FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE MEETING
Arlington, Virginia
June 11, 2003

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ACTION ITEMS

- John Kingscott will examine the feasibility of expanding the content of the FRTR website to include the operation, maintenance, and monitoring of certain types of long-term cleanup technologies.
- Roundtable members will review the information provided by the two-part meeting on decision support tools (DSTs) and determine agency interest in sponsoring the development and maintenance of a DST page on the FRTR site.

WELCOME/OPENING REMARKS

Walt Kovalick (U.S. EPA/TIO) welcomed the attendees and opened the meeting of the Federal Remediation Technologies Roundtable (FRTR) with self-introductions of the participants. He gave an overview of the agenda, which concludes a two-part series on support tools and focuses mostly software that can be used for organizing remediation work, characterization, risk assessment, and cost estimating. He suggested a follow-up discussion in the afternoon concerning the desirability of compiling and indexing the content of the presentations for the website.

He remarked that he had recently been asked how a topic could become a roundtable project. It's a simple process: present the idea, the Table vets it, and three agencies (one of which is not a DoD agency) elect to support it under the FRTR umbrella.

He directed the attention of the attendees to the flyers and other handouts available at the back of the room and reminded them of the upcoming RevTech conference scheduled for July 22-24 in Pittsburgh. TIO is co-sponsoring RevTech with the Brownfields office and with assistance from Pennsylvania and New Jersey Departments of Environmental Protection. The conference focuses on brownfields revitalization with regard to site assessments, the Triad approach, RCRA corrective action, and cleanup technologies. More information is available at http://www.brownfieldstsc.org/revtech.htm.

The final Phase III report of the NATO/CCMS five-year study has been completed, and NATO has agreed to proceed with a new, but related pilot study on Prevention and Remediation in Selected Industrial Sectors. The Phase III report is available at http://www.clu-in.org.

In policy news, an initiative called the "One Cleanup Program" was announced at an Environmental Council of States (ECOS) meeting in Washington, DC, by Marianne Horinko, EPA's Assistant Administrator for Solid Waste and Emergency Response. The initiative integrates the assessment and cleanup efforts of its solid and hazardous waste cleanup programs (CERCLA, RCRA, and UST) to increase speed and efficiency of cleanups. "One Cleanup" has several key goals: (a) return the waste site to beneficial and productive use once the primary cleanup goal is accomplished, with a focus more on end use than cleanup; (b) assure more consistency and efficiency in cleanups through integration and sharing of technologies and cleanup techniques across OSWER programs; (c) make all information about any site more accessible to citizens and remediation professionals via institutional control databases and other means under development.

Ballots listing potential topics of interest were passed around, and Kovalick asked participants to rank the ones they found most interesting to help determine an agenda for the next meeting, to be held in November or December.

UPDATE: FRTR PROJECTS

Optimization Conference

Richard Mach (NAVFAC) provided a description of the three-day optimization conference planned for next year, "Accelerating Site Closeout, Improving Performance and Reducing Costs through Optimization," to be held June 15-17 in Dallas, Texas. The event is a follow-on to the 1998 optimization conference and will cover a wide range of remediation optimization topics: financial aspects, implementation strategies, remedy evaluation, data management and evaluation, long-term monitoring, and case studies of successful programs. There is particular interest in applying optimization techniques early in the remediation process to the feasibility study and technology selection, instead of waiting until after systems have been designed and are in place. The conference organizers include FRTR, EPA, DOE, the State of New Jersey/ITRC, SERDP/ESTCP, and the Navy, Air Force, and USACE. More information will be available in late summer or early fall at http://www.clu-in.org.

Cost and Performance Case Studies

John Kingscott (EPA/TIO) updated the Roundtable on the Spring 2003 additions to the cost and performance case studies and discussed proposals for expanding FRTR coverage. Kingscott credited overall management of the FRTR site to the U.S. Army Corps of Engineers, Omaha, with Jeff Breckenridge as point of contact.

The major technical components of the FRTR site include the field screening matrix, managed by the Army Environmental Center (Richard Williams, U.S. Army/AEC), the cost and performance reports, managed by Kelly Madalinski (EPA/TIO), and a compilation of multi-site remediation technology assessment reports organized by Kathy Yager (EPA/TIO). Another area has been proposed—a section for cost-predictive tools and case studies of the site data the different tools have delivered—with the rationale behind this idea to be discussed later in the program by Brian Skokan (DOE), representing the Interagency Cost Estimating Committee.

Twenty-nine new remediation cost and performance case studies by the Navy, Air Force, ESTCP, Interagency DNAPL Consortium, DOE, EPA, and different state environmental agencies have been posted, bringing the total now in the database to 342 studies searchable by contaminant and by technology. Kingscott noted that two Air Force in situ bioremediation case studies involve PRBs containing mulch as the reactive medium. Two studies cover DNAPL demonstrations performed at Cape Canaveral, and a report has been produced for DOE's Lasagna® demonstration at Paducah. Eleven new characterization and monitoring case studies from the Navy, ESTCP, and EPA have been posted, totaling 121 cases. The page for multi-site assessments of treatment technologies now contains 52 reports. An updated CD-ROM of the case study databases will be issued in about a month. Around 3000 copies of the last CD-ROM were distributed, and it proved to be an excellent marketing tool for the website. Volume 7 of the *Abstracts of Remediation Case Studies* also is in preparation. A fact sheet describing the updates was available at the meeting.

Kingscott discussed a proposal to investigate the feasibility of expanding FRTR coverage to address the operation, maintenance, and monitoring of certain long-term remediation technologies: phytoremediation, soil vapor extraction/bioventing, monitored natural attenuation, pump and treat, and containment. He will look into the value of adding documentation concerning long-term, site-specific experiences to the Cost and Performance initiative and make a report at the next meeting.

