151 Suffolk Lane
Gardner, MA 01440
Phone: (978) 730-1200
Fax: (978) 632-3422
rbaker@terratherm.com
www.terratherm.com

RALPH S. BAKER, Ph.D.

Chairman and Chief Scientist

PROFESSIONAL HISTORY

TerraTherm, Inc.	(2000 – present)
ENSR Consulting, Engineering, and Remediation	(1989 – 2000)
University of Massachusetts, Amherst	(1985 – 1989)
Ralph S. Baker Associates	(1976 – 1985)
USDA Soil Conservation Service	(1975 – 1976)

EDUCATION

Ph.D. (Soil Physics) University of Massachusetts, 1989
M.S. (Soil Chemistry) University of Maine, 1986
B.S. (Natural Resources) Cornell University, 1972

REGISTRATIONS AND TRAINING

Certified Professional Soil Scientist (State of Maine)
HAZWOPER 40 hr + 8 hr Refresher Training Current

SUMMARY OF EXPERIENCE

Dr. Baker has 40 years of experience in selection, design, implementation, oversight and evaluation of in-situ remediation technologies for treatment of contaminated soil and water, including in-situ thermal remediation (ISTR), soil vapor extraction (SVE), in-situ air sparging (IAS), and multi-phase extraction (MPE). He draws on experience gained from over 100 major projects, of which 50 utilized ISTR, 30 SVE, 20 IAS, and 20 MPE; of these, approximately half were dense non-aqueous phase liquid (DNAPL) sites. Most of these projects were conducted for industrial or governmental clients, and several were focused primarily on research objectives. In addition, he has authored over 70 technical publications on in-situ/on-site remediation and applied environmental soil physics.

TerraTherm, Inc., Fitchburg, MA. **Chairman/Chief Scientist** (2010 – present); **CEO** (2000 – 2010)
Co-founder, Chairman and Chief Scientist. Frequent spokesperson for company and intellectual property manager. Dr. Baker serves as a Technical Director on selected TerraTherm's projects. Representative project experience includes:

U.S. Agency for International Development (USAID) – In-Pile Thermal Desorption® (IPTD®) Remediation of Dioxin at Danang Airport, Vietnam. TerraTherm is under a four-year contract with USAID to treat 73,000 m^3 (95,000 cy) of soil and sediment at Danang Airport. The IPTD® approach incorporates placing contaminated soil and sediment within an above-ground, covered and fully insulated treatment pile structure, and then heating each batch of soil over several months to destroy the dioxin. As Technical Director and Contract Manager for the project, Dr. Baker oversaw the year-long design effort in 2012, and serves as senior reviewer of major deliverables. TerraTherm has successfully completed the first of two phases of the project. Period of performance: 2012 – 2017. Total project value: $37M.

Beede Waste Oil Superfund Site, Plaistow, NH – SEE. Principal-in-Charge (PIC) of Steam-Enhanced Extraction (SEE) remediation of Chlorinated Volatile Organic Compounds (CVOCs) and Light NAPL (LNAPL) at former waste oil disposal facility. As PIC, Dr. Baker reviews client correspondence and ensures compliance with corporate procedures and contractual requirements. SEE operations are ongoing as of June 2015. Total project value: $4.8M.

Confidential Client, Newbury Park, CA – ISTD and SEE. PIC for combination ISTD+SEE remediation of CVOCs at a site in a corporate office park. As PIC, Dr. Baker reviews client correspondence and ensures compliance with corporate procedures and contractual requirements. Design is complete, and mobilization to the site will occur in July 2015. Total project value: $5.6M.

ESTCP Funded Project, W. Trenton, NJ – ISTD. Senior reviewer/ technical support of research study to evaluate the use of ISTD for the remediation of CVOCs from bedrock. Field implementation of a small pilot was performed at the USGS' CVOCs/Fractured Bedrock research site at the former Naval Air Weapons Center in NJ. Controlled laboratory tests were also performed to verify field results and to examine the removal processes for a variety of bedrock types. Period of performance: February 2008 to December 2010. Total project value: $1M.

Confidential Client, SE US – ISTD. Senior reviewer/ technical support for remediation of former solvent tank area contaminated with CVOCs (TCE) using ISTD. Total volume of treatment zone was 8,700 cy to 95 ft depth, including 20 feet of fractured bedrock. Clean-up goals for constituents of concern: TCE ≤ 0.6 mg/kg. Goals were met (95% UCL of mean TCE concentration was 17 µg/kg) and project was completed on time and under budget. Period of performance: July 2006 – June 2007. Total project value: $1.3M.

