CENTER FOR NUCLEAR WASTE REGULATORY ANALYSES

TRIP REPORT

SUBJECT: Principles and Practice of Forced Air Remediation Course (20.01402.158)

DATE/PLACE: February 21–23, 2001
Denver, CO

AUTHOR: W. Illman

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PERSONS PRESENT:

This short course was attended by W. Illman of the CNWRA for professional development.

BACKGROUND AND PURPOSE OF TRIP:

The main purpose of this trip was to attend the course on state-of-the-art in design and operation of *in situ* forced air systems for remediation of organic contaminants in soil and ground water.

This course has been determined to be suitable for CNWRA staff professional development and complementary to CNWRA staff expertise in designing, conducting, and interpreting air injection tests. The practical knowledge and professional contacts gained through this course will be useful in developing business in the area of modeling ground water remediation.

COURSE SUMMARY:

The course was offered by the National Groundwater Association and taught by Jack Parker, Ph.D. and Bruce Bosshard, both of whom are recognized in innovative, ground water cleanup technologies.

Jack Parker, Ph.D., was a professor of contaminant hydrology at Virginia Tech and served as a visiting professor at the Swiss Federal Technical University in Zurich. He is an internationally recognized expert on contaminated soils and groundwater, who has presented numerous seminars, workshops and invited talks throughout the U.S. and in over 15 countries.

Bruce Bosshard, PE, has 20 years of experience with an extensive background in new remedial technology development including pneumatic soil fracturing, bioremediation, air sparging, bio-slurping, multiphase extraction, soil heating, and multiple technologies integration.

The three-day course summarized the state-of-the-art in design and operation of in situ forced air systems for remediation of organic contaminants in soil and ground water. Technologies considered include soil vapor extraction, bioventing, and multiphase extraction technologies (e.g., dual phase extraction, bioslurping). Corollary technologies, such as soil heating and pneumatic fracturing, were also discussed. The course emphasized the integration of basic principles, lessons learned through the field application of technologies, and use of simple computational tools that enabled remediation professionals to design the most cost-effective systems possible.

The course began by the presentation of basic principles of air flow to wells in the unsaturated zone and its implications to remediation system design and its optimization. Design protocols were presented to determine air pressure, flow rate, pulsed flow scheduling, well placement, pipe sizing, equipment specifications and material selection. Valuable lessons and experience from the field were presented for technology selection and preliminary design. Practical, yet quantitative design optimization protocols were also outlined. Presented design protocols enabled participants to design systems that meet cleanup criteria with minimum cost. Site characterization, monitoring and pilot test methods necessary to achieve cost effective remediation were also discussed.

Discussions on partitioning relations for VOCs in air, water, solid phases were presented next and technologies including vapor extraction and biodecay were suggested for mass removal. A discussion on the characterization of extraction efficiency of contaminants lead to numerous comments from participants.

Hands-on exercises with practical design tools implemented in an easy-to-use spreadsheet format were integrated into the course to enhance understanding and to provide training in practical design optimization protocols. Exercises involving the computation of VOC phase partitioning and the evaluation of efficiency parameters from SE pilot tests proved to be extremely useful. Other computer exercises involved: 1) the determination of the optimal vacuum, flow rate and well spacing; 2) estimation of free and residual contaminant volume; 3) evaluation of the effects of vacuum and pump level on mass recovery; 4) evaluation of pulsed flow effectiveness for sparging; and 5) calculation of net present value cost of forced air remediation systems.

Problem solving in small groups allowed the participants to reinforce their knowledge of the technologies presented. The tools provided a practical means of performing preliminary analyses of remedial alternatives, designing and analyzing pilot tests, and optimizing final system design and evaluating performance of operating systems.

During the latter part of the course, case studies were presented to show the design and conduct of ground water remediation involving air sparging, multiphase extraction and pneumatic fracturing at the Salton Sea and El Centro sites in California. The case studies were helpful in illustrating the utility of presented technologies. The instructor repeatedly referred to difficulties in ground water remediation caused by subsurface heterogeneity. One suggested solution to overcome difficulties due to subsurface heterogeneity was to "over-engineer" the remediation scheme.

Course participants were encouraged to bring case studies to class for use in problem-solving sessions. One participant presented a case study involving a Dense Non-aqueous Phase Liquid (DNAPL) spill in glacial outwash underlain by fractured dolomite. The instructor and the course participants interacted to apply innovative cleanup solutions using principles learned in the classroom.

RECOMMENDATIONS:

The course, Principles and Practice of Forced Air Remediation, was highly useful in learning practical remediation technologies applied in the ground water industry. Discussions with course participants resulted in useful insights into practical aspects of ground water remediation, potential research areas, and business opportunities.

At the very minimum, the course should help staff to stay abreast of new technologies in ground water remediation. Continued participation in NGWA courses such as this one by CNWRA hydrology staff is recommended for professional development.

SIGNATURE:

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