PCB Primer

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PCB Primer

Table of Contents

Incineration (Orange Section)

"Management of Incinerator Ash". League of Women Voters, 1989

Preliminary Risk Assessment. Westinghouse, 1987

The Bloomington Ash Landfill: Answers to your Questions

The Sites (Pink Section)

State of the Sites Tour, June 3, 1993

Alternative Technologies (Yellow Section)

Alternative Remedy Development Process. EPA

Consent Decree Party Technical Meetings

Operating Principles of the Parties for Exploration of Alternative Remedies. 1994

"Discovering Microbes with a Taste for PCBs". **Science**, 1987

"A Superoxide way to get rid of PCBs". **Science News**, 1988

"A New Process Promises to Remove the Chlorine from PCBs". **New York Times**, 1994

"Detoxifying PCBs". **Science News**, 1987

SUPERFUND (Lavender Section)

EPA Fact Sheets on the Superfund

* History of Superfund
* Superfund Contracts
* The Challenge of Superfund
* Superfund Enforcement
* Superfund Blueprint
* Superfund Technology
* Superfund: Future Strategy and Directions
* Who Pays for Superfund?
* Superfund: Fact vs. Fiction
* Superfund Cleanup Process

National Priorities List Sites: Indiana

Historical and General Information

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PLAYING WITH FIRE

From Bhopal to Bloomington, communities are plagued with environmental hazards resulting from corporate negligence.

Citizens have every reason to fear multinational corporations like Westinghouse and Union Carbide that expose their own workers to toxic chemicals, conceal plant records, fail to report legal violations, and dispose of their hazardous wastes in ways that threaten public health, cause emotional distress, and lower property value.

Consequently, it should not be surprising that many Bloomington-area residents are wary when they are told by city, state, and federal officials that a Westinghouse-built and operated incinerator is the best solution to the county's PCB crisis.

Until recently critics of incineration have focused their attention on the noxious emissions this projected plant likely will generate. The recent explosion of the garbage incinerator in Akron, Ohio, however, warns us that there are still other potential hazards to consider.

Although incinerators may be called resource-recovery facilities and may be built by companies with environmentally-conscious-sounding names like Pristine, Inc. or Bio-Ecololgy Systems, a grim reality hides behind this rhetorical facade.

The experience of other communities in which incinerators are operating substantiate the worst fears of local opponents of the proposed consent decree. In all of their various forms, incinerators fail to live up to their advance billing. Even the briefest review of the record of this "solution" reveals tragic accidents that have occurred in, at, near, or on the way to America's thermal destructors.

UNPROVEN TECHNOLOGY FAILED

The Connecticut Resources Recovery Authority (CRRA), the city of Bridgeport and a developer tried an unproven technology to turn garbage into refuse-derived fuel.

Eco II fuel was to be formed by pounding refuse into fine powder; the powder then was to be burned to produce fuel. Although the powder burned well in tests by United Illuminating Co., the plant suffered a number of financial and mechanical problems. Residents frequently complained of a foul odor. The $53 million project failed and was shut down in November 1980.

INCINERATOR EXPLOSIONS

The shredding or sorting of trash is a vexing problem at the Akron incinerator. During the fall and winter of 1983, *13* explosions occurred at the Akron facility which opened in 1979. Many of the explosions resulted from the inability to sort out incompatible items such as solvents, paints, and industrial waste products. One worker was injured seriously in these mishaps. The explosions caused several million dollars worth of damage to the facility.

On December 20, 1984, the Akron incinerator exploded once again. This time the disaster made headlines around the nation: three people were killed and eight seriously injured. Damage to the plant is estimated at $1 million. The explosion in the trash-shredding portion of the incinerator has been blamed on the presence of a volatile substance.

Rollins Environmental Services began operating an incinerator in Logan Township, New Jersey, in 1971. Although the plant was burning PCBs, the public was not informed of this. By 1974 local residents were complaining of foul odors and ill-health effects which bore a striking similarity to exposure to an incomplete PCB burn. People later found out the truth—Rollins was, in fact, burning PCBs.

New Jersey's Department of Environmental Protection (DEP) seemed unconcerned with citizen complaints until December 1977. In that month three tanks exploded, igniting 45,000 gallons of PCBs. A blackish-brown smoke was emitted from the incinerator. According to one witness, a ball of fire "like napalm" rolled across the ground. Six people died. The DEP orderd the plant closed.

PLAYING WITH FIRE

The Rollins plant reopened in June, 1978, despite public opposition. Although the DEP made 64 inspections at the plant, none were operational-safety inspections. These would have revealed improper disposal by incineration and inadequate storing of chemical wastes.

Another explosion took place at the Rollins incinerator on May 4, 1981. A black cloud of smoke was emitted into the air as a result of "overpressurizing the kiln." Rollins again was ordered to close the plant. It since has been permitted to reopen—even though not all the violations have been rectified.

TRANSPORTATION HAZARDS

Accidents also happen when transporting hazardous wastes to the incinerator site. In Somerville, Massachusetts, hazardous wastes leaked from a train car. Firemen made an effort to control the spill by spraying water on it. The water reacted with the chemicals and formed a toxic cloud—causing 300 people to be treated at Boston hospital and 117,000 others to be evacuated from their homes. The same problem could have resulted if it had been raining that day. The mistake cost the city $5,000,000 to clean up the spill, all the money coming from the city's tax revenue.

ON-SITE ACCIDENTS

In 1980, an explosion and fire occurred at Chemical Control Corporation's incinerator in Elizabeth, New Jersey on the very day that hazardous waste regulations were to be imposed on the property.

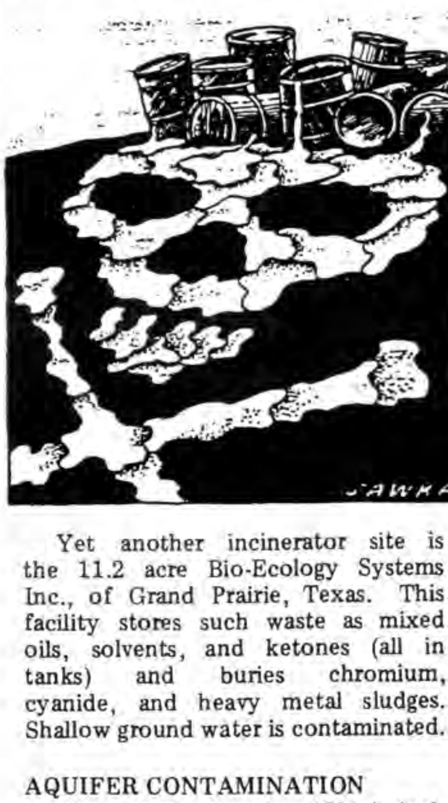
A toxic cloud formed when 60,000 barrels of stored hazardous waste were ignited. Since the plant first opened, residents have suffered many breathing difficulties and skin disorders. Kenneth Rosen, director of the Health Department's Occupational and Enviromental Services, said that "it doesn'tmake sense to me to have people living smack up against industrial plants."

Homeowners are caught in a dilemma: prospective buyers have been refused mortgages for the properties they wish to purchase. Robert Ginsberg, chemist/toxicologist and research director of the Chicago office of Citizens for a Better Environment (CBE), cites the explosion in Elizabeth as "an excellent example of demands for short-term profits by short-sighted entrepreneurs, leading to environmental disaster."

According to Citizens Clearinghouse for Hazardous Waste (CCHW), lagoons, ponds, and other impoundments used for storage of large amounts of wastes pose two problems.

First, the mixing of wastes that are not compatible can cause explosive reactions. In Shelby Township, Michigan, two men died in an explosion following the dumping of a tank of hazardous wastes into a lagoon full of chemicals—hydrogen sulfide gas was produced.

Second, lagoon or pond liners eventually leak into surrounding soils, as the EPA and many scientists agree. Liquid-Disposal, Inc., of Utica (Shelby Township), was the site of an incinerator for liquid wastes. EPA and state investigations revealed contamination of air, soil, surface water, and ground water in the vicinity of the site. In May 1982, the EPA cleaned up a PCB—contaminated oil spill and closed the incinerator.



Yet another incinerator site is the 11.2 acre Bio-Ecology Systems Inc., of Grand Prairie, Texas. This facility stores such waste as mixed oils, solvents, and ketones (all in tanks) and buries chromium, cyanide, and heavy metal sludges. Shallow ground water is contaminated.

AQUIFER CONTAMINATION

The Miami County (Ohio) incinerator and its associated landfill in Troy, Ohio opened in 1968 with the belief that it would be an environmentally safe, cost-effective disposal method for residential, commercial, and industrial wastes for 20 years.

Scrubber waster from the incinerator stacks and quench water from the ashes were discharged into an infiltration lagoon. A combination of unsound disposal practices and poor geologic location resulted in significant contamination of one of Ohio's most productive aquifers. The aquifer is contaminated with chlorinated hydrocarbons, heavy metals, and aromatic solvents. Municipal wells serving 19,000 people are within three miles of the site.

HEALTH EFFECTS

The first incinerator ever to get a permit to burn PCBs was the Rollins Environmental Services facility in Deer Park, Texas. In 1981 it began burning PCBs from all over the country.

Stack samples show that the incineration of PCBs produces particulates, hydrochloric acid, carbon monoxide and carbon dioxide. An August 1980 test burn showed trace amounts of dioxin and furans. The EPA, however, said that it cannot determine what effect these two deadly toxins could have in combination with hazardous materials already being emitted into the air from vehicles and industries in Deer Park.

Residents are victims of vasculitis, a rare skin disease usually caused by exposure to toxic substances. The national average for vasculitis is 1:100,000. Deer Park residents show an average of 6:25,000. When these victims leave the area, the problem ceases; when they return, the skin disorder does also.

FAILURES TO COMPLY WITH EPA REGULATIONS

In September 1981, Rollins Environmental Services of Texas violated a clause in its PCB-incinerating permit which ordered the firm not to burn material on air stagnation advisory days. Prior to this, the EPA told residents not to worry about Rollins burning PCBs on air stagnation advisory days. After a lengthy court process, Rollins was reprimanded for its violations.

Energy Systems Co. (ENSCO) of El Dorado, Arkansas, was fined $44,550 by the EPA for failing to properly store 2,217 boxes of PCB capacitors, failing to keep proper records on the actual incineration of PCB liquids and solids, and failing to maintain annual reports on PCB activities for *four* years.

LEGAL LOOPHOLES

The Toxic Substances Control Act (TSCA) regulates *how* PCBs should be disposed of. It does not regulate *where* such disposal facilities should be located. Many of the TSCA provisions are used as an excuse to ignore the concerns of citizens.

TSCA does not work in concert with the Clean Air Act. Therefore, pollutants not listed under national

(continued page 16)

DIOXIN DOWN ON THE FARM

(Editor's Note: Mick Harrison, PCB Project Researcher for INPIRG, Jim Manion of REM Productions, and Greg Moore of the Veridian *staff all visited the dairy farm of Mack and Caroline McCullough on January 18 of this year. What follows is Moore's account of the McCullough's perilous situation and its relevancy for Monroe County's PCB crisis.)*

Mack and Caroline McCullough operate their family-run dairy farm about ten miles south of Brazil in Indiana's Clay County.

The McCullough's began experiencing serious health problems with their animals in the summer of 1980. The series of events which followed that fateful summer are a grim nightmare indeed.

All the more interesting—and frightening perhaps—are the remarkable similarities between the McCullough farm tragedy and the PCB problems in Monroe County. The State Board of Health and Environmental Protection Agency (EPA) have been unwilling or unable to provide adequate testing for toxic chemicals in either location. As Mr. McCullough so succinctly puts it, "By the time you find out you have a problem, it's too late."

