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A Study of Innovation: ERD Takes Pollution Prevention to a New Level

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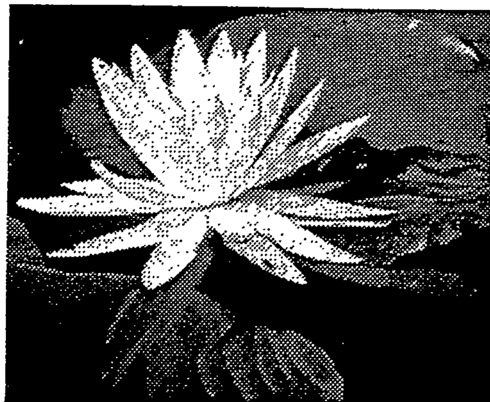
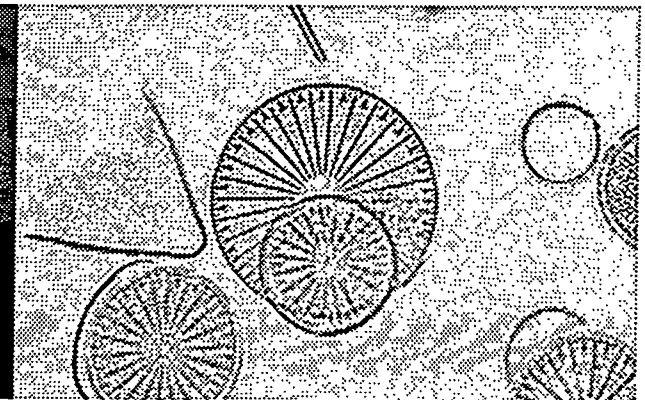
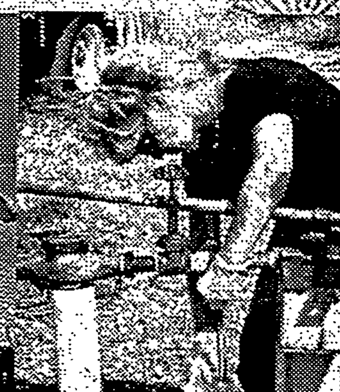




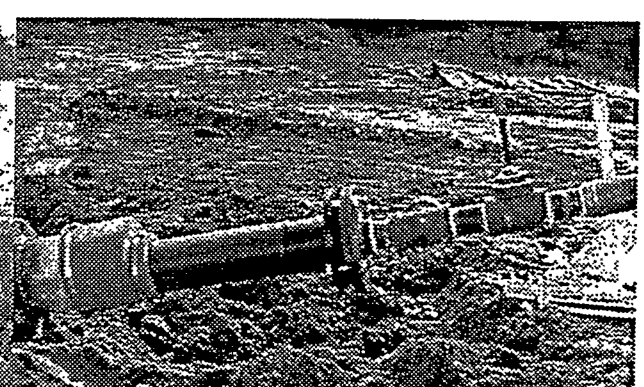


Environmental Restoration

"Restoring the Environment Today for a Cleaner Tomorrow"

A STUDY of INNOVATION

ERD Takes Pollution Prevention to a New Level



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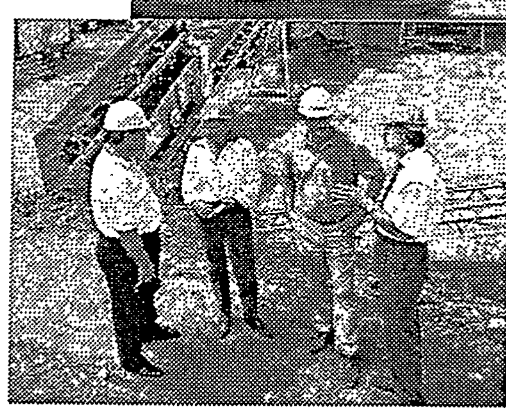

Nature Photos by
David Scott, SREL

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Innovation is the watchword as the Savannah River Site's (SRS) Environmental Restoration Division (ERD) aggressively pursues the challenge of preventing pollution and minimizing waste while cleaning up the environment. As SRS approaches the 21st Century, ERD takes its pollution prevention (P2) program beyond the building blocks of "Reduce, Reuse, Recycle" to a new level - one of innovative technology deployment and thinking outside of the box.

INNOVATION: a change; something new or creative

For more than 40 years, SRS produced weapons-grade nuclear materials, conducted nuclear research in support of our nation's defense programs, and supported other non-defense government missions. The end of the Cold War signaled a shift in priorities from nuclear materials production and research to environmental cleanup and nuclear materials stabilization, storage, and disposal. The requirement to balance the federal budget resulted in budget reductions and workforce downsizing. To support these changes, SRS made a commitment to adapt and work to enhance our nation's security, reduce the risk of nuclear proliferation, accelerate environmental cleanup, and advance mission-related science and technology.

With this commitment in mind, ERD approaches its mission with a vision of continuously exceeding customer needs and expectations and continuously improving. It's this vision of continuous improvement that drives the ERD pollution prevention program towards innovation. Technological breakthroughs and new ideas on how to do the job better are essential to continuous improvement.

INITIATIVE: the first step of action

ERD senior management assumes responsibility for taking its pollution prevention program to a new level. Visionary leadership - the first step - translates into a top-down decision to allocate the necessary technical and financial resources to ensure success. This upper level commitment to integrating pollution prevention initiatives into site cleanup projects is demonstrated by the establishment of a pollution prevention group within the division.

The pollution prevention group works with ERD project managers to emphasize enhanced work planning, encourage waste forecasting, and establish quantifiable waste reduction goals. ERD prepares a Pollution Prevention Opportunity Assessment (PPOA) that addresses the waste-generating activities associated with each ERD project. The PPOA compiles information pertaining to a project's objectives, work plan, and waste streams and identifies improvements that will avoid or minimize the production of waste.

Once P2 opportunities are identified, ERD pollution prevention professionals work with ERD project managers and Savannah River Technology Center (SRTC) researchers to compare innovative and conventional remediation technologies and determine which technologies are most efficient and most cost effective in reducing waste volumes and achieving project remediation objectives.

Environmental Restoration Division

Mission: remediate waste sites and groundwater units, reduce risk to the environment for future land use, and demonstrate capabilities to attract and succeed in new missions.

Vision: continuously exceed the needs and expectations of our customers and become recognized as best for environmental restoration through the application of innovative technologies, a strong commitment to teamwork, highly qualified personnel, and attention to continuous improvement.

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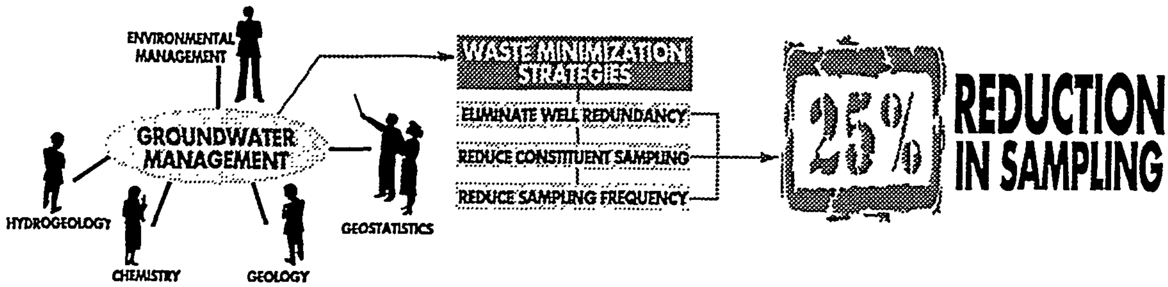

ERD brings together multi-disciplinary teams to consider remediation projects from numerous perspectives: geology, hydrogeology, chemistry, statistics, and regulatory compliance. Looking at projects from multiple angles allows ERD to think outside of the box when it comes to developing waste reduction strategies for environmental clean-up projects. Recently, ERD assembled a Groundwater Management Team consisting of subject matter experts from these five disciplines. Together, the team was able to look at the big picture, relative to groundwater remediation, and develop a protocol that eliminates sampling well redundancy, reduces constituent sampling, and reduces sampling frequency. Incorporating these three strategies ERD decreased wastewater associated with sampling by 25%.

Successful implementation of ERD pollution prevention initiatives requires planning. To sustain development and implementation of P2 activities while cleaning up the more than 450 surface and groundwater waste units, ERD utilizes a P2 Program Implementation Plan. The ERD P2 Plan identifies the ERD P2 vision, goals, evaluation criteria, responsible personnel, and program objectives and actions. Identifying innovative P2 techniques and technologies is the first of eight objectives that direct ERD P2 Program activities:

1. Identify innovative P2 techniques and technologies with ERD applicability
2. Improve current P2 techniques and technologies for further volume reductions
3. Develop incentives for subcontractor participation in P2 efforts
4. Develop an evaluation system to ensure continuous improvement in P2 performance
5. Promote P2 through management support, policies, procedures, training, and awareness
6. Develop a self-assessment procedure to ensure compliance with the ERD P2 Program Plan
7. Develop accurate waste volume forecasts for environmental restoration activities
8. Ensure training (department-specific) of all waste generator personnel

IMPLEMENTATION: following a definite plan or procedure

The Plan specifically addresses minimizing the generation of sanitary, radioactive, hazardous, and mixed waste in three of ERD's major waste-generating activities:

- Waste Site Investigation
- Waste Site Remediation
- Removal/Interim Action

The following pages highlight technological breakthroughs and innovative approaches that ERD has used or plans to use in the future.

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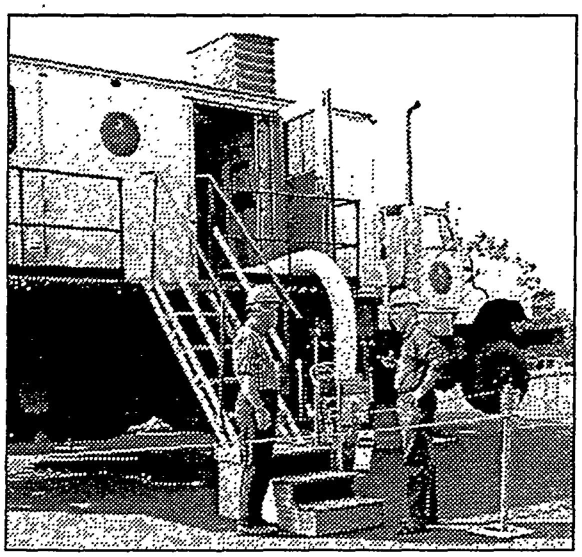
The Cone Penetrometer/Gamma Probe is a state-of-the art in situ measurement tool that SRS uses in place of conventional soil sampling equipment to perform soil testing and determine radionuclide concentrations in soils below the surface of waste sites.

