Surfactant Injection for Ground Water Remediation: State Regulators' Perspectives and Experiences

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Preface

This report is based on a series of interviews with State regulators involved in the review and approval of applications for demonstrations or applications of surfactant technologies for the remediation of contaminated ground water. Treatment of aquifers contaminated by non-aqueous phase liquids (NAPLs) by traditional pump-and-treat systems has proven impracticable in many instances. State regulators, researchers, and engineers are working on innovative solutions to this problem. This report focuses on identifying specific technical issues, non-technical problems, training, and technical or policy needs that would contribute to improving the use of *in situ* surfactant enhancements. The goal of the study was to identify barriers and describe successes in gaining State regulatory approval, in order to promote understanding among the various stakeholders vital to developing this important technology.

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Surfactant Injection for Ground Water Remediation: State Regulators' Perspectives and Experiences

This is a report on a series of interviews conducted with eight State regulatory representatives regarding the use of surfactants for *in situ* ground water remediation. The interviews were a follow-up to a analysis conducted last year by the Environmental Protection Agency's Technology Innovation Office (TIO). In the previous study, TIO identified State regulations and policies concerning the injection of surfactants, co-solvents, or nutrients into contaminated ground water for remediation. The present study examined procedures used in States that have reviewed proposals for surfactant demonstrations to identify specific technical issues, non-technical problems, training, and technical or policy needs that would contribute to improving the use of *in situ* surfactant enhancements. The goals of the study are to identify barriers and describe successes in gaining State regulatory approval, and make recommendations to future applicants that may improve their chances for approval. TIO sponsored a meeting of several principals involved in ongoing surfactant demonstrations on September 20, 1995, in Kansas City, Missouri.[1] Participants in the meeting addressed issues of regulatory barriers and other problems. This information is included in this report where appropriate.

Surfactant Demonstration Report and State Regulation Study

In April of 1995, TIO conducted an investigation to identify research, demonstrations, and field applications of *in situ* surfactant enhancement technologies to remove contaminants from soils and ground water at hazardous waste sites.[2] Information was collected from computerized databases, such as Dialog Information Services, EPA technology databases (VISITT, ATTIC), Superfund Innovative Technology Evaluation Profiles, and the Department of Energy's Office of Technology Development Program Reports. This information was supplemented with telephone interviews with selected representatives of federal agencies, academic research centers, and hazardous waste remediation consulting firms to identify ongoing or planned demonstrations and commercial applications of surfactant technologies. A separate investigation of applicable State regulations identified a number of additional sites where surfactant

Technology Needs

Traditional pump-and-treat systems have proven impracticable in many instances for treating non-aqueous phase liquids (NAPLs) in aquifers. NAPLs have very low solubility in water, leading to very slow rates of removal by pumping. NAPLs tend to exist in pockets at the subsurface location to which they have migrated. New technologies are being developed to improve removal efficiency through mobilization or solubilization of these pockets.

use has been reviewed, approved, or implemented.[3]

Method

State ground water contacts in each of the States where surfactant demonstrations or applications had been identified were sent a letter inviting them to participate in the study. A questionnaire directed toward gathering information on the process used to review surfactant applications was included (see appendix). The letter explained the purpose of the study and asked for their participation in a half-hour interview. The questionnaire included questions regarding the site, the length of application review, the most important technical information contained in the proposal, technical deficiencies (if any), non-technical problems that caused delays, suggestions for improving the review and approval process, and the potential benefit of training or guidance on surfactant chemistry and processes. Following the letter, each state contact was called and a telephone interview scheduled at their convenience. Interviews were completed with State representatives in Alaska, California, Colorado, Kentucky, New Jersey, Pennsylvania, Texas, and Utah.

Interview Summaries

Each of the eight interviews conducted by EPA are summarized below. In some cases, specific information about the site where surfactant use has been approved or is under consideration is included, as well, to provide a context for understanding the State regulator's perspective. In addition, each of the items in the questionnaire is addressed to the extent possible for each State respondent.

Alaska

Jonathan Williams of EPA Region 10 provided information regarding the use of a surfactant as a sequestering agent for iron-fouling problems with a ground-water remediation system at an oil refinery in Kenai, Alaska. The Region was asked for their approval after the Alaska Division of Environmental Conservation had already reached a decision to approve the project. The process was fairly informal, and was not very lengthy. The State reviewed the work plan and surfactant chemistry. They were convinced that the system was well contained and that the surfactant being used was harmless. The State informed the company that an Underground Injection Control (UIC) program review and approval also would be needed. The Regional UIC staff did not see the need to issue a permit in this situation.The surfactant was being used only in the area of the pumping wells to increase the effectiveness of recovery of spilled petroleum.