Between 1980 and 1982, the McCulloughs spent thousands of dollars and an unaccountable number of hours consulting with veterinarians, feed consultants, the Farm Bureau, experts from the universities of Wisconsin, Purdue, Iowa State, Wright State, and other respected laboratories throughout the US trying to find out what the problem was.

Calves were still-born. Milk production was down. Cattle would exhibit abnormal behavior—rooting like pigs and eating dirt. Some calves were born with twisted stomachs and the lines to the kidneys were plugged off completely.

Sometimes, cows would lay down and be unable to rise for hours or even days and then suddenly rise and appear normal again. Abcesses "as large as a volley ball" developed on some of the cattle, according to Mack McCullough. Blood circulation was poor and the pancreas and liver were often abnormal.

Mack tells a story that can make one's skin crawl. The McCulloughs had been instructed to kill some calves and send their livers in for testing. Mack selected one that seemed fairly normal and put it down. He cut the calf open and reached in to pull out the liver. As he grasped the organ, it ran through his fingers "like jello."

But Mack McCullough has even more terrifying stories to relate. On one occasion a cow had died and the body left overnight. The next day Mack put a noose around the unfortunate animal's neck and attached the rope to his tractor. As he began to tow the carcass, the head and hide pulled off of the body, leaving the flesh, bones, and organs behin

This mass fell apart on the spo it was in an advanced state of decon position. And the cow had been dea for only one day!

In addition to the problems wit the cattle, other animals were affectec Dogs died. Cats developed diarhea an died, perhaps as many as 50 in all Birds of all kinds were found dea everywhere. This is unusual, for mos dead birds are found immediately anc eaten quickly by both domestic anc wild animals.

Even the hardy survivalist, the rat, disappeared. Wade McCullough, Mack and Caroline's son, says that rats only recently have started to reappear around the farm after a two-year absence. The McCulloughs seem to be encouraged by the rats' presence.

Theories and explanations ranged from chlamydia to lead poisoning to leukemia. Indeed, some of the cattle did have leukemia. None of the symptoms, however, were consistent enough to make a clear diagnosis and neither innoculations nor feed changes seemed to correct the problems.

The general health of the dairy herd continued to decline. They were consuming two to three times the amount of feed considered normal but without any apparent weight gain.

In March 1983 a friend of Mrs. McCullough called to tell her about a Phil Donahue show which she had seen and video-taped. The show's guest was Judy Piatt, a woman from Times Beach, Missouri, whose horses were suffering from the same symptoms as the McCullough's cattle.

When Mrs. McCullough heard that the horses were suffering from acute dioxin poisoning, she flinched. When she found out that it was related directly to the spraying of road oil, Caroline was convinced that this could be the source of their own problems—the McCullough's gravel road had been sprayed with oil for years.

The summer of 1983 was the worst. The McCulloughs lost nine cattle in one week alone. Caroline called the State Board of Health and requested tests for dioxin. She was informed that the State did not have the time or the money to get involved! When she told the gentleman at the State Board of Health that she was going to call the EPA, he told her that it would be of no use since the State would have to do the foot work and, again, the State Board of Health did not have the time or the money.

Mrs. McCullough credits the local news media and the persistence of their veterinarian, Dr. Richard Rodgers for getting the State and the EPA to take action, however reluctantly.

The McCulloughs were warned not to try the case in the prss, yet muchof the information which they were to receive in the following months came to them through the media, via the almighty press release.

On one occasion, Caroline heard a radio report of a "secret meeting" in Indianapolis concerning some test results. Mack and Caroline were not invited to that meeting.

Finally, in late 1984, after some "priority" test results came back with some marginal dioxin readings, the McCulloughs were informed that the EPA and the State Board of Health could do nothing more and were closing the case.

Less than ten days later some of the other tests came back. The roadside showed 550 ppb of dioxin! The pasture showed 780 ppb! What action will be taken now remains to be seen. Whatever that action may be, it will be too little, too late for Mack, Caroline and Wade McCullough.

GREG MOORE

A Better Way to Burn

A Canadian scientist has developed a powerful incinerator that may offer the best means yet designed to destroy hazardous wastes. Scientist Tom Barton's plasma arc incinerator uses a high-powered lightning-like bolt of electricity to blast chemical wastes into atoms. Tests show the destructive efficiency of Barton's burner approaches 99.9999999 percent—ten thousand times more efficient than current EPA standards for ocean burning. According to a report in *ACRES, USA*, the plasma arc incinerator should be capable of reducing 10,000 tons of waste to less than one-third of an ounce. The EPA and State of New York plan to build a prototype to handle the cleanup at Love Canal. The prototype would be a mobile incinerator measuring only 10-feet long. It would be able to destroy high-level toxics like PCBs at the rate of one- gallon-per-minute. These small burners are expected to cost around $500,000 each. "If everything goes well, we hope to put them out at a rate of one per week after December 1985," Barton predicts.

—G.S.

CRITICAL EYE

RADON CAPITOL

Homeowners in Grand Junction, Colorado, must receive a certificate of decontamination from the federal government before selling their homes.

During the 1950s and 1960s, tailings from the area's many now-defunct uranium mines were used as a cheap building material in 7,000 area homes. The cement made from the tailings is mildly radioactive and emits radon gas at levels shown to cause cancer in test animals. Thus far, 61 homes have been decontaminated at an average cost of $15,000-$20,000 each—the government rips out driveways, patios, and basements as needed. Radon-contaminated sites have been discovered as far east as Pennsylvania.

SPERM COUNTDOWN

Donors for artificial insemination may soon become an endangered species. According to the Washington, D.C. Fertility Center, donors who can meet minimum for sperm quality or quantity are falling at an alarming rate. If the trend continues, in five or six years the nation will be out of potential donors. Studies show sperm damage to be caused by agricultural pesticides, by anti-cancer drugs, by lead, and by compounds inhaled in tobacco and marijuana cigarettes.

CORPORATE MURDER CHARGE UPHELD

A Cook County, Illinois (Chicago) Circuit Court judge refused on January 28 of this year to dismiss the unprecedented murder indictments against four officials from the Film Recovery Systems, Inc.

The four corporate officials are charged in the cyanide-related death of a worker in the Elk Grove Village plant on Feb. 10, 1983. The worker, Stefan Golab, died after allegedly inhaling cyanide that was used at the plant to recover silver from photographic film.

The recent ruling by Judge Ronald Banks was a major legal hurdle for the prosecutors in what both they and defense attorneys believe will be the first time in the nation's history that corporate officials have been charged with murder in the operation of a factory which resulted in a worker's death. The four also face 20 counts each of reckless conduct, resulting from charges that workers at the plant suffered harmful effects from cyanide used in the recovery process.

HUBER TECHNOLOGY COOKS DIOXIN OUT OF SOIL

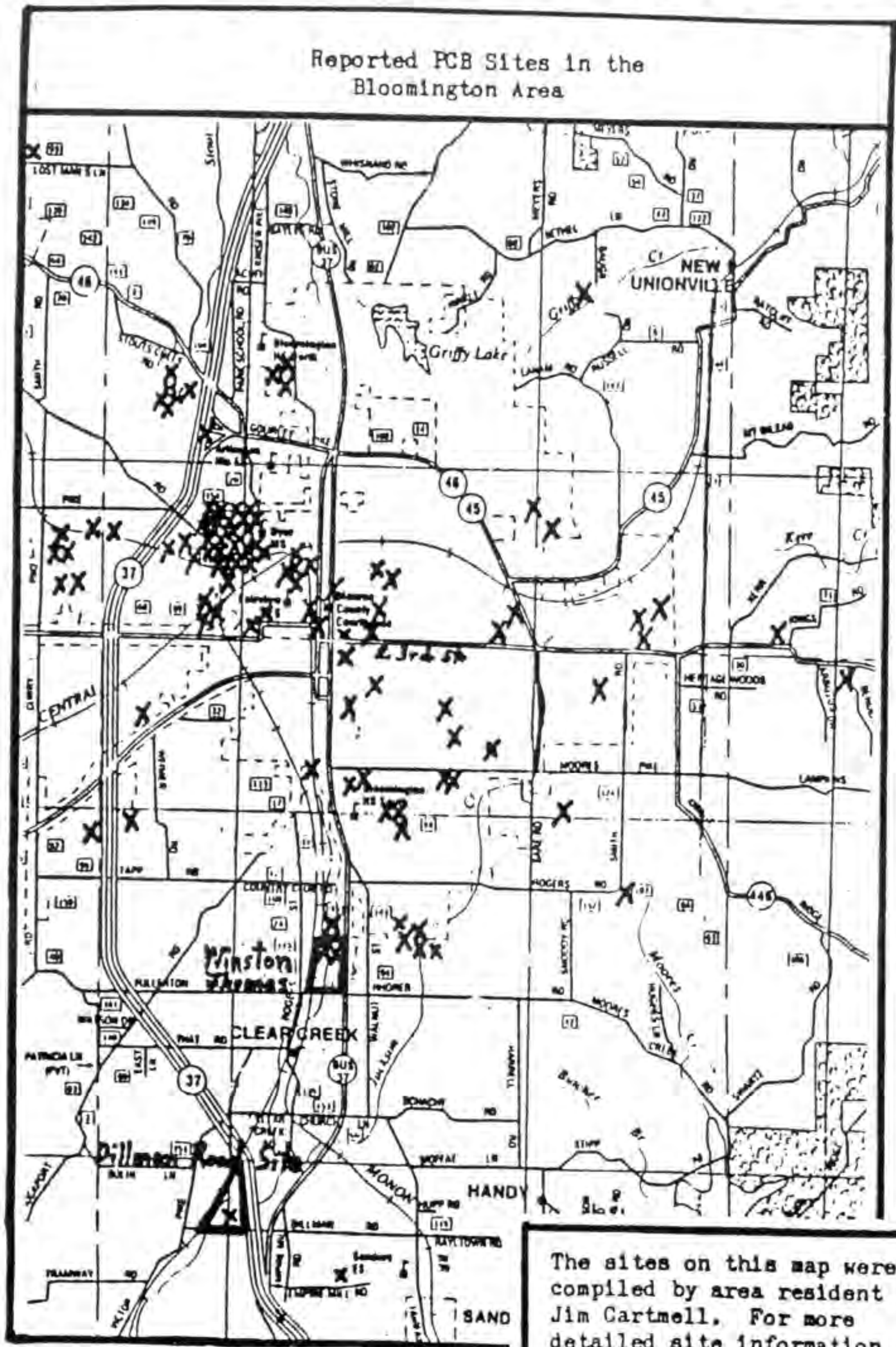
Tests have shown that a new technology actually destroys dioxin in soil, according to Fred A. Lafser, director of the Missouri Department of Natural Resources.

The technology is an electric reactor that bakes dioxin-tainted soil at a temperature averaging 4,000 degrees F. The new machine was developed by the J. M. Huber Corporation of Edison, NJ.

According to Lafser, tests on the dioxin-contaminated soil reveal "there was no dioxin detectable at a level of 1 part per billion." The Huber technology was unveiled at Times Beach, Missouri, the site of a significant amount of dioxin contamination. The technology had been used earlier at Borger, Texas, to destroy PCBs. At Times Beach, the electric reactor destroyed soil containing dioxin at levels of about 100 parts per billion.

While Missouri officials are very pleased with the reactor's performance, they caution that cost might make it prohibitive to use on the state's estimated 500,000 tons of dioxin-contaminated soil. Huber's manager of marketing and product development says that between $250 and $1,000 would have to spent to treat each ton of contaminated soil. Meanwhile, the U.S. Environmental Protection Agency will solicit competitive bids for dioxin-destruction technology for use at specific sites across the country. The Huber technology breaks down dioxin into carbon, hydrogen, and chlorine. Soil goes through the reactor, becoming molten droplets that resemble gray beach sand.

AND STILL COUNTING . . .



