

Longterm Stewardship

As technological processes for remediation are improved, cleanup should become easier and less expensive. At least that is the hope. Over time, the demand for plutonium and nuclear weapons has decreased; consequently facilities and equipment have slowly been closing at many of the sites. However, new policies of the Bush Administration may reverse this trend. If it comes to pass that DOE constructs and operates the new plutonium pit facility being talked about for Savannah River, Los Alamos or Pantex, then cleanup will be greatly complicated, if not totally jeopardized.

Without active management, it is certain that contamination will continue to spread. Remediation has begun but vast, complicated decommissioning and cleanup projects must be completed before long-term stewardship can be introduced at each of the sites. The nature of the radionuclides and hazardous chemicals used at each of the sites requires extensive and regular monitoring indefinitely. It will be thousands of years before some of the radioactive materials naturally decay.

Given the longevity and toxicity of the wastes in question, we must repeat the question: Will the remediation work? Is it a full, complete, remediation? Or is it a band-aid solution? Are we adequately protecting the public and the environment?

Following remediation, long-term stewardship takes over. Successful remediation reduces the risk to the public, though most of the sites considered in this report will remain contaminated for thousands of years, long after humans will remember the hazard and the reason why waste must be carefully sequestered. Future generations will likely ask why scarce resources should be expended. Also, with population growth, land will become more valuable. Though monitoring and maintenance must continue forever, future generations will ask, why? To transition to a stewardship program from a remediation program, the Department has created the Office of Legacy Management (OLM). After major remediation is completed and sites are “closed,” they are transferred to this new office. OLM will be responsible for long-term pump and treat operations, monitoring and maintenance.

Why Long-term Stewardship?

DOE’s underlying idea behind long-term stewardship is to restrict access to contaminated areas and monitor the amount of contamination that remains after remediation. Clearly, doing something – treating pollution and producing studies, is more expensive than monitoring. But even monitoring waste sites will be expensive because of the time periods involved. Some

radioactive contaminants will not decay naturally for tens of thousands of years. Some toxic chemicals will remain hazardous forever. These materials leach into the soil and enter the groundwater and will remain until the environmental media is removed and treated.

The principal goals of long-term stewardship will be to maintain engineered units and institutional controls, monitor groundwater and surface water, continue surveillance, operation and maintenance of treatment systems, and enforcing access restrictions for surface and subsurface contamination. At some sites, pump-and-treat will have to continue for the foreseeable future. Activities of long-term stewardship may also include: well field operations and maintenance, research and development to estimate future contaminant concentrations, improved monitoring regimes and finding a method of maintaining consistency in record-keeping far into the future.

In addition to long-term maintenance, there must be consistent research and review to ensure that the remediation has not failed. Considering DOE's behavior in the past, we have no reason to believe that the agency will be more prudent in the future. As we move further away from the original mission of DOE factories to produce nuclear weapons, there is less incentive for Congress to pay for long-term stewardship. Unfortunately, this is already a trend in Congressional funding.

One example is funding for the Subsurface Contaminants Focus Area, the office whose primary mission is to develop better solutions for contaminated groundwater and soil. Between 1994 and 1998, funding has dropped from \$82 million to an effective \$9.7 million in 1998.¹ It is also imperative that the DOE includes the public and stakeholders in the decision making from the outset with opportunities for meaningful public participation in future cleanup and stewardship decisions. To ensure that long-term stewardship is sustainable, the most essential element is strong local public involvement.

The Alliance for Nuclear Accountability has repeatedly stated that the public has a right to know what materials were handled at each of the sites, what contamination levels still exist, and what health risks are present. The public also has a right to share in the responsibility for protecting their communities with setting cleanup standards, choosing between different remediation options, establishing zoning restrictions, and monitoring technologies.

Although the groundwater may be treated, it is imperative that access to residually contaminated areas be restricted indefinitely. For example, at the Nevada Test Site restrictions are placed on areas of the surface and subsurface that are contaminated. Restricted access to bomb test cavities, groundwater, and associated subsurface contamination should remain in place indefinitely. Currently, fences and signs are in place, as well as a monument marking the location of where the testing took place. Particularly with a new push to resume testing, these areas must be kept off limits. At sites where nuclear weapons research and production is ongoing, remediation of contaminated soil and groundwater onsite must also continue indefinitely.