Mr. Williams was unsure of the efficacy of the surfactant in solving the problem. He also felt that technical guidance would be valuable. Guidance should describe the different sequestering agents available, their strengths and weaknesses, and what could happen if they could not be recovered.

California

In California, ground-water remediation is regulated by a number of Regional Water Quality Control Boards and the Department of Toxic Substances Control, part of the California Environmental Protection Agency. The contact we interviewed in the Central Valley Regional Water Quality Control Board has been involved in planning for an *in situ* surfactant remediation at the Department of Energy's Lawrence Livermore National Laboratory. The proposed project will be conducted at the Livermore Site 300 Superfund site, about 50 miles east of San Francisco.

The site is characterized by channel deposits underlain by thick sandstone and claystone deposits. There are four primary

hydrogeologic units: a shallow isolated, perched water bearing zone; an unsaturated perching horizon; a claystone aquitard; and a deep uncontaminated regional aquifer. The site is contaminated with high levels of volatile organic compounds (VOCs), specifically trichlorethene (TCE). TCE, mixed with a silicone-based lubricant (TBO), was used as a heat exchange media in military production. The plume is relatively concentrated near the source area. Researchers believe that the perched zone represents a good opportunity to test innovative technologies.

The proposed surfactant injection will be used to initially solubilize the contaminants, followed by phase focusing on mobilization. The project should provide proof of the concept, as well as the opportunity to demonstrate a separation technology. Preliminary partition tracer tests were conducted in November 1995; the appropriate surfactant will be selected in January 1996, and the surfactant test is planned for March 1996. Participants include the Department of Energy, Lawrence Livermore National Laboratory, California's Department of Toxic Substances Control, the Central Valley Regional Water Quality Control Board, U.S. EPA Region 9's Hazardous Waste Management Division, the EPA Subsurface Protection and Remediation Division of the National Risk Management Research Laboratory (formerly R.S. Kerr Environmental Research Laboratory), and researchers from the University of Oklahoma.

In our interview with Susan Timm of the Central Valley Regional Water Quality Control Board, we learned that LLNL had not made a formal application to the State, but had contacted RPMs involved at the site more than six months ago to begin discussions of the project. The State has been pleased with the level of interaction and is quite interested in the possibility of using a perched area for a demonstration of surfactant technology. According to the State of California, the most important technical information they need from the other parties includes certainty of hydrogeologic control (both surfactant and tracers), and the understanding the interaction of the surfactant with the contaminant and the media. The State also must be convinced that the monitoring system is adequate to answer these questions.

In California, surfactant proposals would be reviewed using procedures established for other types of remedies, which are based on modeling, empirical data, and technical knowledge. The Department of Toxic Substances Control also has regulations for underground injection of hazardous waste that may result in a need for a permit (This has not been at issue for the present project, as it is a Superfund site). Also, for the LLNL project, a public meeting was held as part of the CERCLA process, but citizen concerns focused on the overall cleanup rather than on the small section where surfactants are proposed.

State regulators in California are aware of the potential benefits of surfactants, but concerned about hydrologic control and possible reactions with other contaminants. Although this project has not yet been conducted, she said that the State would probably require further action (probably pump-and-treat) if no results are gained from the surfactant project.

Ms. Timm thought that both training and guidance from EPA would be of benefit. A number of people in the State office who haven't been involved in following surfactant research would be very interested to learn more. She recommended that training also focus on the private sector. This is especially important because private parties are the source of technology decisions, state regulators do not generally propose specific

solutions due to liability concerns, but do give final approval.

Colorado

The Colorado Department of Health and Environment has reviewed one proposal for a surfactant remedy at a petroleum facility in Loveland, Colorado. This was a corrective action for a leaking underground storage tank site, and the remedy was rejected. However, Mark Walker, whom we talked to, explained that in Colorado, the facility can be reimbursed for any technology that is demonstrated as technically and economically feasible. In this case, the State not only had to approve the project, but literally to pay for it.