The sites on this map were compiled by area resident Jim Cartmell. For more detailed site information call 332-8166 or 335-7575.

Key
X- PCB site

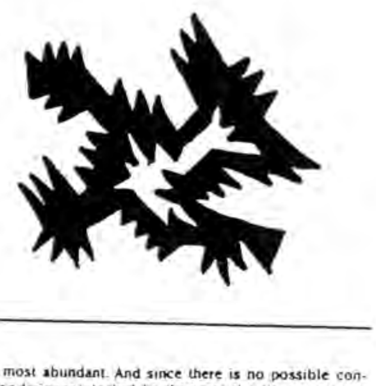
map explanation

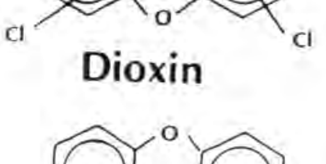
Evidence of the extent of PCB contamination in Monroe County mounts each week. As the map on the previous page indicates, environmental activists already have identified dump, sludge, and garbage sites in numbers that dwarf the six "official" locations scheduled for cleanup in the consent decree that has not yet been ratified.

As *Veridian* goes to press, however, this map already is outdated. More than seventy sites will have to be added based on the Utility Service Board's own records for soil and water testing, dating back to 1976. Still others will be included in newer listings based on phone call to the offices of INPIRG and the Toxic Waste Information Network (TWIN).

Even the current figure of 220 known or suspected locations is certain to be found to be too low by a wide margin. In the first place, USB records show that between 1972 and 1977 alone, from 500-1,000 individuals took PCB-laced sludge from the now-decommissioned Winston-Thomas waste treatment plant. Furthermore, neither thinly-veiled threats of litigation by the city's attorney Joe Karaganis nor fear of property value loss has stemed the flow of information to those individuals and groups seeking to determine the extent and dispersion of the contamination.

JIM SIMMONS





Dioxin

Furan

Dioxin deposits far from the source

Isle Royale, Mich., is a pristine 40-mile swatch of land in northern Lake Superior, a haven for wolves, moose, loons and occasional canoeists. Since 1940 it has been a roadless National Park where all motorized vehicles are prohibited. Yet three researchers from Indiana University in Bloomington found trace amounts of chlorinated toxic chemicals—dioxins and furans—in sediments taken from a lake on the island. The finding, reported in the Nov. 2 SCIENCE, gives weight to the belief that such contaminants can circulate widely through the atmosphere and deposit themselves far from their combustion sources.

Ronald A. Hites, Jean M. Czuczwa and Bruce D. McVeety sliced up core samples of lake sediment and extracted and measured the amounts of the dioxins and furans in each sediment fraction.

Their analysis showed 13 dioxins and furans in proportions similar to those found in air samples taken from Washington, D.C., and St. Louis. In both air and sediment, octachloro-dioxin was the most abundant. And since there is no possible contaminating drainage into the lake, they note, the dioxin contamination must be the result of air pollution from faraway incinerators that burn municipal and chemical waste. "Because it is a remote location it is getting material deliveries from the atmosphere which come from many sources," says Hites.

The researchers also found vanishing amounts of the compounds in sediment layers (below 8 centimeters) deposited before World War II. And this, says Hites, refutes Dow Chemical Corp.'s implication that dioxins have always existed and their seeming increase is due only to improved detection methods. Dow chemist Warren Crummett says the measurements might not support the company's hypothesis, but there are other studies that do and one set of data won't disprove it.

The minute amounts of the Isle Royale dioxins — 38 parts per trillion of tetrachloro-dioxin — hardly compare to the 300 parts per billion that closed down Times Beach, Mo., but it's not likely they'll go away. "Once dioxins are deposited in the soil and sediment," says Hites, "they are stable."

UNACCEPTABLE RISKS

(Editor's Note: In the following article Ron Smith, Bloomington's new City Chemists, argues that the risks associated with the new incinerator will be much greater than the EPA suggests.)

The incineration of hazardous waste or municipal refuse produces PCDDs (dioxins) and PCDFs (furans). Although the various isomers of dioxins and furans vary greatly in toxicity, certain members of these two groups of compounds are the most toxic manmade compounds known. They also have been linked to cancer and birth defects.

The EPA has attempted to assess the cancer risk associated with breathing atmospheric levels of the dioxins and furans emitted from some incinerators, and the agency has concluded that the risk is acceptably small. When these compounds are released into the environment, however, they are very persistent because they are water soluble, easily absorbed by living things, but poorly metabolised and detoxified.

Given these properties, dioxins and furans could be expected to pose a greater health risk through bioaccumulation in our food supply than through inhalation of them in the ambient air. This conclusion is corroborated by the work of Olie, Berg, and Hutzinger of the University of Amsterdam.

They concluded that although breathing the air in the vicinity of a Dutch incinerator presented no appreciable health threat, "the regular consumption of food, especially milk and milk products grown in the neighborhood of the previously described incinerator, could lead to elevated health risks."

This article assesses the theoretical risk associated with drinking milk produced in the vicinity of an incinerator which emits dioxin and furans at the same rate as the SCA hazardous waste incinerator in Chicago, an EPA approved facility.

The SCA test burn data are used in this analysis because the emissions appear typical for rotary kiln hazardous waste incinerators and have been judged by EPA to pose a risk of only one additional cancer per twelve million people, an acceptable risk.

The following procedure is used to calculate the potential cancer risk in milk. First, the dioxins and furans are converted into toxic equivalents of 2378 tetrachlorodibenzodioxin, and the average emission rate of this equivalent is calculated. Th e emission rate is divided by an atmospheric dilution factor to obtain the ground-level concentration in the ambient air. The fallout rate (depositional velocity) for this type of pollutant has been determined experimentally and is used to determine the flux of dioxins onto a unit area of pasture.

Since sunlight destroys a portion of dioxin if it is thinly spread on the leaves of plants, an allowance is made for the half-life of dioxin in the environment. The daily dietary intake of dioxin for a cow can be computed from the area of pasture a cow requires for grazing.

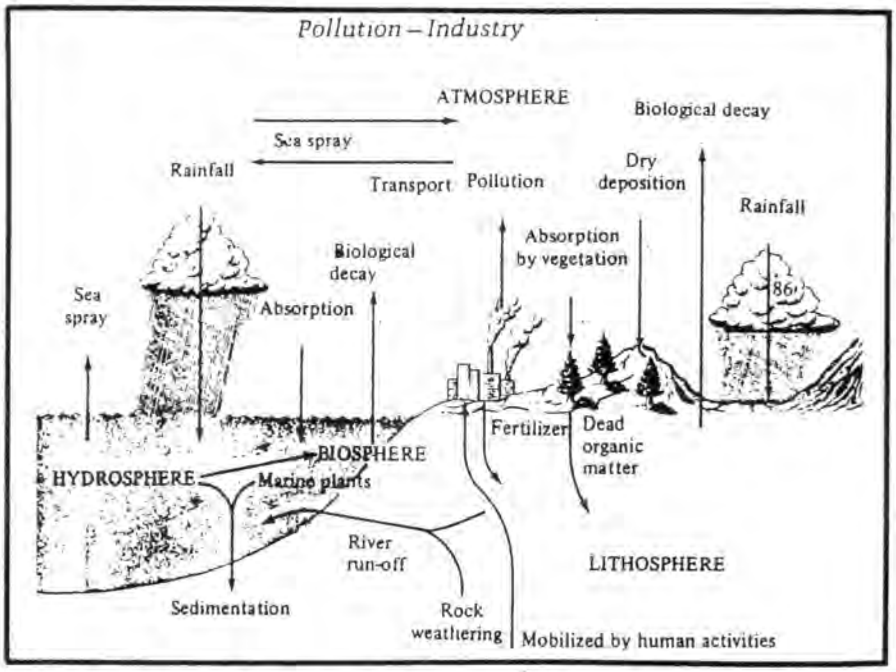
Next, the findings of PCB and dioxin feeding studies are used to predict the level in milk which results from the level of dioxin in the cow's diet. Finally, the EPA established relations between ingesting a specific dose of dioxin and the cancer risk associated with it is used to determine the risk of drinking a pint of this milk a day.

When computed in this manner, the cancer risk is from 2% to 10%, depending on which of the two feeding studies is used. Since the maximum risk deemed acceptable by the EPA is one in a million (.0001%), the incinerator falls short of meeting the safety criterion by a factor of at least ten thousand.

EPA questions the validity of deposition modeling partly because the agency failed to find dioxins in the runoff from the roof of a large building near an incinerator. But Rappe has shown that airborne furans and dioxins dissolve into painted surfaces. A probable explanation for EPA's findings, then, is that these compounds dissolved into tar or asphalt roofing materials, from which rain water could not remove them.

EPA also could not find dioxins in cow's milk produced near an incinerator. But the Indiana State Board of Health has also missed dioxin contamination of milk, up until cows were found to be dropping dead from dioxin in Clay County. The negative results of an initial study should not be taken as an indication that a thorough investigation is not warranted.

EPA derived its interim drinking water guidelines using bioconcentration data. In fact, 99% of the risk resulting from PCB contaminated



surface water was estimated to come from eating fish, not from drinking large quantities of water daily. There is no reason that incinerator emissions could not also be assessed from the viewpoint of bioconcentration.

The impact of incinerator emissions on agriculture could be mitigated in several ways. The distance which particulates travel from a stack could be used to determine a radius within which agriculture should be restricted or monitored.

Performance criteria could be established to limit emissions of PCDDs and PCDFs. However, no pollution control technology is currently in use which could adequately reduce toxic emissions, so establishment of an unattainable standard would achieve nothing. It would also be difficult to devise standards for all the hundreds of other compounds emitted from incinerators along with dioxins and furans.

UNACCEPTABLE

Hazardous waste incinerators are being built all over the U.S., largely because EPA regards them as a preferred technology. Currently 538 incinerators are burning hazardous waste in the U.S. and of these, only 3 have approved permits to do so.

Such a full-scale program of incineration should not be undertaken by EPA without an assessment of its impact upon our food supply.

Calculation of the risk estimate

Test burn emissions from the SCA facility, Table 2-3 of the C.T. Main risk assessment for the facility, were converted into carcinogenic equivalents of 2,3,7,8 TCDD using the following criteria:

1. All TCDD is assumed to have 2,3,7,8 TCDD toxicity, since results were not isomer specific.

2. All TCDFs are assumed to be 1/5 as toxic, again data available is not isomer specific.

3. All other PCDDs and PCDFs are 1/35 as toxic as 2,3,7,8 TCDD.

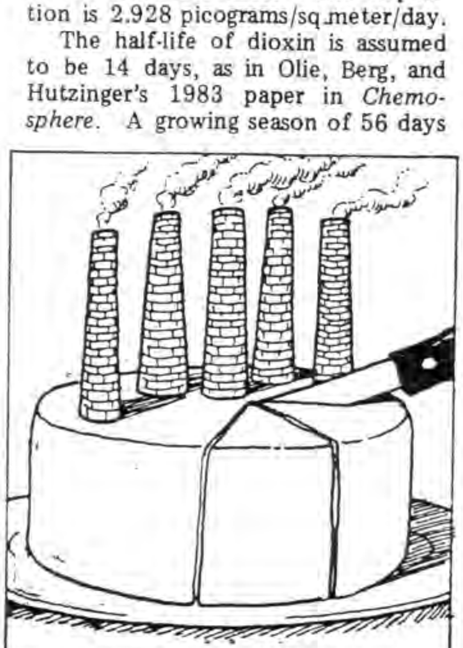
These criteria are similar to "Case 2" in the C.T. Main report, and are not as conservative as the assumptions used elsewhere in that report or the approval actions for Rollins and ENSCO.