Monitoring

Over the years the Department of Energy has consistently denied the possibility of the spread of contaminants offsite. It was not forthright when that migration became evident, and then underestimated the speed at which radionuclides and toxic chemicals would travel. Given this history, a rigorous monitoring program is necessary throughout the DOE complex.

One of the major long-term stewardship activities entails the monitoring of remediated areas. Adequate monitoring of both operating and recently closed sites must continue for the indefinite future. Unless this monitoring program is in place, the public will have to rely on verbal reassurances from DOE that the remediation has worked and is continuing to work. Such verbal guarantees have failed over and over in the past.

The design and operation of the monitoring regime must not cut any corners. Location and depth of monitoring wells, types of contaminants being monitored, frequency of sampling, and full and timely disclosure of monitoring results must be available at appropriate – and accessible – public locations. These locations must be in the vicinity of each nuclear weapons factory and at central locations, such as a federal building in Washington, DC. Clear and detailed monitoring reports are a necessary part of a rigorous monitoring regime.

Costs

Not only are methods of remediation costly, but long-term monitoring and surveillance creates additional costs.

As it stands, environmental management at these sites requires annual funding from Congress that waxes and wanes as a function of budget pressures and the political priorities of the Administration. This is an entirely unsatisfactory situation for long-lived waste materials at the DOE sites. We recommend that a trust fund, not subject to the political winds, be established for perpetual maintenance of these waste materials and the sites.

Indicative of the need to get the cleanup funding process safe from political maneuvering is a recent policy change by the Department of Energy. As this report goes to press, the DOE is pushing an “accelerated” cleanup plan for the nuclear weapons complex. Unfortunately, “accelerated” is a euphemism for sloppy, short cuts that are designed to cut costs at the expense of human health and the environment. As noted in an August 2002 critique by the Alliance for Nuclear Accountability “the DOE is looking for loopholes to save costs and ...is accelerating cleanup by doing less of it.”²

Under the plan, based on a so-called Top-to-Bottom Review, the DOE wants to change cleanup standards and reclassify wastes as more benign. This would enable DOE and its contractors to permit less thorough and less costly cleanup. Not only does the plan involve unsafe waste management practices, such as redefining high-level waste as transuranics so that the waste can be left in tanks, but it also allows for very limited public review. In state after state throughout the country, the public has been allowed only 1, 3, and 5 days to comment on extremely complex plans. Although the DOE plan has temporarily been held up by criticism from the field and members of Congress, the Accelerated Cleanup Plan is a dangerous indicator of future DOE policy.

Survey of Remediation Plans

We next briefly describe the current remediation and long-term stewardship plans at each of the 13 DOE sites.

Fernald Site

According to DOE, access to the Fernald Site will remain restricted until remediation work is completed, expected to be 2008. Groundwater remediation for the perched aquifer and the main aquifer, approximately 2000 acres, will rely on pump and treatment prior to discharge to the Great Miami River. Thus far about 5.8 billion gallons of contaminated water have been removed from the Great Miami Aquifer and 3,600 lbs of uranium have been removed. The present uranium concentrations in groundwater ranges from 500 to 800 ppb; the concentration must be brought down to 30 ppb to meet EPA regulations. DOE now believes it will not be until the year 2020 that this is accomplished.³

All contaminated materials above regulatory limits will be removed from the 37-acre waste pit area. So far, Fernald has shipped more than 500,000 tons of an estimated 790,000 tons of waste to Envirocare.⁴ Over a five year period, ending in 2004, this will amount to 124 trains, each consisting of 60 railcars. The end result will be that all remaining contamination will be at acceptable levels, according to DOE. "Acceptable" will be determined by a risk analysis, assuming future use of the site is recreational. That is, the DOE wants to remediate the Fernald Site to recreational, not residential (more stringent), standards with long-term institutional controls and monitoring in place. This implies eternal deed restrictions.

Soil that meets acceptable levels will be disposed of in a 125-acre landfill onsite; otherwise the waste will be disposed of offsite. The location for off-site disposal for Fernald and other site wastes will be either Envirocare, in Utah, or elsewhere. For some DOE sites, disposal at the former Cotter uranium mill in Canon City, Colorado has been recommended. This project is strongly opposed by local residents in Colorado.

