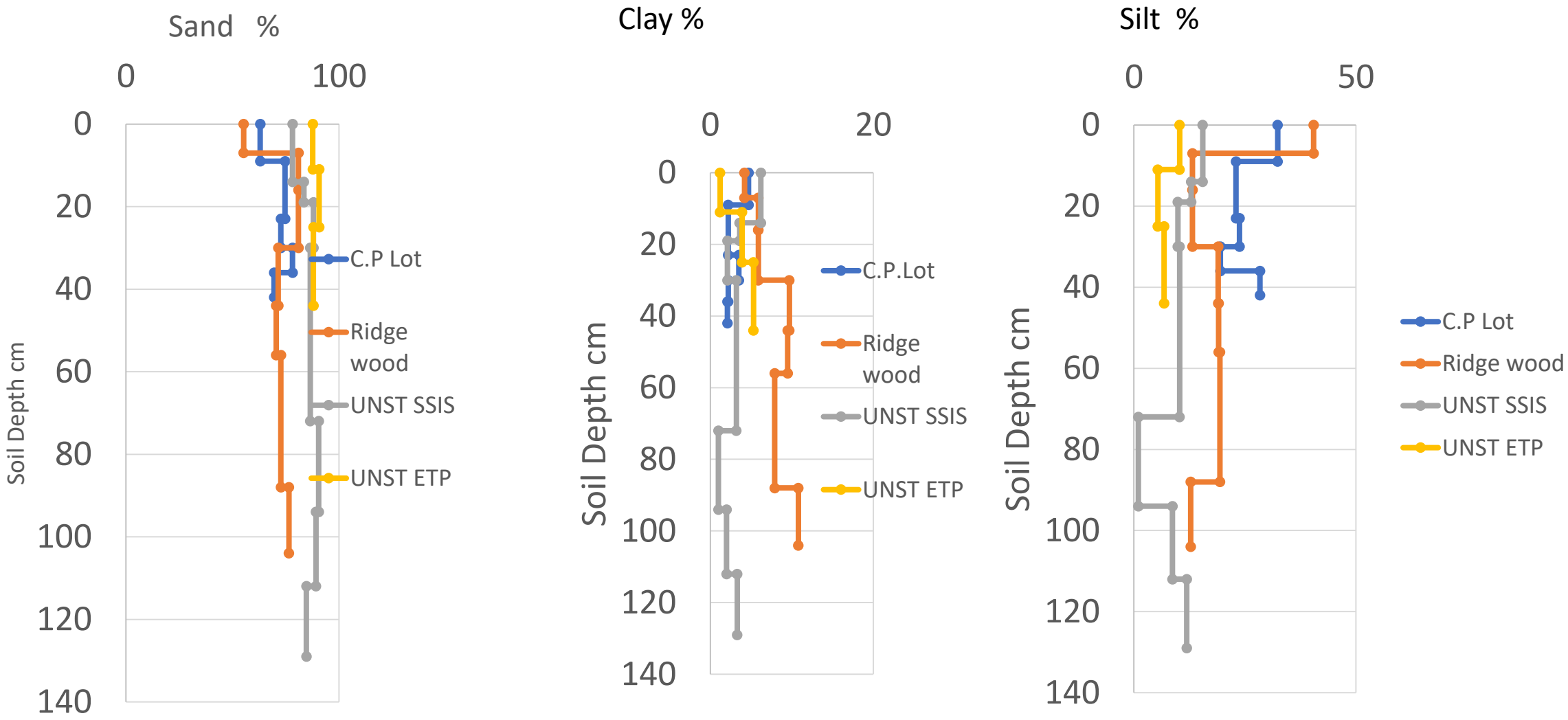
Union ETP

Union SSIS

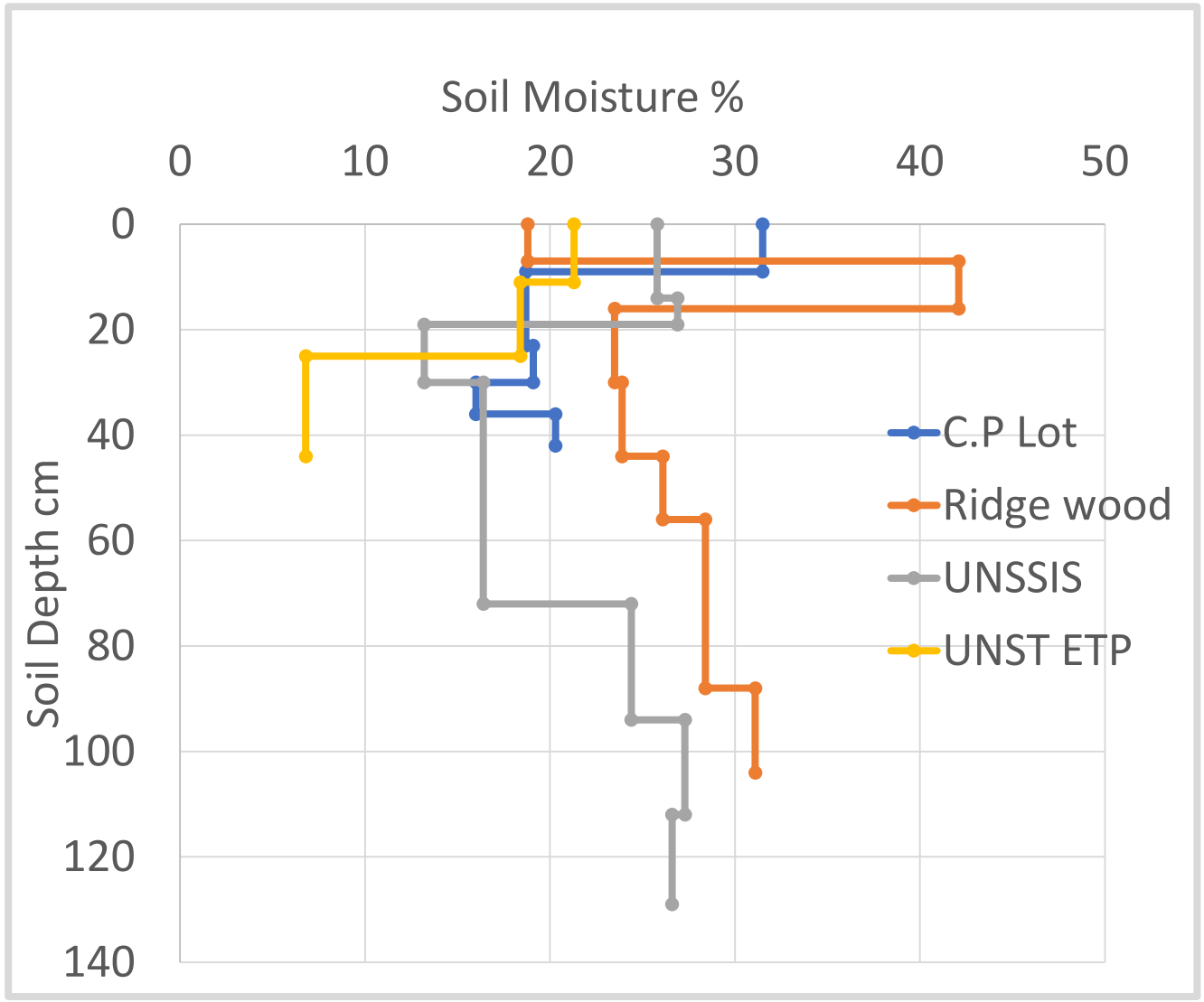
Ridgewood

Canarsie Parking Lot

Soil Texture

