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BUSINESS CENTER – HCE™
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Defining Subsurface Strata and Drillholes
Version 2.20

Using the Takeoff Module in BC-HCE version 2.20, you can define subsurface soil/rock strata, based on the data provided by geotechnical investigations such as soil borings or drillholes. The surface forming the interface between two strata can be shown within profile and cross-section views in the same way that any other surface profile or cross-section can be created for those views. These surfaces are dynamically dependent on the *drillhole* objects, which can be created based on geotechnical reports in which the various strata depths and thicknesses are reported at the locations on site where each soil boring or investigatory excavation was performed. The drillholes dynamically reference the original ground surface from which the soil investigation measured the depth to the top of each material strata. The resulting strata surfaces are therefore dynamically dependent on that reference surface and the drillhole data. The surfaces separating material strata will therefore automatically be updated in response to (1) the presence of additional drillholes, (2) corrections made to existing drillhole data as a result of a quality control check of the data entry, or (3) edits made to the original ground surface, to which the drillholes are referenced.

There are three commands associated with the modeling of a subsurface stratum, each discussed below.

The Define Strata Command

This command allows you to (1) define each strata by selecting the earthen material of which it is composed, (2) name the surface that will be created to form the upper limit of that material and the interface between it and the overlying material, and (3) select the surface *model type* to be used in shaping that surface. The *Define Strata* dialog box is shown below, where five strata have been defined.

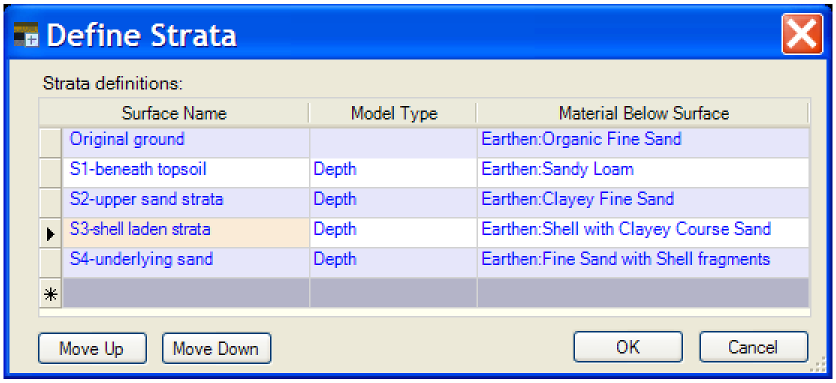

Figure 1 – The Define Strata Dialog

Trimble Construction Division, 5475 Kellenburger Road, Dayton, OH 45424, USA

Key Point 1 — It is important to note before going on, that this command refers to the definition of existing, in situ subsurface earthen materials (soil or rock) that might be encountered on the site during excavation operations. This subject has nothing to do with the specification of the materials being used to construct proposed in-ground site improvements. That objective is accomplished within the Material and Site Improvement Manager when defining those site improvements.

The strata definitions, defined as noted in Figure 1, will result in an entry within the Mass Earthwork Analysis section of a takeoff report as shown below.

Mass Earthwork Analysis

The prepared original mass earthwork surface is compared to the finished mass earthwork surface.	
Applicable Surface Names and Classifications	
OG with topsoil stripped (& subgrades demolished)	Classification: Mass earthwork prepped
FD with topsoil absent (& subgrades adjusted)	Classification: Mass earthwork finished

Earthen Material Properties				
		Density Variation Percentages		
Type	**Material Name**	**Shrinkage**	**Hauling bulkage**	**Hauling compaction**
Exposed	Organic Fine Sand	9.6%	9.2%	17.2%
Stratum	Sandy Loam	8.0%	11.0%	17.1%
Stratum	Clayey Fine Sand	7.8%	9.7%	16.0%
Stratum	Shell with Clayey Course Sand	7.9%	11.2%	17.2%
Stratum	Fine Sand with Shell fragments	8.6%	10.3%	17.1%
Borrow	Gravely Course Sand	8.3%	10.4%	16.9%

Figure 2 – Sample Portion of a Takeoff Report Showing the Earthen Material Properties

The *Earthen Material Properties* portion of that report section produces a reflection of the earthen material strata, with the exception of the *Borrow* entry, which itself is defined when creating a takeoff report, to designate the material that will be imported from offsite, if necessary, to accommodate a deficit in the earthwork balance. Note that the materials identified as being of the Type *Exposed* or *Stratum*, are those defined in the *Define Strata* dialog shown in Figure 1. The material that is identified as being of the Type *Exposed*, is that of the uppermost strata, in this case an *organic fine sand* topsoil.