After the presentation, a participant noted that some of the case studies are lengthy and others quite brief, some are for full-scale applications and others seem to be at the pilot-scale or demonstration level: are there guidelines that specify what belongs in a cost and performance report? Kingscott referred the questioner to *The Guide to Documenting and Managing Cost and Performance Information for Remediation Projects*, available at the FRTR website, which specifies the information that ideally will appear in each report. Walt Kovalick said that although the case studies initially were focused on full-scale remedial applications, it was decided to lower the bar and accept studies of full-scale demonstrations for fuller coverage of emerging technologies, such as phytoremediation.

Another participant mentioned being unable to find any reference to FRTR on the EPA website and wondered if TIO could make it easier to find. Walt Kovalick explained that EPA strictly limits the listing of non-EPA sites on the EPA web server, which is why a searcher must penetrate down to the TIO page to locate references to FRTR.

In reference to the expansion of coverage, another questioner wondered if FRTR might consider including sites that apply multiple technologies instead of only one. Kingscott responded that there is strong interest in such sites, but documentation so far is lacking. Kovalick added that use of multiple technologies at DNAPL sites held particular interest, but though those involved in that type of cleanup might write up the technology used on the front end to "cut off the head of the dragon," they neglected to follow up with case studies of the monitored natural attenuation or other measures used to deal with residual contamination, the "tail."

UPDATE: INTERAGENCY ACTIVITIES

DOE Reorganization

Mac Lankford (DOE/EM) substituted for Skip Chamberlain in presenting news concerning the reorganization of the EM Science and Technology Program. The Technology Focus Areas (e.g., tanks, subsurface contaminants, decontamination and decommissioning) were closed out at the end of FY 2002, and the program, now referred to as the Technology Development and Deployment Program, has moved away from broad-based research ranging from basic to applied science to concentrate on near-term technology development and deployment. The program has been realigned to address a limited number of high-risk, high-cost problems structured around two new thrust areas: (1) site closure support, and (2) alternatives and step improvements to current high risk/high cost baselines at the larger facilities.

The first thrust area will assure that Closure Sites such as Rocky Flats and Ohio have the technology and technical support needed to meet their 2006 closure schedules. This initiative also will provide technical support to improve baselines and schedules at all small sites by providing a dedicated budget to assure that necessary resources are available and establishing a multidisciplinary, hands-on technical team to help solve cleanup problems and assist site closure. The team will visit sites that request

assistance to provide advice on approaches to resolving technical issues that might prevent the site from closing on time.

For the second thrust area, EM has established a focused HQ-directed program to address alternatives to current baselines at the more complex sites and identified technology areas where an aggressive investment strategy will realize the greatest benefits. These actions have been taken to ensure that cleanup goals can be accomplished at reasonable cost and on schedule, with reasonable, workable alternatives available for use as DOE's accelerated cleanup program progresses. DNAPL remediation and tanks containing high-level wastes are problem areas of high interest. The program will fund 10 to 15 Alternative Projects at a time. The presentation identified the current projects:

- Carbon tetrachloride source term location (Richland). Contractors have been selected to model the large plume and validate it with field measurement.
- Cleanup of TCE under buildings with particular interest in deeper-reaching technologies to remediate ground water (Paducah).
- Accelerated risk reduction of chlorinated ethenes using monitored natural remediation subsequent to source removal (Savannah River). The ITRC is involved with this effort.
- Tank high-level waste immobilization (Hanford).
- Stepwise optimization of the low activity waste vitrification process (Hanford).
- Next generation low activity waste melter (Hanford).
- Medium and low curie waste pretreatment (Hanford).
- In situ stabilization of tank heels (Hanford).
- Disposition of high-level salt waste (Savannah River).
- In situ TRU waste delineation and waste removal (Richland).
- Next generation tank farm caps (Richland).
- Deposit removal at gaseous diffusion plants (Portsmouth).
- Shipment of TRU materials to the Waste Isolation Pilot Plant; examining large containers of hazardous wastes without having to open them (Carlsbad).

Lankford added (with a caveat as to the speculative nature of the statement) that additional reorganization is still being formulated to link technology staff and cleanup staff to take the closure emphasis and the alternative projects emphasis forward as quickly as possible.

SERDP Update

Andrea Leeson (SERDP) presented information on the development of decision support software tools and programs to develop guidance documents.

The project led by Karla Harre (NFESC) and Kathy Yager (EPA/TIO) to apply transport optimization codes to groundwater pump-and-treat systems is wrapping up this year. The technical approach compared the result of three optimization formulations: two modeling groups applying transport optimization algorithms and one group applying traditional trial-and-error as a scientific control. The project has demonstrated that mathematical optimization is capable of identifying substantially improved solutions to field-scale problems. The transport optimization algorithms found improved solutions of 3 to 50 percent over the trial-and-error methods, with an average improvement of 20 percent. The project used the code to track the movement of contaminants, not just the flow of volumes of water. The final report should be out this summer, and a cost-and-performance report in the fall. User’s manuals, reports, codes, example input-output files, and screening tools will be posted to the

FRTR and NFESC web site, and the project leaders are investigating the possibility of web-based training for pump-and-treat optimization.