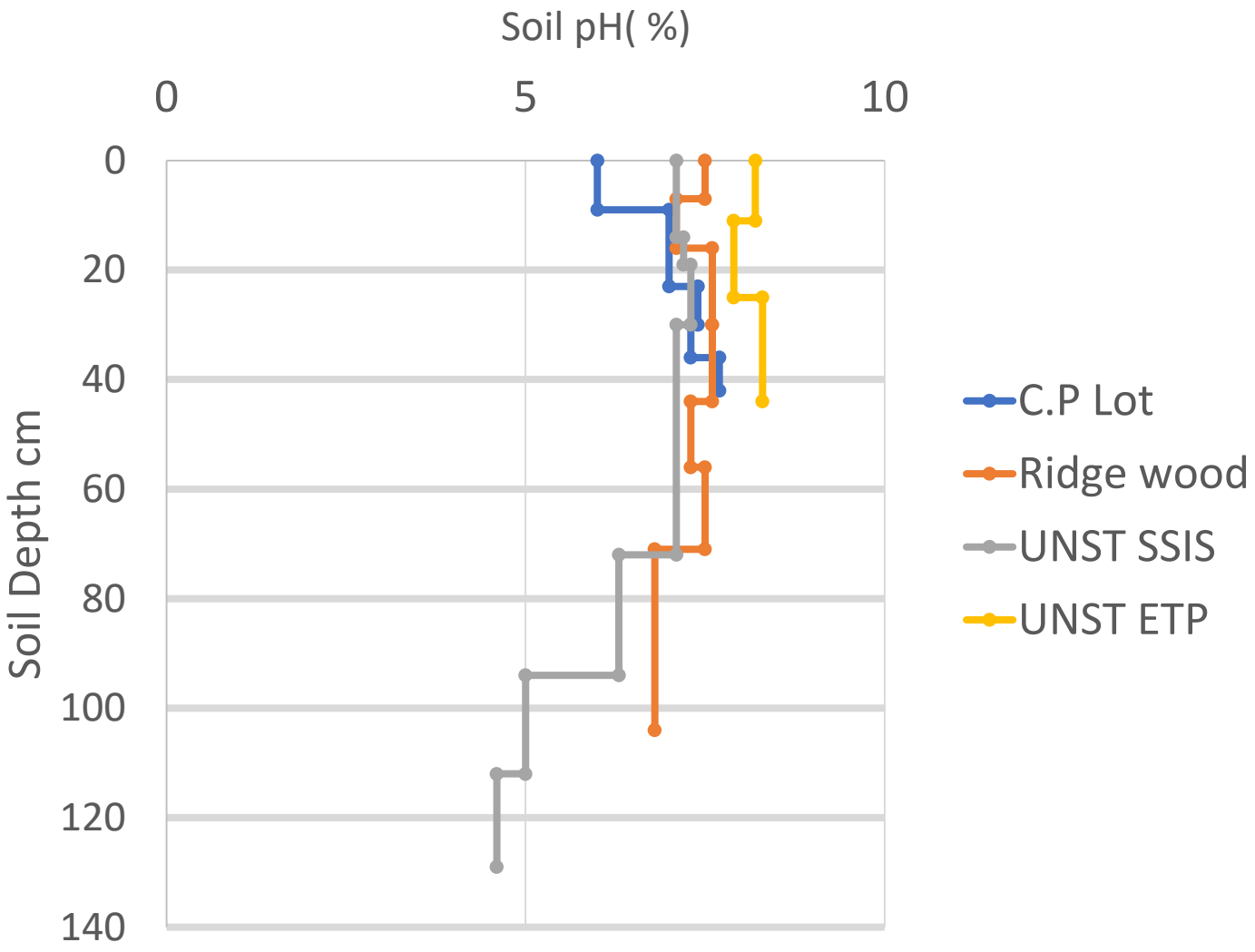


Soil Moisture

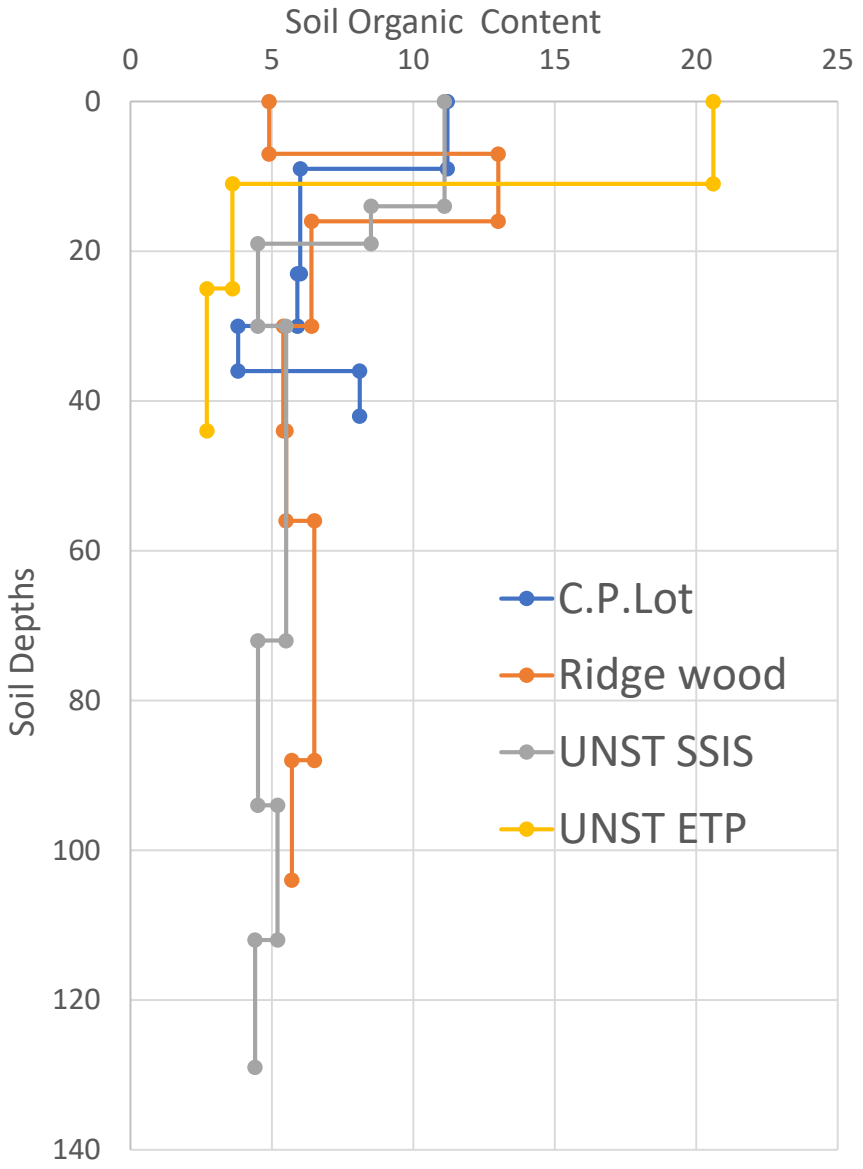


- Soil moisture appears to be constant or decreasing with depth at shallower depths (<40 cm), in ETP, SSIS or parking lot.
- Soil moisture increases with depth below 40 cm (in SSIS).
- Very wet soil (thin layer) was observed in the field just above the storage medium (stones or crushed glass covered by landscape fabric. It could be that the fabric becomes a restricted layer for water when fine particles accumulate over time.