The proposal review process took from four to six months, and consisted of review of the site assessment documents and corrective action plan to remediate a gasoline leak from the leaking underground storage tank. The State's concerns in this case focused on the chemical makeup of the surfactant, which was a proprietary product. The State requested a sample of the surfactant that was analyzed by a State laboratory. They found two problems: the surfactant itself contained hazardous components (e.g., benzene, toluene) and the laboratory had a problem in quantifying the surrogates. This was considered problematic in that it would mask detection of the contaminant at the point of compliance.

The State encouraged the applicant to conduct a pilot scale test that compared the surfactant to a clean sample, a sample contaminated with diesel fuel, and a fourth sample with both diesel fuel and the surfactant, and analyze for total petrol HCs. Finally, the contaminant source was largely in the soil rather than the ground water, and the State was concerned with the idea of cleaning the soil by moving the contaminant into ground water. Alternatives that addressed removing the contaminant directly from the soil were not considered.

Technology Description (1)

The application of surfactants can enhance remediation by increasing contaminant mobility and solubility to improve pump-and-treat performance; by decreasing the mobility of contaminants to prevent their migration; and by speeding the rate of biodegradation of contaminants in soil.

Surfactants increase contaminant removal by increasing the apparent solubility of the contaminant in water which improves the mass removal per pore volume. They may also be used to reduce interfacial tension between the water and the contaminant. This requires greater surfactant concentrations than those needed for increasing solubility, but results in direct mobilization of NAPLs, which may allow them to be extracted more efficiently. However, if uncontrolled, increasing the mobility of the NAPLs also increases the risk of increasing the contaminant plume.

Other technical issues of concern include the need for very good hydrologic control as demonstrated by monitoring wells, slug tests, and flow direction, as well as adequate confidence in the ability to detect problems at the point of compliance. It would be preferable that there be no immediate downgradient receptors.

Mr. Walker was quite interested in the possibility of training or guidance on a national level. He suggested that EPA should be involved in conducting research to determine which surfactants are best in particular situations. Guidance should focus on an impartial test of surfactant reliability and performance. The State would also be interested in EPA guidance on "how clean is clean." Training should be modeled on a recent workshop called the Strategic Technical Exchange Workshop. In this training, instructors, regulators, and the regulated community met together and in break out sessions to discuss specific techniques.

Pennsylvania

Jim Shaw discussed the State of Pennsylvania's experience in reviewing and approving a pilot study to evaluate the use of surfactants for remediating PCBs at the Delmont Site in Westmoreland County. The State received a work plan and MSDS (Material Safety Data Sheets) sheets from the company with toxicity information on the proposed surfactant. The information submitted was adequate, but delays were caused since this was the first such proposal and the State did not have procedures in place to review it. Eventually, the information was reviewed by a hydrologist, an aquatic biologist, and a toxicologist. Mr. Shaw said that he coordinated with the Bureau of Water Quality to find the proper staff. Another problem involved proprietary information regarding the surfactant itself; however, this was overcome by the MSDS information.

According to State staff, there are no legislative or public barriers to the use of surfactants in Pennsylvania. Proposals are reviewed on a case-by-case basis; and approval is determined on the basis of technical merit. It is possible that future proposals would also be reviewed by State UIC staff as well.

Pennsylvania has recently enacted new cleanup legislation that should make the remediation process easier at a number of sites. The law incorporates generic remedies, background levels, and the development of site-specific standards as options. Each region in the State will have responsibility for sites in that area. Review of proposals will be contingent on the availability of technical resources and management priorities, but there is a requirement for a 60-90 day turnaround on remedial projects. Mr. Shaw thought the effect of the new legislation would be to make it easier to implement innovative technologies.

State staff in Pennsylvania would benefit from a conference or training course on surfactants. Mr. Shaw noted that it was difficult to locate staff with familiarity with the topic. The best approach would be a series of regional conferences provided by EPA. Guidance on how to implement surfactant demonstrations, focusing on the process and options, also would be helpful.

Kentucky

The Department of Energy's Paducah Gaseous Diffusion Plant has numerous contaminated areas (200 potential release sites or solid waste management units). TCE used for cleaning metal and machinery parts has been identified in ground water plumes both to the northwest and northeast of the site. (Other contaminants include the radionuclide technetium-99, uranium, PCBs, chromium, and other substances in both soil and ground water.)

The Commonwealth of Kentucky approved a proposal for a surfactant demonstration to facilitate removal of TCE in a small area (about 200 square yards). Although there were no specific permit requirements or regulations that were applicable to the site, DOE submitted a work plan to EPA for review under UIC regulations. Kentucky's Division of

Waste Management has an arrangement for technical support from the University of Kentucky, where their Federal Facility Oversight Unit is located. Therefore, even though this was the first such request, technical staff were available to review the proposal within three to four weeks.