City of Richmond Redevelopment Authority – ISTD Design-Build-Operate at Terminal One, Richmond, CA. Senior reviewer/technical support for remediation of former tank farm area contaminated with CVOCs (PCE, TCE, DCE, DCA, VC) using ISTD. Total volume of treatment zone was 6,700 cy to 20 ft depth in Bay Mud. Successfully achieved clean-up goals for constituents of concern: PCE – 1 mg/kg; TCE – 2 mg/kg; cis-1,2 DCE – 17 mg/kg; VC – 1 mg/kg. Project was on time and on budget. Period of performance: January 2005 – November 2005. Total project value: $2M.

Confidential Client Chlorinated VOC Site, Carson, CA – ISTD. Technical oversight of implementation of ISTD system for the remediation of 6,700 cy of soil containing 1,1-DCA. Site soils consisted of low-permeability, dense clays located below the water table. Clean up objectives included attaining 1 mg/kg of 1,1-DCA in soil within treatment zone and reducing concentrations in groundwater in underlying permeable aquifer. Project duration: November 2003 to June 2005. Total project value: $1M.

Southern California Edison Co. (SCE) – ISTD RD and RA at a Former Wood-Treating Site in Alhambra, CA. TerraTherm treated 16,500 cy of creosote-contaminated soil, for which the contaminants of concern, PAHs, PCP and dioxins were treated to residential cleanup standards, to a maximum depth of 105 ft beneath former treatment tanks and piping, in two phases. Dr. Baker's roles included preparation and oversight of design and work plan documents, including the Air Discharge Permit through the SCAQMD; speaking at several DTSC-convened public hearings; design and oversight of a thermal conductivity test at the site; and coordination of simulation modeling. He served as the technical and QA manager during the RA effort, which included construction, operation and assessment of an ISTD system comprising 785 thermal wells, Air Quality Control, Continuous Emissions Monitoring, and electrical distribution, control and monitoring equipment. Project duration: 2001-2005. Total project value: $15M.

Strategic Environmental Research and Development Program (SERDP) – Principal Investigator for research project funded by the DoD to evaluate and quantify the removal and in-situ destruction mechanisms associated with using ISTD to remediate CVOCs. Laboratory and large tank experiments were conducted at the *VEGAS* research institute located at the University of Stuttgart in Germany. Period of performance April 2005 – June 2009. Total project value: $500K.

U.S. Army Corps of Engineers - Remediation Engineering Guidance Document. Contributing author of Engineering and Design Manual for U.S. Army Corps of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste - Center of Expertise (HTRW-CX) on In Situ Thermal Remediation.

ENSR International, Acton, MA. **Technical Director** (1989-2000)
Served as ENSR's corporate-wide in-situ remediation technology leader. As Technical Director, Dr. Baker chaired the company's Bioremediation and In-Situ Remediation Skill Centers, which provided technology transfer and technical coordination among representatives from more than 20 offices. Among more than 100 major project contributions, major project management and technical assignments included:

U.S. Army Corps of Engineers - Remediation Engineering Guidance Documents. Project Manager and principal coordinating author of three comprehensive Engineering and Design Manuals for U.S. Army Corps of Engineers (USACE) Hazardous, Toxic, and Radioactive Waste - Center of Expertise (HTRW-CX): (1) SVE and Bioventing (EM 1110-1-4001); (2) IAS (EM 1110-1-4005); and, (3) MPE (EM 1110-1-4010). .

SELECTED PUBLICATIONS (THERMAL REMEDIATION RELATED ONLY)

Baker, R.S., S.G. Nielsen, G. Heron and N. Ploug. 2015. "How Effective is Thermal Remediation of DNAPL Source Zones in Reducing Groundwater Concentrations?" *Groundwater Monitoring & Remediation*, submitted for publication.

Heron, G., J. LaChance and R. Baker. 2013. "Removal of PCE DNAPL from Tight Clays Using In Situ Thermal Desorption." *Groundwater Monitoring & Remediation*, Fall 2013, 33(4):31-43.

Lemming, G., S.G. Nielsen, K. Weber, G. Heron, R.S. Baker, J.A. Falkenberg, M. Terkelsen, C.B. Jensen and P.L. Bjerg. 2013. "Optimizing the Environmental Performance of In Situ Thermal Remediation Technologies Using Life Cycle Assessment". *Groundwater Monitoring & Remediation*, 6 May 2013, http://onlinelibrary.wiley.com/doi/10.1111/gwmr.12014/abstract.

Lemming, G., P. Bjerg, K. Weber, J. Falkenberg, S. Nielsen, R. Baker, G. Heron, M. Terkelsen and C. Jensen. 2012. "Environmental Optimization of In Situ Thermal Remediation Technologies using Life Cycle Assessment (I)." In: *Remediation of Chlorinated and Recalcitrant Compounds – 2012.* Eighth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2012). Battelle Memorial Institute, Columbus, OH.