CONE PENETROMETER/GAMMA PROBE: an in situ site characterization tool that utilizes a direct-push technology system, rather than drilling, to advance small diameter metal rods with sensors into the ground.

A truck equipped with a hydraulic direct-push technology deploys the cone penetrometer rod or gamma probe. The probe measures the physical parameters of the subsurface and characterizes the geology of the push locations. The probe then transmits analog signals up an electrical cable to the truck where the real-time data is used to immediately identify radionuclides in the soil. The gamma probe can also be fitted with sensors that determine chemical parameters in the soil and with equipment that samples groundwater and gas below the surface.



The P2 implications of using the cone penetrometer are significant. This tool eliminates the waste resulting from soil sampling (i.e., the sample itself and laboratory waste generated during analysis of the sample). Additionally, use of the direct-push system for deployment of the probe, rather than drilling, eliminates well installation and the soil waste it generates. Conventional rotary drilling methods can produce several cubic feet of waste.

Significant cost savings also result from using this tool. The expense of taking a sample, transporting and handling the sample, analyzing the sample, and disposing of the sample, laboratory wastes and other investigation-derived waste are all eliminated.

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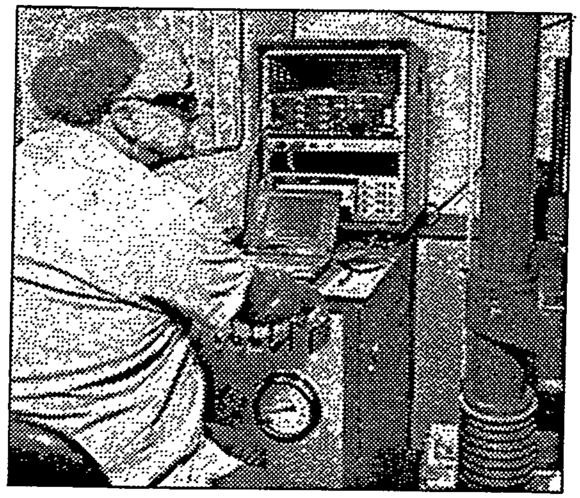
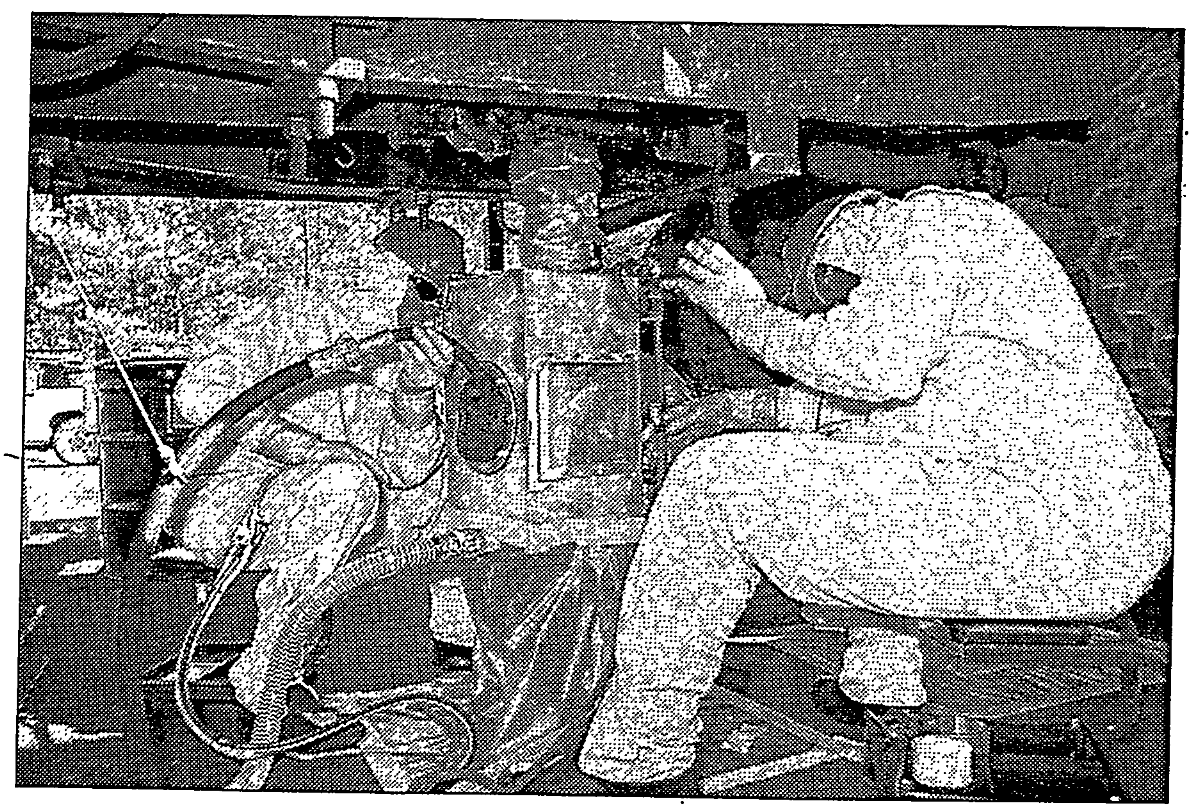
CONE PENETROMETER/GAMMA PROBE: an in situ site characterization tool that utilizes a direct-push technology system, rather than drilling, to advance small diameter metal rods with sensors into the ground.

SRS performed a technology demonstration of the direct-push deployed gamma probe at the R-Reactor Seepage Basins in 1997. Prior to this demonstration, in situ measurement of gamma emitting radionuclides in the subsurface was not possible. The demonstration, a joint venture with the DOE Office of Technology, DOE Special Technologies Laboratory, Argonne National Laboratory, and the Army Corps of Engineers, confirmed the operational capabilities of the gamma probe as a site characterization tool when subsurface radionuclide contamination exists.

The characterization of the R-Reactor Seepage Basins was performed at a savings of more than $1,000,000 when compared to conventional characterization methods. Other benefits included a significant reduction in radiological exposure to site employees and an expedited characterization process.





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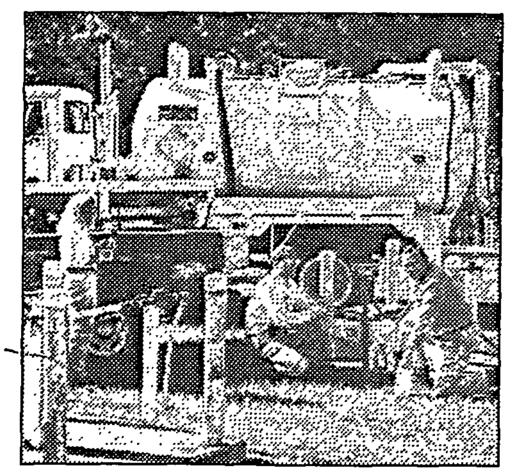
The Purge Water Management System (PWMS) is an innovative technology developed by SRS to manage purge water generated during the sampling of groundwater monitoring wells. This closed-loop, non-contact system returns purge water to the originating aquifer after sampling without significantly altering the water quality.

PURGE WATER MANAGEMENT SYSTEM: a closed-loop, non-contact system that returns groundwater monitoring well purge water back to the originating aquifer after a sampling event.

Traditional sampling methods require the purging of three to five well volumes prior to the collection of a protocol sample. The SRS groundwater monitoring network consists of nearly 2,100 wells and generates a total volume of more than 441,000 gallons of purge water annually.

In the past, purge water was discarded on the ground adjacent to the sampled well. However, in 1991, the U. S. Environmental Protection Agency (EPA) mandated the management of purge water as a hazardous waste when it contains hazardous, mixed, or radiological constituents that exceed certain threshold levels. In response, SRS instituted a complex Investigation-Derived Waste Management Plan (IDWP) as a strategy for managing purge water. The IDWP used a fleet of tanker trucks to collect purge water and transport it to SRS air strippers or an effluent treatment facility for treatment.



The PWMS is much simpler than the IDWP. It consists of a bladder contained within a steel tank, a supply system, and a return system. The PWMS connects to the monitoring well's discharge pipe and water level measurement orifice. A submersible pump, located within the monitoring well, pumps groundwater through the supply system into the bladder, which expands in direct proportion to the volume of water introduced. After a sufficient quantity of groundwater is purged from the well and certain water quality parameters are stabilized, a technician takes the required protocol groundwater samples from the well sampling port. The purge water, held in the bladder, returns to the originating aquifer by gravity feed through return piping.

Waste minimization is one of the primary benefits of the PWMS since returning contaminated purge water to the originating aquifer totally eliminates the generation of waste. Full-scale implementation of the PWMS will eliminate the production of 126,000 gallons of aqueous waste: nearly 92,000 gallons of non-radioactive purge water currently containerized and treated by a site air stripper and 34,000 gallons of radioactively-contaminated purge water currently containerized and transported to the site effluent treatment facility.

Other benefits of the PWMS include the elimination of containerization and storage areas; the elimination of tanker trucks and water buffaloes; the elimination of personnel affiliated with transportation and packaging, the effluent treatment facility and health protection; and an accelerated schedule which reduces purge water management costs.

