Wood-Treating Sites and Their Cleanup 2

The wood-preserving industry treats lumber with various chemicals to protect against insect damage and decay. Chemically preserved wood is used in products for outdoor use such as railway ties, fencing, telephone poles, exterior plywood panels, and outdoor decks (23). The industry has operated in the United States for over 100 years, with sites often having operated for decades (23). Spills from the treatment process have left many of these sites heavily contaminated with the chemicals used to preserve wood.

U.S. Environmental Protection Agency (EPA) has identified 56 wood-treating sites among the Superfund sites in the United States (17). Because the processes that have been used at these wood-treating sites are generally so similar, the contamination and cleanup needs are also similar. Recognizing this, EPA has recently moved to standardize the process for selecting cleanup remedies. Following a thorough review of past experience with remedial activities, the Superfund program has developed a short list of preferred cleanup technologies or presumptive remedies for wood-treating sites. It is intended that presumptive remedies will be selected for future remedial actions at all wood-treating sites, except under unusual site-specific circumstances. Wood-treating sites are one of three categories of sites for which EPA has designated presumptive remedies.

For sites contaminated with preservatives such as those used at the Texarkana Wood Preserving site, EPA suggests bioremediation as the preferred cleanup remedy. If bioremediation is found to be infeasible, thermal desorption methods are to be considered. Incineration may be selected if bioremediation and thermal desorption are not feasible. In downplaying the role of incineration among the presumptive remedies, EPA stresses the difficulty in gaining public support, but recognizes the method's effectiveness.

In addition to the technologies that EPA now identifies as presumptive remedies, a number of other innovative technologies have been selected for use at wood-treating sites in recent years. OTA has reviewed 47 records of decision (RODs) for 40 Superfund wood-treating sites to investigate the selection of remedies. This chapter provides a description of the contaminants typically found at wood-treating sites, a list of the remedies that have been selected at Superfund wood-treating sites, and a summary of EPA's recent efforts to standardize the remedy selection process at wood-treating sites. The remedial technologies are described in greater detail in chapter 3.

WOOD-TREATING SITES

The wood-preserving industry pressure treats wood with chemicals that protect against insects and fungus. Just a few preserving chemicals have been widely used by the industry. The oldest preservative process treats wood with creosote, a tarry liquid derived from coal (see box 2-1) (17). Pentachlorophenol (PCP) became widely used as a preservative after 1950, although its purchase and use is now restricted (see box 2-2) (17). Metal salts made from chromium, copper, arsenic, or zinc (e.g., chromated copper arsenate [CCA]) are now the most frequently used preservatives. The metal salts present special cleanup problems that we do not consider in this paper.

Almost 60 wood-preserving sites are on the National Priorities List, which lists facilities eligible for cleanup under the Superfund program. Hundreds more may have been abandoned and are in need of cleanup. Most of these sites present similar cleanup problems (see the descriptions of five Superfund wood-treating sites presented in boxes 2-3 through 2-7). The older sites in need of cleanup typically used creosote and PCP. The treatment process produced significant spillage, waste sludges, and contaminated wastewater. The Texarkana Wood Preserving site is typical of the many wood-treating sites that have used creosote and PCP over a number of decades.

At these sites, wood was generally treated under pressure with creosote or PCP in a heated oil-based solution (21,23). After treatment, the wood was removed from the pressure chamber and allowed to drip dry outside, resulting in large volumes of contaminated soil. Other treatment wastes include wastewater and sludges. Wastewater was generated as a condensate in the treatment process and also by rinsing tanks and equipment. After separation of recoverable chemicals, wastewater was often spread onsite or stored in evaporation ponds. An oily sludge gradually accumulates in wastewater evaporation areas and also in treatment cylinders and storage tanks. This sludge was historically dumped into unlined pits onsite. Sludge pits found at wood-treating sites can contain very high concentrations of the preservative chemicals, which may limit treatment options for these areas (17).

The preservatives PCP and creosote are found as contaminants, alone or in combination, at nearly all abandoned wood-treating sites in the United States (21,23). Both of these materials can be hazardous to human health. Creosote contains polycyclic aromatic hydrocarbons (PAHs). Commercial grades of PCP always contain small amounts of dioxins and furans as impurities. It is thought that additional dioxins might be generated by heating PCP solutions (17). The dioxins, furans, and PAHs are considered by EPA and other health agencies to be likely human carcinogens (see boxes 2-1 and 2-2).

BOX 2-1: Creosote and Polycyclic Aromatic Hydrocarbons

Creosote has been widely used as a preservative in the wood treatment industry for more than a century. It is an oily, translucent, brown-to-black liquid with a sharp smoky or tarry odor. Creosote is produced from high-temperature carbonization of bituminous coal. It is not a single chemical, but rather a complex mixture, containing several thousand compounds. It is about 85 percent polycyclic aromatic hydrocarbons (PAHs), along with phenolic compounds (about 10 percent) and a variety of other related chemicals.

The PAHs contained in creosote are a group of more than 100 related chemicals that are both man-made and naturally occurring. They are found in crude oil, coal, coal tar pitch, and road and roofing tar. Although in pure form a single PAH is usually a white or pale green solid, they almost always occur as a mixture of PAHs. Typically, human exposure involves exposure to a mixture of PAHs.

The human health effects of the individual PAHs found in creosote vary. About 17 PAHs have been studied extensively. These 17 are considered the most harmful, the most likely to be involved in human exposure, and the most frequently identified at Superfund sites. People living near waste sites contaminated with PAHs may be exposed to them by contact with contaminated air, water, or soil. Most PAHs that enter the body are excreted in feces and urine within a few days.

PAHs are considered by EPA and other public health organizations to be human carcinogens. The Department of Health and Human Services (DHHS) has determined that certain PAHs “may reasonably be anticipated to be carcinogens.” The International Agency for Research on Cancer (IARC) has determined that certain PAHs “are possibly carcinogenic to humans.” EPA has determined that certain PAHs “are probable human carcinogens.”