Soil pH



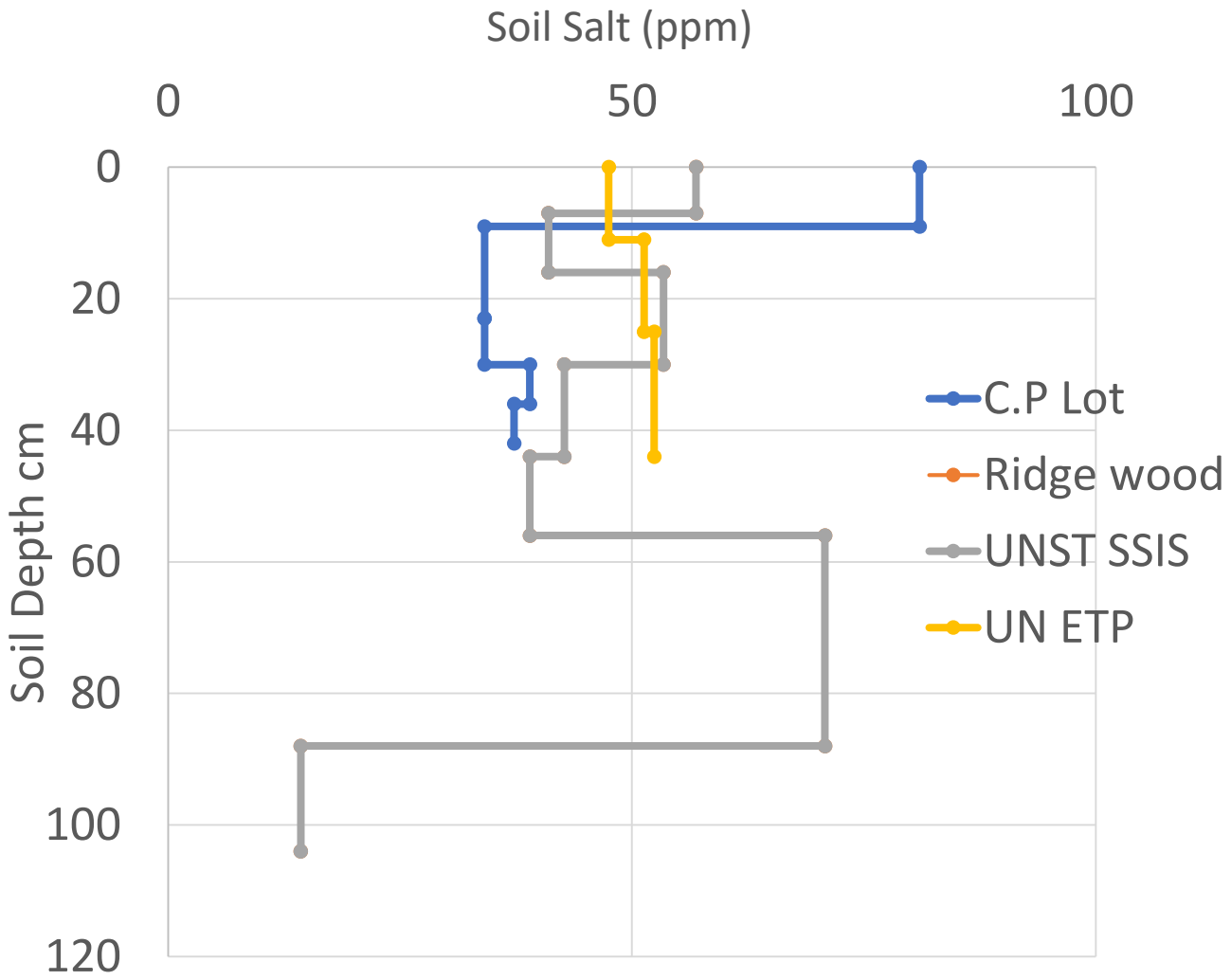
- Soil pH is relatively constant between 6-8 at shallower depths (<40 cm).
- pH decreases with depth below 40 cm.
- It is possible that reducing conditions exist in deeper, wet soils. Acid may be generated.
- This is consistent with field observation of redox-morphic features.