Three SERDP projects were initiated in FY 2000 concerning monitored natural attenuation (MNA) of chlorinated solvents, specifically to assess aerobic and anaerobic transformation of cis-DCE and vinyl chloride for more accurate predictions of the time required to attain end states. The fundamental work has studied the microorganisms, enzymes, mechanisms, and site conditions that favor transformation. Follow-up work has been initiated for FY 2003 to address the long-term sustainability of the process. In a four-year effort, a multi-agency team is developing an integrated protocol for the assessment of the long-term sustainability of NA of chlorinated solvent plumes. Led by Mark Widdowson with Frank Chapelle (USGS), Dave Becker (Army), Jack Perkins (ORNL), and Dan Waddell (Navy SOUTHDIV), the team will software tools and computer models in conjunction with field monitoring to develop a practical methodology to supplement existing guidance. A team from Parsons led by Doug Downey will begin working soon on the second project, a two-year effort to produce another supplement to the AFCEE MNA protocol based on advanced analysis of case studies. This guidance will focus on methods to quantitatively evaluate long-term performance of MNA at achieving remedial objectives and cleanup levels.

A study of DNAPL source zone remediation began late in FY 2002 led by Chuck Newell of Groundwater Services. It involves studying the characteristics of NA sites to determine what approach might work best given a particular type of site. It examines the impact of source zone treatment; if only part of the source can be removed, what effect does that have on a particular treatment? The project will develop a new source evaluation methodology and a source remediation cost and performance database for a variety of technologies. The methodology will be applied to the cases in the database for analysis, from which to develop general rules and a decision support system. The decision support system will allow users to simulate characteristics of a source, simulate effects of various remediation alternatives, and estimate remediation costs, benefits, and plume pattern over time. The final deliverable is due in 2005.

A multi-agency effort led by the Air Force is evaluating performance and costs associated with anaerobic dechlorination. Phase I of the project collected information on the state of the art in anaerobic dechlorination technologies. In Phase II, detailed site surveys and evaluations were conducted and given a comparative analysis. The project goal is to produce a guidance document to detail the applicable technologies, identify lessons learned, and provide cost estimating information. The results of the site survey should be posted to the ESTCP website by July 2003. The guidance document is due this September.

"Spatial Estimates of Toxic Metal Bioaccessibility at DoD Facilities" is a follow-on to a small SERDP project on the bioavailability of metals by Phil Gardine of Oak Ridge and Mark Barnett of Auburn University. They were able to correlate specific soil parameters with the bioaccessibility of heavy metals. They are incorporating the data into a spreadsheet tool that RPMs can use to assess heavy metal bioaccessibility. A guidance document will be prepared that describes how to use the spreadsheet tool and provides information on sampling and analysis protocols for obtaining site-specific measurement of soil metal bioaccessibility. It should be available early in 2004 on the SERDP website.

Following the presentation, Walt Kovalick asked if there was any concern about how state regulators will accept the new guidance documents. Leeson replied that the multi-agency group plans to work with the ITRC to introduce the guides to the state regulatory community.

NEW INITIATIVES

Overview of Groundwater Central

Skip Chamberlain, (DOE/EM) introduced Diane Roote (GWRTAC/CTC), explaining that the idea for Groundwater Central arose during the Interagency DNAPL Consortium's DNAPL remediation demonstrations at Cape Canaveral. Roote presented GWRTAC's Groundwater Central©: Groundwater Info Portal & Communication Center, which was launched in January 2003. The Groundwater Central portal is a fully integrated, multi-component system for groundwater technology information that already exists on the Internet. The website incorporates a resource database and communications center. All database and communication services can be publicly accessed for no fee. All components except the real-time discussion room can be freely accessed and viewed at any time without registration. Registration of a brief profile is necessary to post or reply to messages posted on the public bulletin board, to post events on the public calendar, to receive email services, and/or to access or use the discussion room. Registration is intended to allow provision of email (listserv) services and encourage responsible use of Groundwater Central. The portal includes the following components:

- A resource search via a "smart search engine" provides only meaningful results, i.e., results associated with groundwater. The search engine penetrates through multiple layers at source web site to provide direct links to resources, and allows a search within a search to narrow down a topic. The resources come mostly from federal sites (EPA, DoD, DOE, USGS, NSF), public/private partnerships (FRTR, IDC, RTDF, ITRC), and professional organizations (NGWA, API), with some academic, state, and vendor links. The links database contains over 3,000 records, with expansion to come.

- A public events calender lists upcoming events of interest to the groundwater community.

- Public discussion forums provide a unique opportunity to make announcements, or to informally communicate with other Groundwater Central customers who might share similar problems or who have potential solutions. There are seven forum categories: Access, Characterization & Monitoring, Contaminants, NAPL Cleanup, Physical Setting, Policy, and Remediation Technologies.

- A chat room allows incidental or scheduled discussion "chats" between any logged-in registered customers—primarily a tool to facilitate international or long-distance communication.

- Ask an Expert is provided to assist registered customers in obtaining expert opinions regarding specific technical questions in several areas related to groundwater remediation and innovative technologies. This service will begin on a limited trial basis with four experts (Drs. Terry Hazen, Kent Sorenson, Robert Puls, and Eva Davis), and will be expanded if deemed successful by all participants. The questioners will have anonymity, and a response will be provided within two weeks. Q&As of general interest will be posted on the forum.

- Tutorials are planned for the future to include presentations, slides, educational courses, and project ideas.

DOE funded the initial design of Groundwater Central and the development of its population of links to general groundwater remediation and characterization, as well as DNAPL links of interest to the Interagency DNAPL Consortium. EPA has provided funding for developing the population of general

and LNAPL links, and for future development of vapor intrusion information. GWRTAC seeks sponsors for the development of other topic areas, such as metals, explosives, and emerging contaminants.