Reports with humans show that individuals exposed to PAHs by breathing or skin contact for long periods can develop cancer. Some PAHs cause tumors in laboratory animals when breathed, eaten, or after long periods of skin contact. Mice fed high levels of certain PAHs during pregnancy had difficulty reproducing and so did their offspring. Offspring from pregnant mice fed PAHs showed other harmful effects, including birth defects, although there is no information about similar effects in humans.

PAHs have low water solubility, but they can contaminate underground water that comes into contact with soil contaminated by them. They have been found in some U.S. drinking water supplies. PAHs can evaporate, but most will stick to solid particles in soil. In soil, most PAHs can break down in weeks to months, mostly because of microorganisms, although very large PAH molecules are more stable. Some wood-treatment sites have cleanup standards only for those PAHs considered to be carcinogenic while other sites may focus on all the PAHs present.

SOURCE: U.S. Environmental Protection Agency, Office of Research and Development, *Contaminants and Remedial Options at Wood Preserving Sites*, prepared by Foster Wheeler Enviresponse, Inc., EPA/600/R-92/182 (Washington, DC: October 1992); U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, “Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites,” EPA/540/F-95/006 (Draft), Washington, DC, May 1995; and U.S. Department of Health & Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, “Toxicological Profile for Polycyclic Aromatic Hydrocarbons (PAHs),” draft, Atlanta, GA, October 1993.

BOX 2-2: Pentachlorophenol

Pentachlorophenol (PCP) has been used for many years as a preservative in the wood treatment industry. It is a manufactured substance not occurring naturally in the environment. PCP was formerly one of the most heavily used pesticides in the United States. Today its purchase and use is restricted to certified applicators, and it is used industrially as a wood preservative for power line poles, fence posts, etc. Before restriction, PCP was widely used as a wood preservative. It is made by only one company in the United States. Pure PCP is a white crystalline material, but the commercial grade form usually found at waste sites is dark gray to brown.

Commercial grade PCP used for treating wood is a mixture of many related compounds. It contains PCP (85 to 90 percent); 2,3,4,6-tetra chlorophenol (4 to 8 percent), more highly chlorinated chlorophenols (2 to 6 percent), and dioxins and furans (about 0.1 percent). Dioxins and furans are also mixtures of various related compounds. The principal dioxins and furans found in commercial grade PCP have six to eight chlorine atoms present in their structures. The most toxic dioxin and the one of greatest regulatory concern is 2,3,7,8-tetrachloro-p-dioxin (TCDD), which contains four chlorine atoms in its structure.

Analysis of commercial PCP produced in the U.S. has not found TCDD. But some wood-preservation methods use PCP at higher temperatures, which might produce traces of TCDD from the PCP itself. Octachloro-dibenzo-p-dioxin (the dioxin containing 8 chlorine atoms) is by far the largest dioxin contaminant, while the most toxic dioxin, TCDD, occurs only at trace or below detection levels. According to EPA, octachloro-dibenzo-p-dioxin is about 1000-fold less toxic than TCDD. In any event, EPA recommends that site managers should ensure that sampling for dioxins and furans is conducted at all wood-treating sites known to have used PCP.

Public health agencies consider that PCP, at most, might be a human carcinogen. The International Agency for Research on Cancer (IARC) determined PCP is not classifiable as to its carcinogenicity to humans, while EPA classified PCP as a "probable human carcinogen". Large doses of PCP can cause death, and long-term exposure to lower levels can cause damage to liver, kidneys, blood, and nervous system.

However, there is no convincing evidence from epidemiological studies that PCP causes cancer in humans, although it does cause cancer in some laboratory animals fed large doses for long periods. Many, but not all, of the harmful effects of PCP may be due to the impurities in the commercial grade, including dioxins and furans. Although pure PCP might not be a human carcinogen, the small amounts of dioxins and furans found in the commercial grade of PCP might account for its apparent animal carcinogenicity.

The physical properties of PCP are such that it will not evaporate very quickly from contaminated soil or sludge. The most significant human exposure comes through breathing and skin contact, and it does not seem to accumulate in the human body, but is excreted in urine. After environmental release onto soil or sludge, most PCP will tend to slowly move with any water that contacts that contaminated soil or sludge. PCP will tend to stick to soil particles. It is broken down in soils and surface waters by microorganisms and in surface waters and air by sunlight.

SOURCE: U.S. Environmental Protection Agency, Office of Research and Development, *Contaminants and Remedial Options at Wood Preserving Sites*, prepared by Foster Wheeler Enviresponse, Inc., EPA/600/R-92/182 (Washington, DC: October 1992); U.S. Department of Health & Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry. "Toxicological Profile for Pentachlorophenol," draft, Atlanta, GA, October 1992; U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, "Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites," EPA/540/F-95/006, PB 95-963410 (Draft), Washington, DC: May 1995.

BOX 2-3: The American Creosote Works Site, Pensacola, Florida

The 18-acre American Creosote Works (Pensacola plant) site is in a dense, moderately commercial and residential area of Pensacola, Florida. A wood-preserving facility operated at this site from 1902 to 1981. During this time, process wastewater containing pentachlorophenol (PCP) was discharged into unlined, onsite surface impoundment ponds. Before 1970, these impoundment ponds were allowed to overflow through a spillway into neighboring bays. After 1970, wastewater was discharged to designated onsite spillage areas. Additional discharges occurred during periods of heavy rainfall when the ponds overflowed.

In March 1980, the city found considerable quantities of oily, asphaltic, creosote material in the groundwater near the site. Because of the threat posed to human health and the environment, EPA and the state performed an emergency cleanup in 1983. This included dewatering the ponds, treating the water, and discharging treated water into the city sewer system. The sludge in the ponds was then solidified and capped.

EPA signed a record of decision (ROD) in 1985 requiring all onsite and offsite contaminated solids, sludge, and sediment to be placed in an onsite RCRA-permitted landfill. A second ROD, signed in 1989, addresses remediation of contaminated surface soil. A future ROD will address treatment of contaminated subsurface soil, sludge, and groundwater. The primary contaminants of concern affecting the surface soil are organics, including dioxins, carcinogenic polycyclic aromatic hydrocarbons (PAHs), and PCP.