One problem identified by Randall Thomas of the Federal Facility Oversight Unit was that DOE was not convinced that the State was supposed to review and approve the proposal. If DOE had involved the State earlier in the process, a better working relationship most likely could have been established. Also, by the time the Federal Facility Oversight Unit became involved, DOE had strict time schedules to initiate the demonstration. The contractor doing the work was willing to work for free in order to show DOE their capabilities, but delays would have made this impossible.

The proposal contained no major technical difficulties and approval was granted initially based on technical merit. However, the contractor did not want to disclose much information about the surfactant. The compound initially proposed contained a hazardous waste component and later a different surfactant was substituted. The Commonwealth also was concerned with mobilizing the DNAPL (dense, non-aqueous phase liquid), since this may result in DNAPL moving deeper into the aquifer.

Unfortunately, the demonstration did not turn out as planned. The contractor was unable to recover all of the surfactant, some of which either moved downgradient or was bound up in the matrix. Mr. Thomas identified a number of possible reasons: they did not pump aggressively enough; there was not enough geologic testing in advance of the demonstration; and possibly they used the wrong surfactant. In spite of these problems, Mr. Thomas remains enthusiastic about using surfactants to enhance pump-and-treat remedies. The Commonwealth would like DOE to try again, and DOE has not ruled out this possibility.

Mr. Thomas also noted that training for both the regulators and the regulated community is essential. People need knowledge about the process and how to use it; however, he thought it may be too early in the development of the technology for EPA to provide guidance.

Utah

A number of remedial projects are ongoing at Hill Air Force Base in Utah. Surfactant-based technologies will be included as three of eight field demonstrations in one project led by researchers from the University of Oklahoma at Operable Unit 1 (OU1). A project at OU2 is being conducted by researchers from the University of Florida and the U.S. EPA Subsurface Protection and Remediation Division of the National Risk Management Research Laboratory in Ada, Oklahoma. Both projects were discussed in the State regulator's interview.

Hill AFB is designated as a Superfund site. Other partners in the projects include U.S. EPA, Region 8; the Utah Department of Environmental Quality; and Hill AFB. The purposes of the studies are to evaluate innovative remediation technologies for the removal of NAPL or constituents in NAPL from saturated and unsaturated soil; and to conduct treatability studies of these technologies for remediating LNAPL contamination. For the OU1 project, field demonstrations will be executed inside a test cell constructed to hydraulically isolate the investigation area and minimize migration of fluids from the cell. Participants hope to make preliminary assessments of the long term effectiveness of the technology and to develop

basic cost factors that can be used for cost estimates for full scale application.

Technology Description (2)

Cationic (positively charged) surfactants have been shown to improve the capacity of soil to sorb hydrophobic organic contaminants, such as polyaromatic hydrocarbons (PAHs). Other research suggests that low concentrations of surfactants may be useful for enhancing *in situ* biodegradation of hydrophobic pollutants.

Our interview was with Duane Mortensen of the Utah Department of Environmental Quality, and with one of his staff members who is a State Project Manager at Hill AFB. The application was reviewed in six months. The most important technical information included in the proposal from the State perspective was information regarding the expected effectiveness of the technology (*e.g.*, as demonstrated through treatability studies), how well the containment system was designed, and the type of chemical to be used. The State Ground Water Quality Protection Rule specifies levels equal to Maximum Contaminant Levels (or, in some cases where ground water has not been impacted by contamination, specified percentages of MCLs) as a standard for the concentrations of injectant. A State applicable or relevant and appropriate requirements (ARAR) waiver would be necessary for full remediation.

While there were no technical deficiencies in the application, appropriate regulatory requirements of EPA's Treatability Study Guidance had to be addressed in the work plan. No UIC permit was required as this is a CERCLA site; however, one would be needed at a RCRA site. Approval of projects are based on technical merit, and state regulators suggested there were no institutional barriers, at least for Superfund sites. They did note that it would be more complicated for a RCRA site. Also, so far, no one has proposed using a proprietary product for use as the surfactant. The State noted that they would need enough informa-tion on the chemical properties of the proposed surfactant to ensure public safety.