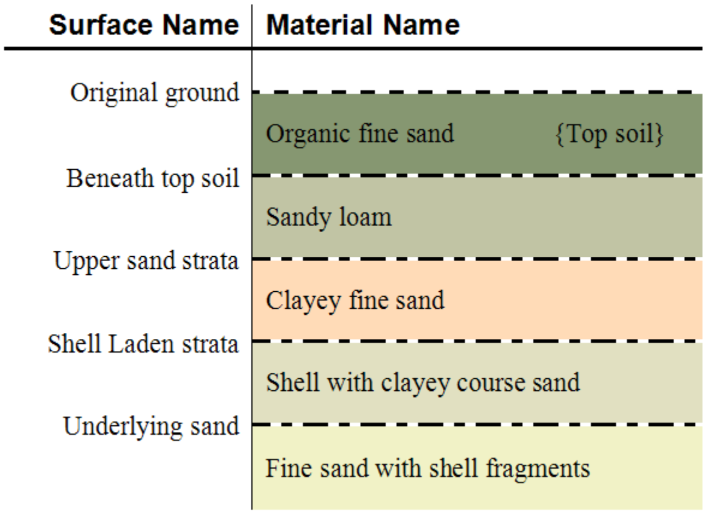

Figure 3 – Schematic Portrayal of Soil Strata

Key Point 2 — It should be noted that the currently supported means of defining subsurface strata requires that the progression in which the various strata are encountered, be consistent over the entire site. The content presented within the *Define Strata* dialog must represent the entire site, though the thickness of any particular stratum can be noted as being 0.00 at any given drillhole, if the material associated with that stratum was not found to be present at that location.

Key Point 3 — The *Define Strata* command must be executed to define the earthen material strata, create the associated surfaces and identify the surface's model type, prior to the creation of drillholes. The process of creating and editing the drillholes, which is dependent on the prior establishing of the strata, is discussed further below.

Referring to Figure 1 again, each of the surfaces beneath which a stratum lies must be designated as being formed using a *model type* of either *Depth* or *Elevation*, as explained in the subsections below.

Depth Surfaces

When a surface representing the top of an earthen material strata is defined as a *depth surface*, its depth, as measured from the original ground at each drillhole location, is used to establish the elevation of that surface at the drillhole. However, instead of interpolating between the computed elevations of that surface at each drillhole, the depth of the subject surface beneath the overlying surface, as measured at each drillhole, is interpolated. Then, at all other locations on the site, the interpolated depth value is subtracted from the elevation of that overlying surface at that location, thereby arriving at the elevation of the subject stratum. Note that the measured depth from the overlying surface to a depth surface is equivalent to the thickness of the earthen material stratum lying above the depth surface. A depth surface, therefore generally tends to follow the profile and shape of the overlying surface. That is not to say that the earthen material lying above a depth surface is a constant thickness. In effect, it is the stratum's thickness that is interpolated between those values measured at each drillhole.