The results from all five test burns are averaged together, giving an average daily emission rate of 14.1 mg. toxic equivalents of dioxin. The concentration of equivalents in the stack is 11.3 nanog./cubic meter.

Most gaussian plume models give worse case dilution factors of 10 to the fifth to 10 to the seventh power. This includes the SCA and Rollins assessments. A value of 10 to the sixth power was arbitrarily chosen for this article, as it is moderate and was suggested by Donald Barnes during an EPA-sponsored meeting. Ground level air concentration was obtained by dividing 11.3 nanograms/cubic meter by one million, yielding .0113 picogram/cubic meter.

The depositional velocity of PCBs and related compounds was measured in the field by Eisenreich to be .5 to .1 cm./sec. Dioxins and furans are similar to PCBs, a little heavier, in fact, and a median velocity of .3 cm./sec. was multiplied by the ground level air concentration to get the deposition on a unit area of pasture in one second's time. The deposition is 2.928 picograms/sq.meter/day.

The half-life of dioxin is assumed to be 14 days, as in Olie, Berg, and Hutzinger's 1983 paper in *Chemosphere*. A growing season of 56 days



is assumed. By taking the definite integral of the exponential decay, or half-life, equation from time zero to 56 days and multiplying by the deposition, a concentration of 55.5 picogram/sq.meter is calculated to remain on the grass.

A lactating cow requires from 5 to 20 acres of pasture to feed itself for one year. Using a value of 10 acres, the cow will graze on 112.7 sq. meters, ingesting 6,255 picograms of dioxin equivalents.

Levels expected in the milk will be calculated two ways, as an accuracy check. The first way uses the results of a 1979 feeding study conducted by Firestone which used hexa, hepta, and octa dioxins. The cow is assumed to absorb 10% of the dioxins ingested (as in Norback's rat feeding study 1975) and excrete 30% of this into 10 liters of milk. The concentration in milk will then be 18.8 pg./liter.

The second way of predicting the milk concentration uses a PCB feeding study by George Fries, published in 1983. He found that PCB in milkfat reached a stable maximum of 4 to 5 times the level in the feed. Since dioxin is known to bioconcentrate at least as much as PCB (EPA's *Dioxin Strategy* document claims 4 times as much), these results can be applied to dioxins and furans.

If the 6,255 pgs. of dioxin equivalents were consumed in 20 kgs. of grass, the milkfat concentration should be 1,407 pgs./lb. At 4% milkfat, the level in milk would be 56.4 pgs./lb.

The EPA's potency slope for dioxin is .091/ng./cubic meter of air. This was derived from feeding studies based on the assumption that 20 cubic meters of air are respired a day. Therefore, the slope must be multiplied by 20 to get the slope for the ingestion of a nanogram per day.

The risk associated with the daily dose of 9.9 pg./pint of milk predicted from the work of Norback and Firestone is 1.7% chance of cancer from drinking 1 pint of milk a day for 70 years. The risk of drinking milk containing 56.4 pg./pint, as predicted from the Fries study is 10.3%.

RON SMITH

PLAYING WITH FIRE

ambient air quality standards, such as PCB and dioxin, can be emitted legally into the air under guidance provided by TSCA.

EPA officials admit that under TSCA, state officials cannot pass laws that would impinge on federal legislation. As Stanley Jorgenson, chief of the solid waste division of EPA Region VI explains to Environmental Action magazine in 1982:

"If Texas State Rep. Watson's legislation to ban further incineration has passed the Texas legislature, EPA could override the law because EPA has sole authority in this area."

A case in point: local authorities in El Dorado, Arkansas, did enact an ordinance that would have stopped incineration of PCBs (the incinerator already was in operation). But the EPA overrode the local legislation.

The EPA considers one part per billion (ppb) of dioxin a possible health hazard. The EPA, however, does not have to regulate for dioxins. Two tests done soon after the Wheelabrator-Frye incinerator opened in Saugus, Massachusetts in 1975 showed less than seven ppb. in the air emissions.

No tests for dioxin in the ash residue from the garbage-burning process ever have been performed. The incinerator still is operating.

Seven area doctors have spoken against incineration at public hearings.

WORST CASE SCENARIO

So . . . what *can* go wrong in relation to the incinerator which Westinghouse is proposing to design, construct, and operate in order to clean up 650,000 cubic yeards of PCBs—only a *portion* of the PCB contamination that Westinghouse is responsible for in Bloomington?

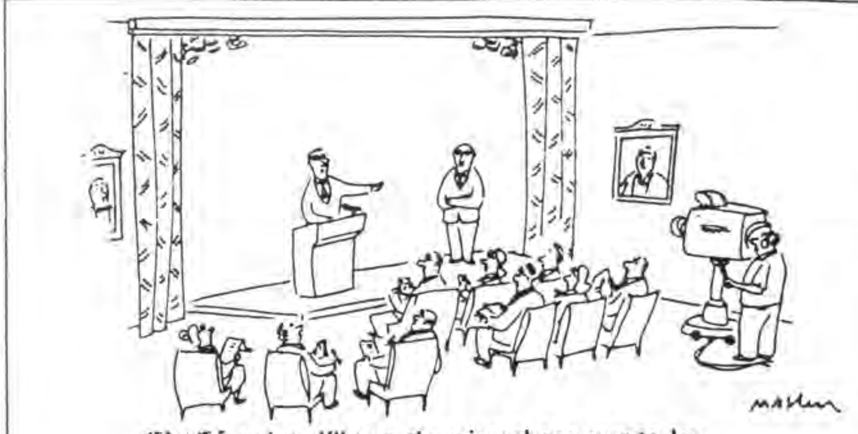
Well . . . IF this unproven, "state-of-the-art" technology does not fail after the *trial* test burn, a lot could happen!

Westinghouse will be permitted to begin operating the incinerator. Westinghouse may fail to perform certain obligations—conducting operational safety inspections, keeping proper records on the actual incineration of PCB liquids and solids, maintaining annual reports. Westinghouse may fail to store properly hazardous wastes that are explosive when not stored separately.

Explosions may occur within the incinerator itself or at the toxic-storage area of the site. Explosions can also occur while transporting hazardous wastes to the incinerator site. Many people could be affected by these explosions: workers, people living near the explosion or traveling along adjacent roads, and police, firefighters, ambulance drivers, medical and other emergency response people who attempt to treat victims and clean up the road-side spill.

Improperly-stored hazardous wastes may leak into our soil, surface water, and aquifer, severely contaminating the environment. This includes the food chain.

Emissions and ash residue from the incinerator may have high levels of dioxin. . . . But, we may never know, since the EPA doesn't have to regulate for this toxin. These toxins alone or in combination with carbon monoxide from vehicles or with other pollutants may be spread all over Bloomington.



"At this point, I'll turn the microphone over to Joe Karaganis, who'll deflect any questions you might have."

Since the location of the incinerator isn't something which the EPA is obliged to regulate under TSCA, the south-southwesterly winds coming from the proposed incinerator site could spread pollutants all over the Bloomington area.

Many, or all, of our residents could suffer from vasculitis and a number of other toxic-related illnesses.

Homeowners may not be able to sell their homes, assuming that someone even would want to buy a home in the contaminated zone—buyers may not be able to get mortgages for hazardous-waste property. If the federal government doesn't buy out the city of Bloomington, many of us may be forced to stay whether we want to or not.

In other words, in the very near future we could be faced once again with a situation quite similar to the present one: waiting eight years for a proposed consent decree to clean-up part of a Westinghouse-caused environmental crisis.

NANCY HASAN

DETOX'S BIOREACTOR

Last summer, Detox, Inc., of Stafford, Texas got EPA Region VI approval to dispose of PCBs in sludge using naturally-occurring microbes that ordinariy "eat" PCBs when given the opportunity.

By providing an ideal soil condition for these microbes, Detox was able to bring PCB-contaminated sludge down from 2,000 ppm to 4 ppm in a few months.

Their "bioreactor" contained PCB-contaminated sludge, though the sludge did not have heavy metals, pesticide residues, and other materials found in Bloomington sewage sludge which might be toxic to their microbes.

To the sludge were added PCB-contaminated oil, a catalyst to speed up the process, enzymes which helped disperse and liquify the PCBs, and an air-driven auger which stirred and aerated the sludge.

Without proper moisture, air, soil, and chemistry the microbes work slowly or not at all.

In other words, it's not possible to sprinkle Lemon Lane with microbes and wait for them to eat down through the PCB-soaked gumbo below. "Each waste material must be examined to determine if the process may be applied," according to Detox's technical summary. Region VI EPA demands include protection of groundwater, uniform reduction of contaminated materials to below 2 ppm, upfront plans for disposal of treated materials, and an alternative disposal technology—either "a landfill approved pursuant to TSCA Section 6 (e) to receive PCB wastes; or, an incinerator approved to receive PCB wastes pursuant to TSCA Section 6 (e)."

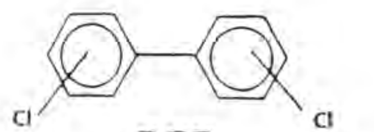
Applying Murphy's Law to a proposed indiscriminate microbial treatment of our half-million tons of contaminated refuse and gunk, a healthy skeptic might find plenty of reasons for not wanting the "finished" product to be landfilled next door.

Westinghouse, General Electric, and utilities-industry executives are desperate to get out of the PCB mess as cheaply as possible. Multinational corporations cannot afford to put all their contaminated eggs in one technology—incineration—which may become illegal or politically unworkable tomorrow. Westinghouse engineer George Levin has said, "I thnk there are some applications, in Bloomington, even, where we may end up using it (i.e., microbial degradation)."

It would be well to encourage testing of this process, particularly on soils from scavenger or garden sludge sites. Our Region V EPA officials have reportedly dismissed microbial degradation and other alternative technologies without testing them here. One wonders how many residents, sick of waiting for their property to be cleaned up, will perform their own experiments with available local microbes, garden tillers, and water hoses, confident that the most finicky microbes will work faster than our public health watchdogs.

ERIC HOLM

(Copies of the Detox Technical Summary and EPA VI's Conditional Approval of the Detox Process are available at InPIRG and the Monroe County Library.)



PCB

MICROBIAL DEGRADATION

Have you ever heard that PCBs are not biodegradable? There is an element of truth in this myth. PCBs don't readily break down in the environment. But numerous microorganisms do transform PCBs into products which are then broken down by other microbes into harmless substances. These bacteria utilize PCBs as a source of energy and carbon in the same way that they use sugars or other organic compounds.

Destruction of PCBs in the laboratory by acclimated (as opposed to geneticallly engineered) microorganisms has been demonstrated successfully. Scienstists involved in this field believe that it is only a matter of time before this method of PCB destruction becomes a commonplace method of dealing with PCB contamination.

One drawback to microbial degradation of PCBs is the toxicity inherent in PCBs. One focus of current research is development of bacterial strains capable of surviving relatively high levels of PCBs. A second focus of research is developing strains which generate large amounts of the PCB-degrading enzymes consequently performing the degradation rapidly enough to be commercially useful.

The industrial use of bacterial enzymes is extensive. Rennet used in cheese making, lactase to break milk sugar (lactose) into more digestable sugars, laundry detergents with enzyme power: all are examples of industrial bacteriology. There are many, many other examples.

One advantage to enzymatic systems is their extreme specificity. An enzyme will break a specific substrate into specific end products.

If we develop bacterial enzymes capable of degrading PCBs into safe end products, we can be assured that the degradation *will* generate those safe end products. There will be no hazards of "incomplete oxidation." Because of the specificity and reliability of enzymatic chemistry, and because of the simplicity of growing bacteria—natural living organisms—bacterial degradation of PCBs well may prove to be the best ecological answer. Research continues to find microbes capable of commercially degrading not only PCBs but all toxic chemicals and chemical wastes.

