

## LABORATORY EVALUATION OF Provect-IR™ IN A FLOW-THROUGH COLUMN STUDY

**Objective.** Evaluate the potential for Provect-IR Antimethanogenic ISCR Reagent to reduce the concentration of chlorinated volatile organic compounds (CVOCs) listed in **Attachment 1** while minimizing the production of methane at a remediation site. Under laboratory test conditions designed to simulate continuous groundwater flow, 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.** Site-specific information regarding site hydrogeology will be provided by the Client and used to establish column geometry and flow rates. The Client will subsequently provide at their expense sufficient amounts of site soil and site groundwater to meet the project requirements. In general, each study requires ca. 3 kg of soil along with 20 L of site groundwater.

Upon request, ReSolution Partners will provide containers for Client's use in sample collection. The Client will provide alternate remedial amendments / reagent(s) if a parallel comparison to Provect-IR is requested. Samples will be shipped 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](mailto:kbaker@resolutionpartnersllc.net)

### **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.

### Continuous-Flow Column Study Set-Up.

A minimum of four columns (**Photo 1**) will be prepared using site soil<sup>1</sup>. One column will be a control sample (*i.e.* no reagents); the remaining columns will have up to three dosages of Provect-IR. Upon request, other technologies provided by the Client can be substituted for a Provect-IR dose(s) to compare performance (maintaining a total of four columns). To the extent possible, columns will be prepared under a nitrogen atmosphere in a glove box, sealed and then transferred to a laboratory rack where the trials will be completed at room temperature. A *Dehalococcoides* spp. (DHC) inoculum can be added upon request.



Columns will be operated in a bottom-up continuous flow mode using a flow rate selected to model site conditions. Influent and effluent aqueous samples will be collected from each of the 4 columns and analyzed for pH, ORP, DO, CVOCs and dissolved gases (methane, ethane, and ethene) at five time intervals (for example Day 0, 1 week, 4 weeks, 8 weeks and 12 weeks). The intervals between sampling for the later events can be modified based in the initial sample results with client

concurrence, however the total number of samples will remain unchanged.

A summary letter report will be prepared upon completion of the study.

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 *bcvA* Vinyl Chloride Reductase (BAV1), *tceA* TCE Reductase, and *vcrA* Vinyl Chloride Reductase. Other gene probe assays can be conducted at an additional cost. Please inquire.

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<sup>1</sup> The experimental design assumes that: (1) 4.8 cm id columns and 15 cm in length and (2) flow rates ranging from 0.1 to 0.4 mL per minute will be adequate to represent site conditions. Alternative columns and flow rates require project-specific discussions and cost estimating.

**Price.**

The testing described in this proposal can be performed for a price of \$14,500. DHC inoculation and qPCR testing is 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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**ATTACHMENT 1**

**Screening-Level GC-PID/FID Analytes**

Updated February 2015

<b>Chlorinated Ethenes</b>	<b>Aromatic Hydrocarbons</b>
Tetrachloroethene	Benzene
Trichloroethene	Ethylbenzene
cis-1,2-Dichloroethene	Toluene
trans-1,2-Dichloroethene	m-Xylene
1,1-Dichloroethene	o-Xylene
Chloroethene	p-Xylene
	Naphthalene
<b>Chlorinated Ethanes</b>	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
<b>Gases</b>	<b>Ketones</b>
Ethene	Acetone
Ethane	2-Butanone (MEK)
Methane	2-Hexanone
	2-Pentanone
<b>Ethers</b>	4-Methyl-2-pentanone
Methyl tert-butyl ether (MTBE)	

Additional volatile organic compounds can be analyzed upon request.