The selected remedial action for this site includes

- excavating and treating 23,000 cubic yards of PAH-contaminated soil using solid-phase bioremediation at an onsite land treatment area. Dissolved oxygen, pH, nutrients, and soil moisture content will be monitored,
- disposal of treated soil onsite in the excavated areas or by spreading the soil over the entire site,
- spraying collected drain water over the treatment area to moisten soil,
- repairing fences around the site, monitoring the site cap, and
- implementing groundwater use restrictions.

The estimated cost for this approach is $2,275,000.

SOURCE: Environmental Protection Agency, Region 4, “Record of Decision: American Creosote Works Inc. Site,” Atlanta, GA, January 5, 1989.

BOX 2-4: The Koppers Site, Oroville, California

The Koppers site is a 200-acre operating wood-treating plant in Butte County, California. Nearby land use is mixed agricultural, residential, commercial, and industrial. Although there is a history of wood-treating operations at the site, they were greatly expanded in 1955 when Koppers Company, Inc., became the owner and operator. Pentachlorophenol (PCP), creosote, and chromated copper arsenate (CCA) solution are among the chemicals that have been used at this site.

Wastewater discharge and other site activities have resulted in contamination of unlined ponds, soil, and debris. PCP was detected in onsite groundwater in 1971 and in residential wells in 1972. Pursuant to a state order, Koppers conducted cleanup activities from 1973-74, including groundwater pumping and discharge to spray fields and offsite disposal of contaminated debris, and process changes, including construction of a wastewater treatment plant. In 1986, Koppers provided nearby residents an alternate water supply for domestic uses.

Following a 1987 explosion and fire at a PCP wood-treatment process facility, EPA issued a removal order requiring cleanup of fire debris and removal and stabilization of surface soil.

The present record of decision (ROD) addresses the remaining contamination in onsite soil and groundwater affected. The primary contaminants of concern are polycyclic aromatic hydrocarbons (PAHs), PCP, dioxins and furans, and metals including arsenic and chromium.

The selected soil remedy includes

- onsite biodegradation of 110,000 cubic yards of PCP-contaminated soil,
- excavation and soil washing of 200,000 cubic yards of soil contaminated with wood-treating wastes with disposal of treated soil onsite and treatment of residual contamination in the washing fluid in an onsite treatment facility,
- installation of a low-permeability cap over the wood-treating process area (an interim remedy) and down gradient extraction wells, and
- excavation and chemical fixation of 4,000 cubic yards of soil contaminated with metals, followed by onsite disposal.

The groundwater remedy includes pumping and treatment of approximately 22,000,000 cubic yards of groundwater using activated carbon, reinjection of treated waste to the groundwater, and formalization of the provision of an existing alternate water supply and extension, if needed, of the water supply during implementation of the remedy.

According to the ROD the estimated cost for this cleanup strategy was $77,700,000.

EPA has had some difficulties implementing bioremediation at the Koppers site. It found that the soil excavated for a bioremediation treatability study was contaminated with more dioxin than anticipated. This caused the cancellation of the treatability study and a switch to a removal action, placing soil in a RCRA-approved landfill. The soil washing pilot test showed that soil washing was not capable of meeting cleanup standards. Bioremediation effectively destroyed PCP but was not effective in reducing dioxins. The owner is reevaluating soil remedies for the remainder of this site.

SOURCE: U.S. Environmental Protection Agency, Region 9, “Record of Decision: Koppers Co. Inc. (Oroville Plant) Site,” San Francisco, CA, September 1989; Fred Schauffler, Project Manager, EPA Region 9, Oroville, CA, personal communication, July 13, 1995 and written comments, August 8, 1995.

BOX 2-5: The Koppers Site, Morrisville, North Carolina

The 52-acre Koppers Morrisville site is a wood-laminating facility in Morrisville, Wake County, North Carolina. Surrounding land use is a mixture of commercial, light industrial, and rural residential. The site has been used by lumber companies since 1896. In 1962, Koppers began treating wood at the site using pentachlorophenol (PCP) and isopropyl ether injected into wood. Process wastes were put into unlined lagoons. Koppers discontinued wood treatment in 1975, but past wood-treatment processes and associated disposal activities have left the site contaminated with PCP, dioxins, and isopropyl ether affecting the soil, groundwater, and surface water.

In 1989, in response to state studies of water contamination from the site, nearby residents began using public water lines instead of wells to obtain drinking water. In 1990, EPA required extensive studies of the soil, groundwater, drainage pathways, and ponds, and also determined that additional studies were needed to further assess contamination of the surface soil in the lagoon and wood-treatment process areas. In 1992, EPA completed a record of decision (ROD) for the site that specified incineration as the primary remedy and base-catalyzed decomposition (BCD) as the “contingency remedy” whose use would be dependent upon the results of a treatability study. One driving force for providing for an alternative to incineration was the strong interest of the community.

The primary strategy was offsite incineration of soil involving

- excavation of contaminated soils from lagoon and process areas and transportation to an offsite permitted incineration facility,
- extraction of contaminated groundwater from within the plume via extraction well(s) and piping it to an onsite carbon adsorption treatment unit,
- use of institutional controls including fencing of the pond, lagoon, and wood-treatment process areas.

Base-catalyzed dehalogenation was selected as a contingency cleanup strategy. According to the 1992 ROD, BCD could substitute for offsite incineration if it proved itself in treatability studies. BCD would involve the excavation of contaminated soils from the lagoon and process areas, and transportation to an onsite BCD treatment system,

According to the ROD, the estimated cost for the selected cleanup strategy was $11,500,000.

The treatability study with BCD was completed in August 1993. The results showed that BCD was effective in treating soil contaminated with both PCP and dioxins. However, it may be premature to consider BCD a general technology for wood-treatment site cleanup. The size of this demonstration was very small compared to other wood-treatment sites. According to the site engineer at Koppers, the BCD demonstration involved only 700 cubic yards of soil; the amounts of soil requiring treatment at some of the largest contaminated wood-treatment sites are as much as 100 times larger (see table 2-1). Another concern raised by one EPA wood treatment site manager is that the results from this BCD trial seem to show significant stack emissions, presumably from the thermal desorption stage, that are equal to or greater than those that would be seen if incineration had been used instead of BCD.

