Rule of Transmissivities at Material Interfaces in Landfill Leachate Collection Systems

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Leachate collection systems (LCS) at the bottom of landfills generally include a drainage layer receiving leachate percolating down through waste layers and conveying the liquid laterally to a leachate collection pipe. The leachate collection pipe, in turn, conveys the leachate to a leachate collection sump. The leachate in the sump is normally removed through a gravity line penetrating through the lining system or through a submersible or primer pump.

The drainage layer may consist of a porous medium such as a layer of gravel, a granular medium such as a sand layer, or a synthetic layer such as a geocomposite. In all cases, the designer develops plans and details how these various components come together prior to construction of the leachate collection system. Hydraulic characteristics of the materials used in the LCS control flow of leachate through the LCS. For soil materials, hydraulic characteristics of one soil medium against another soil medium is important; and for the case of geosynthetics, the dimensions of the medium may be too small to consider the material as a medium, but rather as an interface. This article uses the word "interface" with the aforementioned meaning of the medium versus interface. The interface between various components of the leachate collection system plays an important role for the proper flow of leachate to the LCS pipe. The designer should consider a very important general rule when designing interfaces of various components of the leachate collection system. This general rule (sometimes referred to as the Rule of Transmissivities) should apply and should be verified by the designer. The general rule for flow of liquids through the leachate collection system is that each liquid-receiving component of the leachate collection system must possess higher transmissivity (or at least equal transmissivity) than the prior liquid-delivering medium. If this rule is not followed, a flow bottleneck will be created between a delivering medium with a higher transmissivity and the receiving medium with a lower transmissivity, and the flow bottleneck can potentially cause backup of liquids in the delivering medium. An example of a case that does not follow the above general rule is described below and illustratively shown in Figure 1.

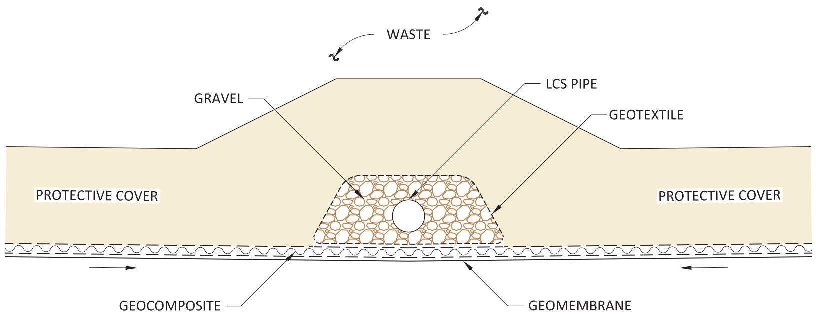

FIGURE 1. LEACHATE COLLECTION SYSTEM WITH A POTENTIAL FLOW BOTTLENECK

Case 1: The entire thickness of the protective cover layer is uniform sand with hydraulic conductivity equal or greater that the overlying waste. The drainage geocomposite is extended through the LCS corridor (where the LCS pipe and gravel are located), and the LCS pipe is encased in gravel and wrapped in geotextile located directly above the geocomposite. The sequence of media interfaces involved in the flow of leachate from waste to the pipe for this case is: 1) from waste to the protective cover layer; 2) from the protective cover

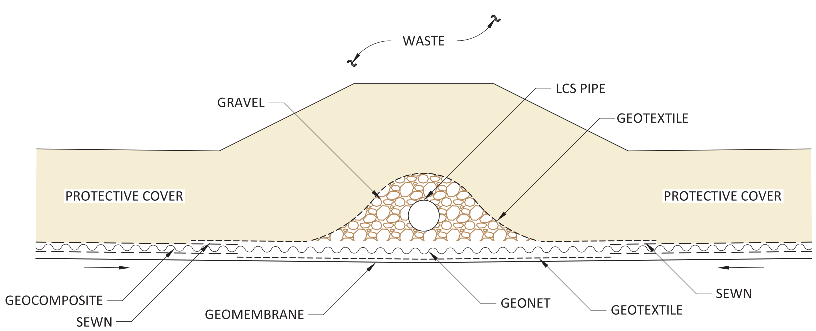

FIGURE 2. LEACHATE COLLECTION SYSTEM WITH NO FLOW BOTTLENECK

layer to the upper layer of geotextile in the geocomposite drainage layer; 3) from the upper layer of geotextile in the geocomposite drainage layer to the geonet component of the geocomposite drainage layer; 4) from the geonet component of the geocomposite drainage layer to the upper layer of the geotextile in the geocomposite drainage layer (directly below gravel); 5) from the upper layer of the geotextile in the geocomposite drainage layer to the geotextile wrap of the LCS pipe; 6) from the geotextile wrap of the LCS pipe to the gravel around the LCS pipe; and 7) from the gravel around the LCS pipe to the LCS pipe. A careful review of these seven interfaces reveals that leachate is flowing from a higher transmissive medium to a lower transmissive medium at interface 4, which means liquid may backup in the geocomposite drainage layer because a flow bottleneck exists in the path of the leachate from the geocomposite drainage layer to the gravel around the pipe.

An example of a case that follows the above general rule is described below and illustratively shown in Figure 2.

Case 2: The entire thickness of the protective cover layer is uniform sand with hydraulic conductivity equal or greater that the overlying waste. The drainage geocomposite is not extended below the LCS pipe, instead the gravel is directly placed over a layer of geonet overlying a geotextile cushion. The geotextile covering the gravel does not wrap around gravel, but is sewn to the upper geotextile of the geocomposite drainage layer on either side of the LCS pipe. The sequence of media interfaces involved in the flow of leachate to the pipe for this case is: 1) from waste to the protective cover layer; 2) from the protective cover sand layer to the upper layer of geotextile in the geocomposite drainage layer; 3) from the upper layer of geotextile in the geocomposite layer to the geonet component of the geocomposite drainage layer; 4) from the geonet component of the geocomposite drainage layer to the geonet below the gravel around the LCS pipe; 5) from the geonet below the gravel around the LCS pipe to the gravel around the LCS pipe; and 6) from the gravel around the LCS pipe to the LCS pipe. A careful review of these six interfaces reveals that leachate is constantly flowing from one medium to another with higher transmissivity, which means flow bottleneck is unlikely.

There is no one-single design that would meet the above general rule, so it is recommended that check the general rule when the design of the leachate collection system is underway.