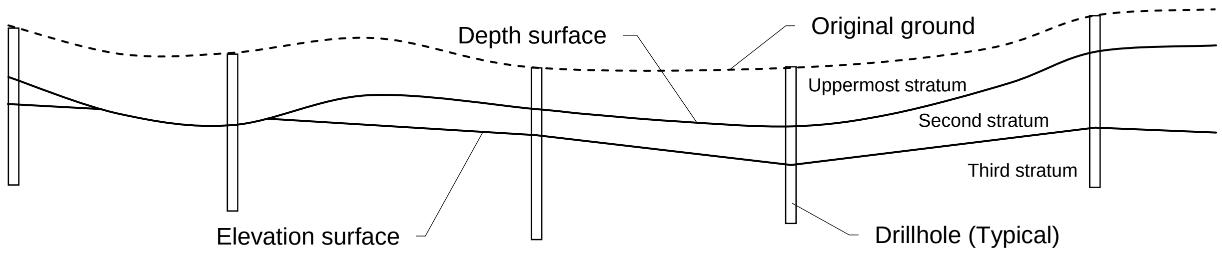

Figure 4 – Illustration of a Depth Surface and an Elevation Surface

Figure 4 above, illustrates the original ground line and a number of drillholes from which the depths from the original ground to the top of each earthen material strata have been measured. Three material strata have been encountered, as shown. Figure 5 below shows the strata definitions that would correspond to the illustration in Figure 4.

The *uppermost stratum* in Figure 4 is the first defined in Figure 5, consisting of an organic fine sand. The *second stratum* consists of a sandy loam material. The surface created above that material is defined and identified as a *depth surface* in both figures. The *third stratum* shown in Figure 4 and defined in Figure 5, consists of a clayey fine sand. The surface above that third stratum is defined as having a model type of an *elevation* surface.

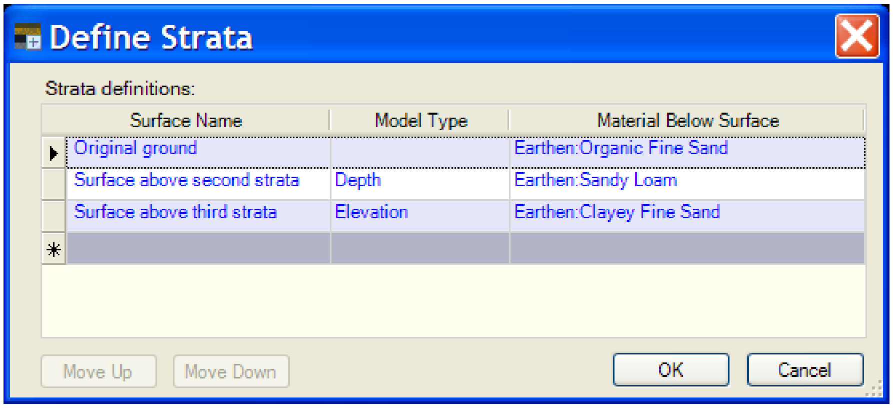

Figure 5 – Strata Definition Corresponding to Figure 4

The depth surface shown in Figure 4 can be seen to tend to follow the profile and shape of the original ground as a result of the interpolation of the measured depth from the original ground to the top of the *second strata* material. Figure 4 clearly illustrates that, in effect, it is the *thickness* of the material strata above a depth surface (the *uppermost stratum* in the illustrated case) that is interpolated. The depth surface that is associated with the sandy loam material stratum in Figure 5 (the *second stratum* in Figure 4), can be seen to control the modeled shape of the top of that material, and the bottom of the material from which the *uppermost stratum* is formed. The key word in the above statement is "modeled". The choice between a depth and an elevation surface will be seen to have what could be a profound impact on the model that is created. Nevertheless, we really know nothing about the actual depths to the various materials except specifically at the drillhole locations. Therefore, we need to be very astute in selecting a *model type*, as will be discussed later.

Elevation Surfaces

An elevation surface differs in that it is the computed elevation of the top of the underlying material, as measured at each drillhole, which is interpolated in forming the surface above the stratum composed of that material. The shape of an elevation surface is therefore not particularly influenced by the surface above it, as is a depth surface. However, there can be exceptions, as illustrated in Figure 4. As the interpolated elevations are determined at any given location, the top of an elevation surface will not be allowed to exceed the elevation of the surface above it. As a result, near the left edge of Figure 4, the elevation surface can be seen to encounter and follow the depth surface above it, resulting in a circumstance where the sandy loam material of the *second stratum* does not exist in that area. It can be seen in Figure 4 that the second drillhole from the left does not encounter the sandy loam material, but instead encounters the clayey fine sand immediately beneath the organic fine sand. However, as stated in the Key Point 2 on page 3, every stratum must be included in every drillhole. Therefore, if the sandy loam is not encountered in performing the soil investigation at a particular drillhole, it will still be listed in the drillhole data, but given a thickness of 0.00.