For BCD to be considered successful at this site, it had to achieve 7 parts-per-billion (ppb) or lower dioxin levels in the treated soil. However, the soil levels were fairly low to begin with and dioxin soil concentrations were probably not very important for the choice of BCD as a soil cleanup technology.

(continued)

BOX 2-5: The Koppers Site, Morrisville, North Carolina (Cont'd.)

The neighboring community was brought into the treatability study process. More than 100 citizens were invited to observe the results of the BCD treatability study. According to one EPA official involved with the study, the citizen involvement was very helpful in the overall process of developing the alternative. A new ROD has been approved that specifies BCD as the primary means of treating contaminated soil. Koppers as the principal responsible site owner, is in the process of awarding a contract to build a full-scale onsite BCD treatment facility.

SOURCE: U.S. Environmental Protection Agency, Region 4, "Record of Decision: Koppers Site (Morrisville Plant)," Atlanta, GA, December 1992; B. Hudson, Site Engineer, Koppers Superfund site, Morrisville, NC, personal communication, April 12, 1995; E. Hendrick, Site Manager, EPA Region 6, Dallas, TX, personal communication, April 12, 1995.

BOX 2-6: The Arkwood, Inc., Site, Omaha, Arkansas

The 15-acre Arkwood site is a former wood-treatment facility in Boone County, Arkansas. Land use in the vicinity of the site is primarily agricultural and light industrial. Approximately 200 residences are located within 1 mile of the site, and 35 domestic water supply wells are within 1.5 miles of the site. Groundwater on or near the site is highly susceptible to contamination as a result of underground cavities, enlarged fractures, and conduits that hinder monitoring and pumping.

From 1962 to 1973, Arkwood operated a pentachlorophenol (PCP) and creosote wood treatment facility at the site. In 1986, the site owner dismantled the plant. State investigations conducted during the 1980s documented PCP and creosote contamination in surface water, soil, debris, and buildings throughout the site. Contaminated surface features at the site include the wood-treatment facility, a sinkhole area contaminated with oily waste, a ditch area, a wood storage area, and an ash pile.

In 1987, EPA ordered the site owner to perform an immediate removal action that included implementing site access restrictions, such as fencing and sign postings.

The present record of decision (ROD) addresses remediation of all affected media and provides the final remedy for the site. The primary contaminants affecting the soil, sludge, debris, and groundwater are organics including PCP, polycyclic aromatic hydrocarbons (PAHs) and dioxins.

The selected remedial action for this site includes

- excavating approximately 21,000 cubic yards of contaminated soil and sludge followed by soil washing,
- onsite incineration of approximately 7,000 cubic yards of materials that exceed cleanup levels,
- incineration of any free oil wood-treating material,
- using washed and decontaminated materials and any residual ash for backfilling,
- covering the site with a soil cap and planting revegetation,
- site access restrictions including fencing, and
- monitoring of drinking and groundwater and connecting affected residences to municipal water lines.

According to the ROD, the cost of this approach would be $10,300,000.

SOURCE: U.S. Environmental Protection Agency, Region 6, "Record of Decision: Arkwood, Inc. Site," Dallas, TX, September 1990.

BOX 2-7: The United Creosoting Site, Conroe, Texas

The 100-acre United Creosoting site in Conroe, Montgomery County, Texas, is occupied by a residential subdivision, a distributing company, and a construction company. From 1946 to 1972, the United Creosoting Company operated a wood preserving facility at the site. Pentachlorophenol (PCP) and creosote were used in the wood-preservation process, and process wastes were stored in waste ponds.

During 1980, the county used soil and waste pond backfill from the site on local roads. After residents living near the improved roadways experienced health problems, the county sampled and compared leachate composition from the affected roadways and the site. They determined that leachate from both the site and the roadways was contaminated with PCP. Roadway soil was subsequently removed and disposed of using land farm treatment.

In 1983, in response to contaminated stormwater runoff from the former waste pond areas, the property owner was directed under terms of an EPA Administrative Order to regrade contaminated soil, divert surface water drainage away from the residential portion of the site, and cap the contaminated soil.

The present record of decision (ROD) specifies a final remedy for contaminated soil at the site and complements a 1986 ROD that determined that no action was necessary to remediate shallow groundwater. The primary contaminants of concern affecting the soil are organics including polycyclic aromatic hydrocarbons (PAHs), PCP, and dioxins.

The selected remedial action for this site includes

- excavation and onsite treatment of 94,000 cubic yards of soil containing contaminants that exceed target action levels using critical fluid extraction with liquid propane,
- offsite incineration of residues containing the concentrated contaminants produced by this technology,
- recycling or discharge of wastewater generated during the treatment process, and
- spreading treated soil on the commercial portion of the site, and backfilling residential areas with clean fill.

According to the ROD, the estimated cost for this remedial action is $22,000,000. However, based on a signed contract for a major portion of the remedial activities and estimates for the remainder of the work, the expected cost of this cleanup is now expected to exceed $34,000,000.

SOURCE: U.S. Environmental Protection Agency, Region 6, “Record of Decision: United Creosoting Co. Site,” Dallas, TX, September 1989; Hendrick, E., Senior Project Manager, EPA Region 6, Dallas, TX, written comments, August 9, 1995.

Sometimes residues of the preserving chemicals can be found at a site in a nearly pure form (21,23). Typically though, the highest concentrations of waste contaminants are found near treatment areas and waste pits (23). At many wood-treating sites, the primary contamination has moved through the soils into nearby ground and surface waters (23). Because PCP and most PAHs have very low water solubility and were often used after being dissolved in oil, the contaminants can form non-aqueous phase liquids (NAPLs) when they come in contact with ground or surface water (23). This means that the contaminant is in a liquid form that either floats on or sinks below water it contacts. Contaminants in the form of NAPLs are particularly difficult to locate and treat.