At Fernald, synthetic and natural materials will be used to cap disposal areas, but these landfills must be continually monitored and maintained. Maintenance must ensure deep-rooted plants do not grow on landfills. At Fernald, no mixed waste will be disposed of onsite. The majority of facilities will be decontaminated and demolished.

Hanford Reservation

Hanford is divided into many areas with varying remediation strategies. According to the DOE, all special nuclear materials, irradiated nuclear fuel, and high level wastes (HLW) will be sent offsite. By the year 2012, DOE intends to remediate 50 burial grounds, 551 waste sites, 261 unused facilities and seven plutonium production reactors! Closure of waste tanks throughout the site will be determined by partial shipment of contents, converted to a glass, offsite to the proposed Yucca Mountain repository. DOE intends to do this by the year 2035. It remains to be seen how much waste will eventually be shipped to Yucca Mountain since that potential repository is already over-committed to almost three times its legal capacity and is decades behind schedule.

However, in the case of residual HLW, and the tanks themselves, DOE wants to redefine these materials as Waste Incidental to Reprocessing and fill the tanks with cement. This poses a potential threat to the groundwater system since this so-called "incidental" waste is extremely radioactive and long-lived. Clearly the motive here is cost, not safety. It is less expensive to produce a carefully worded and optimistic risk analysis than to face the fiscal reality of actually remediating all high-level waste at Hanford. The redefinition exercise is now on hold since Natural Resources Defense Council and the Snake River Alliance successfully brought suit against the DOE. However, DOE may appeal the decision, or Congress may override the court decision by redefining tank waste.

Low-level waste, mixed low-level waste, and other contaminants will remain onsite. The 200-Area, where reprocessing and waste disposal took place, will be restricted forever. In order to begin remediation on groundwater, characterization must first be completed. Characterization involves, among other tasks, defining the type and boundaries of soils present, the nature and extent of the underlying geology and hydrology, plus determining the types and amounts of radionuclides and toxic chemicals found in the area.

As yet boundaries of plumes of cesium and other radionuclides, plus a complete definition of the hydrology in the vicinity of the high-level waste tanks are incomplete. Groundwater will need to be monitored and its use restricted, though this does not ensure contamination does not further travel to the Columbia River. DOE has the technology to remove strontium and cesium from groundwater in the 200-area and should use this technology here.

Contaminated soil and waste will be excavated and most engineered units will be removed from the 100 Area, located adjacent to the Columbia River. Reactors will be stabilized and facilities maintained, though this means strontium-90 will continue to leach into the Columbia River. Hazardous areas will be monitored with remote sensory technologies.

The site will maintain contaminated soil sites by controlling vegetation growth and removing contaminated vegetation. The site will restrict access to areas used for radioactive waste disposal and buffer zones for as long as necessary to ensure protection. Routine surveys and monitoring will take place across the site indefinitely. Monitoring will continue on a semi-annual basis for at least 30 years following closure of all of the facilities, a period far too short to allow decay of the remaining radioactive materials.

Monitoring around the high-level waste tanks should take place once a month, not once every six months.

Idaho National Engineering and Environmental Laboratory (INEEL)

Remediation at INEEL entails leaving organic contaminants in the Snake River Plain Aquifer and residual contaminants, such as chromium, tritium, mercury, cesium, iodine-129 and cobalt in the so-called perched water table. (The relationship between the perched aquifer and the Snake River Plain aquifer is not fully delineated.) Also plutonium has been injected into the aquifer. As yet there are no plans to remove this contamination. As mentioned before, INEEL estimates that it will not be before 2095 that some contaminants are removed from the Snake River Aquifer. Groundwater will be monitored and flood diversion structures will be maintained. Capping will be used to contain buried wastes and contaminated areas.

Facilities will be deactivated and demolished or decontaminated for reuse by the year 2025 under the new accelerated program. The majority of the site will not require access controls but will likely transition into a National Multi-Program Engineering and Environmental Laboratory. DOE proposes that the future use of the land will include grazing and industrial use, though this prospect seems unduly rosy. According to DOE, residential use will not be permitted for the next 100 years. In our opinion, under the present DOE proposal, land use should be restricted essentially forever. New reactors currently being proposed for the site will, of course, generate more wastes and more remediation problems far into the future. Removal of over 1 million gallons of high-level waste from the tanks is on hold and dependent on whether DOE will be able to label remaining sludge in the tank as waste incidental to reprocessing so that these wastes can be left in the tanks.