DENNIS COLE

MCPL

PCBs Collection

THE RYDER

AN INTERVIEW WITH SAAKU SAAR

PAGE 16

THE PCB CONSENT DECREE

PAGE 23

Number 60

FREE

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1/95

By David Parry

THE PCB CONSENT DECREE

Theme and Variations

THE Bloomington community now has before it the long-awaited PCB Consent Decree. This document is the product of fourteen months of negotiations among attorneys for the Westinghouse Corporation, the city, the state, and the federal government, negotiations entered into as a result of the $329 million lawsuit the city of Bloomington filed against Westinghouse in 1981. Once this decree is signed by all the parties involved, it will carry the binding weight of law for the duration of its implementation.

The decree has been a source of controversy since October 1983, when it was first announced that Westinghouse would clean up the PCB-contaminated material from the Winston-Thomas sewage treatment plant and five major dump sites in the area and burn it in a high-temperature incinerator which was to be fueled by municipal trash. At the time that that initial announcement was made, the city maintained that discussion of the details of the agreement must be conducted in private because the issue was under litigation. Subsequently, members of the public who opposed the incinerator proposal accused the city of operating under an unnecessary cloak of secrecy. One such closed-door meeting of city officials was postponed and another disrupted by the arrest of one of the citizens protesting the secrecy. Several months later, on August 27, 1984, the city fired its chemist, David Schalk. The official reasons given for his dismissal was that Schalk was insubordinate and that his desire to investigate some of the broader concerns of PCB pollution in the Bloomington area were outside the jurisdiction of the city utilities department and therefore beyond his duties as city chemist. But it seems likely that Schalk's outspoken criticism of the proposed incinerator and of the legal strategy being used by the city in formulating the Consent Decree was a major factor in his dismissal.

BECAUSE of advance public awareness of the incinerator proposal, numerous members of the community have been expressing their apprehensions about the Consent Decree at the city council meetings held since the late summer of last year. It has been during this period that the most persistent of this group of citizens have at times severely tested the patience of the local government and even of the public at large. Not every question or comment is always well thought out or central to the issues. But as a group these people have done an enormous amount of research on their own time, and, for every speaker who is not well prepared, there are many more who are. Without the participation of these good citizens, there would have been little public debate on the matter. It has been clear from the beginning that these "activists" are not motivated by any anti-government feelings, as some seem to think, but rather by what they have learned through their research about PCBs, and dioxins, and dibenzofurans, and the effects of these substances on human health. They are in many cases worried about whether they or their children or their neighbors might not be affected by exposure to these substances in their own neighborhoods.

All during the time that Bloomington was awaiting the release of the Consent Decree, local officials assured us that the public would be given ample opportunity to comment before the issue was brought to a vote. Since the decree was made public early last month, two public meetings have been held. The community had slightly more than two days in which to read the 108-page decree prior to the first, which was held during a snowstorm. The second was held six days later, on December 12, when many people were busy preparing for the holidays. Many members of the "fringe element" made the effort to attend each meeting, and it was during the second meeting that it became clear that the opportunity for comment does not necessarily mean that there will be any public input into the decree. When the city's special PCB attorney Joseph Karaganis stated that any changes in the decree at this point would mean that all parties involved would have to go back to the negotiating table, the document took on a take-it-or-leave-it character.

The official Consent Decree is not a lot broader in scope than was the initial proposal announced in October 1983. Its release does offer an insight into the details of the legal structure of the agreement, and there are some features which were heretofore unannounced, such as provisions for monitoring of the ground water and the hydrovacuuming of streams adjacent to some of the sites.

Within the scope and intent of this proposed cleanup, the decree is indeed a fairly strong and consistent document. At the very least, its signing would provide our local government and its citizenry with a written admission from the Westinghouse Corporation of its responsibility, if not for creating the toxic hazard present in our environment, then at least of their obligation toward cleaning up that hazard, something with which continuing litigation may not provide us for years, if at all. The document clearly defines what is to be cleaned up and establishes the protocol to be used in doing so. It also provides a timetable in which these events are to occur and guarantees that the timetable will be followed. There are seemingly no loopholes through which Westinghouse could escape its responsibilities, and there are provisions for insurance in the event that anything should not go according to plan. There are even provisions under which Westinghouse can change to the use of an alternative destructive technology if it becomes obvious that they cannot get the incinerator to work in the manner intended. The Consent Decree is a strong document, but it would seem that there are still some very valid questions about it which need to be answered, and perhaps some revisions need be made in it before any signatures are applied.

Paragraph 136 states that "Where the city is given authority or responsibility under this Consent Decree, the city's functions shall be performed by the USB [Utilities Service Board] to the extent that is permitted by law." This document was of course negotiated by Messrs. Karaganis and Fore in the employ of the USB, but the seat of government in this city is on East Third Street, where our elected officials preside, and not on South Henderson, where the members of the USB serve by appointment.

In Section VI, entitled "Solid Waste Supplied by the City and the County," Paragraph 23 states: "The city and the county each have determined that landfilling of solid waste represents a less desirable environmental and public health alternative to high temperature incineration." The first and most obvious question here is: Who in the city and the county made this determination and when? It would seem that the disposal of solid wastes is an issue of public policy which is entirely separate from the issue of cleaning up PCBs from the environment. This linkage of the PCB problem to the landfill problem in Bloomington and Monroe County represents what some consider to be a creative solution, while for others it is perceived as an idea which could further compound an already serious problem.

Several recent studies, including one by Indiana University's Ronald A. Hite, have demonstrated that the burning of trash as a fuel to produce energy results in numerous forms of dioxin entering the atmosphere. Hite reported in his study that the dioxins he found were of the least toxic varieties but added that "No one knows whether the airborne dioxin poses a threat to public health." Municipal trash also contains numerous forms of heavy metals such as lead, cadmium, nickel, and zinc from such common items as ink, flashlight batteries, and small galvanized metal products. Some of the compounds formed by these metals can be extremely toxic. Will the trash which feeds our incinerator be sorted to the extent that such items will be removed? Does the Environmental Protection Agency have any studies of the risk assessment for burning these metals? Section XXVIII of the Consent Decree states that the "remedial actions required herein . . . are consistent with the National Contingency Plan." The question here is: Is the burning of municipal trash a national contingency plan? Many environmental groups across the country might be interested in a yes or no answer to that question.

CONSIDER the other things that are common to municipal trash, such as solvents and paint cans and aerosols and plastics. On December 20 of last year, a plant in Akron, Ohio, which burned trash to produce steam, exploded, killing three people, and preliminary indications are that a solvent had entered the trash feed. Also keep in mind that, as the practice of recycling paper increases, a larger and larger percentage of the trash that might be burned in our proposed incinerator will consist of many of the materials mentioned above. The plastics and solvents are of course hydrocarbons, that is, they are made of hydrogen and carbon. If the burning of municipal trash produces dioxins (chlorinated hydrocarbons), as has been found in aforementioned studies, and if the incinerator to be built here will burn not only the trash which has been found to produce dioxin but also will burn materials that contain PCBs, will the increase in the chlorine levels caused by the presence of the PCBs lead to an increase in the amounts and/or types of dioxins produced by the incinerator proposed in this Consent Decree?

While landfilling and incineration are mentioned as ways of dealing with solid wastes, the document fails to include a third alternative: recycling. National contingency plan or no, recycling has been growing in popularity and implementation for more than a decade and will continue to do so. As our society turns more and more toward facing its environmental problems, the technology and economic feasibility of recycling seem likely to continue to grow. Now, in Section VI of the

Consent Decree, Paragraph 25 states that "the city and county shall each through appropriate ordinances, regulations and all other necessary actions, direct that all solid waste generated in the city and county, respectively, that is capable of incineration shall be delivered to the incinerator."

Given that the Consent Decree is passed as is, this section logically leads to the question of whether private trash haulers such as Rumpke and Global will be affected, but of perhaps much greater importance is the question of how such ordinances might affect current and future recycling programs within this area. The Consent Decree of course states that the inability of the city and the county to deliver an adequate supply of burnable solid waste as fuel for the incinerator shall not relieve Westinghouse of its obligations to incinerate the PCB-contaminated material. It further states that, if this should become the case, Westinghouse will instead use other conventional fuels such as gas, oil, or coal. It is not clearly stated, however, as to who will pay for these conventional fuels in the event that they are needed. If we commit our trash to the incinerator for the next fifteen years, and eight years from now the price of recyclable paper has risen to 5¢ per pound, or some as yet unforeseen technology arises that makes scrap polyurethane worth 10¢ a pound, will we have to pay for increasing amounts of alternative fuels (perhaps at deregulated prices in the case of natural gas) as an increasing volume of our solid wastes go to be recycled?

It has been mentioned that no one knows whether airborne dioxin represents a threat to human health. If the incinerator plan is implemented, and, say, three years into its operation the "dioxin rain" which Dr. Hite discusses in his study is perceived as a threat, will Westinghouse be obligated to further reduce the already small amounts of dioxin which the EPA says will be emitted from the incinerator or perhaps be required to carry out their obligations via some other destructive technology?

It is proposed that the incinerator will burn the 60,000 cubic yards of PCB-contaminated soils and sludge in fifteen years at a minimum rate of 300 days per year. Such a rate will require the burning of 133 cubic yards per day. This leads to several technical questions. What will be the ratio of trash to soil during the burning process? Will that ratio necessitate the use of a blower in order to supply ample oxygen to assure the complete combustion of the materials to be destroyed? And how will that increased gas flow, if it is present, affect both the residence time of vaporized PCBs and the function of the scrubber processes to be used?

AS IS PROPOSED in the Consent Decree, the incinerator will destroy both PCB-laden soils and municipal trash and will also generate steam and/or electricity in the process. Critics of the plan feel that the multiple functions required of this technique will compound the difficulty of achieving the primary function of the plan, which is to destroy the PCBs. Technical consultants to the plan, however, seem confident that the proposed incinerator will function as expected. Section V, Paragraph 16 of the Consent Decree requires that the city and the county shall endeavor to supply customers for or to purchase the steam or electrical energy generated by Westinghouse at the planned facility. The city could certainly use some of that energy at the Dillman Road sewage treatment plant, which will be adjacent to the incinerator. It seems, however, that finding customers for a power source which could be inoperative for up to 65 days a year would be difficult. Therefore, it would appear that metering the excess energy onto the existing power grid might be a better alternative.

The final question here in regard to the incinerator plan is directed to the insurance stipulations discussed in Section XX. Where it is required that there be liability coverage against environmental impairment, whether it be sudden or gradual, what burden of proof will be required in cases of gradual impairment? Will there be a statute of limitations applied to the filing of such gradual damage claims, and if so, then over what time period will such a limit extend?

AS PREVIOUSLY STATED, there is also a protocol for the monitoring of ground water in Section XIII of the Consent Decree. Westinghouse will be required to monitor test wells located at several of the sites to be cleaned up. Those wells will be monitored for PCBs, but will they also be checked for the presence of dioxins and dibenzofurans, especially at the sites where PCB wastes are known to have been burned? It came up at a recent meeting that the testing protocol used by the EPA thus far, in determining the presence of such byproducts of PCB-burning, emphasized the possible existence of what the EPA considers as the most toxic forms of those two compounds. It was noted, however, that those forms of dioxin and chlorinated dibenzofurans were not necessarily of the type that would likely be formed in the burning of the PCB-carrying chemicals known as Alychor 1016 and 1242 which were used by Westinghouse in the manufacture of their capacitors. Will future testing protocols be adjusted to properly address the possible presence of these most-likely-to-be-formed byproducts? If so, will that protocol be extended to cover not only ground water monitoring but also preclosure on-site testing and the monitoring of incinerator effluents and ash?