GWRTAC has used the services of many students to locate, index, and abstract resources for the site. Support offered by other students or interns will be very welcome. The portal is available at http://www.groundwatercentral.info/

When asked how GWRTAC has promoted or advertised the website, Roote responded that it had been announced in TIO's Tech Direct and presentations had been made to the RTDF LNAPL team and at the Tri-Services Environmental Technology Symposium in March. She is ready to make further presentations at any suitable venue.

Interagency Cost Estimating Committee

Brian Skokan (DOE) presented an overview of the history and mission of the Environmental Cost Engineering Committee (EC^2) with the objective of lobbying for a Cost Engineering Interest Area within the FRTR. EC^2 has worked cooperatively with FRTR in the past on the Screening Matrix and on the guides for cost element breakdowns. EC^2 would like to see a Cost webpage that identifies cost estimating contacts, tools, and projects and gathers other cost estimating information, interagency cost data, and cost analysis case studies. This cooperative effort would make more cost estimating expertise available to FRTR and more data available to EC^2 for the further development of tools.

EC^2 strives to provide agency leadership in promoting sound cost estimating practices and techniques by promoting advanced tools, sharing lessons learned, and providing training. The Committee has developed many useful products:

- *Guide to Developing & Documenting Remedial Alternative Cost Estimates During the Feasibility Study* (2000) – updates and clarifies previous EPA guidance for developing and documenting complete and accurate remedial alternative cost estimates during the feasibility study. Available at http://www.epa.gov/superfund/resources/remedy/costest.htm.

- Environmental Cost Element Structure (ECES) – an organization system for standardized environmental costs that can model a project-specific work breakdown structure and track project costs for environmental restoration, waste management, and facility decommissioning and dismantling projects. Skokan will send a copy of the 2002 ECES manual and dictionary to anyone who requests them.

- Historical Cost Analysis System (HCAS) – a database of cost information on hazardous, toxic, and radioactive waste (HTRW) projects.

- Remedial Action Cost Engineering Requirements (RACER) system, TankRACER, and potential future Enterprise RACER – PC-based tools for programming remediation cost estimates for well-developed and documented technologies.

- Extensible Markup Language (XML) standards – a bridge platform for leveraging cost model development via the sharing of cost items, assemblies, models, and data.

- CostRisk – a risk analysis program applied to determine the amount of contingency needed to provide a certain level of confidence in an overall estimate.

- Micro-Computer Aided Cost Estimating System (MCACES/M2) – a multi-user software program used to prepare detailed construction cost estimates for military, civil works, and environmental projects.

- Area Cost Factors –developed specifically for HTRW environmental remediation work to adjust cost data from one location to another at 29 locations across the country.

- Decontamination & Decommissioning (D&D) Models – cost models developed by DOE for sampling and analysis, surface decontamination, site characterization, final site survey, and segmenting and dismantling of structures in the remediation of fixed nuclear facilities; six additional models in development.

- Munitions Response Modules – a proposed mapping between RACER technologies and integrated CERCLA phases for UXO identification and removal.

At the end of the presentation, a member of the audience remarked that it seemed RACER was the tool to be adopted, but the Navy had its own accredited tool, Cost-to-Complete. Skokan responded that he was not proposing to highlight any single cost estimating tool or group of tools on the Cost webpage. Other comments referred to the need for standardized cost elements to refer to when entering data for the Cost and Performance Reports, the desirability of listing a contact/proponent for every tool included on the Cost webpage, and the hope that the content of the site be comprehensive, not restrictive.

EPA, DoD, & DOE Study on PRBs

Bob Puls (EPA/ORD) described the permeable reactive barrier (PRB) performance evaluation initiative undertaken in 1998 by EPA, DOE, and DoD at eight sites. The purpose of the three-year effort was to determine how well and how long each elemental iron PRB was likely to function once in place. The eight sites were selected from a larger group because they had the most complete data. The elements of the study included geochemical modeling and geochemical, microbiological, and hydraulic evaluations. The team found that the hydraulic evaluation – water levels, flowmeters, slug test, tracer studies – identified the most constraining factors in terms of PRB efficacy, with water level measurements the best indicator of bulk flow and performance in terms of capturing the plume.

Puls illustrated his points with examples from the PRB site at Elizabeth City, NC. The study indicated a general need for improvement in the design and installation of monitoring networks. Puls noted that plume concentrations might vary spatially, seasonally, or progressively over time, which should be a major factor considered in the design and placement of a PRB. This variability makes it important to model a range of hydraulic scenarios at a site, and not to use just the average hydraulic property values in the design.

Geochemical tools were employed to analyze what was happening to the iron over time. Mineral or biological buildup usually occurred within the first 10 centimeters of the iron, or immediately upgradient of the iron. The team was able to see that the buildup was correlated to the groundwater

chemistry and the flow area; with these two pieces of information, it begins to be possible to predict how long a PRB will perform.

Tremendous variability was noted in microbial populations at the different sites, with the highest biomass accumulation occurring at the Denver Federal Center. The pores in samples of the iron were not just plugged, they were cemented with sulfur and microbial biomass. Interestingly, some of the minerals that formed in the system also acted to reduce the contaminants.

Puls summarized his presentation with the following points:

- Adequate site characterization –especially hydraulic characterization – is imperative for successful design.
- Low-flow or passive sampling approaches work best, and their frequency can be decreased over time.
- Geochemical parameters as early warning indicators of decline in performance were not documented.
- Extra care must be taken to insure good hydraulic connection between aquifer sediments and the PRB in fine-textured formations.
- Lifetime estimates generally exceeded 10 years, with some exceeding 30 years.

