BMP 5.6.2: Minimize Soil Compaction in Disturbed Areas

Minimizing Soil Compaction and Ensuring Topsoil Quality is the practice of enhancing, protecting, and minimizing damage to soil quality caused by land development.

Image Source: "Developing an Effective Soil Management Strategy: Healthy Soil Is At the Root Of Everything", Ocean County Soil Conservation District

Key Design Elements

- Protecting disturbed soils areas from excessive compaction during construction
- Minimizing large cleared areas and stockpiling of topsoil
- Using quality topsoil
- Maintaining soil quality after construction
- Reducing the Site Disturbance Area through design and construction practices
- Soil Restoration for areas that are not adequately protected or have been degraded by previous activities (Section 6)

Potential Applications

Residential: Yes
Commercial: Yes
Ultra Urban: Yes
Industrial: Yes
Retrofit: Yes
Highway/Road: Yes

Stormwater Functions

Volume Reduction: Very High
Recharge: Very High
Peak Rate Control: High
Water Quality: Very High

Water Quality Functions

TSS: 30%
TP: 0%
NO3: 0%

Description:

Soil is a physical matrix of weathered rock particles and organic matter that supports a complex biological community. This matrix has developed over a long time period and varies greatly within the state. Healthy soils, which have not been compacted, perform numerous valuable stormwater functions, including:

- Effectively cycling nutrients
- Minimizing runoff and erosion
- Maximizing water-holding capacity
- Reducing storm runoff surges
- Adsorbing and filtering excess nutrients, sediments, pollutants to protect surface and groundwater
- Providing a healthy root environment and creating habitat for microbes, plants, and animals
- Reducing the resources needed to care for turf and landscape plantings

Once natural soils are overly compacted and permeability is drastically reduced, these functions are lost and can never be completely restored (Hanks and Lewandowski, 2003). In fact, the runoff response of vegetated areas with highly compacted soils closely resembles that of impervious areas, especially during large storm events (Schueler, undated). Therefore this BMP is intended to prevent compaction or minimize the degree and extent of compaction in areas that are to be "pervious" following development.

Although erosion and sediment control practices are equally important to protect soil, this BMP differs from them in that it is intended to reduce the area of soil that experiences excessive compaction during construction activities.

Applications

This BMP can be applied to any land development that has existing areas of relatively healthy soil and proposed "pervious" areas. If existing soils have already been excessively compacted, Soil Restoration is applicable (Chapter 6).

Figure 5.7-1 Example of development with site compaction of soils

Design Considerations

Early in the design phase of a project, the designer should develop a soil management plan based on soil types and existing level of disturbance (if any), how runoff will flow off existing and proposed impervious areas, areas of trees and natural vegetation that can be preserved, and tests indicating soil depth and quality. The plan should clearly show the following:

1. **Protected Areas.** Soil and vegetation disturbance is not allowed. Protection of healthy, natural soils is the most effective strategy for preserving soil functions. Not only can the functions be maintained but protected soil organisms are also available to colonize neighboring disturbed areas after construction.

2. **Minimal Disturbance Areas.** Limited construction disturbance occurs - soil amendments may be necessary for such areas to be considered fully pervious after development. Areas to be vegetated after development should be designated Minimal Disturbance Areas.

3. **Construction Traffic Areas.** Areas where construction traffic is allowed - if these areas are to be considered fully pervious following development, a program of Soil Restoration will be required.

4. **Topsoil Stockpiling and Storage Areas.** These areas should be protected and maintained and are subject to Soil Restoration (including compost and other amendments) following development.

5. **Topsoil Quality and Placement.** Soil tests are recommended. Topsoil applied to disturbed areas should meet certain parameters as shown in Appendix C. Adequate depth (4" minimum for turf, more for other vegetation), organic content (5% minimum), and reduced compaction (1400 kPa maximum) are especially important (Hanks and Lewandowski, 2001). To allow water to pass from one layer to the other, topsoil must be "bonded" to the subsoil when it is reapplied to disturbed areas.

Figure 5.7-2 Example of site development with extreme soil compaction on steep slope

The first two areas (Protected and Minimal Disturbance) should be made as large as possible, identified by signage, and fenced off from construction traffic. Construction Traffic Areas should be as small as practicable.

Detailed Stormwater Functions

Volume Reduction Calculations

Minimizing Soil Compaction and Ensuring Topsoil Quality can reduce the volume of runoff by maintaining soil functions related to stormwater and thereby increasing infiltration and evapotranspiration. This can be credited in site stormwater calculations through lower runoff coefficients and/or higher infiltration rates. See Chapter 8 for volume reduction calculation methodologies.

Peak Rate Mitigation Calculations

Minimizing Soil Compaction and Ensuring Topsoil Quality can reduce the rate of runoff by maintaining soil functions related to stormwater. This can be credited in site stormwater calculations through lower runoff coefficients, higher infiltration rates, and/or longer times of travel. See Chapter 8 for peak rate calculation methodologies.

Water Quality Improvement

Minimizing Soil Compaction and Ensuring Topsoil Quality can improve water quality through infiltration, filtration, chemical and biological processes in the soil, and a reduced need for fertilizers and pesticides after development. See Chapter 8 for Water Quality Improvement methodologies.

Construction Issues

1. At the start of construction, Protected and Minimal Disturbance Areas must be identified with signage and fenced as shown on the construction drawings.
2. Protected and Minimal Disturbance Areas should be strictly enforced.
3. Protected and Minimal Disturbance Areas should be protected from excessive sediment and stormwater loads while upgradient areas remain in a disturbed state.
4. Topsoil storage areas should be maintained and protected at all times. When topsoil is reapplied to disturbed areas it must be “bonded” with the subsoil. This can be done by spreading a thin layer of topsoil (2 to 3 inches), tilling it into the subsoil, and then applying the remaining topsoil. Topsoil must meet certain requirements as detailed in Appendix C.

Maintenance Issues

Sites that have minimized soil compaction properly during the development process should require considerably less maintenance than sites that have not. Landscape vegetation will likely be healthier, have a higher survival rate, require less irrigation and fertilizer, and even look better.

Some maintenance activities such as frequent lawn mowing can cause considerable soil compaction after construction and should be avoided whenever possible. Planting low-maintenance native vegetation is the best way to avoid damage due to maintenance.

Protected Areas on private property could have an easement, deed restriction, or other legal measure to prevent future disturbance or neglect.

Cost Issues

Minimizing Soil Compaction and Ensuring Topsoil Quality generally results in a significant construction cost savings. Minimizing soil compaction can reduce disturbance, clearing, earthwork, the need for Soil Restoration, and the size and extent of costly, engineered stormwater management systems. Ensuring topsoil quality can significantly reduce the cost of landscaping vegetation (higher survival rate, less replanting) and landscaping maintenance.

Design costs may increase slightly due to a more thoughtful, site-specific design.

Specifications

Soil Restoration specifications can be found in Chapter 6.

References

Hanks, D. and Lewandowski, A. *Protecting Urban Soil Quality: Examples for Landscape Codes and Specifications*. USDA-NRCS, 2003.

Ocean County Soil Conservation District. *Impact of Soil Disturbance during Construction on Bulk Density and Infiltration in Ocean County, New Jersey*. 2001. Available at http://www.ocscd.org/publications.shtml as of May 2004.

Schueler, T. "The Compaction of Urban Soils," Technical Note #107 from *Watershed Protection Techniques*. 3(2): 661-665, undated.