EPA AND WOOD-TREATING SITES

Since 1980, EPA has classified 56 wood preserving sites as Superfund sites (17). At about 40 of these sites, EPA has completed the process of selecting a cleanup strategy for the soil, sludge, sediments, and water contaminated by wood-treatment wastes. EPA's process for selecting a cleanup strategy at a Superfund site is described in the ROD, which summarizes the basis for the decision and describes the remedial strategy. EPA's work with wood-treating sites has produced about 47 RODs for 40 such sites. The details of these sites, the cleanup strategies selected by EPA, and the current land use of the area surrounding the site are summarized in table 2-1. Current land use was included as an indicator of future use of a contaminated site.

Not surprisingly, the similarity in the contamination across wood-treating sites has resulted in the selection of similar treatment and remediation strategies. At least 10 approaches have been selected by EPA for cleaning such sites. For the treatment of contaminated soil, sludge, and sediments at wood-treating sites, table 2-1 shows that EPA has generally selected from among the following strategies: bioremediation, incineration, thermal desorption, soil washing or flushing, chemical dechlorination, solvent extraction, site capping, solidification and stabilization techniques, construction of barrier walls, and disposal in RCRA authorized landfills. Figure 1-1 in chapter 1 shows how often EPA selected various strategies for dealing with soil, sludge, and sediments at 40 wood-treating sites as revealed in 47 RODs.

Incineration was a frequently selected remedy during the period from 1986 to 1990. Since 1990, the selected remedy is much more likely to have been bioremediation (perhaps in combination with soil washing or with limited incineration of the most contaminated wastes), thermal desorption, or chemical dehalogenation. Groundwater at wood-treating sites is typically dealt with by pump-and-treat methods in conjunction with ongoing monitoring. According to EPA, a general approach now used at wood-treating sites is bioremediation to remove creosotes and PCPs from soil, followed by capping and immobilization to deal with residual dioxins or metals (i.e., to ensure they do not leach from the soil). The Libby Groundwater site (see table 2-1) is one place where such an approach is being tried (1).

Generally no single technology can be used to clean up an entire wood-treating site (8). Rather, as in most of the RODs reviewed by OTA, a combination of treatment technologies and control methods will be required. Boxes 2-3 through 2-7 illustrate the variety of technologies selected, although many of these have not yet been fully implemented. Often some contamination will remain even after cleanup, and various institutional or engineering control strategies must be used to prevent exposure to the remaining contamination. For example, the combination of bioremediation or incineration followed by site-capping (covering the site with a liner and clean soil) and restrictions on future site use was used in more than half the cases.

In some cases a sequence of cleanup remedies in a "treatment train" may be needed to address the various contaminants. For example, when metallic wastes are mixed with organic (PCP and creosote) contaminants, bioremediation or thermal desorption to remove the organics may be followed by immobilization to control the metallic waste (10). A variety of treatments may also be used to clean up different areas of a contaminated site. Hot spots can be particularly difficult to clean. A site manager may prefer to excavate sludges, perhaps incinerating this material, while applying bioremediation to the less contaminated soils (1). These combined approaches have been specified in the remedial actions for wood-treating sites reviewed by OTA.

The selection of a technology as documented in a ROD does not necessarily mean that the technology proved effective. In many cases, cleanup has not been completed at the sites reviewed by OTA; in other cases, an unsuccessful trial of the selected technology has led to a change in plans.

EPA'S PRESUMPTIVE REMEDY APPROACH

EPA has found that most wood-treating sites have very similar characteristics (21,23). EPA has determined that it is useful to group wood-treating sites together based upon their common characteristics, such as the contaminants present, the environmental media affected by those contaminants, and the cleanup technologies selected (23). Past experience with such sites can be summarized to streamline future site investigations and remedy selection (21,23).

As part of an effort to accelerate cleanup at Superfund sites, the EPA Superfund program is putting together a group of cleanup strategies that have been used successfully at similar sites in the past (21,22,23). EPA has also reviewed other technologies that have less available performance data but nevertheless may be appropriate or useful for wood-treating sites (21, 23).

EPA calls these proven cleanup technologies for common site types presumptive remedies. Presumptive remedies are technologies for common types of sites selected on the basis of historical patterns of remedy selection and EPA's scientific and engineering expertise (23). EPA's presumptive remedies program uses Superfund program experience in an effort to streamline cleanup (23). The presumptive remedy approach focuses only on proven technologies. In general the approach would not consider a small-scale demonstration such as pilot plant demonstrations as sufficient proof for a recommended presumptive remedy (1). However, some other technologies with more limited performance data are also considered by EPA (21,23).

EPA's presumptive remedies for treating soil, sludge, and sediments at wood-treating sites with organic contamination from creosote and PCP are bioremediation, thermal desorption, and incineration. Immobilization is the presumptive remedy for treating inorganic contaminants at sites where metallic salts have been used (23). The presumptive remedy process is a decision-making strategy for selecting among these remedies. EPA expects to use this process at all wood-treating sites and expects to select one of the remedies unless there are unusual site-specific circumstances. Bioremediation should be chosen unless it is shown to be infeasible. Incineration should be selected only if bioremediation and thermal desorption have both been shown to be infeasible. So far, EPA's presumptive remedy approach for wood-treating site cleanup covers only the contaminated soils, sludges, and sediments at wood-treating sites. EPA is currently working on presumptive remedies for groundwater cleanup at wood-treating sites (23).

According to EPA's presumptive remedy analysis for wood-treating sites, incineration is the most technically developed and proven technology (see table 2-2); however, it was not designated by EPA as the primary presumptive remedy because of the difficulty in getting public support for incineration. The other technologies, including bioremediation, have track records indicating they may be appropriate for this type of site; however, the selection of technologies that are less proven or less capable than incineration will always bring a greater risk of failure to achieve cleanup goals.

EPA divided the presumptive remedy project for wood-treating sites into two parts. One project was directed toward summarizing cleanup of PCP and creosote contamination. A second effort was to evaluate dioxin cleanup issues separately, but EPA has not yet completed this aspect of the problem (1). Thus, the wood-treating site presumptive remedies documentation from EPA does not specifically address the dioxin issue (1). For example, bioremediation might have some limitations as a remedy for sites like Texarkana, where PCP has been used. It might give excellent results for cleaning up the PCP and creosote, but it is not likely to adequately clean up the associated dioxins. Other approaches may be needed to supplement bioremediation in such cases, such as soil capping and site use restrictions (1).