The Create Drillhole Command

The Create Drillhole command allows you to create a new drillhole, entering the data made available by a geotechnical investigation and specifying either the thickness of each material strata, the depth from the top surface of the drillhole to the top of that material, or the elevation of the top of the strata. The command's user interface is shown at right.

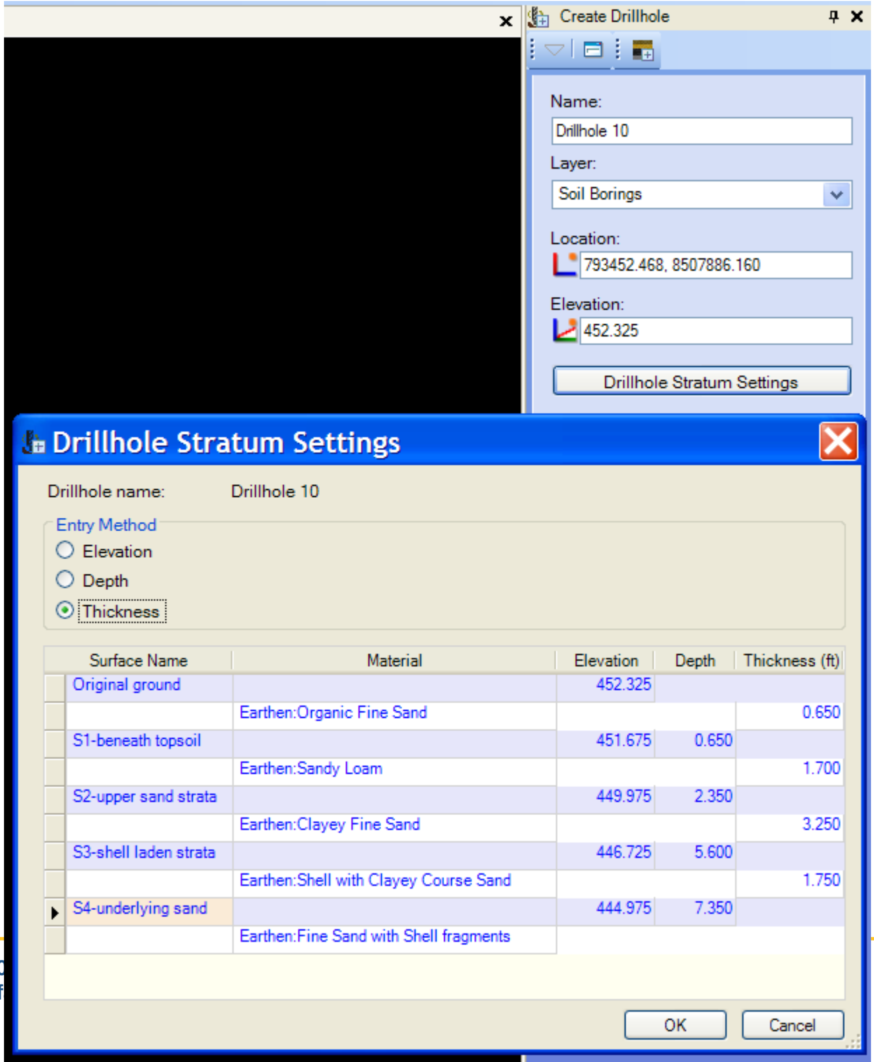

Figure 6 – The Create Drillhole Command

The earthen material strata shown in the *Drillhole Stratum Settings* dialog in Figure 6 are those defined in Figure 1 on page 1. It is repeated below for convenience.