He concluded that they are still looking for a "dipstick" indicator of PRB performance, but so far it seems best to continue to examine water levels and COCs as indicators. The findings will be published. A summary report has been put through peer review recently. The three agencies also will publish individual reports for their own PRB sites.

A questioner asked why the team chose to examine porosity rather than hydraulic conductivity. Also, were any geophysical methods used in the evaluations? Puls replied that porosity was the focus because it was easier to accurately quantify relative to the degree of uncertainty in appraising hydraulic conductivity. No geophysics played a part in the exercise.

DECISION SUPPORT TOOLS FOR REMEDIATION

Introduction and Review of DSTs

Terry Sullivan (DOE/BNL) presented a brief introduction to decision support tools (DSTs). Decision support is the process of combining experience, data, and problem-specific knowledge with the analysis and integration of information (e.g., cost and risk variables) to enable decision-making. The tools can help provide the basis for making decisions, but understanding of the subject matter is essential to the process. The tools can identify realistic options, integrate information and pick out key variables, establish a management process, and optimize a solution within the regulatory framework. Sullivan urged the assembly to keep the following questions in mind while listening to the day's presentations:

- What are your needs for decision support tools with regard to site characterization, risk assessment, remedy selection, and remedy optimization?
- What needs more or less emphasis?
- What are the technical and institutional limitations to implementation of these tools?
- What would help your institution overcome its limitations?

Adaptive Sampling and Analysis Techniques in Support of Precision Excavation

Robert Johnson (DOE/ANL) discussed the benefits of an alternative sampling and analysis approach over that of a standard sampling program (see Attachment A). Sampling programs are key components of the entire environmental restoration process, but standard sampling and analysis programs are expensive and can delay the investigation because the samples are sent off site for laboratory analysis. The alternative approaches go by many names – expedited site characterization, directed sampling, the Triad approach – but they share common themes: systematic planning, dynamic work plans, and "real-time" methods that can cut costs significantly. Real-time data collection methods are becoming increasingly common and allow data to move more quickly from interpolation to interpretation. The real benefits come from being able to focus your dollars more effectively. Joint Bayesian/geostatistical methods provide one approach for guiding discrete sample collection to infer the contamination status of large areas using limited data points. Non-parametric techniques are of particular value for scanning technologies and can provide 100 percent coverage of a site surface.

Adaptive sampling techniques have been applied successfully at numerous federal sites. Johnson supplied as an example a remediation case study of the Ashland 2 FUSRAP site, a dump site for radioactively contaminated soils. When the Corps took over the site from the original contractor, the baseline estimate of 14,000 cubic yards of contaminated soil was off considerably from the actual total of over 40,000 cubic yards, though an extensive Remedial Investigation had taken place.

The Corps implemented its own real-time data-gathering program. Data gathered from a Gamma walkover guided the work and enabled precision excavation of only contaminated soil. The Gamma walkover data were collected, processed, and disseminated daily, and allowed workers to divide the surface into three categories: clean, contaminated, and uncertain. The method worked well and very little clean soil was excavated and shipped. The difference between the footprints of precise excavation and earlier characterization data were significant: 4,000 cubic yards would have been excavated unnecessarily and 8,000 cubic yards would have been missed if excavation had been based on the earlier RI data.

The approach saved both time and money: surficial soil lifting could take place shortly after the Gamma checker walked over it, with excellent discrimination between clean and contaminated soil. The walkover and data analysis cost about $200K, and the Corps estimated total cost savings of better than $10M from waste stream minimization. Money was spent on remediation, not more studies. The data collection techniques provided assurance that contaminated soil had been removed, with no final status survey surprises. The program also provided documentation and justification for the 45,000 cubic yards of soil removed, an important factor when the cost of removal far exceeds the original budget estimate. The website where project data and other information were disseminated was critical to the success of the project. All participating parties – state regulators, the Corps, and the contractor – had access to real-time information.

After the presentation, a member of the audience asked if it had been difficult to get the regulators to go with the program. Johnson replied that the Corps had involved the regulators in the project in its early stages, and they had no problems with the approach. The contractors, on the other hand, were initially uncomfortable with the flexibility of the approach because they were accustomed to a predetermined schedule and concrete plans, and they took some time to adjust.

Visual Sampling Plan Case Study

Kelly Black (Neptune & Co.) presented a Visual Sampling Plan (VSP) case study set a site contaminated with Cesium-137 (see Attachment B). She has used VSP in the characterization of several sites.

VSP is a software developed at Pacific Northwest National Laboratory with partial support from DOE, EPA, and DoD. It provides statistical solutions to sampling design in a user-friendly visual interface, while answering two important questions in sample planning:

How many samples are needed? and
Where should the samples be taken?

The answers to these questions determine how much the effort will cost. The software has recently been integrated with FIELDS software, and allows excellent visualization of a site and some after-the-fact data analysis, but it is designed primarily for getting ready for data collection. The software allows site maps to be imported.

The Cs-137 site had been remediated; the purpose of sampling was to verify that remediation goals had been attained so the site could reach closure. A sister site that had been cleaned up and verified with three different sampling and analysis methods provided data for a standard deviation. The methods compared were HPGe fixed laboratory analyses, sodium iodide (NaI) 10-second walkover field counts, and NaI 30-second walkover field counts.

The engineers chose to assume that the site was dirty so that they would have to prove that the site was clean to be able to say they had attained the cleanup standard. Black showed the VSP screens on which to enter the applicable data for HPGe sampling: a false positive rate of 0.05 percent, a false negative rate of 0.20 percent, a gray region set at 0.31, the action level at 6.2 pCi/g, and an estimated standard deviation derived from data supplied by the sister site. VSP responded that given these parameters, 14 HPGe samples would be required at a total cost of $2800. For the NaI 10-second and NaI 30-second methods, the results were 1046 samples at $1569 and 95 samples at $285, respectively. The investigators undertook grid sampling using the NaI 30-second field count and verified that the site was clean.