Since this is a CERCLA site, a certain level of public involvement is required. The local Community Working Group and South Weber Landfill Coalition have been very active and involved in the overall project. So far, local citizens have not been overly concerned with treatability studies, but they would be very concerned if the Record of Decision (ROD) called for injecting some-thing with hazardous constituents. They also have concerns regarding the overall cleanup strategy at the site.

Finally, State regulators noted the impor-tance of having very good communication and coordination with all the parties involved. They have had several meetings with the Universities, EPA, and the Air Force that have helped keep the projects moving by keeping everyone informed. They suggested that others become more familiar with the State's administrative process to facilitate approval of demonstration proposals. Researchers involved in the projects agreed with these conclusions. In particular, they recommended that keeping the regulators involved throughout the process, developing work plans, and familiarizing researchers with the regulatory process are all essential steps.

<u>New Jersey</u>

At Picatinny Arsenal, TCE was used for years as a degreasing solvent and has contaminated a sand and gravel aquifer. The site was recently listed as a Superfund site and a pump-

and-treat system was installed as an interim remedy. The water table is 10 feet below the surface, and a lower confining unit 10 to 15 feet thick is another 40 feet from the water table, making the site ideal for a small scale field test.

Laboratory research indicated that a nonionic surfactant, Triton X-100, may increase the desorption rate of TCE from soil and organic materials to ground water. This theory was field tested by researchers from the U.S. Geological Survey (USGS), the University of Virginia, and the Army. The preliminary results from the field test completed in March 1995 support the laboratory research. The work will be incorporated into the site Remedial Investigation/Feasibility Study (RI/FS) and used in selection of final remedies.

The USGS designated the site as a research site, and the University of Virginia has a grant from EPA to conduct research on the site. The State of New Jersey has granted the Army a permit to discharge to ground water. State regulators were brought into the process up to a year prior to beginning the field test. According to the researchers, the State was willing to let the project go forward because the field test was being conducted within the capture zone of the existing pump-and-treat systems. Modeling studies showed that all but 5% of the ground water is being captured by the existing system.

Any discharge to ground water in New Jersey, whether it is clean water discharged from a treatment system or chemical surfactants injected/infiltrated into an aquifer, would be regulated by the New Jersey Water Pollution Control Act (N.J.S.A. 58:10A). Two sets of regulations from this Act directly apply to discharges to ground water. They are: 1) the New Jersey Pollutant Discharge Elimination System (N.J.A.C. 7:14A) and, 2) the New Jersey Ground Water Quality Standards (N.J.A.C. 7:9-6).

The New Jersey Pollutant Discharge Elimination System (NJPDES) regulations focus on the operational aspects of a discharge to ground water. They outline requirements for obtaining and maintaining permits for discharge to ground waters or surface waters of the State. These regulations also specify procedures for public comment/public notice, and requirements for constructing and operating treatment works. The New Jersey Ground Water Quality Standards (NJGWQS) focus on the classification and quality of ground water. These regulations deal with aquifer classifications, exceptions to aquifer classifications, ground water quality criteria, calculation of ground water criteria, identification of practical quantitation levels, and anti-degradation policies. Discharge limits contained in a NJPDES discharge to ground water (DGW) permit would be obtained from specified ground water quality criteria (or guidance provided to calculate criteria) contained in the New Jersey Ground Water Quality Standards.

Under CERCLA Section 121 “Cleanup Standards”; federal, state, and local permits are not required for the portion of any removal or remedial action conducted entirely on-site. However, also under Section 121 is the requirement for remedial actions to at least attain legally applicable or relevant and appropriate federal and state standards, requirements, criteria, or limitations (*i.e.*, ARARs), unless such requirements are waived.

The State of New Jersey does not waive requirements, and ARARs must be met at publicly-funded and Federal CERCLA sites. ARARs include the Technical Requirements for Site Remediation, N.J.A.C. 7:26E-6.1(b)3, which require a responsible party to meet the equivalent of a permit's conditions; however, a permit number is not issued nor is a permit fee required. The surfactant injection project at Picatinny must meet the equivalent

requirements that the Department would set for any request for a permit to inject to ground waters of the State. The NJDEP utilized a "Permit by Rule" approach to facilitate the surfactant injection project while meeting regulatory requirements.

At the NJDEP, contaminated sites are identified, assessed, scored, and ranked. Depending on the ranking and the regulatory program, the site is assigned to a Bureau which appoints a case or site manager to handle the case. For sites with substantial ground water and soil contamination, a full case team is usually assigned. A full case team consists of the case manager, a technical coordinator (responsible for evaluating soil data, QA/QC, and related technical issues), and a geologist. The case team operates as a unit under the direction of the case manager.