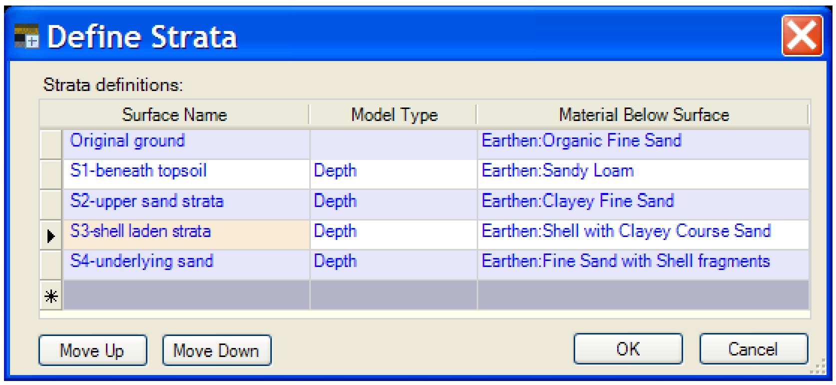

Figure 7 – The Define Strata Dialog Corresponding to Figure 6

So, referring to Figure 6, Figure 7, and Figure 3, you can see that the organic fine sand topsoil has a thickness of 0.65 feet. That places the surface named *S1-beneath topsoil* at a depth of 0.65 feet. Note that the *Drillhole Stratum Settings* dialog in Figure 6 allows you to enter either the actual elevation of the surface representing the interface between two strata, the measured total *depth* from the original ground to any of those surfaces, or the thickness of each stratum. That choice is made by selecting the appropriate radio button within the *Entry method* group box in Figure 6.

Figure 6 shows the depth to the surface named *S2-upper sand strata* as 2.35 feet, therefore establishing the thickness of the sandy loam strata at this drillhole as 1.70 feet. The depth to the surface named *S3-shell laden strata* is indicated as 5.60 feet, therefore establishing the thickness of the clayey fine sand stratum, at this drillhole, as 3.25 feet. Finally, the depth to the surface named *S4-underlying sand* is indicated 7.35 feet, therefore establishing the thickness of the shell with clayey course sand stratum, at this drillhole, as 1.75 feet. The material beneath that last encountered strata interface surface is fine sand with shell fragments, but its thickness is undetermined due to the limited depth of the drillhole.

The Edit Drillhole Command

The Edit Drillhole command is very similar to the Create Drillhole command, the only difference being that it allows you to edit existing drillhole objects. Its user interface is shown below in Figure 8, where Drillhole 6 has been selected and the *Drillhole Stratum Settings* button clicked, in order to display the dialog of that same name, wherein the data is entered.