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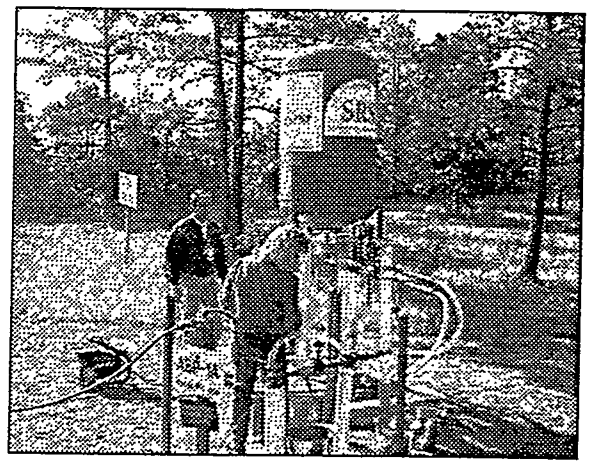
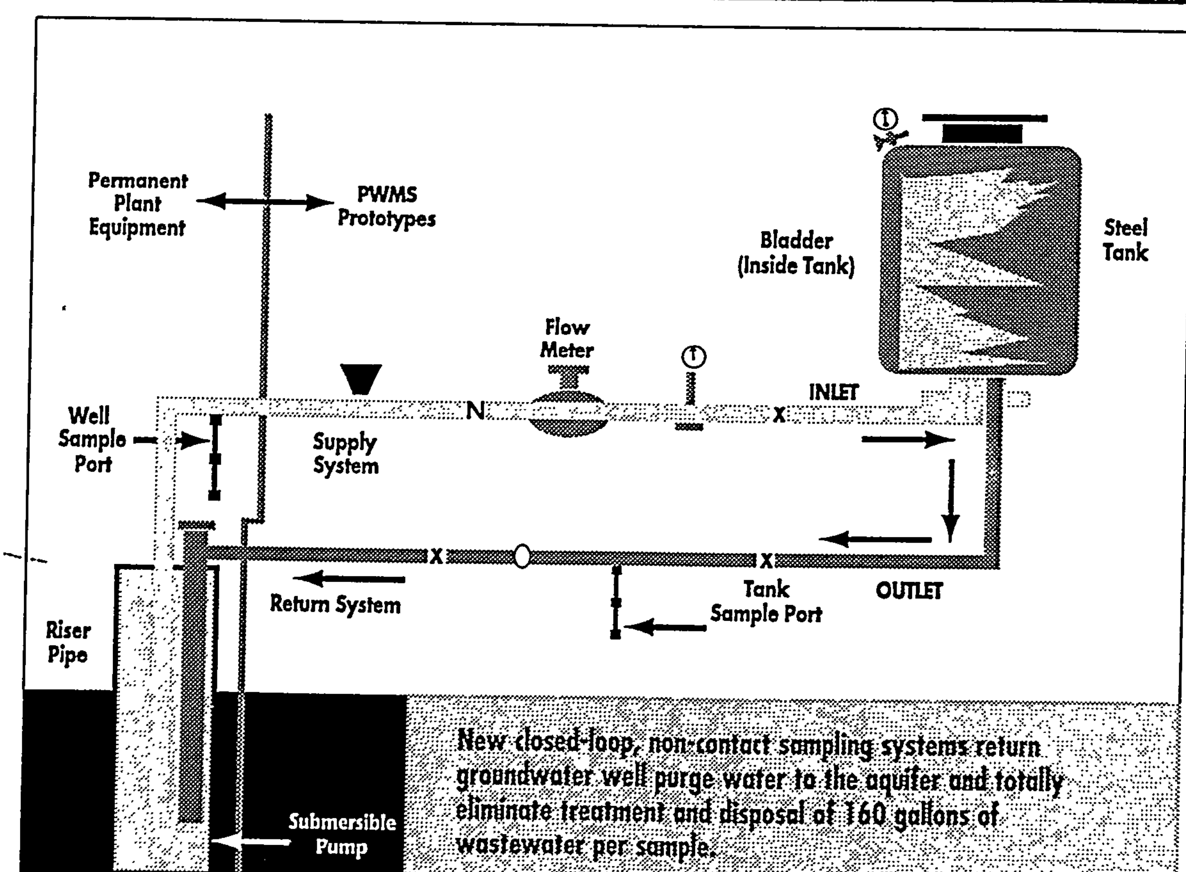
PURGE WATER MANAGEMENT SYSTEM: a closed-loop, non-contact system that returns groundwater monitoring well purge water back to the originating aquifer after a sampling event.

Potential cost savings attributed to installing PWMS units at the 396 wells currently requiring containerization and treatment is estimated at $400,000 per year. This conservative estimate only considers the current annual cost of containerizing and treating purge water at SRS. It does not consider the reduction in administrative costs resulting from a more streamlined approach to purge water management.





New closed-loop, non-contact sampling systems return groundwater well purge water to the aquifer and totally eliminate treatment and disposal of 160 gallons of wastewater per sample.

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Fenton's Chemistry is a patented in situ chemical oxidation technology that SRS uses in place of conventional pump and treat technologies to remediate groundwater contamination.

FENTON'S CHEMISTRY: an in situ chemical oxidation process that injects oxidizing agents into contaminated soil and groundwater and converts volatile organic compounds (VOCs) and dense non-aqueous phase liquids (DNAPLs) into harmless, natural compounds.

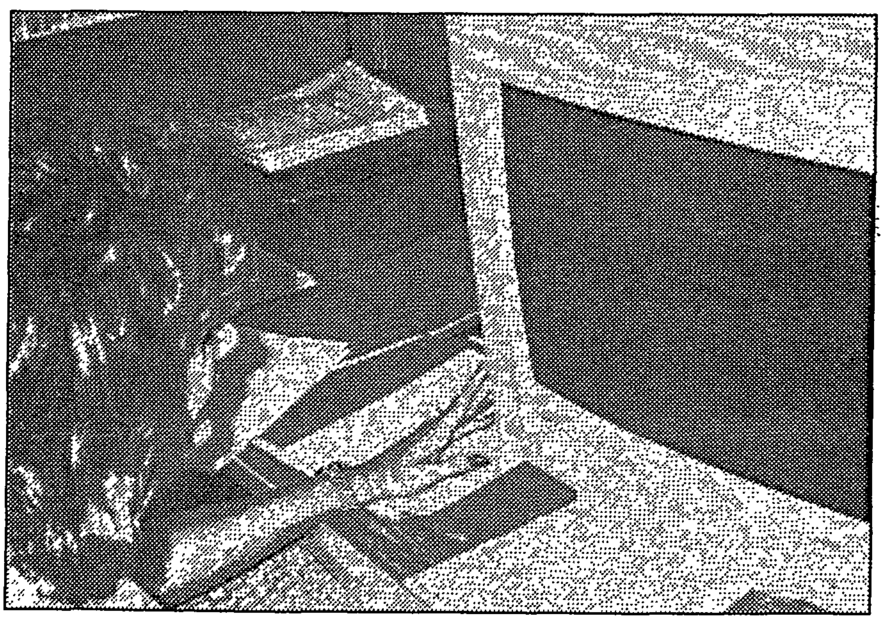
This technology uses specially designed equipment and injection wells to disperse a powerful solution of oxidizers, catalysts, and other non-hazardous and environmentally safe compounds into contaminated subsurface soils and groundwater and destroy/treat the contaminants.

This chemical oxidation process increases the permeability of most subsurface soils and then chemically converts the organic contaminants to carbon dioxide, water, and chloride ions, all considered innocuous materials. Any remaining reagents are converted into oxygen and water or continue to be used as nutrients by microorganisms in the soil and groundwater.

The Fenton's Chemistry technology complements ERD's P2 programs. No waste is generated from the treatment process, and no material is brought to the surface.

Since the Fenton's Chemistry technology destroys DNAPLs in its purest form, each gallon of concentrate that is removed and treated eliminates more than a million gallons of water that would be treated by conventional methods.

Remediation using this innovative technology significantly reduces or totally eliminates organic contaminants. Destroying the DNAPLs while they're still concentrated precludes cleaning millions of gallons of water and tons of soil. The environment can be cleaned faster and more cost effectively; potential cost savings are estimated at 60 cents per 1,000 gallons treated.



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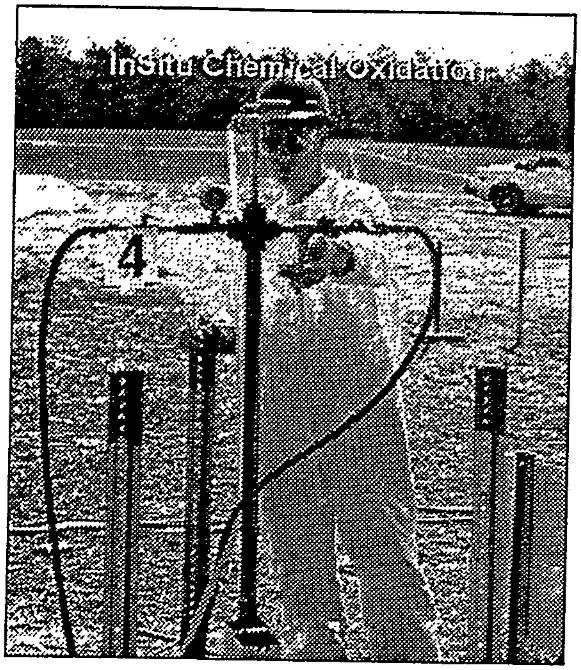
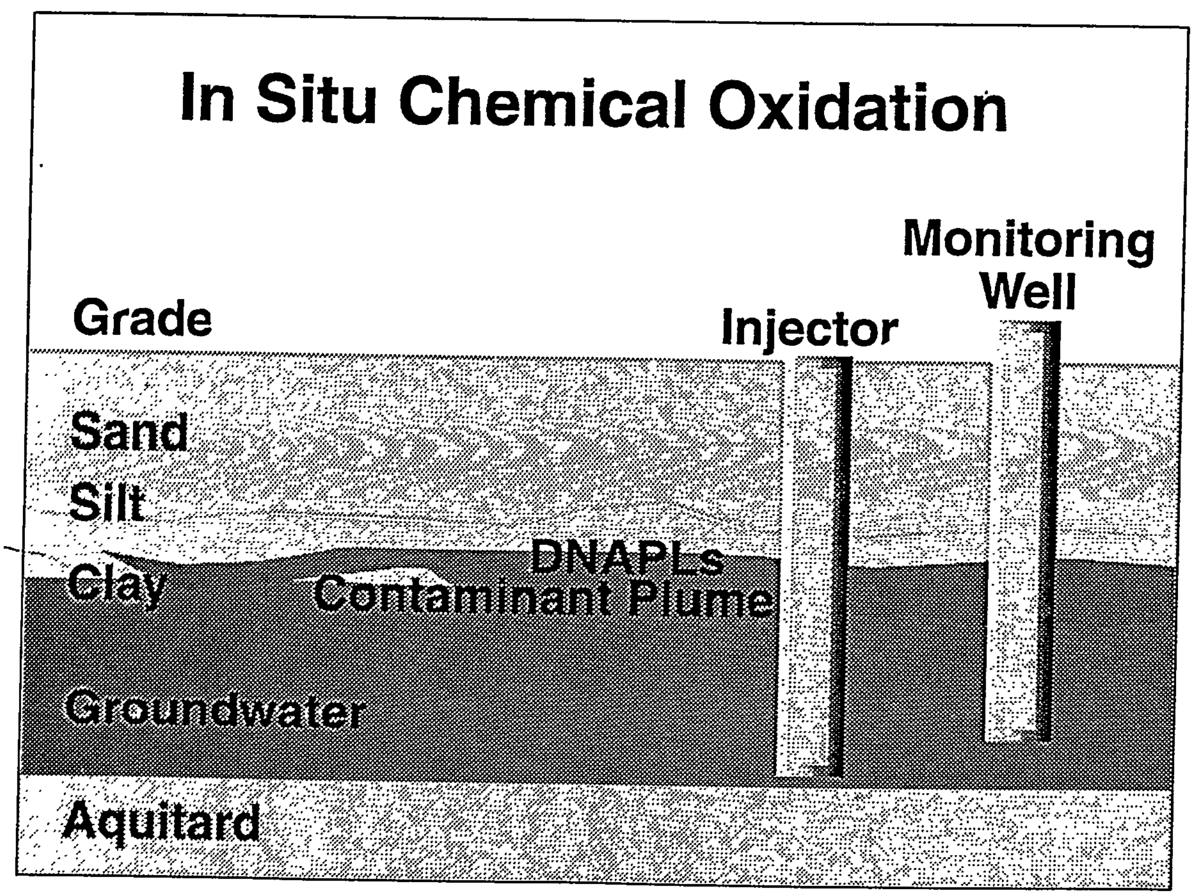


SRS is currently using Fenton's Chemistry in the A/M-Area to clean up groundwater contamination. The A/M-Area groundwater plume, which covers more than 1,500 acres, is one of the largest DNAPL-contaminated groundwater plumes in the nation. More than one-half million pounds of contaminants have already been removed from the soil and groundwater using conventional pump and treat technology. However, the presence of DNAPLs severely limits the possibility of completely remediating the site using conventional technologies.



