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Highly Successful ERD Pilot Evaluation Utilizing Simple Additive Delivery Approach to Compare Additive Efficacy under Actual Site Biogeochemical Conditions

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Background/Objectives. The Site location is a former Railroad facility in Ottawa, Ontario, Canada with past site uses to include photographic and printing facilities. Concentrations of chlorinated volatile organic alkane and alkene compounds (cVOCs) documented in soils and groundwater exceed Ontario Ministry of Environment (MOE) Table 2 criteria. Site hydraulic conductivity is >50%, with subsurface soils containing silty-clay with glacial till present. Trichloroethylene (TCE), the primary contaminant of concern (COC), with secondary cVOC alkane and alkenes are present.

One Nation Engineering, Inc. initiated an on-site treatability evaluation in November 2014. The purpose was to identify a safe, sustainable and effective remedy to destroy Site cVOC contaminants. Evaluation compared efficacy of a hydrogen release agent (HRA) and a carbon, carbohydrate and macro-micro nutrient biostimulation additive (**ERD**ENHANCED™).

Approach/Activities. Five monitoring wells were amended using additive filled passive release sock (PRS) deployment units; two with HRA, three **ERD**ENHANCED™. PRS units are fabric tubes suspended vertically in saturated screened interval of existing ≥ 2-inch groundwater monitoring well(s); providing low-cost low-impact evaluation process, under actual Site groundwater biogeochemical conditions. Baseline groundwater conditions were recorded November 7, 2014 prior to initial PRS deployment. Two PRS replacement and three performance monitoring/sampling events were completed during the ≈8 month period; December 2014, April 2015 and July 23, 2015 (no new PRS). At no time during the evaluation was groundwater augmented with cultured bacteria.

Results/Lessons Learned. Performance data indicates **ERD**ENHANCED™ amended wells realized greater performance with regards to reductions in dissolve phase parent [TCE], Parent:Parent Daughter Molar Ratios, daughter cVOC production-reductions, and the generation of [Ethene]; which, confirms complete biotransformation. Of note, evaluation well MW13-5 demonstrated the greatest gross percent decrease [TCE] ($95\%_{DECREASE}$) of all wells tested. The lowest percent decrease [TCE] at **ERD**ENHANCED™ amended well ($80\%_{DECREASE}$ MW13-30) outperformed the best HRA amended well ($65\%_{DECREASE}$ MW12-5). In summary, **ERD**ENHANCED™ amended wells realized >80% $_{DECREASE}$ (MW13-1), >90% $_{DECREASE}$ (MW10-1) and >94% $_{DECREASE}$ (MW13-5); while HRA amended wells realized $65\%_{DECREASE}$ (MW12-5), 281% *increase* (MW13-4).

A direct comparison of test locations MW13-4 (HRA) and MW13-5 (**ERD**ENHANCED™) follows. Each location is proximate to the other, downgradient from source contaminants and with similar subsurface characteristics. With regards to Parent;Parent Daughter Molar Ratio (P:PD) MW13-5 recorded a $92.2\%_{DECREASE}$ while MW13-4 recorded a $17.1\%_{DECREASE}$. With regards to concentrations [TCE], MW13-5 recorded an overall $79.4\%_{DECREASE}$, MW13-4 a $6.4\%_{DECREASE}$ and in regards to Total Moles cVOCs, MW13-5 realized greater daughter product production ($169.2\%_{INCREASE}$ vs. $13.1\%_{INCREASE}$) *and* a greater decrease from peak bioavailability ($36.1\%_{DECREASE}$ vs. $34.6\%_{DECREASE}$). Furthermore, **ERD**ENHANCED™ amended wells realized a greater decrease in the arithmetic mean decrease in [Vinyl chloride] (>$47\%_{DECREASE}$ vs. <$44\%_{DECREASE}$) and were the only locations to yield [Ethene], further demonstrating complete

cVOC dechlorination. Secondary geochemical metrics provide additional support of superior biogeochemical conditions at **ERD**ENHANCED™ amended wells, with greater percent arithmetic mean decreases in Sulphates, a generally greater overall reduction in [dissolved Manganese/Iron], and consistently low ORP values.

Site locations amended with ERDENHANCED™ safely, sustainably and effectively enhanced native microbial populations and pushed treatment zone conditions closer to the 'target zone' necessary for robust, enhanced reductive dechlorination and greater contaminant mass destruction. PRS deployment units proven a low-impact and cost-effective on-site evaluation tool.