For discharges to ground water, the purpose of a NJPDES permit is to ensure the protection of human health and ecological receptors. However, NJDEP modified its NJPDES regulations in September 1994 to ease the administrative permitting requirements for certain discharges to ground water. These include discharges related to pilot studies, aquifer testing, or other discharges to the ground related to monitoring, engineering, or design needs.

The following approach would likely be followed at the NJDEP to allow surfactant injection to be considered and implemented. As with any proposal to test a specified remedial approach, a responsible party or their consultant should inform the NJDEP case manager that they would like to evaluate the feasibility of surfactant injection. The case manager would require submittal of a proposal outlining the details and nature of a requested discharge. This proposal should provide all technical data to allow the Department to fully review it, including where will the discharge occur, what is the nature of the discharge, expected concentrations, flow rates, duration of the discharge, static ground water flow velocities and directions, health and safety provisions, sampling/monitoring plans).

As discussed above, for pilot studies or aquifer tests, NJPDES regulations now authorize using a "permit by rule" for a discharge to the ground. The permit by rule is simply a letter and no public noticing procedures are required. Adequate monitoring of the discharge, ground water quality, and hydraulic conditions would be required through whatever regulating mechanism or oversight document is driving the remedial work, not as part of the permit by rule. The permit by rule would include effluent limits based on specific criteria found in the Ground Water Quality Standards for the aquifer classifications receiving the discharge.

Discharges occurring outside the limits of a capture zone must meet "anti-degradation limits" (as discussed in Section 7:9-6.8 of the NJGWQS). These limits are designed to prevent any further degradation of ground water quality from a regulated discharge. Higher discharge limits may be allowed, on a case by case basis, if the discharge is occurring within the limits of hydraulic capture, or if the Department determines it is appropriate to issue a Classification Exception Area (CEA). For a full scale system, a formal NJPDES-DGW permit would be issued, except for on-site discharges at CERCLA sites, in which case a "Permit Equivalent" would be issued. Currently, submittal of formal application forms is not necessarily required for Permit Equivalents for a discharge to ground water.

Training on surfactant chemistry and processes would be beneficial for future decision making; however, New Jersey has drastically cut back on training due to resource limitations, and staff would be able to attend only if training is offered free of

charge. Guidance would also be helpful in integrating information on surfactants, and should focus on State concerns and how these can be mitigated.

Texas

EPA has identified one completed demonstration of surfactant technology for hazardous waste remediation in Texas. “In Situ Remediation Technology Status Report: Surfactant Enhancements” describes a pilot test of use of a surfactant to facilitate removal of carbon tetrachloride at the Corpus Christi Dupont site in 1993. The demonstration showed positive results. No current projects in Texas have been identified; however a number of companies are looking into the technology, and a pilot project is being considered at Kelley Air Force Base.

Gary Beyer of the Texas Natural Resources Conservation Commission's Federal Facilities Team, discussed some of the technical information requirements and regulatory requirements for conducting a demonstration. His office deals with corrective actions under the RCRA program. The time to review a proposal for a Corrective Measures Study would likely be about one month. A Class 5 UIC well permit would be required, but could be obtained from within their office. The most important technical data for the proposal would be hydrogeological data explaining recovery and chemical solubility data on the surfactant. A surfactant containing hazardous constituents would not be likely to be approved.

Pilot studies can be approved under the State Risk Reduction rules through a letter permit as part of the normal corrective action process. No public hearing would be required for a pilot study. However, a full Corrective Measures Investigation under RCRA does include a public participation requirement. The proposal would be reviewed by staff hydrogeologists and toxicologists. The requirement for an injection permit would be the main regulatory issue.

There would be a good deal of interest in training on surfactant use, especially for remediation of TCE. The State's Innovative Technology Program has offered vendor presentation days that have regulators become familiar with the technology. Because of travel restrictions, training or a workshop in Austin would be the best venue. Written guidance would also be welcome.