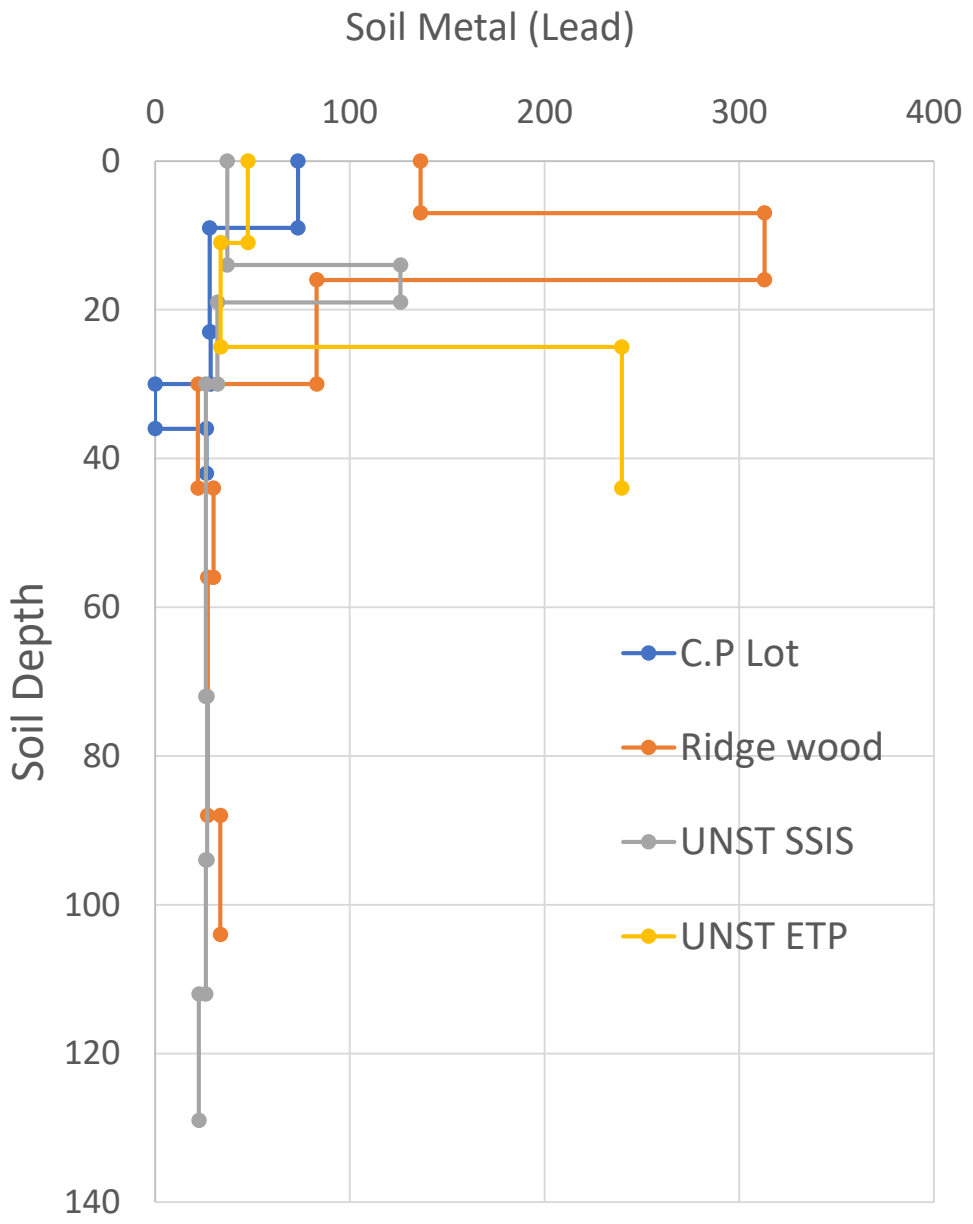
Soil Organic Matter

- Higher organic content at the surface is due to mulch addition and plant leaves & roots.
- Organic content of soil remained at ~5% throughout the depth.

Soil Salt Content (1:2, in ppm)



- The soil salt content is relatively low, despite runoff containing road salts in the winter.
- This is likely due to the sandy texture of the soil, onto which CEC is low.
- The relatively higher organic content of these soils increases CEC and this retain some salts throughout the soil profile.



- Significant amount of Pb exist in surface soil, suggesting contaminated particles from the runoff or from air.
- High Pb content appeared in soils within 40 cm depth. Partially due to manual mixing of the soils in these bioswales.
- Surface soils have been “diluted” by frequent addition of new organic material (mulch, or leaf and plant litter)
- Pb hasn’t moved to deeper soils, even under hydraulic pressure, indicating its stability.

Summary of Preliminary Results

- The engineered soils in bioswales of NYC was relatively homogeneous from top to bottom when they were installed about 10 years ago.
- Soil development under intense hydrological conditions have occurred, and horizonization have appeared.
- The downward movement of fine particles, expected to be enhanced under frequent hydraulic pressure, is not appearant from preliminary data.
- This is evidence that water content and water retention at different depths vary, this could be affected by organic content as well.
- The surface soil texture is also affected by sediments flux from run off, redistribution and settling of suspended particles, and addition to organic materials in the flooded bioswale during storm events.
- Salt from the winter runoff had been largely flushed out of the system.
- Lead from the runoff (or air) has accumulated in bioswales, and remained in the shallow soils.

Significance of the Study

- Studies in pedogenesis in the green infrastructure have not been found in literature.
- This study is novel and would contribute to the scientific understanding of biogeochemical processes in these “extreme” environments.

THANK YOU!