The Consent Decree provides for the cleanup of six major PCB-contaminated sites. Members of local citizens groups and numerous residents of Bloomington's West Side both claim, however, that the proposed cleanup does not address the full extent of the problem. By interviewing both current and former Westinghouse employees, long-time West Side residents who were at one time involved in salvaging discarded Westinghouse capacitors from the city-owned Lemon Lane dump, as well as area residents who suspect that they might have placed PCB-contaminated sludge from the city's Winston-Thomas sewage treatment plant on their gardens, these groups have compiled a list of some 160 sites throughout the city, and especially on the West Side, which could potentially be highly contaminated with PCBs.

Section V, Paragraph 17 of the Consent Decree prohibits the incineration of any PCB-laden materials other than those to be excavated from the six major sites but does state that "This prohibition may be modified with the express written approval of the United States, State, City, and County to address any future discoveries of materials contaminated with PCBs in and around Monroe County." Furthermore, any waiver which Westinghouse may claim against incineration of materials from such sites could be denied via Section XXV, Subparagraph e of the Consent Decree. So—technically—these sites are included in the proposed settlement.

It seems that the real controversy surrounding these 160 proposed sites is not whether they could be included in the cleanup but rather to what extent they will be included. The most prevalent and ongoing source of frustration for those critical of this aspect of the proposed settlement rests not only in the vagueness with which these proposed sites are addressed in the Consent Decree but also with the manner in which they have been dealt in the past. Leon Mullis, who led the city to the discovery of PCB contamination at its own landfill on Lemon Lane, claims that he received the actual results of tests performed on his property by the city lab nearly four years later, in a letter from the state. Some time after those tests were conducted, the city determined that further such tests were outside the jurisdiction of the city lab. Indeed, it was former city chemist David Schalk's "desire to investigate [some of these] broader environmental concerns" that led to his dismissal by the city in August of last year. When the City-County PCB Site Search Committee (formed in August 1984) held its first press conference last October 1, it was stated that that committee had been formed partly as a result of the previous lack of co-ordination among the various local agencies in sharing information on the location of reported PCB sites. It is now the mandate of that committee to compile and evaluate sites such as the 160 now known and to integrate any proven site into the mechanism of the Consent Decree.

IT was at that same October 1 press conference that several questions were asked in regard to granting amnesty to persons who might now report sites which had possibly become contaminated with PCBs due to their actions as haulers for Westinghouse or as participants in the salvaging of discarded capacitors. It was pointed out that such an amnesty might be necessary in order to allay the fears of persons who could come forward with such information but had failed to do so because of the risk of either assuming liability for their actions or of being prosecuted for violation of the EPA deadline for reporting hazardous waste sites which passed on June 6, 1981. It was also noted that there might be a need to offer some sort of assistance to property owners who had either salvaged capacitors or used PCB-contaminated sludge on their property but who feared to come forward for fear that their property values would suffer. It was stated by the committee that no one would be prosecuted for failing to report sites, but none of the other points taken was clarified.

How does this amnesty question relate to the Consent Decree? Section XXIII, "Covenant Not to Sue," Paragraph 111c states that "Nothing herein shall be construed to release any claims . . . against any person or entity not party to this Consent Decree, including but not limited to Monsanto Company." In Section XXV, "Waiver of Claims," the EPA approves the remedial actions which Westinghouse is required to take for the purpose of allowing Westinghouse to assert against persons other than parties to the decree any claim with respect to hazardous waste generated by them. It is also stated in Section XXV that "It is intended that this Consent Decree shall neither create nor affect the rights of persons or entities who are not parties to this action." Can these sanctions of the Consent Decree be taken to mean that Westinghouse reserves the right to sue their former haulers or persons who spread PCBs around the area through their salvage activities? As for property owners who have placed contaminated sludge obtained from the city on their gardens, it seems that they will have to recover their damages from Westinghouse. Section XXX on "Indemnity" states that Westinghouse shall defend the city and county against all claims "for personal injuries or physical damage to property arising out of, resulting from or related to past, present or future exposure to, contamination by or transportation of PCBs at, to or from the sites and areas covered by the Consent Decree." As has been the case for some time now, for such property owners and the people who have become disabled while working at the Westinghouse plant, the statute of limitations has run out.

SOON the Utility Service Board's PCB questionnaire will begin arriving at Bloomington homes along with the January water bill. This survey is being touted as a forum on what the community as a whole thinks of the Consent Decree. It is hoped that it will be worded as carefully as possible and that the information which accompanies it will fully convey not only what will be done but also what will *not* be done as a result of the passage of the Consent Decree. If the survey is not perceived as an accurate and impartial vehicle for the collection of public opinion, it is likely that it too will become a part of the ongoing controversy which has so injured our city.

Certainly the depth of understanding

and the range of opinion within the community with regard to this issue is great. Thus far, those in the forefront have been those making the proposal and those opposed to its implementation.

FOR the city and for Westinghouse, who are proposing this largest-ever settlement of an industrially caused environmental problem, it is a creative and progressive solution. Both major and minor PCB-contaminated sites will be cleaned up. Westinghouse's liability for allowing a harmful substance to be spread beyond the bounds of its plant will be addressed. Any liability accumulated by the city or county, such as possessing landfills or a sewage treatment plant in which toxic substances are being "stored without a permit" and therefore in violation of state or federal law, will also be properly dealt with. The city will no longer be liable to its own citizens who unknowingly carried off some of the toxic substances which the city was "storing without a permit" at the Winston-Thomas plant to spread on their farms and gardens. And, by signing the Consent Decree, the city will not only be shedding these liabilities toward state and federal authorities but will also be saving itself, and therefore its taxpayers and utilities ratepayers—we the people—a very large amount of money which may otherwise have to be spent in ridding itself of the toxic PCBs which it was illegally "storing." In addition, signing the Consent Decree provides the city with a way in which to deal with its municipal trash problem for a fifteen-year period.

The PCB questionnaires being mailed this month will be sent to those water and sewage ratepayers. The purpose of this survey is to determine whether all the citizens of the community who have not been attending public meetings to debate the PCB issue have stayed away because they support the proposal and feel no need to express that support publicly or if they are instead in agreement with the so-called "fringe element" who oppose it. Clearly, it has been the absence of positive comment by the public at any of the meetings held thus far which has prompted the emergence of the PCB questionnaire.

And as for the "fringe element"—those citizens who dutifully show up at each and every public meeting to voice their opposition to the proposed Consent Decree—how do they view the Consent Decree? What do they want?

To summarize the thoughts of so many different people is difficult. To start, they are frustrated by the ponderously slow manner in which the situation has been handled thus far. They feel that the city is rushing to embrace the idea of an incinerator, but they don't see the necessity of linking the trash problem to the PCB cleanup and would rather see the major sites capped properly while a more complete assessment is made of the range of technologies which could be used to handle those sites. Many of these "fringe element" people live in neighborhoods where PCB capacitors were salvaged. They would like to see their neighborhoods tested as soon as possible and to see heavily contaminated areas quickly cleaned up and hauled away or fenced off. In areas which are extensively polluted they would like to see the people living in those areas relocated, if that is the best way to assure their protection. They would like to see a more complete medical evaluation of the people who live in such neighborhoods and adjacent to the major dumps, of the people who ate vegetables grown in PCB-contaminated sludge, and of people who worked at Westinghouse. And, after such evaluations, they want to see compensation for those who have been injured.

Even if the Consent Decree is implemented in its present form, it would seem that all parties involved, or the federal government alone, should conduct an ongoing study into the effects of long-term exposure to low levels of PCBs and their byproducts on human health. After all, government officials continue to repeat the litany that no one knows, or that no one fully understands, their effects on humans. Considering that Bloomington was only one of 37 locations in this country where PCBs were used in manufacturing, and that, by the EPA's own estimates (reported in a recent issue of *Science Digest*), over 1,000 PCB transformer fires occur in this country annually, it would seem that this would indeed be a good location in which to begin determining just what those effects are.

OUR PREDICAMENT in Bloomington is a tragic one. The Consent Decree is only one of a number of ways in which our problems could be dealt with, and yet if it is signed it will become law. We will have our settlement. But as long as the likes of West Side resident Pat Gray are around to stand up in public with tears in his eyes and tell us that he is counseling his sons not to produce children of their own, that he and his family are sick and yet cannot get health insurance or knowledgable medical assistance, and that he cannot sell his house because no one wants to buy it—and then be told in return that he is as guilty as any other man for the scourge that lies upon his hand—then we may well have law, but there will be no justice in it. □

The INDIANA SASSAFRAS AUDUBON SOCIETY

of Lawrence - Greene - Monroe -
Brown - Morgan & Owen Counties

A Checklist to the PCB Cleanup:

March 9, 1987

Sassafras Audubon Society

Introduction

The cleanup of Monroe County's PCB contamination problem under the Consent Decree is certainly controversial. Due to the involvement of the Sassafras Audubon Society (SAS) in the issue to date, many citizens have expressed to us a degree of uncertainty about the proposal. This Checklist is designed to help identify the most important issues involved, and provide a foundation from which one can judge the progress of the process.

Background

In the fall of 1984, an out-of-court settlement was proposed to end the lawsuit that the City of Bloomington had filed against Westinghouse for the PCB contamination of several specific sites. The federal EPA and State Board of Health (now Department of Environmental Management, or DEM), with responsibility for cleaning up such hazardous sites were also parties to the agreement, as was Monroe County. The agreement outlined what immediate cleanup steps were to be taken and that a combined municipal waste/PCB-soil incinerator would be built and operated by Westinghouse.

In February, 1985, after attending a variety of meetings on the legal and technical aspects of the Consent Decree, SAS supported the City's signing of the agreement. At that time SAS listed several reservations about the plan. Some have been resolved, others remain, and appear on this Checklist.

The reasons for supporting the Consent Decree were very fundamental. The most likely alternatives were either a simple capping of the sites or an EPA-Westinghouse settlement which excluded the City's involvement. The element of "local control" provided by the Consent Decree offered our community more direct control of the various technical decisions that would be made during implementation of the agreement.

In August, 1986, SAS called for a halt to the implementation process until certain information became available.

One of our concerns at that time was the proposal to begin construction of the incinerator prior to the application for an air permit detailing the limits on emission of hazardous compounds, and the monitoring to be required to demonstrate compliance with these limits.

The second major concern was the lack of analysis of the feasibility and risks associated with possible alternative actions. SAS formally requested that EPA prepare an Environmental Impact Statement (EIS).

Recent Developments

By the end of January, 1987, Westinghouse had submitted the hazardous emissions part of its air permit, and a risk assessment detailing the likely health effects of the incinerator.

Also, in February, the City's Utility Services Board (USB), which acts for the City in this matter, issued a tentative acceptance of Westinghouse's proposal for the surface cleanup of the sites, including the temporary storage of contaminated materials in a building constructed by Westinghouse on the City's Winston-Thomas site. The acceptance hinged on Westinghouse agreeing to several safety measures, including additional testing of the sites.

The U.S. EPA has notified the City that it will move to cleanup the sites and possibly hold the City responsible for cleanup costs if the City does not allow Westinghouse to proceed with its proposed cleanup plan. The EPA also notified SAS that it did not feel that an EIS was required, and that it did not intend to prepare such an analysis.

The Heart of the Problem

The issues surrounding the Consent Decree-based cleanup are not simple. Rational individuals will draw different conclusions given the same information.

Certainly a hazardous waste incinerator is not without risks. On the other hand, this community has an existing health threat that it cannot ignore: heavily contaminated sites leaking into the groundwater and contaminated soil on the surface of the sites blowing off-site.

Monroe County citizens have twice the concentration of PCBs in their bodies compared to the average American. PCBs essentially do not break down naturally, so if we take no action, the current release will continue on a gradual basis during the next several generations.

The risks of the incinerator must be weighed against the risks of the existing situation. Getting a precise judgement of either is not easy; if it were, there would be little controversy.