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Horizontal well technology is an innovative concept developed at SRS in 1987. Wells installed in the lateral planes of the subsurface improve access to subsurfaces and facilitate characterization, monitoring, and remediation of contaminated groundwater and soil.

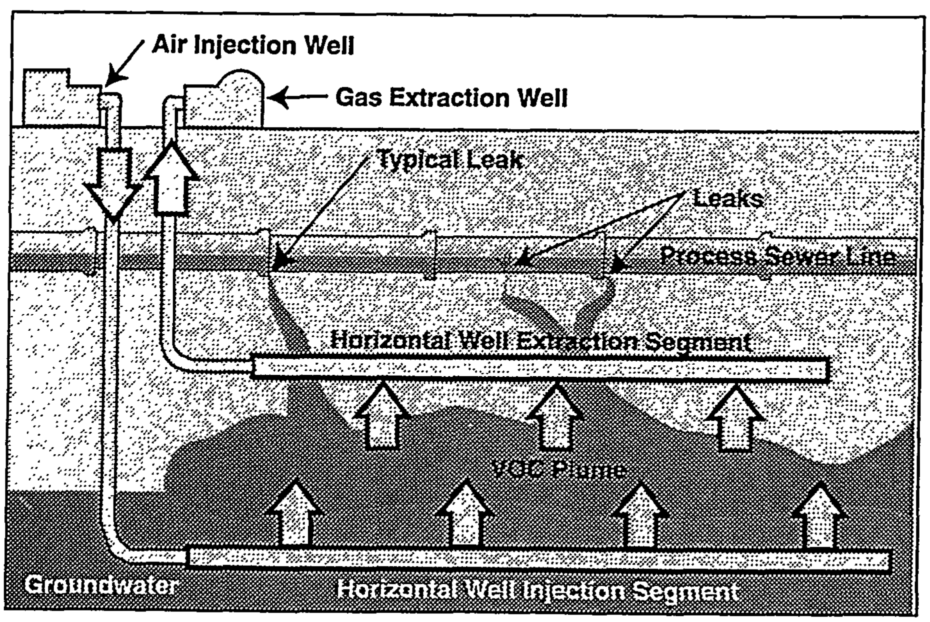
HORIZONTAL WELLS: an in situ bioremediation system that utilizes the installation of wells in the lateral planes of the subsurface to stimulate aerobic biodegradation of contaminants in underground water and soil.

During remediation, horizontal wells are placed in the saturated zone, and media such as atmospheric air, nutrients, and even methane are injected into the wells to stimulate the metabolic breakdown of contaminants by native microbes living in the contaminated region. This process naturally biodegrades the constituents of concern.

SRS conducted its first full-scale horizontal well demonstration in 1988 when it showed how the wells could be used to expedite the cleanup of organic contaminants at the M-Area Basin. Since that time, the commercial sector has embraced horizontal well technology as a viable remediation technology alternative. In addition to teaching a variety of seminars on the topic of horizontal wells, SRS researchers consult on the tremendous potential horizontal wells offer to environmental remediation. Deployment of horizontal wells has a number of advantages:

- maximization of the screen zone and improvement remediation efficiency
- access to contaminated areas otherwise inaccessible, such as areas beneath buildings, ponds, and landfills
- installation along the leading edge of a contaminant plume or at a property boundary for hydraulic control
- reduction of operations and maintenance costs resulting from a larger zone of influence and fewer wells.

Although installation costs are higher for horizontal wells, over the life of the project, the improved treatment coverage results in cost savings greater than two times that of vertical wells. Additionally, the use of in situ technology greatly reduces the generation of Investigative Derived Waste (IDW).



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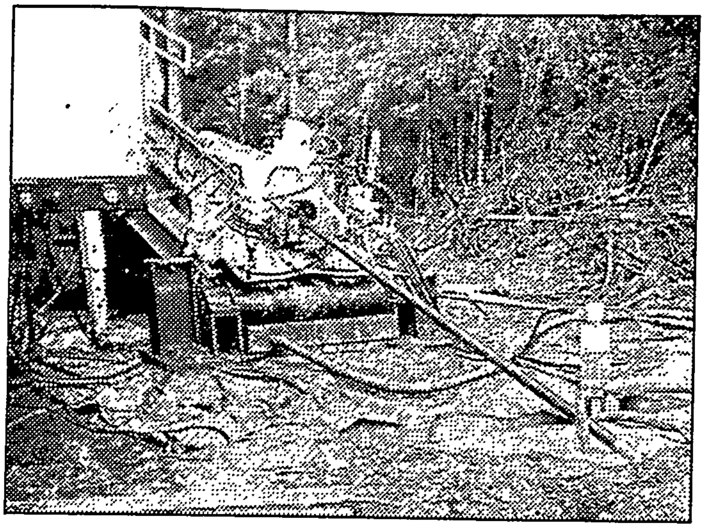
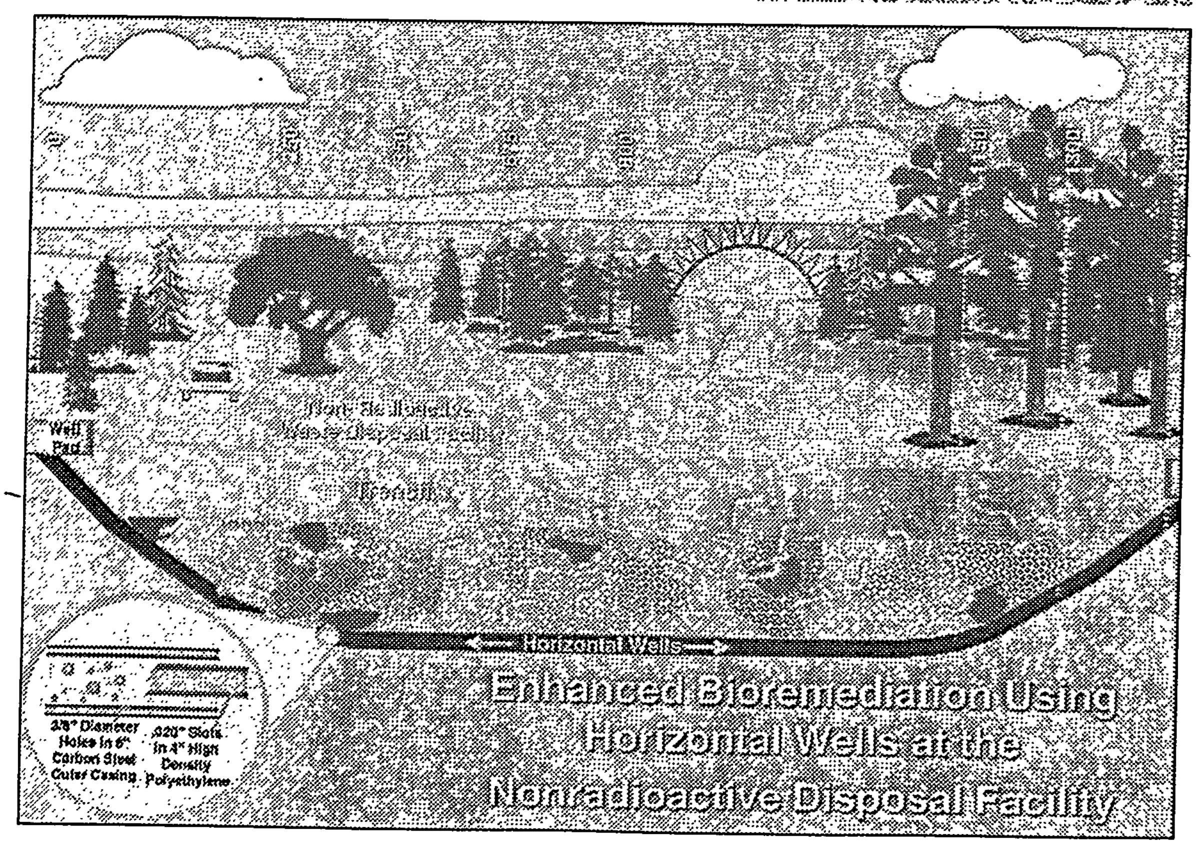


In 1997, SRS installed horizontal wells as part of an overall in situ bioremediation system to clean up chlorinated solvent in the groundwater at the Nonradioactive Disposal Facility. These horizontal wells, believed to be the second longest in the United States at 1/4 mile long, contain the country's longest screen zones used for environmental purposes. Since the in situ bioremediation technology destroys contaminants in place, no waste is generated, costs are reduced, risks and time are minimized, and efficiency is increased.



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An innovative approach to cleaning up four SRS coal piles and their runoff basins is resulting in a savings of more than $11 million over the next five years, a reduced cleanup time of 92 months, and the beneficial reuse of waste that would otherwise require disposal in a permitted landfill.

COAL PILE RUNOFF BENEFICIAL REUSE: recycling of waste from a Superfund site for public use.

Coal pile runoff basins were constructed at SRS in the late 1970's and early 1980's for the purpose of protecting surface water from coal pile contaminants such as suspended solids, sulfides, metals, radionuclides, and semi-volatile organic compounds; all of these constituents occur naturally in coal.

When four of the seven SRS coal piles were no longer needed, the Site proposed a removal action to regulators. The proposal involved removing all visible coal and coal sediments from the basins, securing conveyance structures, backfilling with clean native soil to eliminate ponding and reduce infiltration, restoring the basins to natural grade, and establishing a vegetative cover to prevent erosion.