Black noted that VSP is an excellent tool, but almost too easy to use in error. She recommends that any potential user take the training course beforehand. The VSP software is available for download at http://dqo.pnl.gov/vsp.

SADA Case Study

Christopher Welsh (University of Tennessee) offered an overview of Spatial Analysis and Decision Assistance (SADA) software and discussed applying it to model wildlife exposures at a PCB-contaminated dump site (see Attachment C).

SADA is free Windows-based software that incorporates tools from environmental assessment fields into one problem-solving environment. These tools include integrated modules for visualization, geospatial analysis, statistical analysis, human health risk assessment, ecological risk assessment, cost/benefit analysis, sampling design, and decision analysis. The capabilities of SADA can be used independently or collectively to address site-specific concerns when characterizing a contaminated site, assessing risk, determining the location of future samples, and designing remedial action. The software self-documents all assumptions in an HTML format that can be exported to a word processor.

At a sinkhole site where lighting ballasts had been dumped, SADA was used for modeling wildlife exposures to PCBs. The investigators concentrated on a carnivore, the long-tailed weasel. From tissue concentration, they were able to extrapolate the diet of the weasel and the diet of its prey and use the model to set bioaccumulation factors. The spatial modules showed how doses varied across the site. The program indicated relative risk to different receptor animals. Using the LOAL (Lowest Observed Adverse Effect Level) as the cleanup criteria, remediation managers can figure how much to reduce site dose to below what is significant for a weasel.

In long-term plans, the developers want to provide training support – perhaps as one large training event per year, plus individual training on site. The software should continue to be free. Updates and new releases are planned, and the developers will continue to work with the FIELDS program.

SADA is being developed in the Institute for Environmental Modeling at the University of Tennessee and has been funded by DOE, EPA, and NRC. A fully functional freeware version is available with documentation at http://www.tiem.utk.edu/~sada/.

A participant wanted to know on what platform SADA is based and if it was compatible with ArcInfo. Welsh replied that SADA is built to be standalone; it is an independent program. Some of the capabilities present in SADA also are present in FIELDS, and ArcInfo can be used with FIELDS. Another questioner asked what module or application does SADA's user base find most useful or popular? Welsh applies it to ecological risk, but its capabilities for human health risk assessment and secondary sample location also receive considerable use.

Natural Attenuation Software

Frank Chapelle (USGS) reported on work done for NAVFAC in estimating times of remediation associated with natural attenuation (see Attachment D). His associates on the project are Mark Widdowson and Ed Mendez of Virginia Tech and Clifton Casey of the Navy.

The natural attenuation (NA) project arose because of the difficulty of persuading regulators to include NA processes in site-specific remediation plans. The squabble culminated in 1999 with the EPA directive that said NA should be used "only ... where it will meet objectives within a timeframe that is reasonable compared to that offered by other methods." This brought up the issue of time of remediation (TOR). In 1999, state regulators could perceive no clear approach to identifying TOR.

A 30-year-old mass-balance equation exists that can be solved for time; however, it is difficult to solve and explain in a meaningful way to regulators. Natural Attenuation Software (NAS) is an interface that allows non-modelers to find solutions to the TOR problem. Currently, the program is specific for chlorinated ethenes or petroleum hydrocarbons. If NAS is fed enough data, it will tell the user if monitored NA is feasible. NAS is a tool for decision making. The query must have a remedial objective – an MCL or ARAR or other designated goal. NAS can tell the user what degree of source remediation is required at a site, the distance and time required for plume stabilization, and the time required for NAPL mass dissolution.

Chapelle discussed an example of NAS applied to PCE in groundwater at Naval Submarine Base Kings Bay, GA. Pump and treat was not working well there; if continued, the cleanup would take 50 years. Instead, the source was reduced with in situ oxidation. NAS estimated seven years of attenuation to

reach the cleanup goal. (The software will extract biodegradation rates so the user doesn't have to look them up.)

NAS is designed as a graphical user interface for calculating estimates for the period of time required to achieve site-specific goals at sites contaminated with either fuels or chlorinated solvents. The program requires site characterization data entered by the user to calculate the natural attenuation capacity of various contaminants at a particular site. Using this estimate and contaminant source data, the user can evaluate the effects of source reduction or complete removal in terms of meeting a user-specified contaminant concentration at a specific point of compliance. The software and documentation are available at http://www.cee.vt.edu/NAS.

Statistical and Geostatistical Approaches to Long-Term Ground Water Monitoring Optimization

John Kingscott stood in for Kathy Yager (EPA/TIO) to provide the latest information on a demonstration sponsored by EPA, AFCEE, and USACE of two long-term monitoring optimization (LTMO) methods: the Monitoring and Remediation Optimization System (MAROS) and Parsons' 3-tiered Monitoring Network Optimization (MNO) (see Attachment E). The project provided case study examples of how the methods were applied and highlighted the differences between the two methods. Three sites with chlorinated solvent contamination addressed by ongoing pump and treat were evaluated in the study: Ft. Lewis Army Depot in Washington State, McClellan AFB in California, and the Long Prairie NPL site in Minnesota. Each method was applied to determine the number of wells required and how frequently the wells should be sampled to achieve monitoring objectives.