Lawrence Livermore National Laboratory

Remediation will be conducted at LLNL's Site 300 and Main Site. At Site 300, remediation of groundwater plumes will be accomplished via extraction and air stripping or sorption to granular activated charcoal, natural attenuation, and the installation of guard walls for monitoring. This remediation process will continue for the indefinite future. Soil vapor extraction will be used to remediate VOC contamination. An experimental phytoremediation/constructed wetland is actively remediating nitrate contamination at one of several plumes. PCBs and some dioxin were detected on the surface of a closed pit and have been removed. A sand pile and underlying soil containing high levels of tritium, PCBs and dioxin will be excavated and disposed off-site. Technologies to remediate uranium, tritium, perchlorate and high explosives (e.g., RDX and HMX) are still being developed and are not presently in use. In the meantime, access control and monitoring remain in place. At Site 300, one landfill has been closed and capped. There are two small plumes of tritium and VOCs emanating from the landfill. These will be remediated via monitored natural attenuation. Several other landfills have been capped and will continue to be monitored.

A unique and problematic feature of Site 300 is its use as a high explosives test facility. All the components of nuclear weapons, except fissile materials, undergo testing here. Large blasts occurred in unconfined areas. Periodically, the residues from these tests were collected and placed in unlined pits. Because tritium was used quite extensively, it has since contaminated a groundwater plume extending more than one mile. In 1998, activity levels for tritium were measured at 1,430,000 picoCuries per liter (pCi/L). The drinking water standard is 20,000 pCi/L. In 1998, in the area of these pits, tritium activity in the groundwater was estimated to be 17.7 Curies. At another site, tritium activity in the groundwater was estimated at 40 Ci. With ongoing missions by the DOE's NNSA Office of Defense Programs onsite, future use will be a controlled access, as non-DOE land uses have not been considered in any land-use assumptions. A small area of this 11 square mile site is set aside as an ecological preserve.

At LLNL's Main Site groundwater is remediated through extraction and air stripping, and pump-and-treat systems. In an area where VOCs are commingled with tritium, in situ and ex situ catalytic treatment systems are in use to break down the VOCs. The tritium is re-injected. No removal of tritium from contaminated groundwater is anticipated. Soil contamination is reduced through soil vapor extraction and thermally enhanced vapor extraction. An area of the facility was used for the disposal of various wastes, including radioactive wastes. This area has been excavated several times, including 1998 where plutonium was found above the EPA Region IX preliminary remediation goal. Recently, during the construction of a large laser, over 100 PCB-laden capacitors were found buried in this approximate area. They and surrounding soil were removed and disposed of off site. With ongoing missions by the Office of Defense Programs onsite, future use will be a controlled access, as non-DOE land uses have not been considered in any land-use assumptions. LLNL will continue to design and fabricate new nuclear weapons designs, thus creating more toxic and more radioactive wastes for the indefinite future.

Los Alamos National Laboratory

Los Alamos is located atop the Pajarito Plateau, a volcanic mesa. Eight watersheds drain the plateau into the Rio Grande River. Most of the chemical waste material is buried on small mesas. One groundwater plume of high explosives extends from Technical Area 16. High explosive residues were detected in monitoring well R-25, located on the south rim of Canyon de Valle. LANL is removing high explosives from contaminated soil in Technical Area 16.

Approximately 52,500 cubic yards were excavated using remote equipment. Pueblo and Los Alamos Canyons received the majority of liquid radioactive discharges. The original disposal site for liquid wastes was a tributary of Pueblo Canyon, Acid Canyon. 490 cubic yards of Pu-contaminated sediment have now been removed from Acid Canyon. Plutonium concentration has now been reduced to 206 pCi/g, levels still not acceptable for residential use.

In Mortandad Canyon, Technical Area 50, a permeable barrier consisting of columns of supposedly “pollution-capturing materials” was installed. The effluent stream from the Radioactive Liquid Waste Treatment Facility flows through Mortandad Canyon. Within the 27-foot barrier are layers of fine lava rock, calcium phosphate, pecan shells, cottonseed and limestone. Whether pecan shells and cottonseed will halt the migration of strontium-90, americium, plutonium and chemicals, such as perchlorate, nitrate and heavy metals, remains to be seen.