EPA warns that the remediation technologies considered in its presumptive remedy strategy are at different stages of technical maturity—from proven to innovative to emerging. Application of a specific technology to clean up a wood-treating site requires careful matching with specific site conditions. Estimates of treatment costs for more mature technologies such as incineration and bioremediation can be quite reliable, but estimates for innovative and emerging technologies can be less reliable. Incineration and biological treatment are proven at the commercial scale (17). Nevertheless, most alternatives, including biological treatment and thermal desorption, require site-specific treatability tests to ensure they will work (17).

As a practical example of the risks of using less mature technologies, the wood-treating site project was the first presumptive remedy approach attempted by EPA, but because of delays it will be the third one actually published (1). The main delay was caused by questions about the efficacy of bioremediation, the primary presumptive remedy indicated for wood-treating sites (1). Although bioremediation has been selected for a number of wood-treating sites, it has only been completed at very few sites (1). Moreover, there have been some failures with bioremediation, sometimes caused by simple oversights by the site managers and facility operators, such as overlooking the proper monitoring of soil pH (1). Bioremediation also may have difficulty achieving very stringent cleanup levels sometimes required for carcinogenic PAHs.

SUMMARY

In summary, contaminated wood-treating Superfund sites are a common type of site in the United States. The wood-treating processes and the types of chemicals used as wood preservatives were very similar at all wood-treating sites, thus the contamination problems and the technologies and strategies that appear to work at these sites are also similar. EPA's decisions about how to clean up contaminated wood-treating sites show that, in general, about 10 technologies or strategies are used at these sites, almost always in combination. EPA has analyzed wood-treating site cleanups and, based on success stories, recommends about a half dozen different technologies as presumptive remedies for cleaning up such sites. EPA warns that most of these alternative technologies will not work in all situations and that a site-specific analysis almost always will be required. Nevertheless, it appears that decisionmakers have a range of options for addressing cleanup problems at wood-treating sites.

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites

Site Name Location ROD No. ROD Date	Chemical used[a]	Primary contaminants	Current land use	Site area/ acres	Vol. material to be treated	Remediation strategy[b]
American Creosote Pensacola, FL FLD008161994 85-09-30	Creosote, PCP	PAHs	Commercial & residential	12	?	RCRA landfill of soil and sludges
American Creosote Pensacola, FL FLD008161994 89-09-28	Creosote, PCP	PAHs, PCPs, Dioxins	Commercial & residential	18	23,000 yd^3 soil	Bioremediation of soil
American Creosote Jackson, TN TND007018799 89-01-05	Creosote, PCP	PAHs	Partially developed	60	?	Incineration of sludges offsite at a fixed facility or onsite in a mobile incinerator
American Creosote Winnfield, LA LAD000239814 93-4-28	Creosote, PCP	PAHs, PCP	Mixed agricultural, residential, & recreational	34	25,000 yd^3 highly contaminated sludge, 250,000 yd^3 soil	Incineration of sludge; bioremediation of soil
American Crossarm & Conduit Chehalis, WA WAD057311094 93-06-30	Creosote, PCP	PAHs, PCP, dioxins	Commercial, light industrial, residential, & recreational	?	?	Remove most highly contaminated soil; capping; institutional controls
Arkwood, Inc. Omaha, AR ARD084930148 90-09-28	Creosote, PCP	PAHs, PCP, Dioxins	Agricultural & light industrial	15	21,000 yd^3 soil & sludge, 3,000 gal sinkhole liquids	Soil washing or incineration onsite if washed soil exceeds PCP, dioxin, or PAHs cleanup levels; pump and treat oily sinkhole liquids; monitor groundwater
Baxter/Union Pacific Tie Treating Laramie, WY WYD061112470 86-09-26	Creosote, PCP	PAHs, PCP	?	140	?	Slurry barrier wall to delay offsite movement of contaminated groundwater and surface soils while planning and implementing more permanent remedies
Bayou Bonfouca Slidell, LA LAD980745632 87-03-31	Creosote	PAHs	?	55	150,000 yd^3 sediment	Incineration, capping

(continued)

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites (Cont'd.)

Site Name Location ROD No. ROD Date	Chemical used[a]	Primary contaminants	Current land use	Site area/ acres	Vol. material to be treated	Remediation strategy[b]
Broderick Wood Products Co. Denver, CO COD000110254 91-09-24	Creosote, PCP	PAHs, PCP, Dioxins	Predominately industrial	64	2,170 yd^3 sludge, 500 gal oil	Transport sludge and oil to a RCRA recycling facility; offsite incineration of recycler residues (amended remedial action)
Broderick Wood Products Co. Denver, CO COD000110254 88-06-30	Creosote, PCP	PAHs, PCP, Dioxins	Primarily industrial	64	4,000 yd^3 sludge, 31,000 yd^3 soil	Incineration onsite of sludge; groundwater monitoring
Brown Wood Preserving Live Oak, FL FLD980728935 88-04-08	Creosote, PCP	PAHs	Rural & light agriculture	55	11,500 tons soil	Biodegradation and transport of most severely contaminated soil and sludge to a RCRA hazardous waste facility; and groundwater monitoring
Burlington Northern Brainerd/Baxter, MN MND000686196 86-06-04	Creosote	PAHs	Industrial & residential	?	9,500 yd^3 soil	Bioremediation of soil and sludge; capping with a RCRA-approved cover
Cabot/Koppers, Gainesville, FL FLD980709356 90-09-27	Creosote	PAHs	Commercial & residential	99	6,400 yd^3 soil	Soil washing and bioremediation followed by solidification and stabilization; pumping and treatment of groundwater; monitoring groundwater and surface water
Cape Fear Wood Preserving Fayetteville, NC NCD003188828 89-06-30	Creosote	PAHs	Industrial, agricultural, and residential	9	?	Soil flushing or a low thermal desorption process
Coleman Evans, Jacksonville, FL FLD991279894 86-09-25	PCP	PCP	Residential & light commercial & industrial	11	9,000 yd^3 soils and sediments	Incineration of more contaminated soil; groundwater pump and treat