MAROS is a decision support tool based on statistical methods applied to site-specific data that account for relevant current and historical site data as well as hydrogeologic factors (e.g. seepage velocity) and the location of potential receptors (e.g., wells, discharge points, or property boundaries). Based on this site-specific information the software suggests an optimization plan for the current monitoring system to efficiently achieve the termination of the monitoring program. This public domain software was developed for AFCEE by Groundwater Services Inc. of Houston, Texas, and the University of Houston. MAROS is programmed in Microsoft Access 2000 and can be used by an individual with basic statistical knowledge.

Developed by Parsons Engineering, MNO is a three-phased approach consisting of qualitative, temporal, and spatial evaluations. The qualitative evaluation examines hydrogeology, direction of plume migration, and location of receptors to establish a frequency at which monitoring should be conducted and which wells should be retained or removed from the monitoring network. The temporal trend evaluation uses Mann-Kendall statistical analysis to determine the trend of contaminants over time, after which an algorithm is applied to determine the relevance of the trend to each well in the monitoring network. From this analysis, a decision is made as to whether to keep or remove a well. Finally, a 2-D spatial statistical analysis is applied using a kriging program to determine the relative amount of spatial information contributed by each monitoring well. Combining the results of the three analyses provides a basis for specifying the optimum frequency of sampling as well as which wells should be retained or removed. Use of MNO requires a trained hydrogeologist and a geostatistician, and users must contract with Parsons for support and documentation.

MAROS can evaluate data sufficiency, plume trend, size, shape, and movement, and it is designed to be easy to use. MNO, though much more complicated to use, is considered more flexible and its

geostatistics more robust. Both methods identified the potential for significant reduction in monitoring well networks—an average 36 percent reduction. Based on initial feedback from the facilities and regulators, the results from both methods appear reasonable and potentially could be implemented, though the facilities expressed reluctance concerning the effort required to negotiate changes with regulators or to undertake the costs of implementing changes.

The presentation showed the results of the spatial analysis on the number of wells reduced per site and the reduction in total sampling events per year. Kingscott cautioned that the cost savings indicated don't track with the number of sampling events because of fixed unavoidable costs. LTMO benefits larger sites with a minimum of 20 to 30 wells in each aquifer layer.

LTMO costs were surprisingly low with both methods—about $10K per 30-well site. The study identified no consistent differences between the methods, though the qualitative review may find some. Neither method has seen much use beyond application at Air Force sites; they need higher exposure. Both approaches have potential for determining the adequacy of a particular monitoring network by identifying over- and under-sampling. Potential users will need to work with the regulatory community to build awareness and get buy-in on the approach.

A draft report is expected by August 2003, and an expert review will be conducted. TIO is considering a collaboration with the USACE to prepare a report on LTMO methods that provides a thorough discussion of statistical/geostatistical approaches and applications. For more information, contact Dave Becker (USACE) at 402-697-2655 or Kathy Yager at 617-918-8362.

COST ESTIMATION

RACER & TankRACER

Gerald Johnson (DoD/USAF) discussed the Remedial Action Cost Engineering and Requirements (RACER™) system, an important tool for preparing programming cost estimates for environmental remediation (see Attachment F). Originally developed in 1991 under Air Force funding, RACER™ is the first comprehensive model to detail and document treatment methodologies and cost of remedial action. The latest version of the PC-based system was released in January 2003. Estimates derived from RACER™ are location-specific and based on annually updated multi-agency pricing data. RACER™ was not designed to be a detailed cost estimating tool; it is used primarily for the development of programming or budgetary cost estimates for environmental remediation projects. When an updated version of the software is loaded, it will update previous estimates to present-day costs, if desired.

The system uses a patented parametric methodology for estimating costs. The cost models are based on generic engineering solutions for environmental projects, technologies, and processes derived from historical project information, government laboratories, construction management agencies, vendors, contractors, and engineering analyses. Because the models are based on validated, accredited, proven technologies, RACER™ is not suitable for emerging or unproven technologies. It is suited to estimating full lifecycle costs for CERCLA and RCRA hazardous wastes, petroleum releases, and radioactive facility decontamination and decommissioning. The developers are working on modules for ordnance removal and cleanup, with particular attention to safety issues. Future development will incorporate more information on hazardous chemicals and safety issues.

The TankRACER™ windows-based PC software provides fast, accurate, and comprehensive cost estimates for cleanups at petroleum and underground storage tank (UST) sites. It was produced through an Interagency Agreement between the Air Force and EPA. The cost estimating tool also is based on a patented parametric methodology populated with generic engineering solutions from numerous past projects. The TankRACER database has been updated to reflect 2003 unit costs, and now incorporates phytoremediation technology.

In a few months, DOE will receive eight or 10 new RACER™ models developed for special applications, such as removal of attached contaminated materials, D&D size reduction technology, radiological waste contaminated building demolition, demolition of speciality process equipment, and conduit, pipe, and ductwork demolition.

After the presentation, a participant asked if RACER could be used for multiple technologies at a single site. Johnson replied that it can be done, though the user must set up different folders for the different scenarios. He added that the system enables continuous feedback incorporation, which can help everyone involved in a project correct their data and keep it updated.

Leveraging Cost Model Development via XML

Robert Nash (DoD/NFESC) is part of a group that provides support for engineering cost estimation to NAVFAC headquarters and works with other interagency groups, such as EC^2. He is involved in an effort to standardize or come together on future cost modeling efforts with a structure for collecting cost information, to work out a way to share cost information between different models—a cost leveraging system (see Attachment G). Ideally, a bridge can be built between systems so that developing models are independent of the systems. The bridge will foster competition and reduce reliance on any one model builder or any one source of cost data.