LANL will continue to operate and continue to produce radioactive waste that must be managed. Material area G, located on Mesita del Buey, within Technical Area 54 has been used for disposal of Lab waste since 1957, and will continue to operate into the future. Also located within Technical Area 54 is Material Disposal Area (MDA) H (there are 26 material disposal areas in all at LANL), one of the first mesa-top MDA’s to undergo remediation. This disposal area consists of nine inactive disposal shafts, 60 feet deep, containing classified hazardous chemical and radioactive waste.

Under the accelerated cleanup program, LANL is committed to remediate the site by the year 2015, shortened from the previous date of 2030. The “Quick to WIPP” strategy will send most of the transuranic waste to WIPP by the year 2010, shortened from the previous deadline of 2030.

Mound Facility

The Mound facility is currently being remediated to achieve EPA industrial use standards, which are generally three times less stringent than residential standards. Groundwater remediation methods include pump-and-treat of volatile organics to prevent migration of contamination into the aquifer, in addition to long-term monitoring. Groundwater in the Buried Valley Aquifer will require post-remediation compliance monitoring every 5 years through at least 2015.

Soil contaminated with radionuclides (approximately 125,000 cubic meters) will be excavated and shipped offsite. About 300 cubic meters of plutonium contaminated waste will be shipped to the Savannah River site. Soil contaminated with TCE and PCE will be treated through bioremediation and in situ vacuum extraction. Contaminated facilities will either be demolished or decontaminated to industrial levels.

Seven Mound facilities will be used under the Office of Nuclear Energy. Future use of this site, DOE anticipates as early as 2006, will be as a commercial/industrial complex. Approximately 40% of the structures on the site were transferred to MMCIC, a non-profit corporation established by the City of Miamisburg to redevelop and reuse the Mound site. DOE has imposed deed restrictions on the land stating that soil cannot be removed offsite and groundwater cannot be used without prior regulatory approval. Also, the land use must remain industrial.

Nevada Test Site

Underground testing of nuclear weapons was the principal source of contamination at the Nevada Test Site. During underground testing, the total amount of contamination released exceeded 200 million curies. The primary remediation strategy proposed by DOE for groundwater is natural decay of radionuclides, hoping that radionuclides reach safe levels before coming in contact with the off-site public. With an increasing draw of water by the greater Las Vegas area (which is growing very rapidly), this is a race against time.

The DOE maintains that contamination in the subsurface will remain in place surrounding the areas of testing. Access to and use of groundwater on-site will be restricted indefinitely, due to the nature and extent of remaining contamination and the potential future need for nuclear testing. DOE has no control over off-site water use.

Significantly, the “accelerated cleanup program” signed with the State of Nevada is called an “accelerated management program.” This is because the State has committed to allowing the low-level and mixed waste disposal landfills to remain open. The underground testing area is off-limits for remediation. Use of the majority of facilities onsite will be for continued development and testing of Department of Defense weapons programs; only seven of the facilities will undergo decontamination and decommissioning. If the US resumes underground testing, more contamination will be generated. When and whether the NTS site will be returned to Native Americans who claim ownership has not been specified.

While LANL has remediated the Acid Canyon to Pu concentrations close to 200 pCi/g, Nevada will allow Pu concentrations as high as 1000 pCi/g, under a military land use scenario. Under these minimal criteria, cleanup is anticipated to be completed by the year 2010. On the positive side, Nevada appears to be the only State to request increased oversight funding from DOE to accommodate DOE’s accelerated schedule.

Oak Ridge Reservation

At this point, the EPA has not approved DOE plans for remediation of the Oak Ridge Reservation. Many end-states and corresponding cleanup levels are still being determined. Groundwater, both on- and off-site, has been contaminated by the activities at Oak Ridge. Nevertheless, the DOE believes that up to 75% of the site can be used for recreational or industrial purposes and, under the accelerated cleanup program, can be accomplished by the year 2008. This is an overly optimistic assumption.

Offsite bodies of water will be monitored until the levels of contamination diminish to within allowable levels. At ORNL, contaminated burial grounds will be capped and isolated. Since some of the landfills lie within the water table, it is not clear how capping will isolate the waste materials from the lateral movement of groundwater. According to DOE, portions of this area will be remediated to less stringent industrial levels. At Y-12, burial grounds and other contaminated areas will be capped and, supposedly, hydrologically isolated. Construction of a permanent onsite disposal facility in the Y-12 area is being evaluated. A waste water system will be constructed to reduce Y-12 mercury releases. At the former gaseous diffusion plant, DOE will relocate the depleted uranium hexafluoride cylinders. It is not clear where the DU and cylinders are going, perhaps into recycled materials and into general commerce, perhaps into DU arms and shielding for military vehicles.