From the beginning, SRS acknowledged to EPA and the South Carolina Department of Health and Environmental Control (SCDHEC) that the project would generate many tons of waste that weren't sufficient for burning or energy recovery. In cooperation with the regulators, SRS determined that the coal sediment should be otherwise processed for beneficial reuse - the first time SRS had recycled a Superfund or CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) waste for public consumption.

Starting in April 1997, more than 13,000 tons of coal and sediments were transported to an EPA- and SCDHEC-approved facility in Summerville, SC. The waste was processed so contaminants were bound and could not leach into the environment. The end product was later used as road base material under public highways.

Typically, this waste would have been shipped offsite to a permitted landfill facility. Disposal costs would have been $70 per ton instead of the $23 per ton cost of recycling. The $47 per ton difference allows SRS to realize a $615,000 beneficial reuse savings which can be allocated to the remediation of other waste sites.

Cost savings associated with accelerated cleanup (a reduction in cleanup time of 92 months) will permit the potential redirection of more than $11 million in budget to other remedial activities. Other benefits of the approach include:

- improved groundwater conditions resulting from accelerated cleanup of the contamination source
- elimination of direct exposure and excavated soil pathways resulting from backfilling of remaining basin subsoils
- elimination of ponding and a reduction in infiltration of 44-66% because of regrading
- elimination of more than 25 documents scheduled for submittal to the regulators.

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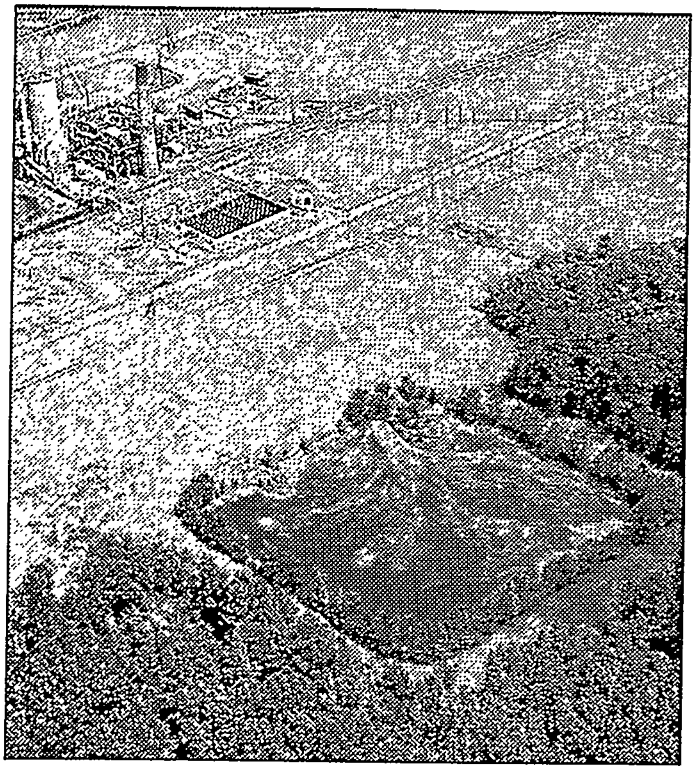
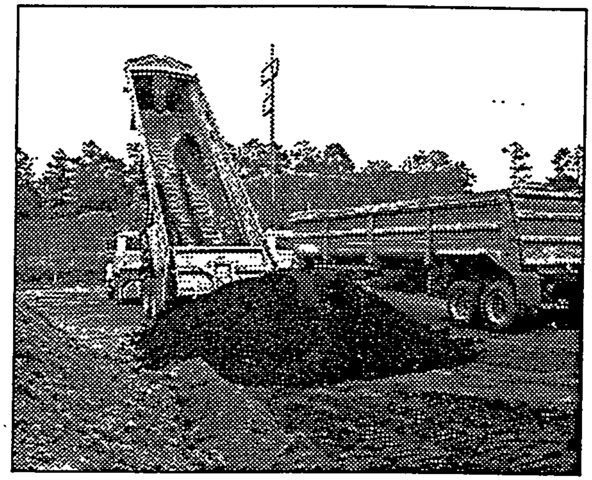
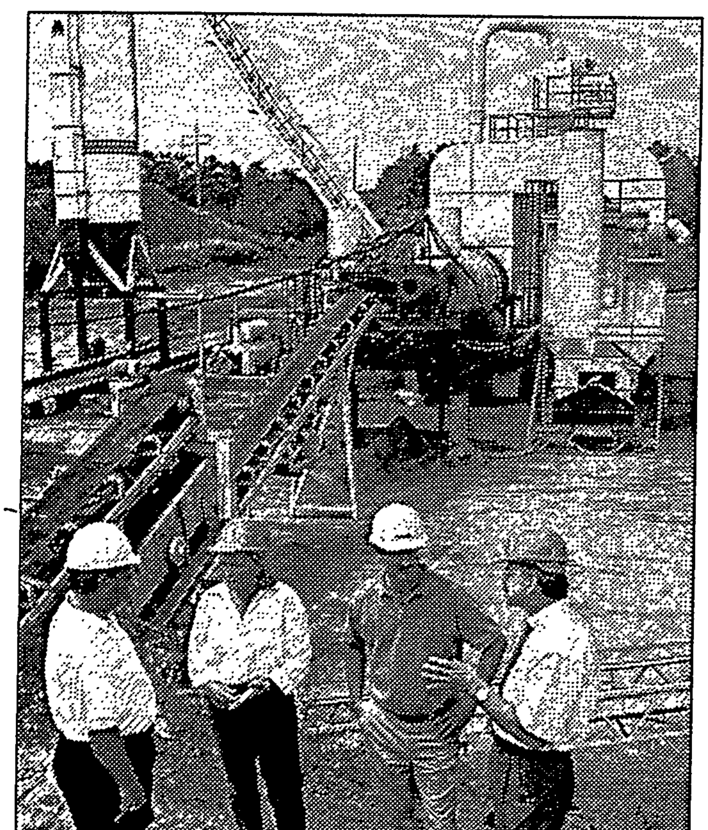


COAL PILE RUNOFF BENEFICIAL REUSE: recycling of waste from a Superfund site for public use.





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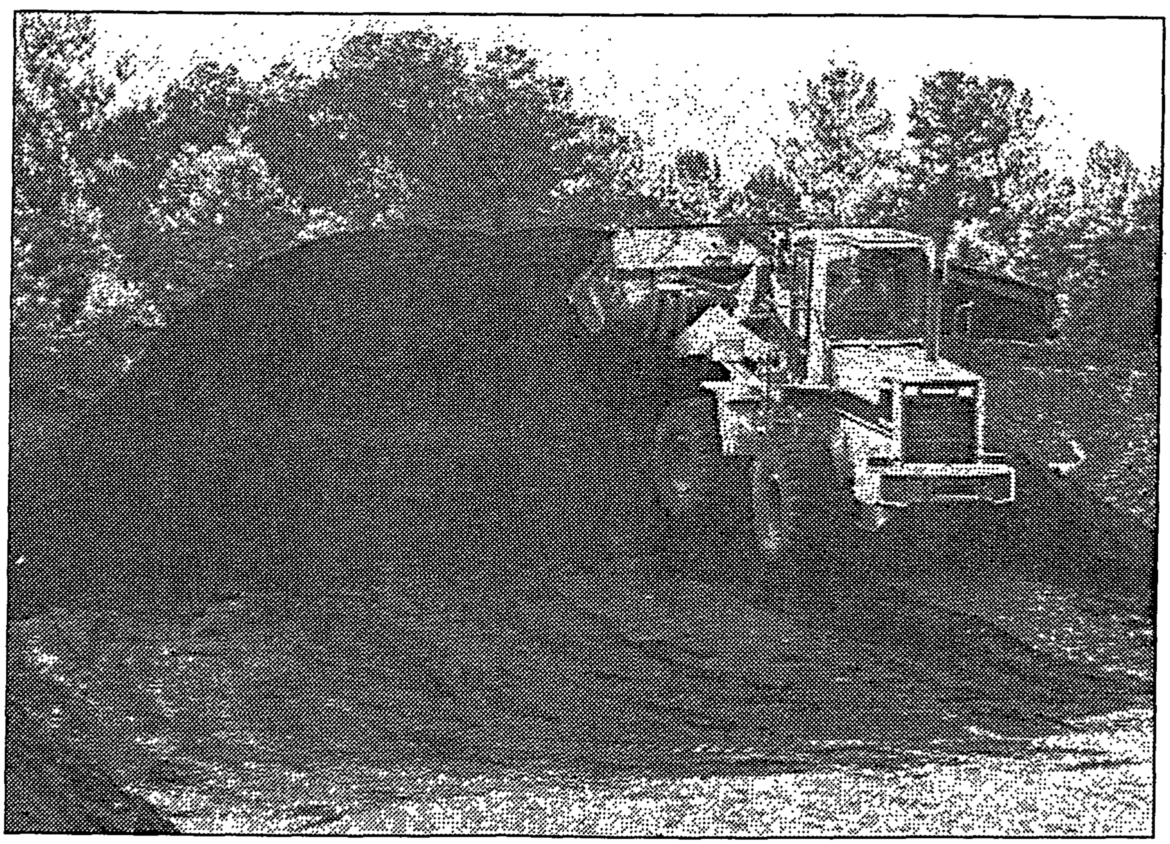
Controlled Low Strength Material (CLSM) is a self-compacted cementitious construction material used primarily as a backfill in lieu of compacted soils. As a result of innovative thinking, SRS engineers developed a CLSM design process that results in the beneficial reuse of a by-product waste material.

CONTROLLED LOW STRENGTH MATERIAL: *a self-compacted, cementitious, construction material used primarily as a backfill in lieu of compacted soil.*

Ashes collected from storage and disposal basins are used as raw material in the preparation of the CLSM design mix. Incorporating the ash material into the mix not only saves the site the cost of CLSM raw materials but uses a by-product waste material that would have required disposal.

SRS plans to use CLSM in radioactively contaminated areas because it can be pumped into place remotely, eliminating the requirement for construction personnel to handle it in the contaminated area. Use of CLSM reduces exposure risks and requires less time and labor. It can also be placed in wet weather, whereas soil cannot be compacted in the rain.