(continued)

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites (Cont'd.)						
Site Name Location ROD No. ROD Date	**Chemical used[a]**	**Primary contaminants**	**Current land use**	**Site area/ acres**	**Vol. material to be treated**	**Remediation strategy[b]**
Coleman Evans Jacksonville, FL FLD991279894 90-09-26	PCP	PCP	Residential, light commercial & industrial	11	27,000 yd^3 soil & sediment	Soil and sediment washing; bioremediation, solidification, and stabilization of fines or sludges; covering the solidified mass; pumping and recovering groundwater
Havertown PCP Site Haverford Twp, PA PAD002338010 91-09-30	Creosote, PCP	PAHs, PCP, Dioxins	Mixed residential & commercial	12-15	?	Interim remedies include free product recovery wells, an onsite groundwater treatment plant, and monitoring groundwater
Havertown PCP Site Havertown, PA PAD002338010 89-09-29	Creosote, PCP	PAHs, PCP, Dioxins	Commercial & residential	12-15	200 barrels soil, 6,000 gal wastewater	Offsite land disposal of soil; oily debris and wastewater stored; multimedia monitoring
Idaho Pole Co. Bozeman, MT MTD006232276 92-09-28	Creosote, PCP	PAHs, PCP	Light industrial	50	42,000 yd^3 soil	Bioremediation, soil flushing, capping
J H Baxter Co. Weed, CA CAD000625731 90-09-27	Creosote, PCP	PAHs, PCP, Dioxins	Operating wood site, pasture, woodland, & residential	33	>41,000 yd^3 soil	Biological treatment and chemical fixation of contaminated soil; groundwater pumping with biological treatment; multimedia monitoring
Koppers (Morrisville) Morrisville, NC NCD003200383 92-12-23	PCP	PCP, Dioxins	Commercial, light industry, & rural residential	52	2,930 yd^3 soil	Offsite incineration; treatability studies for dechlorination as a contingency remedy
Koppers Co., Inc., (Oroville Plant) Oroville, CA CAD009112087 89-09-13	Creosote, PCP	PAHs, PCP, Dioxins	Operating wood site, agricultural, residential, commercial, & industrial	200	334,000 yd^3 soil, 22,000,000 yd^3 groundwater	Biodegradation in situ or washing of soil; capping; pump and treat groundwater
Koppers Co., Inc. Galesburg, IL ILD990817991 89-06-28	Creosote, PCP	PAHs, PCP	Sparsely populated	105	15,200 yd^3 soil	Bioremediation

(continued)

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites (Cont'd.)

Site Name Location ROD No. ROD Date	Chemical used[a]	Primary contaminants	Current land use	Site area/ acres	Vol. material to be treated	Remediation strategy[b]
Koppers Co., Inc. Texarkana, TX TXD980623904 88-09-23	Creosote, PCP	PAHs, PCP	Residential	62	3,300-19,400 yd^3 soil	Soil washing, offsite disposal
Koppers Co., Inc. Texarkana, TX TXD980623904 92-03-04	Creosote, PCP	PAHs, PCP	Residential	62	?	Soil washing; relocating residents; deed restrictions
L.A. Clarke and Son Fredericksburg, VA VAD007972482 88-03-31	Creosote	PAHs	na	40	118,000 yd^3 soil	Soil flushing and in-situ biodegradation; sediments biodegradation; landfarming excavated surface soil, sediments, and subsurface wetland soil; and groundwater monitoring
Libby Groundwater Contamination Site Libby, MT MTD980502736 86-09-26	Creosote, PCP	PAHs, PCP	Active lumber & plywood mill	?	?	Reduce human exposure to contaminated groundwater by continuing and expanding a "buy water" plan sponsored by the onsite company; monitoring
Libby Groundwater Contamination Site Libby, MT MTD980502736 88-12-30	Creosote, PCP	PAHs, PCP, Dioxins	Residential areas & businesses	?	>30,000 yd^3 soil & debris	Biodegradation of soil and debris; recycling and incinerating recovered NAPLs; capping; groundwater bioremediation; groundwater monitoring
Macgillis & Gibbs Co / Bell Lumber Pole New Brighton, MN MND006192694 91-09-30	Creosote, PCP	PCP, PAHs, Dioxins	Residential & commercial	24	100,000 gal. PCP waste oil & sludges	Removing and separating PCP waste oil and sludges; wastewater bioremediation; groundwater pump and treat

(continued)

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites (Cont'd.)

Site Name Location ROD No. ROD Date	Chemical used[a]	Primary contaminants	Current land use	Site area/ acres	Vol. material to be treated	Remediation strategy[b]
Mid-South Mena, AR ARD092916188 86-11-14	Creosote, PCP	PAHs, PCP	?	57	80,000 yd^3 soil	Hot spot stabilization; RCRA cap; oil and sludges transported to a RCRA facility; groundwater pump and treat; and groundwater monitoring
Midland Products Ola, AR ARD980745665 88-03-24	Creosote, PCP	PAHs, PCP	?	37	<24,600 yd^3 soil, sediments & sludges, 450,000 gal groundwater, 620,000 gal. lagoon fluids	Thermal destruction of contaminated soils, sludges, and sediments; waste- and groundwater pump and treat
Montana Pole and Treating Butte, MT MTD006230635 93-09-21	Creosote, PCP	PAHs, PCP, Dioxins	Primarily industrial	?	262,000 yd^3 soil, 9,100 yd^3 debris, 26,500 gal sludge LNAPs, and oil	Bioremediation of soil hot spots; soil flushing and in-situ bioremediation; incinerate offsite sludge, NAPLs, and oil; bioremediation or UV oxidation of groundwater
Moss-American Kerr-Mcgee Oil Co. Milwaukee, WI WID039052626 90-09-27	Creosote	PAHs	Railroad loading & undeveloped parkland	88	210,000 yd^3 soil & sediment	Soil washing and bioremediation; covering remaining soil; removing pure-phase liquid wastes for offsite incineration; and groundwater monitoring
Newsom Brothers Old Reichold Columbia, MS MSD980840045 89-09-18	Creosote, PCP	PAHs, PCP	Primarily residential	81	30,300 yd^3 soil, 7,300 yd^3 sediment, 650 yd^3 tar-like waste	Offsite disposal of soil and sediment; offsite incineration of tar and soil and sediment containing RCRA hazardous wastes. No remedial action planned for groundwater

(continued)

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites (Cont'd.)