Because waste and contamination will remain onsite, the DOE believes that stewardship, including monitoring and institutional controls, will likely be required for hundreds of years. In our opinion, because of the long-lived nature of the radioactive materials on the site, the period

will be considerably longer with the site remaining a wasteland virtually forever. Plans for contaminated White Oak Lake have also not been approved.

Oak Ridge still has a production mission; this means the time line for cleanup of facilities still operating extends far into the future.

Paducah Gaseous Diffusion Plant

At Paducah, groundwater remediation will continue long-term. Methods of remediation for the groundwater will include containment of sources, the removal of water from high-concentration areas, pump-and-treat, and natural attenuation of certain contaminants. Groundwater remediation will continue beyond 2070 due to the long-term persistence of TCE and technetium-99 sources. According to DOE, 180,000 gallons of TCE may be present in the aquifer, at concentrations up to 100,000 $\mu\text{g}/\text{m}^3$, vastly exceeding regulatory limits. DOE is employing an underground heater to vaporize TCE and capture it on carbon filters. Pump and treat will be continued under DOE's long-term stewardship program. An experiment is underway with a pilot plant removing the technetium-99. Offsite contamination will be remediated to residential or recreational levels. The cleanup target level is a risk of 10^{-4} , assuming non-residential use.

Contamination in the burial grounds and landfills will remain after they are closed and covered with a multi-layer cap. Contaminants of concern in soils and stream beds at Paducah include TCE, radionuclides (particularly technetium) and PCBs. Selected facilities will be decontaminated, if necessary, and used for ongoing enrichment operations. Approximately 54,000 tons of scrap material will be removed to parts unknown. Under the accelerated agreement signed with the Commonwealth of Kentucky, all this work will be completed by the year 2019. The gaseous diffusion plant will undergo decontamination and decommissioning (D&D) after the plant closes.

Future land use of the site being promoted by DOE include controlled access, mixed industrial, open space, and recreational uses. Once again these estimates are overly rosy. Since Paducah is the only currently operating enrichment facility in the U.S., production of enriched uranium is likely to continue at this site for at least another decade. This means additional waste materials will continue to be generated for the foreseeable future. This waste will be disposed in the U-landfill.

Pantex Plant

With an ongoing mission within the DOE complex to assemble and disassemble nuclear weapons, Pantex will remain under controlled access and in the future may be usable under industrial standards. Remediation of TCE from a "perched" aquifer is being accomplished using the method of pump-and-treat; the perched aquifer will be monitored indefinitely. What is disturbing is DOE's continuing view that the aquifer is "perched," when it is known that TCE has migrated from the "perched" aquifer to the lower and larger Ogallala aquifer.

Levels of radiologically contaminated soils will be cleaned up to allowable levels as specified in the Texas Risk Reduction Standards Guidance. Soils are contaminated with high explosives, residual radionuclides, and VOCs. Landfills will be capped and maintained. Buildings no longer in use will be demolished and capped. Maintenance of structures will not continue once D&D activities are complete. All legacy waste, supposedly, will be removed from the site by 2004, but this timeline is overly optimistic. Under the accelerated cleanup plan, all remedial actions will be completed by the year 2008.

As long as the United States has nuclear weapons, the Pantex Plant will continue to be used for assembly and disassembly, thereby generating additional waste.

Portsmouth Gaseous Diffusion Plant

The gaseous diffusion plant operated by the US Enrichment Corporation to produce low-enriched uranium is presently on standby. At closure, estimated to be 2035, the gaseous diffusion plant and waste storage facility will undergo decontamination and decommissioning.

DOE claims that groundwater plumes will be contained within the site through still experimental in situ technologies, removal and isolation of sources, and the utilization of passive treatment. According to DOE, cleanup of groundwater is expected to be completed by the year 2053. However, while some volatile organics are removed from groundwater, the remaining contaminants, including all radionuclides, particularly technetium-99 and uranium, are disposed in the Scioto River. Contaminants of concern for groundwater include VOCs, radionuclides, and metals. Under the plan, chromium in groundwater will be immobilized in place, though due to the newness of this technology it is not clear how long the chromium will *remain* immobilized. Surface water will be remediated to meet cleanup levels.