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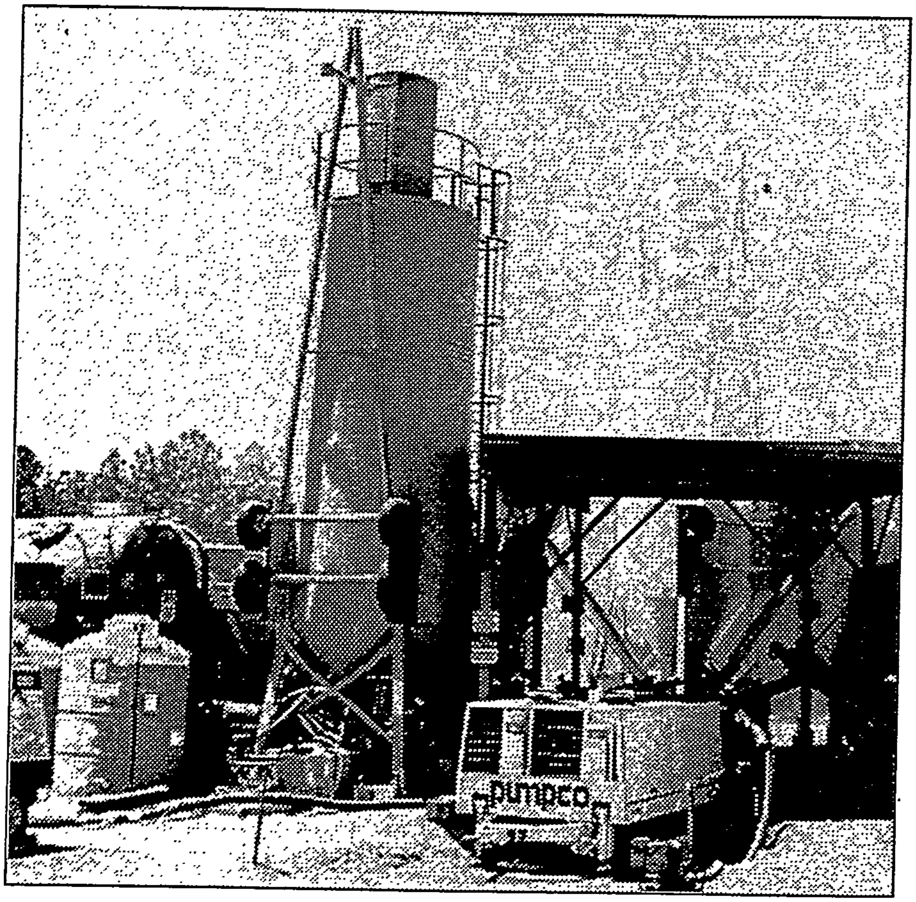

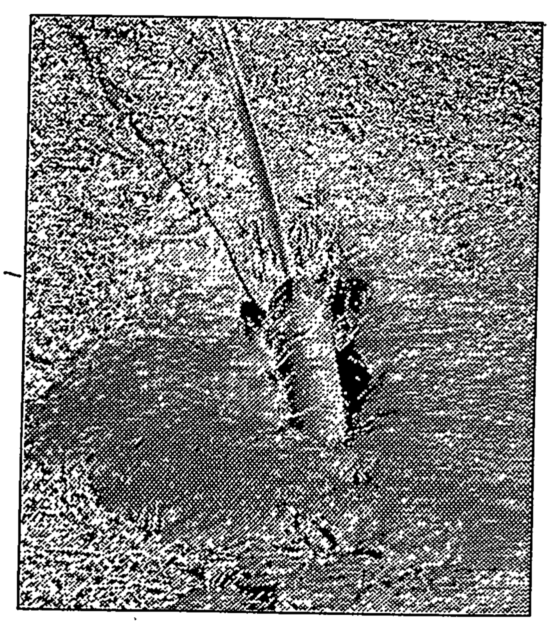

SRS prepared five trial mixes each using ashes from A, D, and F Areas. Ash material from the A and F-Area sites is a mixture of fine fly ash and coarse bottom ash. Therefore, it is used only in common backfill. The D-Area Basin material is finer grained and is recommended for use in both structural backfill and common backfill. The ash material is not recommended for use in structural concrete since it does not meet specifications.

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Dynamic Underground Stripping (DUS) is an innovative in situ treatment system that cleans up soil and groundwater contaminated with organic compounds by combining several remediation technologies. The synergy of the components of the DUS system results in a remediation tool that effectively cleans up contamination above and below the water table and is especially well suited for sites with interbedded sand and clay layers.

DYNAMIC UNDERGROUND STRIPPING: an in situ thermal treatment system that combines several remediation technologies to clean up soil and groundwater contaminated with organic compounds.

The primary technologies utilized by the DUS system are:

- **Steam Injection and Vacuum Extraction** - Injection wells that supply steam and electric current are drilled around an area of concentrated contamination. As permeable soils are heated to the boiling point, a steam front develops in the subsurface and volatile organic contaminants are vaporized from the hot soil. The steam moves from the injection wells to the vacuum extraction wells located in the center of the contaminated area. The extraction wells remove the contaminants.
- **Electrical Resistance Heating** - Electric current is used to heat impermeable soils. Water and contaminants trapped in these relatively conductive regions are vaporized and forced into the steam zone for vacuum extraction.
- **Underground Imaging and Monitoring** - Several geophysical techniques are used to delineate the heated area and track the underground movement of steam to ensure total cleanup and precise process control.

In situ destruction of contaminants results from the thermally accelerated oxidation processes converting harmful chemicals into carbon dioxide and water. Raising the temperature of the soil and groundwater leads to rapid removal of organic contaminants primarily because of the dominating mechanism of increased volatility and steam stripping when the mixture of water and DNAPL reaches the boiling point.

This in situ treatment system offers some of the same pollution prevention benefits that in situ chemical oxidation (Fenton's Chemistry) and in situ bioremediation (horizontal wells) offer. Waste volumes are minimized because the waste is vaporized and therefore concentrated in the treatment process. Additionally, DUS may make it possible for solvents to be recycled.

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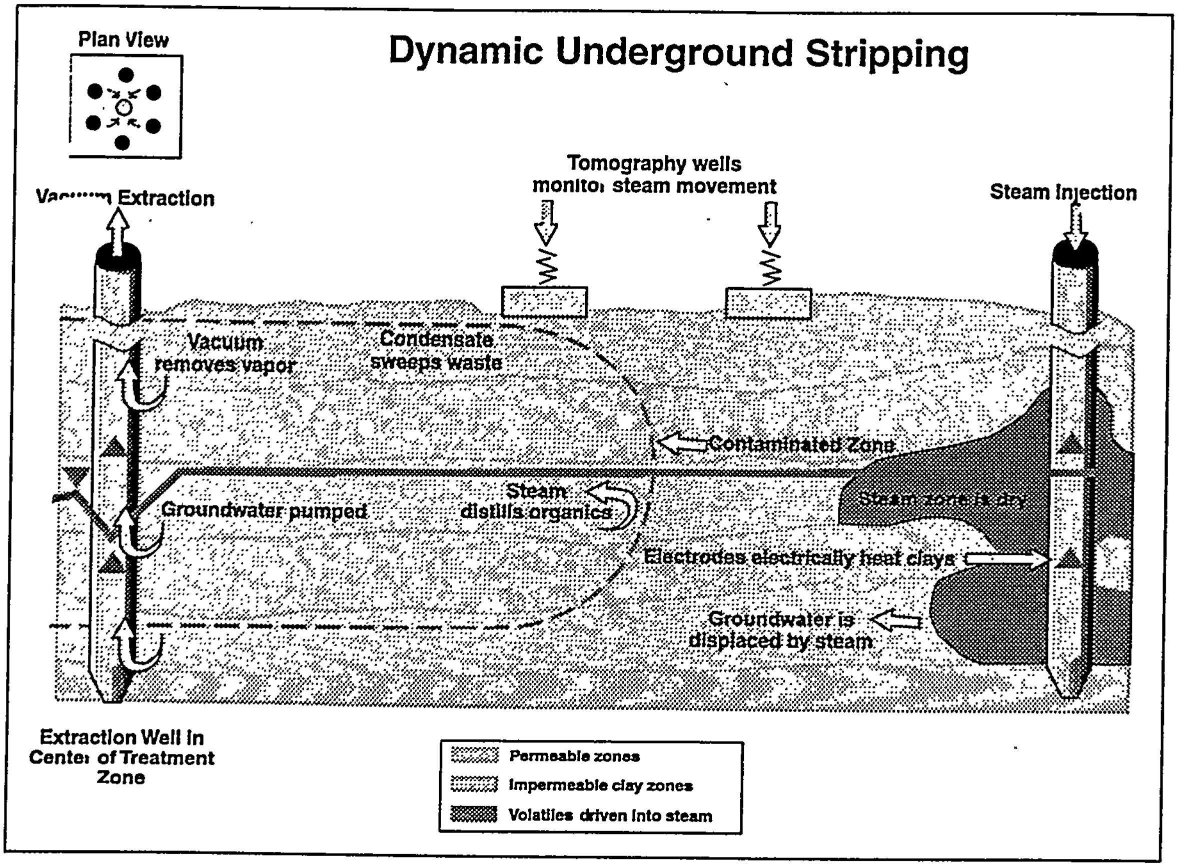

DUS also provides an accelerated method for site cleanup with a low overall cost. Thermally enhanced cleanup currently costs between $11 and $37 per cubic yard of contaminated soil (including energy costs). Additionally, the technology reduces cleanup time from decades to months. DUS can remediate a site in six to nine months while a conventional pump and treat system can take up to thirty years.

SRS is considering deploying this technology because Lawrence Livermore National Laboratory (LLNL) conducted a full-scale demonstration that determined that the DUS cleaned up contamination more rapidly and cost-effectively than conventional pump and treat or pump and treat with vacuum extraction systems. The system removed in excess of 7,000 gallons of gasoline (more than the original estimate) in ten weeks; the maximum extraction rate was 250 gallons per day.

