

Terra Systems Core Competencies

Research and Product Development

Terra Systems, Inc.'s scientists have been developing in situ bioremediation technology since the 1980's. Our roots go back to Richard Raymond, Sr. who received the first patent, U.S. Patent No. **3,846,290** for in situ bioremediation of petroleum hydrocarbons in the 1970's while at Sun Oil Company. Today, led by President Richard Raymond, Jr., Terra Systems, Inc. offers proven anaerobic and aerobic in situ bioremediation products and unsurpassed technical support.

Terra Systems focuses on our customer's day-to-day problems so we invest heavily in Research & Development working with clients to develop products to solve real technical issues like our development of:

- ✓ Modification to the product design and composition based on the lab and field results
- ✓ Full scale implementation.



Description	Product	Year
An emulsified oil/iron product with superior injectability for anaerobic biodegradation and abiotic reduction.	SRS [®] -Z	2013
A large droplet emulsified vegetable oil substrate with a proprietary anionic emulsifier for high groundwater flow-rates, fractured bedrocks, and permeable reactive barriers.	SRS [®] -FR	2011
A small or large droplet emulsified vegetable oil substrate with a proprietary reductant to accelerate metals reduction in a mixed chlorinated plume.	SRS [®] -M	2010
A small droplet emulsified vegetable oil substrate with a nonionic emulsifier for maximum radius of influence	SRS [®] -SD	2008

The foundation of our *Family* of emulsified vegetable oil products is Terra Systems U.S. Patent No. **6,398,960 B1** for the use of emulsified vegetable oil substrate for reductive dechlorination of chlorinated solvents. The Patent and Trademark Office also awarded a patent reissue, U.S. Patent No. **RE40,448** for aquifer remediation using emulsified oils on August 5th, 2008.



In the above cases, a customer approached Terra Systems and challenged us to “develop a better mousetrap” than their current approach for the site.

Typically the product development cycle is several years and includes:

- ✓ Literature research
- ✓ Formulation design
- ✓ Laboratory testing of the formulations
- ✓ A treatability study using groundwater and saturated soil from the actual site.
- ✓ A pilot test

- Terra Systems is a member of **SABRE** (Source Area in situ Bioremediation), an international multidisciplinary team, which is a collaborative R&D project investigating the bioremediation of dense non-aqueous phase liquid (DNAPL) TCE in England. Terra Systems patented SRS[®] emulsified vegetable oil substrate was chosen after an extensive laboratory evaluation process. An estimated 500 kg of TCE DNAPL in a test cell was reduced in 540 days.

An overview of the project and a list of technical papers that can be downloaded can be accessed at:

http://www.claire.co.uk/index.php?option=com_content&view=article&id=53&Itemid=47

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