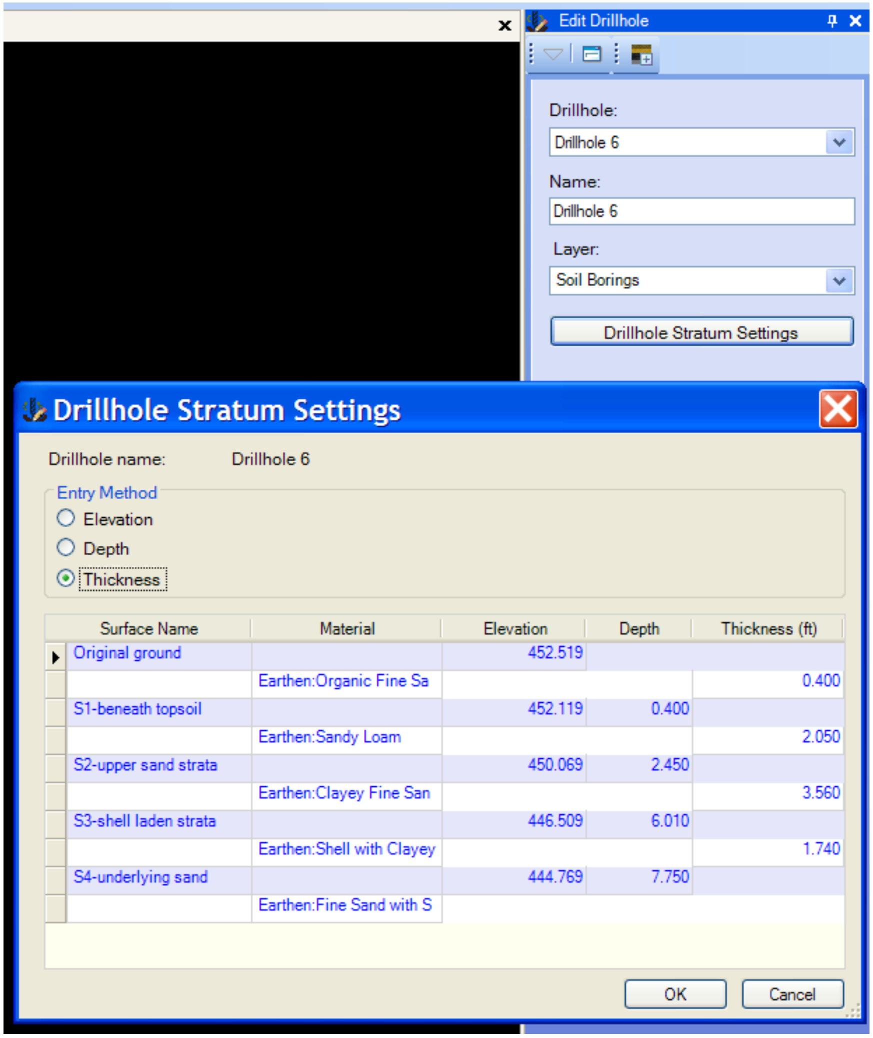

Figure 8 – The Edit Drillhole Command

Selecting Elevation vs. Depth Surfaces

It may be preferable to establish the upper surface associated with an earthen material stratum as a *depth surface* in circumstances where it is expected that it would generally follow the contours and shape of the surface above the overlying material stratum. This is a common occurrence in natural geology. However, there may be circumstances in which the natural ground surface contours have obviously been disturbed by prior earthmoving activities. In some extreme cases, there may be reason to employ an *elevation surface*, at least as associated with one of the strata.

In the example shown below, there are obvious manmade disturbances in the original ground surface associated with a proposed construction site. These may include ditches, swales, dug ponds, stockpile mounds, etc. In such occurrences, it may be deemed unlikely that one or more of the earthen strata beneath the ground actually tends to follow those unnatural surface contours. The illustration below shows drillholes where the surface between the *uppermost stratum* and the *second stratum* has been defined as an elevation surface in order to account for the presence of those disturbances by interpolating the elevation of that surface, as noted in each drillhole, rather than interpolating the depth to that surface.

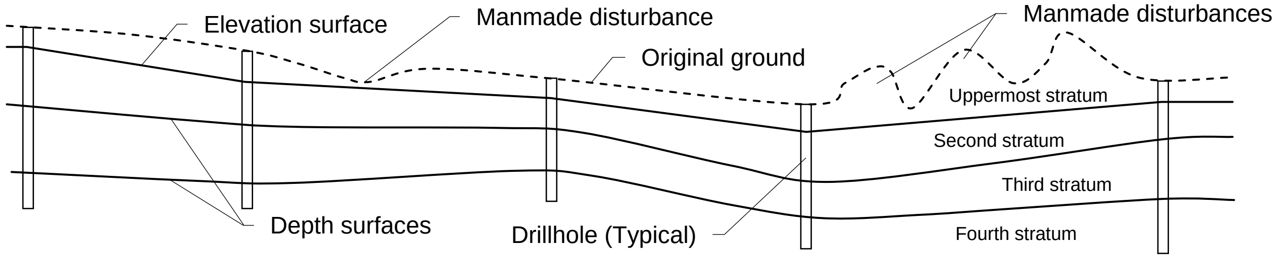

Figure 9 – Illustration of a Depth Surface and an Elevation Surface

The result is that, by interpolating its known elevations, that modeled surface may more likely follow the actual subsurface stratum, since it will not be unduly influenced by the disturbances. Such a decision will depend on how prominent such disturbances are on that particular site. That is, what percentage of the site is disturbed and to what degree. If the disturbances are not prominent, then perhaps a depth surface would, overall, better approximate the actual geology, even though it would likely be wrong in the immediate vicinity of the disturbed features. It is not currently possible to form a stratum surface that is based on the *elevation* model type in some areas and the *depth* model type in others.

Note that only the uppermost stratum surface has been designated as an elevation surface in the above example. The underlying surfaces are all depth surfaces, so they tend to account for the correction made in employing an elevation surface at the top.