Local Control

The process for decision-making outlined in the consent decree is important. It requires the City USB agreeing with all proposals, and allows the USB to set additional requirements beyond those of state and federal law. Of course, the USB is required to justify its actions: it can't arbitrarily refuse a reasonable proposal or demand unattainable standards of safety.

By use of this process, the USB has lowered the acceptable standard for dust at the sites of surface cleanup from 50,000 micrograms per cubic meter to 50, a 1000-fold reduction in the dust level. This would not have happened without the "local control" provision, as the EPA had agreed to the higher figure until perseverance by the USB prevailed.

SAS has found that the city, as represented by the USB, has acted responsibly in reviewing proposals, being neither too quick to agree nor too adversarial. Its chief consultant, Joseph Highland of Environ, Inc., is one of the best.

The Other Parties

In fact, without the Consent Decree, we would be reliant on the Indiana Department of Environmental Management and the federal EPA to protect our interests. Neither agency has shown the political will to fully invoke its powers in defense of public health. This month the state DEM strongly resisted a bill in the legislature requiring the monitoring of emissions from hazardous waste incinerators for dioxins and furans. The DEM asserts that current federal regulations are sufficient, although they require no such monitoring.

The threat of EPA to sue the City for site cleanup costs if it does not approve the current Westinghouse plan is unfortunate. It threatens the heart of local control. EPA has failed to act to clean up the sites for over ten years, so the agency's haste appears to be politically motivated.

For its part, Westinghouse has provided access to its technical staff, and has avoided the common corporate pitfall of denying the validity of community concerns. On the other hand, it has consistently put forth minimal proposals which must be negotiated back to full strength. Westinghouse complains that the city is slowing the process, but it could speed things most by making better proposals in the first place.

Sifting Through the Issues

One of the confusing aspects of the cleanup proposal is the myriad of questions, complaints and charges raised by opponents of the Consent Decree. The key element in evaluating the Consent Decree must be the protection of public health. We have a problem that poses certain risks to the community. Does the proposed solution increase or decrease the probability of public health effects?

Not at issue is Westinghouse' attempt to develop a marketable technology with hopes of selling it elsewhere. Nor is the possible health threat to Westinghouse's employees during its use of PCBs. Nor the existence of additional contaminated sites.

The Consent Decree is an out-of-court settlement for a lawsuit brought by the city concerning specific sites in the area. It was never meant to be, not could it be, a cure-all solution to all PCB-related problems. The sites included were the major known disposal sites of PCB-containing capacitors, and amount to 600,000 cubic yards of contaminated material.

While the Consent Decree allows additional contaminated sites within the county to be added, if all parties agree, it does not assure that such sites will be added. Nonetheless, SAS encourages the City and County governments to actively pursue the identification of additional sites, and ultimately their stabilization and final disposal of contaminated materials. Recently a consulting firm has been hired to perform such testing.

Outstanding Problems

SAS has spent hundreds of hours carefully studying many aspects of the proposal, consulting with a variety of technical experts, and listening to the City, Westinghouse, and the critics of the plan.

We have developed the following list of outstanding concerns and questions whose resolution we believe are the most critical for the Consent Decree process to provide an acceptable solution to the existing contamination problem.

Checklist of Primary Concerns and Questions

1. Alternative technologies - SAS believes that an analysis of the available technologies that might be used to effect a cleanup and their likely impacts should be available in a single document, such as in an EIS. Only by the preparation of such a document can citizens compare the alternatives, and decide if incineration is in fact the best approach. Since EPA is unwilling to prepare such a document, we suggest that the City ask the consulting firm Environ to prepare such a document. The risk assessment prepared by Westinghouse presents the impacts only for the proposed facility.

2. Procedural questions - SAS is concerned that all provisions of the National Environmental Protection Act (NEPA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or superfund), and the Clean Air Act are adequately

followed. We intend to monitor compliance with these laws of all proposals under the Consent Decree.

3. Local Control - While the local control provisions discussed above have already yielded valuable results, imposition of additional requirements by the city has yet to be formally tested. Upon the City's reluctance to accept the initial surface cleanup plan, Westinghouse took the matter to the Judge Hugh Dillon, who oversees the Consent Decree. He refused to rule on the issue, rejecting the appeal on technical grounds.

In February, the USB added specific additional requirements before it would accept the surface cleanup plan. Westinghouse's willingness to agree to the conditions, and a judge's ruling following any refusal on its part, will provide an interesting test of the local control.

If the effectiveness of local control is diminished by EPA actions, or by a court ruling, or if the USB fails in the future to provide strong leadership in requiring adequate measures, then the value of the Consent Decree would be called into serious question.

4. Requirements in the Air Permit

a) stack monitoring - The air permit put forward by Westinghouse is woefully lacking. Once a test burn is completed, it does not require the monitoring of the stack gases for PCBs, dioxins, furans, or metals. SAS believes that Westinghouse should be required to frequently monitor stack gases to prove that the facility is operating safely.

b) ambient air monitoring - Although Westinghouse has contracted for some monitoring of the air we breathe ("ambient air monitoring"), the permit does not set any requirements for such monitoring.

c) background monitoring - Monitoring of both ambient air and soils should be performed <u>before</u> the facility goes on-line, so we have values with which to compare on-going monitoring suggested above. Westinghouse is having some ambient air monitoring performed, but the process should be formalized.

d) repeated test burns - The test burn provides for an elaborate battery of testing of the stack gas while monitoring the operating conditions of the incinerator. Such tests, though expensive (about $1,000,000) should be performed on a periodic basis, not just when the plant is new.

5. Ash testing - Although the Consent Decree requires a very low level of PCBs in the ash from the incinerator prior to landfilling, current federal regulations do not require the testing of the ash for dioxins and furans. These compounds should be added to the testing requirements.

6. Waste separation - The current plan calls for the removal of large objects such as refrigerators from the trash burned in the incinerator. While recognizing that total waste separation may

not be feasible, SAS recommends that the incoming trash is screened for obvious sources of dangerous materials, such as lead batteries.

7. Trash - Because the facility will burn both normal refuse and contaminated materials, the test burn should provide information on the composition of the materials burned. Detailed sampling of the area's current refuse should be conducted to demonstrate its variable nature, and to assure that the test burn uses appropriate materials.

8. Trash-only phase - For a number of years Westinghouse plans to operate the facility solely as a trash-only incinerator. During this time the temperature of the afterburner would be only 1700 degrees (Fahrenheit), compared to 2200 degrees during the later PCB phase. Due to the potential harmful compounds that can be formed from common refuse, the 2200 degrees should maintained during both phases.

9. Continuous monitoring - Currently continuous monitoring of the stack gas for PCBs, dioxins, and furans is not technically feasible. Upon the development of the appropriate technology, Westinghouse should be required to perform such continuous monitoring.

10. Upsets - SAS believes that it is possible to construct and operate an incinerator similar to the proposed facility in such a manner as to solve the current contamination problem without subjecting the public to undue risk. However, SAS is concerned that unusual circumstances that require an emergency shutdown of the facility could result in significant emissions. The risk assessment prepared by Westinghouse addresses this concern, however it lacks the detail required to allow a conclusion to be drawn.

Conclusion

SAS still believes the Consent Decree process can ultimately lead to a successful satisfactory solution to the current contamination problem, and that it may be possible to incinerate the contaminated materials with reasonable degree of safety. However, such a solution is not guaranteed. SAS, other interested groups, and individual citizens must continue to monitor the process to assure that appropriate safety measures are taken. Several key issues remain open. We hope that this statement will be useful to citizens wishing to follow the progress of process.

For information about joining the Sassafras Audubon Society, send your name and address to PO Box 85, Bloomington, IN, 47402.

Blue File - PCBS

10/24/86

CITY OF BLOOMINGTON UTILITIES

PROGRESS REPORT

To keep the utility customers informed on the progress of the PCB clean up project the Utilities Service Board (USB) has prepared the following report. The board would appreciate your taking the time to read it in order to better understand the situation.

POLYCHLORINATED BIPHENYLS (PCB) are chemicals used in the manufacturing of electrical capacitors by the Westinghouse plant in Bloomington for approximately eighteen years.

In the 1970's, it was determined that PCBs posed a health threat and they were banned by the federal government. Unfortunately, the former City wastewater treatment plant, many landfills, and small dump sites in Monroe County were already contaminated by PCBs.

The City of Bloomington sued Westinghouse in federal court and won a court order known as a Consent Decree. Under the Consent Decree, Westinghouse must conduct and pay for an extensive clean up of the PCB contamination. Every step of the clean up will be approved and reviewed by the U.S. Environmental Protection Agency (EPA), State of Indiana and City of Bloomington.

The MAJOR STEPS of the clean up include:

- Removal of PCB contaminated materials from the surface of dump sites and creeks, and the storage of these materials in an environmentally safe INTERIM STORAGE FACILITY. (in progress)
- Development by Westinghouse of plans and permit applications for final excavation, removal and transportation of the PCB contaminated materials from six major sites and for construction of a HIGH TEMPERATURE INCINERATOR for destruction of the PCBs. All of these plans and permits must guarantee that the HEALTH & SAFETY of our community is protected and must be approved by the EPA, State and City. (est. 2-3 years)
- Construction of a HIGH TEMPERATURE INCINERATOR and transportation and destruction of all PCB contaminated material. (operational in 5 years, est. end of job—15 years after start up)

UTILITIES SERVICE BOARD'S Watchdog Role

- Under the Consent Decree, the City USB serves as the local citizens' WATCHDOG and monitoring authority through the clean up process.
- The USB has hired ENVIRONMENTAL HEALTH EXPERTS:

  ENVIRON CORPORATION, Washington, D.C., Princeton, New Jersey. The principal consultant from Environ is DR. JOSEPH HIGHLAND, a national authority on public health impacts of PCBs and other hazardous materials. Before founding Environ, Dr. Highland chaired the Toxic Chemicals Program of the Environmental Defense Fund, worked with the American Cancer Society and as a staff member for Ralph Nader. Highland also served on an advisory panel of the Congressional Office of Technology Assessment (OTA).

- The USB has retained INCINERATOR DESIGN ENGINEERING SPECIALISTS:

  CROSS TESSITORE ASSOCIATES, Orlando, Florida. FRANK CROSS and JOE TESSITORE have over 45 years of combined experience in the design, construction and operation of incinerators. The firm specializes in air pollution control technology and has been involved with dozens of hazardous waste clean-ups nationwide using incineration.

- The Consent Decree with Westinghouse is being implemented with the help of the following LAW FIRMS:

  BELL, BOYD & LLOYD, Chicago, Illinois. JOSEPH V. KARAGANIS.

  GEOFFREY M. GRODNER, Bloomington, Indiana.

Temporary Site and Storage

- The USB required SUBSTANTIAL CHANGES to the Westinghouse plan for temporary storage of PCBs to insure the absolute protection of the health and safety of the community.
  - The building was changed from a pole barn structure to a steel frame structure.
  - The building will have strict air and run-off water monitoring.
  - Impervious covers will be placed both over the contaminated soil and under the concrete floor of the building to prevent the escape of any PCBs.
  - The air from the building will be filtered prior to release during periods of activity in the building.

Health Risk Assessment

- The USB is REQUIRING that a complete HEALTH RISK ASSESSMENT be completed and accepted before plans for the federal court ordered incinerator are evaluated or approved. The Risk Assessment will evaluate the ENVIRONMENTAL IMPACT of the incinerator on human health, water and air quality, the food chain and animal populations.