Conclusions and Recommendations

The survey of state regulators indicated that there is a great deal of variety in approaches and procedures relevant to gaining approval for demonstrations of surfactant technology. For this reason, it is difficult to make generalizations about how states can best be approached. As demonstrated by the projects discussed in the report, it is clear that opportunities do exist. Typically, proposals have been reviewed on a case by case basis and rejected or approved on the basis of technical merit. However, the states are not monolithic. Different agencies within the states may be responsible or involved in reviewing a surfactant application, and some effort may be involved in determining which State office has regulatory jurisdiction. Moreover, the technology is still in a relatively early stage of development for use in remediating hazardous waste, and states are doing their best to keep up. Many questions remain about the technology itself, such as:

- Which surfactants should be considered for particular contaminants?
- Will geochemical interactions with other contaminants be a factor?
- How can you ensure the surfactant will not remain in the matrix? and
- How do you know when you've been successful?

Given these caveats, it is possible to draw some conclusions based on experiences.

Time Required to Review Proposal

None of the states included in the survey had a specific procedure in place for reviewing proposals for surfactant projects. Most states have more general procedures for review and approval of pilot projects or demonstrations of innovative technologies, and these may require a broad range of time. In general, researchers or others proposing a demonstration should plan from one to six months for state review of surfactant proposals. States where pilot studies can be approved and permits issued by rule or letter are likely to take less time.

In some cases review of proposals was delayed because of the need to locate appropriate experts for the review within the state office and because of the need to coordinate among state offices. Types of experts who are likely to be involved in the state review include: hydrogeologists, toxicologists, and possibly others. Suggestions for reducing the amount of time required for state review included knowledge of the regulatory process by those preparing proposals and adequate technical information included in the submission (see below). Training, technical support, or a national directory of experts might also be useful.

Format and Technical Information Requirements

The survey identified state concerns about the toxicity of the surfactant, masking effects, transfer of contaminants from soil to ground water, satisfactory hydrologic control, and adequate monitoring to ensure that processes taking place in the subsurface are understood. In particular, state regulators need to be convinced that use of surfactants will not make the situation worse, that NAPLs are not mobilized without being recovered, and that the surfactant itself can be recovered or remediated.

Information that should be included in the proposal includes:

- A detailed work plan for conducting the project including objectives,
- Comprehensive site characterization information (including water levels and monitoring well data),
- Background information on laboratory studies or other field demonstrations showing the efficacy of the proposed approach,
- Demonstration of hydrologic control over the test site to ensure that surfactant will not be lost, nor NAPLs simply moved further into the matrix,
- Surfactant chemistry and contaminant geochemical interactions, and
- Demonstrated monitoring capabilities.

Barriers to Approval

Underground Injection Control (UIC) regulations are not applicable at Superfund sites and appeared generally not to be considered a serious problem in States that have approved surfactant demonstrations. Permits were not typically required for pilot tests, and the UIC staff were simply kept informed of the surfactant activities. However, UIC permits may well be required for full remediation or even for pilot studies at RCRA or private sites. There are also differences in regulatory requirements based on whether the site is regulated under RCRA or CERCLA, and whether it is a Federal Facility, a Superfund, State, or private party lead. There appear to be fewer restrictions at a Superfund site.

In some states, water quality standards would prohibit use of surfactants that contain Safe Drinking Water Act-listed constituents at

concentrations above the MCL. Waiver of state ARARs may be needed for large scale implementation at a Superfund site. Public disapproval has not generally been a problem for small scale demonstrations, but it could become a concern for larger remedial efforts.

Training and Guidance Needs

Seven of the eight individuals interviewed recommended training in surfactant use and processes for state staff. Most also mentioned that the public needs training as well. The preferred format was a series of regional workshops that would be close enough to state capitals to minimize travel costs, and that would include researchers, regulators, and the regulated community.

Guidance on surfactant use would also be welcome, especially as a substitute or addition to training, but some of those interviewed admitted that it may be too early in the development of the technology for EPA to be able to write useful guidance.

Recommendations

Researchers or others interested in gaining state approval for a surfactant pilot test or demonstration project should consider the following recommendations based on lessons learned by previous proposals:

- All relevant parties should be brought into the process early and kept informed of project progress. Communications with all partners, and especially state regulators, is critical to the process.

- Researchers and others proposing surfactant demonstration or remediation projects need to be well versed in the regulatory process, and should become familiar with the state's regulatory and administrative procedures. This will frequently determine whether or not specific permits are needed, and the specific format the proposal should take to facilitate approval.

- Surfactants about which considerable chemical data is known and those that do not contain hazardous constituents are the most likely to be approved. The use of proprietary products will make approval more difficult in most cases.

- EPA should consider developing training or technology transfer workshops for state staff and the public sector.

As the technology for surfactant enhancements develops, more is learned about which surfactants are least harmful and most efficient, and cost and performance data become available, the approval process in the states can be expected to improve.