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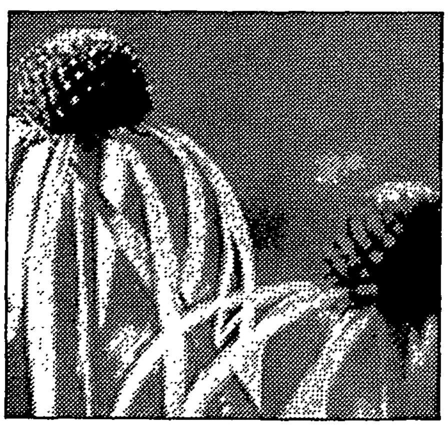
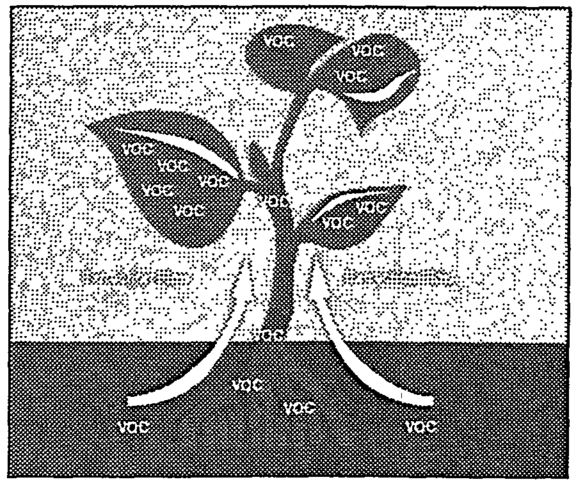
Phytoremediation is a technology that capitalizes on the ability of naturally occurring bacteria and fungi in root systems to clean up many types of organic contaminants, including chlorinated solvents, chlorinated pesticides, organophosphate insecticides, petroleum hydrocarbons, creosote, and refinery wastes. It is most effective when the contaminants are in the top two to three feet of the soil profile, within the reach of plant roots.

PHYTOREMEDIATION: a technology that uses the ability of naturally occurring plants to clean up organic contaminants in subsurface soils.

Phytoremediation is best suited for surface soils contaminated with intermediate levels of organic wastes since contaminant concentrations above certain levels can be toxic to plants. Technicians conduct preliminary soil testing to determine the type and level of contamination, and then plants are selected based on their resistance to the specific contaminant(s).

The technology has some limitations such as the amount of time required (sometimes several growing seasons) and the stage of technology development for some applications. In spite of these limitations, phytoremediation is particularly well suited for sites where large areas of surface soil are contaminated with intermediate levels of organic chemical pollutants. Since conventional agriculture equipment and supplies are used, the technology cost is extremely low, compared to other soil remediation technologies such as soil removal and soil washing.





The pollution prevention benefit of this in situ technology is that it minimizes waste by eliminating the removal and transportation of contaminated material from one site to another. In many cases the organic chemical contaminants are completely destroyed (converted to carbon dioxide) rather than immobilized or stored. Another benefit of this "green technology" is that it reclaims polluted sites so that they can be used for agricultural purposes. The vegetation also prevents the spread of contaminants to other sites by reducing soil erosion by wind and water.

Currently SRS is assessing the phytoremediation potential of trichloroethylene-contaminated (TCE) soils in the former raw materials production area. If proven effective, SRS may deploy the technology to remediate surface soils that an emerging plume of contaminated groundwater is expected to pollute in the next ten years.

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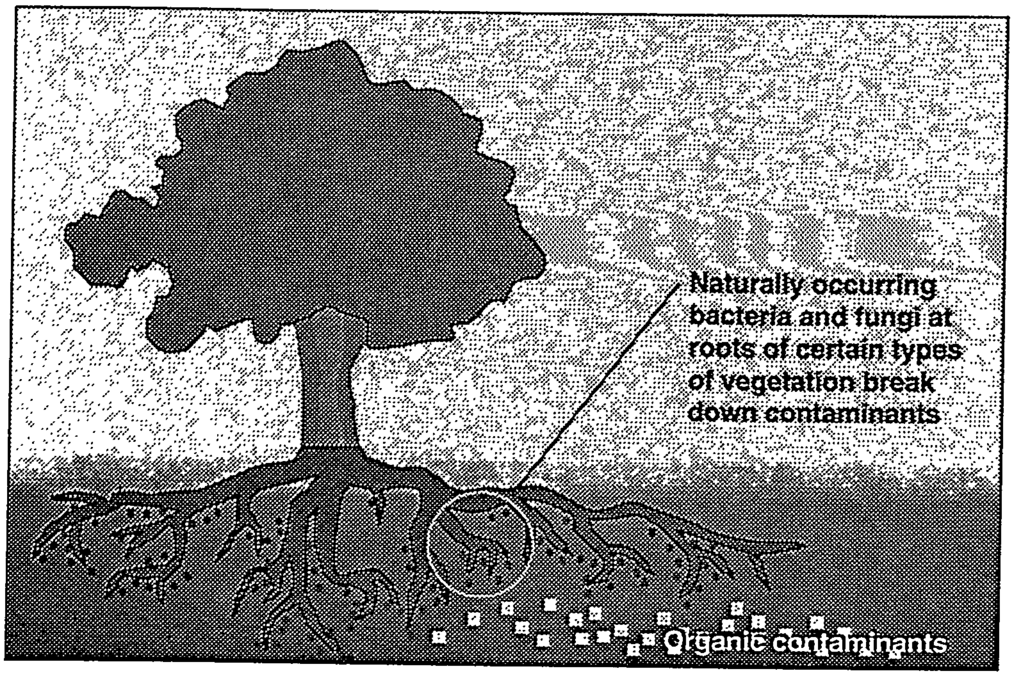
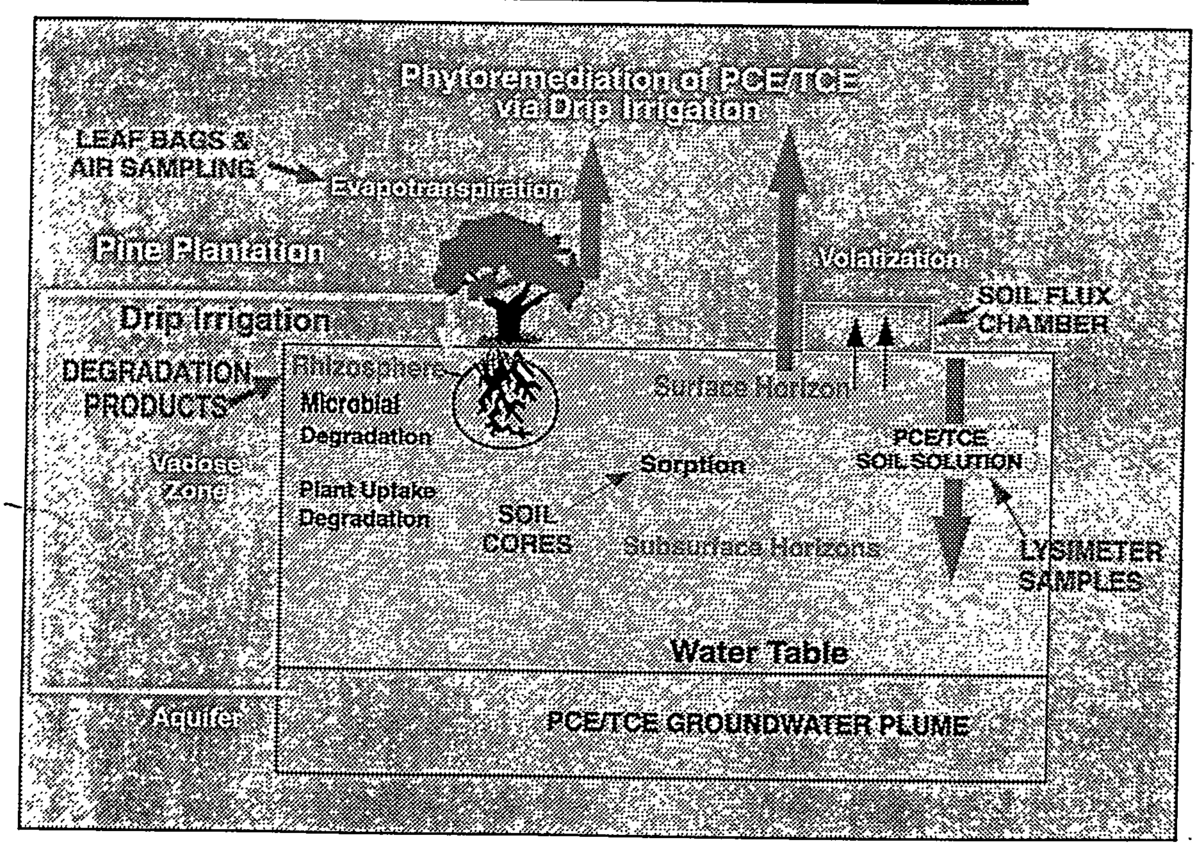
PHYTOREMEDIATION: a technology that uses the ability of naturally occurring plants to clean up organic contaminants in subsurface soils.





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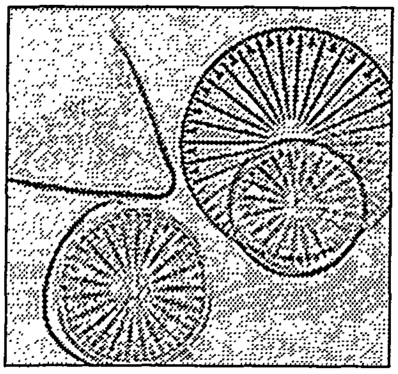
PHOSTER: a technology that effectively delivers phosphorus nutrients to stimulate microorganisms in bioremediation systems.

The PHOSter system is a breakthrough process developed by SRS that harnesses the natural detoxification capabilities of bioremediation systems. PHOSter, recipient of a 1995 National Federal Laboratory Consortium Award for Excellence in Technology Transfer and a 1996 R&D 100 Winner, provides controlled addition of phosphorous, a critical nutrient, into sites contaminated with organic compounds. The PHOSter process stimulates the growth of natural microorganisms by controlling their nutrition; these organisms grow and efficiently consume all types of organic contaminants, such as gasoline, oil, and industrial solvents.

The PHOSter system injects a mixture of air and triethyl phosphate through horizontal wells to encourage the growth of microorganisms that destroy contaminants in situ. The process works with any system that delivers nutrients (in a gas phase) to a microbial population in a site contaminated with chlorinated solvents. Injecting phosphorous in this gaseous form makes it highly available to the target microorganisms.



Deploying PHOSter offers a couple of pollution prevention benefits to ERD. The method enhances natural in situ remediation systems and ensures that one form of contamination is not replacing another. The phosphorous nutrient is safe and is completely consumed in the remediation process. Toxic organic chemicals are decontaminated in situ, eliminating the need to process large quantities of soil or groundwater and the need to transport contaminants to another site for later processing. Additionally, PHOSter uses minimum energy. Earlier attempts with traditional phosphorus-delivering methods failed to deliver the nutrient to a sufficient depth with a cost-effective, non-energy-intensive method.

PHOSter eliminates or greatly reduces problems associated with previous attempts to deliver phosphorous to the biomass. It works with any system (e.g., bioventing, biosparging, etc.) that delivers nutrients in a gas phase to a microbial population in a site contaminated with chlorinated solvents. Cleanup can be performed up to 10 times faster than was previously possible. And the accelerated cleanup results in significant cost savings.

