MICROCOSM EVALUATION OF Provect-IR™ ANTIMETHANOGENIC ISCR REAGENT

Objective. Evaluate the potential for Provect-IR™ Antimethanogenic ISCR reagent to reduce the concentration of chlorinated volatile organic compounds (CVOCs - Attachment 1) while minimizing the production of methane at a remediation site. Using batch microcosm systems, the study will evaluate:

1. Reduced amount of methane produced during ISCR treatment that can potentially migrate from groundwater to shallow soils, and
2. Simultaneously improved removal of CVOCs via multiple ISCR mechanisms.

Sample Requirements. The client will collect and ship site soil/sediment (2 liters) and site groundwater (2 liters) to the ReSolution Partners laboratory at:

967 Jonathon Drive
Madison, WI 53713
Attn: Kevin Baker, Laboratory Manager
Telephone: (608) 669-6949 / Email kbaker@resolutionpartnersllc.net

Please contact us for assistance with sample containers and shipping details.

Sample Preparation and Baseline Testing.

If necessary, the soil sample will be sieved to remove material greater than 4 mm in size and the remaining soil will be quickly and gently homogenized. Samples of the homogenized soil and groundwater will be submitted for baseline compositional analyses of CVOCs. To confirm representativeness of the samples, results of baseline data will be discussed with the Client prior to proceeding with the study.

Batch Microcosm Set-Up.

Testing will be conducted in 125 mL amber glass bottles equipped with PTFE-lined open septum caps (large VOA-type bottles/vials). Soil and groundwater from the site will be used to achieve a water : soil ratio of 1 part water : 1 part soil by weight (approximately 60 grams soil and 60 grams groundwater). One control (unamended) sample and two treatment samples amended with Provect-IR (at dosages defined by site conditions, typically 0.1 and 0.3% soil dry weight basis) will be prepared in duplicate microcosms yielding a total of six microcosms for each of the 5 sampling days (Days 0, 5, 15, 30 and 45), for a total of 30 sample vials. A *Dehalococcoides* spp. (DHC) inoculum can be added upon request (targeting *ca*. 1x10E10 cells/L groundwater). Microcosms will be prepared under a nitrogen atmosphere in an anaerobic glove box. Once the microcosms are sealed they will be removed from the glove box and incubated in the dark at room temperature. Vials will be inverted daily to provide gentle mixing.

Microcosm Sampling and Analysis. Periodic headspace samples will be drawn through septum seals to measure CVOCs (Attachment 1) in the gas phase using a GC photoionization detector (PID) unit. Methane, ethane and ethene will also be analyzed in the dissolved gas phase using a gas chromatograph (GC) with a flame ionization detector (FID) in the gas phase. Henry's Law will be used to estimate the equivalent aqueous concentrations from the headspace concentrations. pH and ORP will be measured once the headspace samples have been collected. Samples will be collected at the 5 time intervals (Days 0, 5, 15, 30 and 45). The duration of the later intervals may be revised with client consensus based on the results of the previous samples.

A summary letter report with results will be provided upon completion of the study (generally within 30 days following receipt of samples).

Optional Assays: Microbiological analyses via quantitative polymerase chain reaction (qPCR) DNA analyses can be conducted to enumerate *Dehalococcoides* (DHC) and methanogens (MGN) along with the number of microorganisms expressing the functional genes *bcv*A Vinyl Chloride Reductase (BAV1), *tce*A TCE Reductase, and *vcr*A Vinyl Chloride Reductase. Other gene probe assays can be conducted at an additional cost. Please inquire

Price.

The testing described in this proposal will be performed for a price of $9,800. DHC inoculation and analyses in not included in the price. Please inquire.

Notices and Disclaimers

Any estimated dosage or recommended application methods are based on the site information provided by others, and they are not meant to constitute a guarantee of field performance. We recommend that a comprehensive remedial design take the precise nature of the COI impact and actual site conditions into consideration.

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www.ProvectusEnvironmental.com

Revision 3 - February 20, 2015

ATTACHMENT 1

Screening-Level GC-PID/FID Analytes

Updated February 2015

Chlorinated Ethenes	Aromatic Hydrocarbons
Tetrachloroethene	Benzene
Trichloroethene	Ethylbenzene
cis-1,2-Dichloroethene	Toluene
trans-1,2-Dichloroethene	m-Xylene
1,1-Dichloroethene	o-Xylene
Chloroethene	p-Xylene
	Naphthalene
Chlorinated Ethanes	1,2,4-Trichlorobenzene
1,1,2-Trichloroethane	1,4-Dichlorobenzene
1,1,1-Trichloroethane	1,3-Dichlorobenzene
1,2-Dichloroethane	1,2-Dichlorobenzene
1,1-Dichloroethane	Chlorobenzene
Chloroethane	Isopropylbenzene
Gases	**Ketones**
Ethene	Acetone
Ethane	2-Butanone (MEK)
Methane	2-Hexanone
	2-Pentanone
Ethers	4-Methyl-2-pentanone
Methyl tert-butyl ether (MTBE)	

Additional volatile organic compounds can be analyzed upon request.