Baker, R.S., T. Burdett, S.G. Nielsen, M. Faurbye, N. Ploug, J. Holm, U. Hiester, and V. Schrenk. 2010. "Improving the Sustainability of Source Removal." Paper C-027, in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010.* Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). Battelle Mem. Inst., Columbus, OH.

Baker, R.S., J.M. Bierschenk, J. LaChance, G. Heron, D. Phelan, and J.A. Clock. 2010. "In Situ Thermal Treatment of MGP Waste and Creosote." Paper H-057, in K.A. Fields and G.B. Wickramanayake (Chairs), *Remediation of Chlorinated and Recalcitrant Compounds—2010*. Seventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2010). Battelle Memorial Institute, Columbus, OH.

Baker, R.S. and U. Hiester. 2009. *Final Report: Large-Scale Physical Models of Thermal Remediation of DNAPL Source Zones in Aquitards*. SERDP Project ER-1423. May 2009, 250 pp. available at: *www.serdp.org/content/download/6039/81933/file/ER-1423-FR.pdf*

Baker, R.S., Smith, G.J., and H. Braatz. 2009. "In-Pile Thermal Desorption of Dioxin Contaminated Soil and Sediment." In: *Proceedings of the 29rd International Symposium on Halogenated Persistent Organic Pollutants* (Dioxin 2009), Beijing, China, Aug. 23-28, 2009.

Heron, G., Baker, R.S., LaChance, J., Bierschenk, J.M., Ploug, N., N., Faurbye, M., Langford, S., Tully, D. 2008. "Thermal conduction heating for DNAPL removal in low permeability soils and bedrock." ConSoil 2008, Milan, Italy.

Baker, R.S., J.M. Bierschenk, J. LaChance, J.P. Galligan, D. Tarmasiewicz, G. Heron and W.R. Leach. 2008. "Why In Situ Thermal Desorption Can Be the Most Cost-Effective Remediation Method for Many Sites." Paper N-003, in: Bruce M. Sass (Conference Chair), *Remediation of Chlorinated and Recalcitrant Compounds—2008*. Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2008). Battelle Press, Columbus, OH.

Baker, R.S., D. Tarmasiewicz, J.M. Bierschenk, J. King, T. Landler and D. Sheppard. 2007. "Completion of In-Situ Thermal Remediation of PAHs, PCP and Dioxins at a Former Wood Treatment Facility." *2007 International Conference on Incineration and Thermal Treatment Technologies (IT3)*, May 14-18, 2007, Phoenix, AZ. Air & Waste Management Association, Pittsburgh, PA.

Baker, R.S., J.C. LaChance, G. Heron, U. Hiester, H.-P. Koschitzky, O. Trötschler, A. Färber, and M. Kuhlman. 2006. "DNAPL Removal from the Saturated Zone using Thermal Wells." *Remediation of Chlorinated and Recalcitrant Compounds: Proceedings of the Fifth International Conference* (May 22-25, 2006). Battelle, Columbus, OH.

Baker, R.S., D. Brogan and M. Lotti. 2006. "Demonstration of Tailored Levels of In-Situ Heating for Remediation of a Former MGP Site." Proceedings of the International Symposium and Exhibition on the Redevelopment of Manufactured Gas Plant Sites (MGP2006), Reading, England, April 4-6, 2006. *Journal of Land Contamination and Reclamation*, 14(2):335-339.

LaChance, J.C., R.S. Baker, J.P. Galligan, and J.M. Bierschenk. 2004. "Application of 'Thermal Conductive Heating/In-Situ Thermal Desorption (ISTD)' to the Remediation of Chlorinated Volatile Organic Compounds in Saturated and Unsaturated Settings." Proceedings of the 4th International Conf. on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA, May 24-27, 2004. Battelle, Columbus, OH.

Baker, R.S. and G. Heron. 2004. "In-Situ Delivery of Heat by Thermal Conduction and Steam Injection for Improved DNAPL Remediation." Paper 2B-18, in: A.R. Gavaskar and A.S.C. Chen (Eds.), *Remediation of Chlorinated and Recalcitrant Compounds—2004*. Proceedings of the Fourth International Conference on Remediation of Chlorinated and Recalcitrant Compounds (Monterey, CA; May 2004). ISBN 1-57477-145-0. Battelle Press, Columbus, OH.

Baker, R.S., H.J. Vinegar, and G.L. Stegemeier. 1999. "Use of In Situ Thermal Conduction Heating to Enhance Soil Vapor Extraction." pp. 39-57. In: P.T. Kostecki, E.J. Calabrese and M. Bonazountas (eds.) *Contaminated Soils*, Volume 4. Amherst Scientific Publishers, Amherst, MA.