The Oleophilic Biobarrier: Field Demonstration Results and Lessons Learned about a Novel, Sustainable Sheen Remedy

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Background/Objectives. Petroleum sheens on surface waters generated due to NAPL seepage from sediment is a widespread concern. At many sites, NAPL seepage occurs as a non-steady and even ephemeral process. Natural depletion of petroleum NAPLs (natural source zone depletion) is a well-documented in-situ process that can destroy thousands of gallons of petroleum NAPL per acre per year and, depending on climate, is a steady to seasonally varying process. The Oleophilic Bio Barrier (OBB) is an innovative technology that was conceived to bridge the gap between the time scales of these two processes. This technology is named after its “oleophilic” or oil-attracting (NAPL wettable) properties, which allow it to intercept and retain NAPL seepage and prevent sheens, while the naturally-occurring, petroleum-degrading microorganisms that colonize the OBB destroy the retained NAPL. Utilizing the oleophilic geocomposite material to retain NAPL provides a buffer between sporadic NAPL seepage and the more steady degradation process. The OBB is a novel, sustainable solution for sheen prevention that relies on a simple, inexpensive material to intercept, retain, and provide a platform for biological degradation of sheen generating NAPLs.

Approach/Activities. The key component of an OBB is a geocomposite material consisting of non-woven geotextiles bonded to both sides of a geonet core. The geocomposite is installed on the sediment surface over a NAPL seep. The geotextile fabric is made of an oleophilic material and is designed to collect and retain petroleum hydrocarbons. The inner geonet has an open structure and is designed to efficiently transmit the flow of water and gasses. Naturally occurring microbial communities colonize and inhabit the geotextile layers, while water and/or air exchange freely into and out of the geonet core delivering oxygen and other electron acceptors necessary for biological degradation of the retained petroleum hydrocarbons. A key aspect of this technology is that the capacity of the OBB to intercept and retain NAPL is regenerated in between NAPL seepage episodes as the retained hydrocarbons naturally degrade. The feasibility and effectiveness of an OBB has been tested in laboratory-scale experiments and a pilot-scale field demonstration. Lab and field studies tested the geocomposite’s ability to retain petroleum NAPL and prevent sheens. The field demonstration OBB underwent geochemical monitoring to determine redox conditions. DNA and RNA analyses were used to characterize the microbial community within and surrounding the OBB. NAPL-laden geocomposite samples underwent hydrocarbon forensics analysis to determine whether NAPL degradation occurred. A model was developed and used for sensitivity analysis to understand how NAPL seepage, NAPL storage on the OBB, and NAPL degradation influence the OBB design life.

Results/Lessons Learned. The lab and pilot studies have provided evidence that a petroleum NAPL was retained by the OBB material and microorganisms colonized the OBB and degraded the retained NAPL. Through these processes, the OBB provides a long-term remedy for preventing sheen formation on the surface water. Based on the effectiveness of the OBB pilot study for mitigating petroleum sheens, the lead regulatory agency approved a full-scale OBB installation as the pilot study site’s sediment remedy with implementation. Field observations, sampling results and lessons learned from sampling the field demonstration and installing the

full-scale remedy will be presented. The model sensitivity analysis results will also be presented, along with considerations outlining site suitability and remedy selection criteria.