Test Report #3: Bench-Scale Hydraulic Conductivity of Typical FW AquaBlok® Formulations in Fresh Water

Background and Purpose of Testing

According to the guidance developed by the U.S. Army Corps of Engineers for the U.S. EPA (Palermo et. al., 1998), one principal function of an in-situ remedial sediment cap should be to reduce the flux of dissolved contaminants from sediments into the overlaying water column. Contaminants can migrate from sediments into water- including underlying ground water resources- through advective and diffusive processes. Advection refers to the movement of bulk porewaters, the ultimate rate and extent of which is largely a function of gradient and hydraulic conductivity. Advective movement of contaminants involves contaminant movement by "mechanical" or non-chemical means. In contrast, diffusive contaminant movement is the process whereby contaminants dissolved in water are transported by random molecular motion from areas of high concentration to areas of low concentration (Palermo et. al., 1998). The rate and extent of contaminant movement by diffusion is primarily controlled by concentration gradients, however, contaminant attenuation by- or sorption to- reactive substrates like AquaBlok can reduce contaminant mobility. AquaBlok's attenuating capabilities are the subject of Test Report #7.

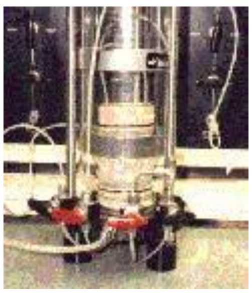

Photo 1. Permeability testing of AquaBlok samples.

The permeability (hydraulic conductivity) or typical freshwater AquaBlok formulations to fresh water under saturated conditions is the focus of the current test report.

Methods

Representative samples of three different freshwater AquaBlok formulations- 5050FW, 4060FW and 2080FW- were used to determine saturated hydraulic conductivity in general conformance with ASTM Method D 5084. Typical physical and compositional characteristics for the range of AquaBlok formulations tested are provided in Test Report #1. One subsample for each of the 5050FW and 4060FW formulations was tested whereas four subsamples of the leaner 2080FW formulation were tested to more accurately determine analytical variability for this method.

Laboratory procedures involved placing masses of dry AquaBlok into flexible-wall permeameters and thoroughly hydrating the samples with de-aired tap water (freshwater) under pressure to assure that samples were completely saturated prior to testing. The pre-saturation process typically took from one to two weeks, until samples stopped taking in water from both ends. After sample saturation, the hydraulic conductivity test was run under constant hydraulic gradients ranging from approximately 17 to 19 cm/cm for 4060FW and 5050FW samples. According to ASTM D 5084, hydraulic conductivity values are presumably unaffected by variable hydraulic gradients- testing values of which were below the recommended maximum (30 cm/cm) for testing low-permeability (less than 10^{-7} cm/sec) materials. Photo 1 shows a typical AquaBlok sample during permeability testing.

Results

Testing results are summarized in Table 1, with the typical appearance of AquaBlok samples after testing shown in Photo 2.

Table 1. Hydraulic conductivity of different freshwater AquaBlok formulations

AquaBlok Formulation	Hydraulic Conductivity Values (cm/sec)
5050 FW	5.93×10^{-9}
4060 FW	3.94×10^{-9}
2080 FW	Arithmetic Mean $=4.59 \times 10^{-9}$
	Geometric Mean $=4.52 \times 10^{-9}$

Photo 2. Typical AquaBlok sample after permeability testing.

Observations and Conclusions

Saturated AquaBlok is relatively impervious to advective flow and is quantitatively on the order of what would typically be expected for hydrated sodium bentonite, which is the dominant sealant layer component of typical freshwater formulations.

Similarly, low hydraulic conductivity values observed for both the more lean 2080FW AquaBlok formulation and the relatively bentonite-enriched 4060FW and 5050FW formulations implies that the presence of relatively significant quantities of aggregate within the hydrated AquaBlok matrix has an insignificant effect on AquaBlok performance as an effective hydraulic barrier.

Consistently low permeability values for AquaBlok (as shown for the 2080FW data) can be achieved through controlled laboratory testing, which is testament of both the reproducibility of the testing procedure as well as the inherently low-permeability nature of the AquaBlok's bentonite component.

References

Palermo, M., S. Maynord, J. Miller, and D. Reible. 1998. "Guidance for In-Situ Subaqueous Capping of Contaminated Sediments," EPA 905-B96-004, Great Lakes National Program Office, Chicago, IL.

Testing conducted by Hull & Associates, Inc. for AquaBlok, Ltd. Permeability data for the 5050 FW formulation from Abeltech, Inc. Report originally prepared by Abeltech, Inc. and revised by AquaBlok, Ltd.

AquaBlok Composite Particle System

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