Notes

1. "*Workshop on In Situ Surfactant Use*", sponsored by U.S. Environmental Protection Agency, Technology Innovation Office, Kansas City, Missouri, September 1995.

2. "In Situ Remediation Technology Status Report: Surfactant Enhancements", U.S. Environmental Protection Agency, Technology Innovation Office, Washington, DC, EPA542-K-94-003.

3. EPA's Technology Innovation Office will publish the results of this study in early 1996.

Appendices

State Regulators' Interviews
Surfactant Injection for Ground Water Remediation

List of Participants:

STATE	NAME	SITE	PHONE	INTERVIEW
AK	Jonathan Williams U.S. EPA, Region 10 1200 Sixth Street (WD132) Seattle, WA 98101	Refinery on Kenai Penninsula (UST Site)	206-553-1369 Fax 553-1280	Aug. 31
CA	Susan Timm Central Valley Regional Water Quality Control Board 3443 Routier Road, Suite A Sacramento, CA 95827	Lawrence Livermore National Laboratory	916-255-3057 Fax 255-3015	Aug. 31
CO	Mark Walker Colorado Department of Health and Environment (HMWMD-RP-B2) 4300 Cherry Creek Drive, So. Denver, CO 80222-1530	1 site where surfactants being used at an UST site	303-692-3449 Fax 759-5355	Aug. 29
KY	Randall Thomas Federal Facility Oversight Unit 14 Reilly Road Frankford, KY 40601	DOE Paduaka Gaseous Diffusion Plant	502-564-4797 Fax 564-5096	Sept. 6
NJ	George Nicholas NJ Dept. of Environmental Protection Division of Publicly Funded Site Remediation (CN 413) Trenton, NJ 08625	Picatinny Arsenal	609-292-8427 Fax 292-0848	Sept. 6
PA	Jim Shaw Dept. of Environmental Protection Bureau of Land Recyclying & Waste Management 400 Market Street (14th Floor) P.O. Box 8471 Harrisburg, PA 17105		717-783-9475 Fax 787-0884	Aug. 28
TX	Gary Beyer Texas Natural Resources Conservation Commission P.O. Box 13087, Capital Station Austin, TX 78711-3087		512-239-2361 Fax 239-2346	Sept. 6
UT	Duane Mortensen UT Dept of Environmental Quality 168 N. 1950 W., 1st Floor Salt Lake City UT 84114	Hill AFB	801-536-4172 Fax 359-8853	Sept. 12

State Regulator's Interview Guide
Barriers and Successes in Demonstrating Surfactant Injection
for Ground Water Remediation

Introduction

This is a follow-up to a survey EPA conducted last year aimed at determining what State regulations and policies are concerning the injection of surfactants, co-solvents or nutrients into contaminated ground water for remediation. At this time, we are interested specifically in procedures used in your state for reviewing proposals for surfactant injection demonstrations. EPA is aware of about half a dozen current surfactant demonstrations. EMS has been employed to assist them in conducting interviews with key state regulators who may have been involved in reviewing and approving such proposals. The goal of these interviews is to identify recommendations for future applicants that may improve the efficacy of approval.

1. Are you the appropriate persons to discuss the details of the proposal for surfactant use within your state?

   a. If not, whom should we contact?

   Name _____ Phone No. _____
   Fax No. _____

   [Thank you for your assistance]

2. What is the name and location of the site? _____

3. Can you give me the time frame during which the application was reviewed by the State?

   From: _____ To: _____

4. What would you consider the most important technical information in the proposal?

   _____

   _____

   _____

5. Were there major technical deficiencies in the application? Yes: _____ No: _____

   a. Could you describe these briefly? _____

   _____

   b. Did you request additional information from the applicant? Was this adequate?

   _____

6. Were there other, non-technical problems that caused delays? _____

   _____

a. If so, how do you think these problems can best be addressed? _____

b. Who would be in the best position to change things? _____

7. Do you have any suggestions about how the application approval process can be speeded up?

8. Do you believe that training on surfactant chemistry and processes would be beneficial for future decision-making related to permitting decisions? _____

   If yes, what recommendations do you have? _____

9. Do you think guidance for specific surfactant applications is needed? _____

10. Are there other technical or policy options that could be addressed nationally that you feel would contribute to improving the use of *in situ* surfactant enhancements in your State?

Thank you for your time. You will be given the opportunity to review our report and recommendations before they are finalized.