Excavation of soils will occur for well-defined areas. However, as burial grounds are closed, the contamination will remain in place covered with engineered, multi-layer caps. Contaminated facilities will be demolished. Supposedly, some parts of the site will be released for commercial or recreational, but not residential, use.

Rocky Flats Site

According to DOE, all special nuclear material is expected to be shipped offsite by the year 2004. The DOE has a goal to accelerate cleanup and closure by the year 2006. However, this plan may be too ambitious with the resistance of South Carolina accepting plutonium from Rocky Flats.

Levels of radiologically contaminated soils will be cleaned up to allowable levels as specified in the Rocky Flats Closure Agreement (RFCA) and will remain in place. Contaminants of concern include radionuclides (uranium, plutonium, and americium), VOCs (TCE and PCE), and heavy metals. Nearly 100 acres of the site, including a municipal and hazardous waste landfill and the former production area, will likely be covered with engineered earthen caps and remain under restricted access.

Remediation of groundwater, contaminated with VOCs (TCE, PCE, and carbon tetrachloride) and radionuclides (uranium), will be limited to sources that become surface water; non-mobile contaminants will remain in place. Passive reactive barrier systems for treatment and containment are in place

Areas of the site not capped will be regraded and revegetated requiring long-term stewardship. Two onsite landfills are in place and will be capped and fenced. Uncontaminated underground storage tanks will be left in place, whereas all facilities will be demolished and will remove all necessary foundations and utilities in remediating the site.

Remediation at Rocky Flats will supposedly enable reuse of the buffer zone as open space and the DOE proposes that the industrial zone will be restricted for open space or light industrial uses.

Savannah River Site

In the contamination hierarchy, the Savannah River site ranks near the top. A combination of methods will be used in remediation for SRS due to differing contamination throughout the site. Groundwater, soil, engineered units and facilities are all contaminated. Contaminants of concern in groundwater include chlorinated VOCs, metals, and radionuclides such as tritium, cesium, uranium, and strontium. According to the DOE, “remediation of intermingled groundwater plumes of metals and radionuclides with each of the five reactor areas (C, K, L, P and R) are a major challenge.”⁵ These plumes will impact the surface environment and the Savannah River floodplain swamp.

Methods of remediation for groundwater will include various experimental technologies, such as ex situ and in situ chemical oxidation treatments, a pump and treat and reinjection system, including reverse osmosis; pre-filtration, air stripping, underground steam stripping, secondary wastewater treatment, and natural attenuation of tritium across the site. These methods are not in effect at the present time and obviously depend on funding. Water that will not be remediated is located in Par Pond, Savannah River Swamp, and L Lake. Thus contaminated water will continue to drain off of the site into the Savannah River, via streams, and swamps. Contaminants of concern in the flood plain swamp area include metals, radionuclides, and VOCs.

Future soil remediation will include treatment and stabilization in place and contained through natural or synthetic capping. Engineered units will be capped and remain in place after stabilization; contamination in engineered units will remain in place. Facilities onsite will be deactivated and are likely to remain in a contaminated state rather than being completely decontaminated and decommissioned.

The duration of remediation and monitoring of SRS will continue indefinitely for as long as contamination remains. A complicating factor is the indefinite storage of plutonium from Rocky Flats and LLNL; not all facilities can be decommissioned while plutonium remains at SRS. Furthermore, plans for a MOX fuel plant and a possible new plutonium pit fabrication plant at Savannah River will create new waste streams. It is highly unlikely that this site can ever be released for public use.

¹ National Academy of Sciences, *Groundwater and Soil Cleanup, Improving Management of Persistent Contaminants*, National Academy Press, Washington, D.C., 1999, p. 15.

² Alliance for Nuclear Accountability, *Critiquing the Department of Energy's Accelerated Cleanup Plans : A Summary of Comments Made to DOE Site Performance Management Plans*, August 2000.

³ D Klepal, « Cleaning water beneath Fernald will take longer, » *The Cincinnati Enquirer*, August 13, 2003.

⁴ DOE, *EM Progress* newsletter, Spring 2003.

⁵ SRS, « Technical Needs Statement, » <http://www.srs.gov/general/scitech/stcg/Needs/02-3037.htm>.