The approach has three components: establish parametric cost model standard practice; develop an electronic standard for data definition, transmission, and application; and establish a cost model library, repository, and network that can be either centralized, or decentralized and distributed. XML, which is considered a language that is pretty much universal, is being studied for the effort. XML is a superset of HTML that works on any platform, on any network, across any application. XML can serve as a mediator and provide common ground for bridging systems, increase consistency and compatibility, leverage existing systems (which lessens development and maintenance costs), and allow multiple systems to leverage existing models and extend them to meet unique needs.

Nash offered an example of how XML can act as a bridge between a web-based application like CTC (Cost-To-Complete, the Navy's environmental budget requirements estimating system) and an object-oriented, Internet-designed application like RTET (Remediation Technology Evaluation Tool, the Navy's technology short list organized by media and contaminant). The bridge allows technologies to be compared against each other and ranked by cost or short-term effectiveness. The example was illustrated with computer screens showing how XML can mediate between the two applications.

The example shows that different system can use the same standardized cost modules. EC^2 is working to support development of standards and seeks input on the *Parametric Cost Modeling Manual* and XML Definitions and Schema from the Association for the Advancement of Cost Engineering (AACE) and the National Institute of Building Sciences-International Alliance for Interoperability (NIBS-IAI). The manuals are ready to review now.

After the presentation, a participant asked if XML bridging is being used in industry. Nash replied that he was not aware of any specific instances of it. Another comment was offered that the bridging issue is a broad issue that applies to sharing data between all sorts of applications beyond cost data—the type of issue that should become more visible and attract more participants.

Discussion of Presentations

Terry Sullivan thanked the presenters and summarized the two-part meeting on decision support tools and the importance of the tools in site characterization, remedy selection and optimization, adaptive sampling, human health risk assessment, and performance demonstration. Although many of the tools are unique, some of them compete, and each tool has its supporters. He proposed that FRTR develop a screening matrix containing categories for defining DSTs based on their functionality, with appropriate criteria for evaluating functionality, and brief, condensed reviews of the different tools.

The categories would address function, contaminants, site characteristics, the analysis approach, and other criteria, such as cost, user support, ease of use, acceptance and use, and transportability (i.e., how it interfaces with other models). Sullivan presented a mock-up of a screening matrix that showed several subcategories under each category by which the software would be evaluated, with other criteria providing qualitative information. He noted that it takes time to demonstrate the usefulness of a new tool, and there is a lot of resistance to innovation.

As an aid to future discussions, Sullivan asked the participants once again to consider the potential value of a DST screening matrix with reference to the questions posed in his introduction:

- What are your needs for decision support tools with regard to site characterization, risk assessment, remedy selection, and/or remedy optimization?
- What kind of tool needs more or less emphasis?
- What are the technical and institutional limitations to implementation?
- What would help your institution overcome these limitations?
- Would further development of a screening matrix be useful?

Dan Powell (EPA/TIO) followed up with examples of projects that had used some of the tools presented at the meeting and noted that he had seen a real need to increase understanding of DSTs. Many of the new tools are ready to use and offer great benefits, but a lack of recognition and understanding of what they're for stands in the way. He hopes the FRTR will serve as a vehicle to educate and inform potential users.

He took part in a project whose team was able to persuade Pennsylvania regulators to allow the Triad approach for a removal action. The project also was able to use FIELDS for maps and gross soil estimates, SADA for sampling programs, and VSP to demonstrate the cost/benefit of taking more samples. But before people will accept these innovative methods, they need to know how the tools will improve decision-making at sites and how they will make the user's job easier. The presentation on data-sharing through XML struck him particularly because one of the large, unexpected costs on the Pennsylvania project involved repeatedly reformatting the data for use in different applications.

Powell asked the assembly: Do we want to pursue trying to create an information product to popularize these sorts of tools?

NEXT MEETING AGENDA AND WRAP-UP

Walt Kovalick asked if the participants wanted to go ahead with the initiative, or think about it a little longer, or was everyone happy with the status quo?

One participant said that although he saw value in gathering information concerning each technology in one place, it needn't be an elaborate undertaking. Powell thought a well-maintained website with links to DST technologies would be useful and suggested focusing on federally-funded systems with the responsibility for updating the information resting on each participant. A Navy participant commented that the site should include shareware as well, but to be wary of proprietary commercial products. One participant said that it was great idea and Walt should fund it, a statement that was greeted with acclaim. A member of the Air Force expressed interest, especially in promoting the tools that help streamline the remediation process, but was not ready to commit at present. The Corps saw DSTs as valuable tools and agreed with the value of a central website. The Army stressed the importance of central management for a DST site to energize the participants and make sure the model owners report updates without delay. DOE expressed interest in DSTs of value to long-term surveillance and monitoring.

Ultimately, the participants decided to give the proposal further thought and discuss it with others within their respective organizations. The proposal will be revisited, probably in a summer FRTR teleconference.

Walt Kovalick thanked the participants for the energy of their discussion and moved on to discuss the agenda for the next meeting. He presented a list of the highest-rated topics from the ballots:

- New developments in characterization and monitoring, e.g., the Triad approach and the nation-wide promotional campaign by DOE's Argonne National Lab, the Corps, and EPA/TIO;
- Cutting-edge applications from the FRTR characterization case studies;
- Field Analytic Technologies Encyclopedia (FATE) update;
- Instruments/sensors.

He remarked that these items could all be addressed briefly in the next meeting or in more depth over the next two meetings, depending on the needs of the FRTR members. He asked that anyone having ideas for other topics send them to Naomi Smith, who will disseminate the agenda for the next meeting, which will be in November or December.

The meeting adjourned.