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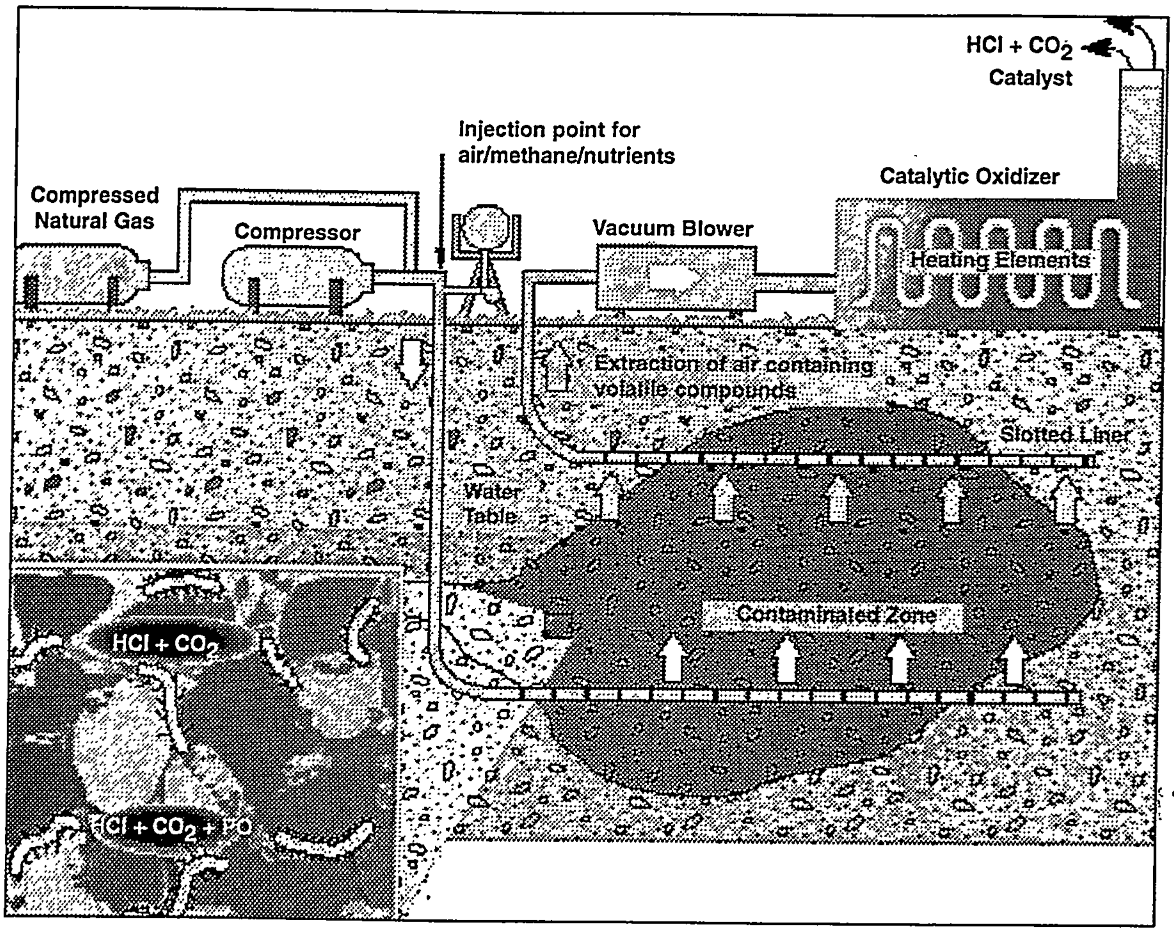
PHOSTER: a technology that effectively delivers phosphorus nutrients to stimulate microorganisms in bioremediation systems.



SRS financial scenarios indicate the cost of a five-year cleanup, including electricity, labor, regulatory documentation, and contaminant testing, total about $263,000. The two-year cost of remediating the same site by adding PHOSter to the project is about $160,000. The increased rate of expenditure during the intense two-year PHOSter effort nets a savings of about 39%, and it returns the land to economic usefulness three years earlier.

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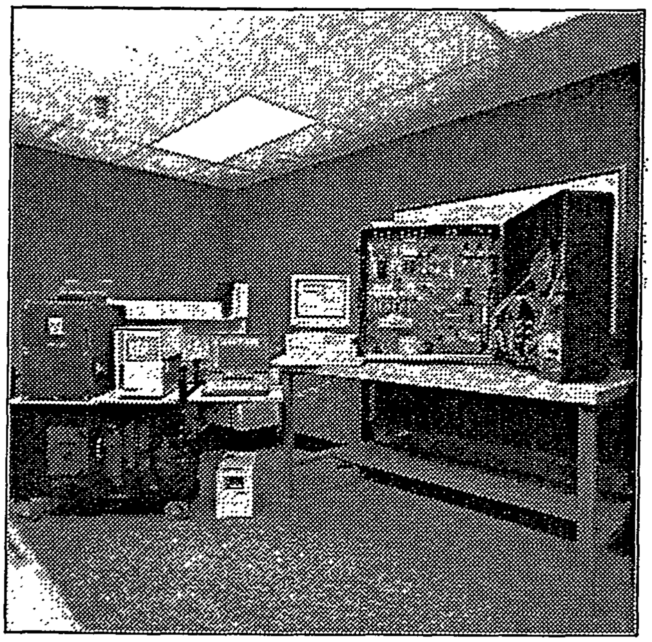
FIELD DEPLOYABLE TRITIUM ANALYSIS: a remotely operated system that measures tritium in contaminated surface and groundwater in near real time.

The Field Deployable Tritium Analysis System (FDTAS) is a readily portable tritium analyzer that was developed and tested at SRS. The system is remotely operated and measures tritium in contaminated surface and groundwater in near real time.

The FDTAS consists of an automated sampling and purification system coupled with a stop/flow radiation detector that utilizes liquid scintillation counting technology. A ample from a well or surface water source is obtained. The sample then goes through a single-use filtration and ion exchange column for in-line purification and is sent to a special cell where the purified sample is mixed with a liquid scintillation cocktail (LSC). The LSC/sample mixture is pumped into a special quartz analysis cell where it is counted and analyzed. The FDTAS can measure a background count rate of less than three counts per minute and uses a 1:1 LSC to sample mixture to achieve a tritium detection efficiency greater than 25%.

A remote computer, connected to the system through a modem, controls the FDTAS. The status of the system is monitored from the remote station during all phases of operation. The FDTAS provides for in situ, near-real time, unattended analyses of tritium in ground and surface water.



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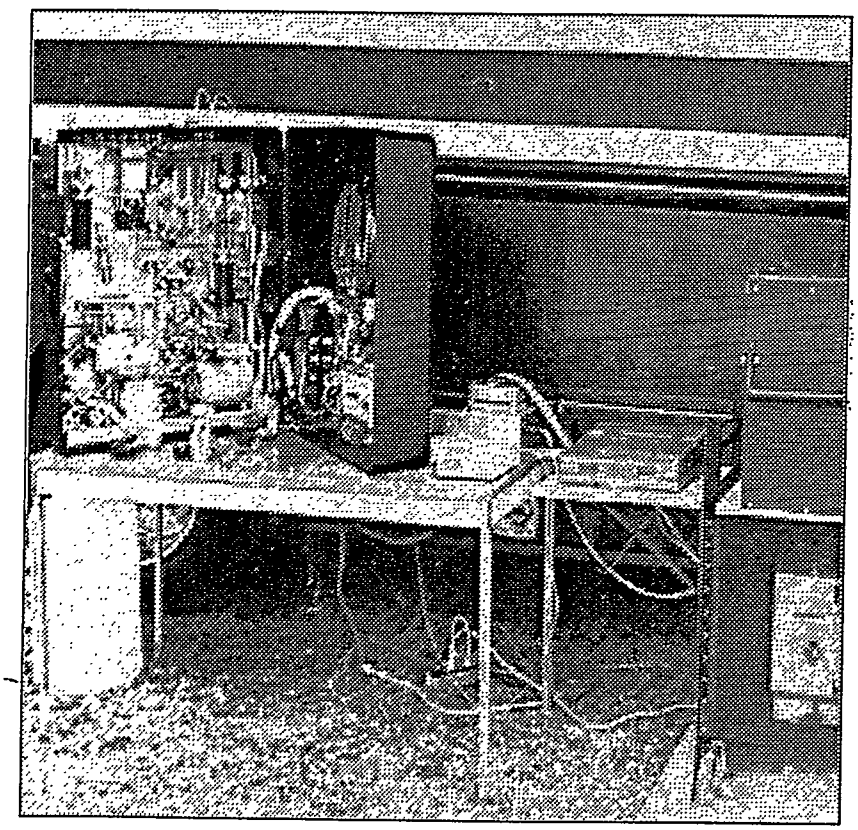
FIELD DEPLOYABLE TRITIUM ANALYSIS: a remotely operated system that measures tritium in contaminated surface and groundwater in near real time.

SRS is currently demonstrating deployment of the FDTAS in the former raw materials production area. The system permits the automated screening and monitoring of tritium plumes in surface and groundwater, and the results match data obtained by traditional sampling and laboratory analysis methods. The FDTAS is preferable to conventional sampling/analysis methods because of the minimal volume of associated waste.



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Innovative thinking, innovative technology, innovative problem solving methods... they all impact the bottom line.

IMPACT: the effect of one thing upon another.

The ERD commitment to identifying innovative P2 techniques and technologies has already had a significant impact on the bottom line of the SRS environmental cleanup program. Taking pollution prevention to the next level has reduced investigation-derived waste, waste generated during remediation, and waste requiring removal, treatment and disposal. Decreased waste volumes translate into reduced treatment and disposal costs and result in numerous cleanup projects being completed under budget. Recent innovations have already resulted in over $1.3 million in savings. These reduced project costs have not only impacted the bottom line of the overall ERD budget but have expedited the site's cleanup schedule since budget surpluses are redirected to other cleanup projects awaiting funding. Technology based innovations are expected to save $300 million dollars over the next 20 years.

The ERD commitment to innovative P2 technologies has also had an impact on cleanup budgets and schedules at other DOE, Department of Defense, industry, and university locations. The site freely exchanges information, technologies, and valuable lessons learned through sharing forums such as technical working groups, expert panels, site-to-site exchanges, international contacts, conferences, workshops, and other presentations and demonstrations. Last year the site participated in more than seventy environmental remediation technology forums. As a result, SRS technologies, such as horizontal wells, PHOSter, and the Field Deployable Tritium Analysis System were shared with other DOE, DOD, and local government facilities. Likewise SRS leveraged its cleanup resources as the beneficiary of approximately ten shared innovative concepts.