Site Name Location ROD No. ROD Date	Chemical used[a]	Primary contaminants	Current land use	Site area/ acres	Vol. material to be treated	Remediation strategy[b]
North Cavalcade Street Site North Cavalcade, TX TXD980873343 88-06-28	Creosote, PCP	PAHs	Residential, commercial, & industrial	21	22,300 yd^3 soil, 5,600,000 gal groundwater	Biodegradation in situ of soil (after pilot testing); groundwater pump and treat; offsite incineration of groundwater NAPLS
Popile, Inc. El Dorado, AR ARD008052508 93-02-01	Creosote, PCP	PAHs, PCP, other organics	Mixed rural, residential, and commercial	41	165,000 yd^3 soil and sludge	Bioremediation and capping; slurry walls to contain groundwater
Reilly Tar & Chem. St. Louis Park, MN MND980609804 90-09-28	Creosote	PAHs	Residential	80	?	Pump and treat; groundwater monitoring
Rentokil Virginia Wood Preserving Richmond, VA VAD071040752 93-6-22	Creosote, PCP	PAHs, PCP, Dioxins	Light industrial, commercial, & residential	?	70 yd^3 sediment & sludge, 12,400 yd^3 soil	Incinerate sediment and sludge offsite (with dechlorination for dioxins); pump and treat surface and groundwater; low-temperature thermal desorption for soil; capping treated soil; monitoring groundwater
Saunders Supply Co. Chuckatuck, VA VAD003117389 91-09-30	PCP	PCP, Dioxins	Mixed residential & commercial	7.3	25,000 tons soil	Dechlorination of sediment; low-temperature thermal desorption of soil and sediment; monitoring groundwater
Selma Pressure Treating Co. Selma, CA CAD029452141 88-09-24	PCP	PCP, dioxins	Agricultural, residential, and industrial	<4	16,100 yd^3 soil	Solidification/ stabilization, capping

(continued)

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites (Cont'd.)

Site Name Location ROD No. ROD Date	Chemical used[a]	Primary contaminants	Current land use	Site area/ acres	Vol. material to be treated	Remediation strategy[b]
South Cavalcade Street, Houston, TX TXD980810386 88-09-26	Creosote	PAHs	Residential, commercial, & industrial	66	30,000 yd^3 soil, 50,000,000 gal groundwater	Soil washing and capping; groundwater and soil washings pump and treat; offsite incineration or recycling of NAPLs; groundwater monitoring. Bioremediation of soil and groundwater if PRP demonstrates equivalent performance and costs
Southern Maryland Wood Treating Hollywood, MD MDD980704852 88-06-29	Creosote, PCP	PAHs, PCP, Dioxins	Agricultural & residential	25	102,000 yd^3 soil & sediment	Incineration onsite of soil, sediments, and tank liquids; ground and surface water pump and treat; multimedia monitoring
Texarkana Wood Preserving Co. Texarkana, TX TXD008056152 90-09-25	Creosote, PCP	PAHs, PCP, Dioxins	Industrial, residential, agricultural	25	77,000 yd^3 soil, sediments & sludges, 16,000,000 gal groundwater	Incineration onsite of soil, sediment, and sludges; pump and treat groundwater
United Creosoting Conroe, TX TXD980745574 89-09-29	Creosote, PCP	PAHs, PCP, Dioxins	Currently occupied by a company & residential subdivision	100	94,000 yd^3 soil	Critical fluid extraction onsite of soil; offsite incineration and disposal of the liquid organic concentrate residues from critical fluid extraction; air monitoring
United Creosoting Conroe, TX TXD980745574 86-09-30	Creosote, PCP	PAHs, PCP, Dioxins (no tetra)	Business & residential	100	?	Dispose of the soils contaminated when an appropriate facility or innovative technology becomes available; temporary cap over consolidated soils

(continued)

TABLE 2-1: Cleanup Strategies Selected by EPA for Superfund Wood-Treating Sites (Cont'd.)

Site Name Location ROD No. ROD Date	Chemical used[a]	Primary con-taminants	Current land use	Site area/ acres	Vol. material to be treated	Remediation strategy[b]
Westline Site Westline, PA PAD980692537 86-07-03	Creosote	PAHs	na	40	710 yd^3 soil	Incineration of deposits with a high heating value and low ash content; transport wastes to offsite RCRA facility
Wyckoff Co./ Eagle Harbor, Bainbridge Island, WA, WAD009248295 92-09-29	Creosote, PCP	PAHs, PCP	Primarily residential	40	<7,000 yd^3 sediment	Solidification/ stabilization; offsite disposal if necessary; capping

TABLE 2-2: Evaluation of Presumptive Remedies for Wood-Treating Sites

Contaminants at Site	Presumptive Remedy Selected	Efficiency of Contaminant Removal
PCP	Incineration	90-99% (B,P,F)[a]
Creosote	Thermal desorption	82-99% (B,P,F)
Creosote and PCP, PCP and CCA, Creosote and CCA, or	Bioremediation	Average of 87% for PAHs and 74% for halogenated phenols and creosols (P)
Creosote, PCP, and CCA	Immobilization	80-90% TCLP[b] (B,P,F)
CCA	Immobilization	80-90% TCLP (B,P,F)

SOURCE: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, "Presumptive Remedies for Soils, Sediments, and Sludges at Wood Treater Sites," EPA/540/F-95/006 (Draft), Washington, DC, May 1995.

NOTES:

[a] Performance efficiencies have been demonstrated in benchmark (B), pilot scale (P), or (F) final remedies.

[b] The toxicity characteristic leaching procedure is a test of the effectiveness of immobilization methods.