The USB will require the following to insure the SAFETY OF THE CLEAN UP:

- EXTENSIVE EVALUATION OF THE PROPOSED INCINERATOR DESIGN:
  - the RISK ASSESSMENT described above.
  - PRIOR to construction on the Bloomington incinerator, a TEST BURN of Monroe County trash, sewage sludge and contaminated soil at an existing incinerator outside of Indiana to determine whether the contaminated materials can be safely incinerated.
  - a CHEMICAL ANALYSIS OF MATERIAL in the dump sites to assess the safety of excavation of the materials and transportation from the sites to the interim storage facility and the incinerator.
  - an evaluation of SITE-SPECIFIC PLANS for each Consent Decree site.
  - an evaluation of TRANSPORTATION ROUTES to be used in the clean up.
  - INDEPENDENT LOCAL MONITORING of incinerator performance.

Do we have alternatives to incineration?

- NO. The PCB contamination must be cleaned up under federal law and federal court order.
- CAPPING AND CONTAINING the materials at each site was the first alternative proposed by Westinghouse but was rejected because NO GUARANTEE could be given protecting against potential CONTAMINATION OF GROUND WATER from PCBs moving off the site.
- VAULTING of the material has also been rejected by the EPA and the United States Justice Department because STORAGE OF PCBs for longer than one year is ILLEGAL under the Code of Federal Regulations, 40 CFR 761.65.

Will the EPA approve any other PCB destruction technologies?

- NO. Currently, the only alternative which the EPA will approve for Bloomington is INCINERATION.

Do we have LOCAL POWER to Stop Westinghouse?

- YES. The Consent Decree gives the USB the power to REJECT WESTINGHOUSE PLANS if the HEALTH AND SAFETY of our community is not adequately protected.

What about OTHER SITES NOT COVERED by the Consent Decree?

- The USB has already requested proposals from ENVIRONMENTAL TESTING FIRMS to develop procedures to test OTHER SITES suspected of PCB contaminaton.

What is the COST OF THE CLEAN UP?

- Since 1974, the USB has invested $1.8 million in the total PCB problem and recovered $1.18 million of this amount from Westinghouse. From the outset over twelve years ago, it was felt that this issue was important enough to get the best environmental, public health and legal advice available.
- WESTINGHOUSE LAW SUIT
  - — Amount spent: $1.4 million.
  - — Amount recovered from Westinghouse: $1.18 million.
  - — Westinghouse assumes responsibility for the costs of the clean up, which are estimated at $100-$150 million.
- The USB's suit against the Monsanto Company seeks to recover the costs not covered by Westinghouse. Monsanto manufactured the PCBs.
- MONSANTO LAW SUIT
  - — Amount spent to date: $400,000.
  - — Amount sought in suit: Tens of millions of dollars.
  - — Status of the suit: Scheduled for jury trial in January 1987.

Citizen Members of USB

The board was created in 1972 by a 3 to 1 majority vote in a referendum of the voters. The USB provides complete citizen involvement in utility decision making. The bipartisan board currently consists of:

- An ENGINEER, an ENVIRONMENTAL SCIENTIST, a DOCTOR, a NURSE, a retired SCHOOL PRINCIPAL, an I.U. STAFF MEMBER, and a former county PLANNING OFFICIAL.
- Ex-officio members represent the City Council and the Mayor.

Regular meetings are held biweekly on Monday at 5:15 p.m. at the City Service Center at 1969 South Henderson. The public is encouraged to attend and participate in the discussion.

QUESTIONS AND COMMENTS on the PCB clean up can be mailed to the PCB Project Coordinator:

JOHN LANGLEY • P.O. Box 1216 • Bloomington, Indiana 47402 • (812) 339-1444

IMPORTANT

PCB INFORMATION

CITY OF BLOOMINGTON UTILITIES
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Bloomington, Indiana 47402

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INSIDE: Ten years after the Vietnam War—a Special Report

Maclean's

APRIL 29, 1985

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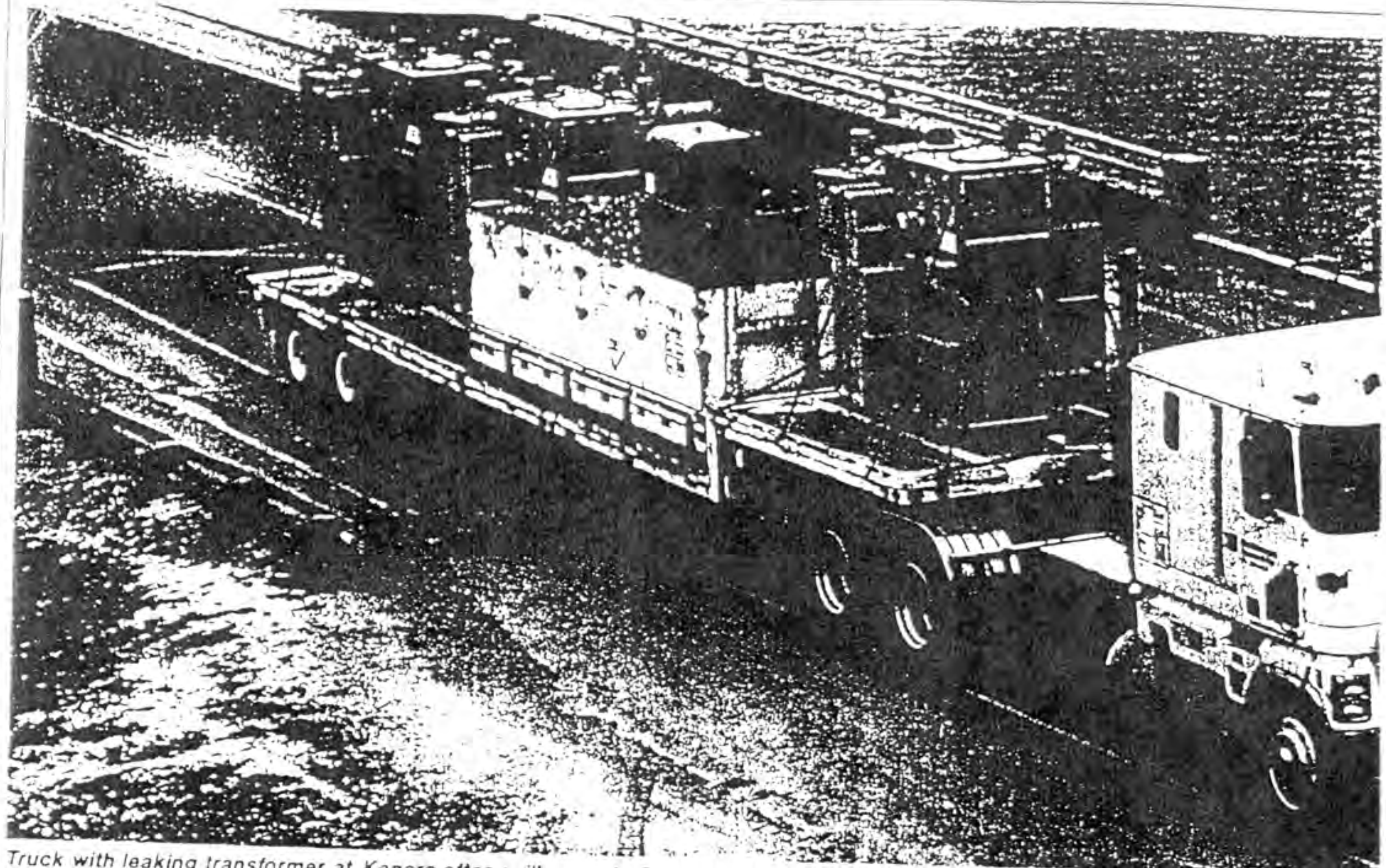
THE TOXIC THREAT

PCBs: What they are, where they come from—and how they can kill

The Kenora spill that exposed a national menace



Truck with leaking transformer at Kenora after spill: gaps in Canada's environmental laws and fears of a repeat

CANADA/COVER

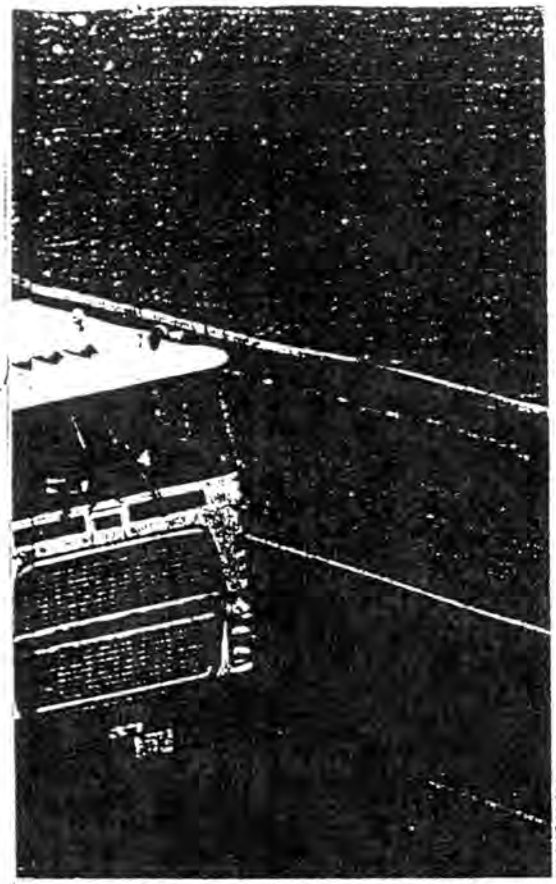
The trail of a toxic disaster

By Mary Janigan

For a distance of 25 km, the Eyjolfson family's 1984 Toyota trailed behind the big flatbed truck as it travelled along the narrow ribbon of the Trans-Canada Highway east of Kenora, Ont. Every time the truck turned a sharp curve a sticky dark liquid sloshed onto the road and sprayed the small car, coating the windshield and the air vents. At a Kenora gas station, a worried Lloyd Eyjolfson, 25, stopped the truck driver and asked him whether he and his pregnant wife, Lori, 24, and their two sons—three-year-old Daryl and one-year-old Mark—should be concerned about the spill. "He says, 'No problem—it's just mineral oil,'" Eyjolfson recounted bitterly. It was another day before the horrified family learned in Winnipeg that the "mineral oil" was transformer coolant laced with toxic polychlorinated biphenyls (PCBs). By late last week the Eyjolfsons were back home in Red Lake, Ont., anxiously awaiting the results of blood tests. Daryl had a face rash. Manitoba officials impounded the family car. The entire country was riveted by the family's plight and engulfed by the disturbing realization that chemical spills can happen anytime, almost anywhere, and that they can menace every Canadian.

Eyjolfson family's PCB-contaminated car in Winnipeg: 'a disaster'

That chilling environmental lesson unfolded after 100 gallons of PCB-contaminated coolant splashed from a transformer anchored to the flatbed truck along 70 km of the Trans-Canada Highway curling along the scenic route between Ignace and Kenora, 240 km [illegible] Winnipeg. For five days the stretch of highway was closed while work crews applied an asphalt sealer over polluted portions and while politicians and bureaucrats in Ottawa and provincial capitals struggled to explain how the treacherous spill could occur. For Canadians it was a vivid reminder that millions of gallons of tox-



ic PCBs are still in use in electrical equipment across the land and that more thousands of gallons are in storage because there are no available facilities to destroy them. The incident also underlined the striking gaps in Canadian environmental laws governing the menacing realm of toxic wastes. And, most important, it hammered home man's tenuous control over potent chemical genies in all-too-fragile bottles.

Insidious: PCBs are among the most insidious of the hazardous chemicals that can escape into the environment and menace people. Because the opaque liquid is difficult to destroy, in the past industry used it as a plasticizer in paints, waxes, lubricating oils and cosmetics, and as an insulator and coolant in electrical transformers and capacitors. But in the late 1960s medical researchers began to suspect that PCBs could be a threat to human life, and subsequent studies have linked the substance with ailments ranging from skin rashes to birth defects in humans. Eight years ago Ottawa banned the commercial production and use of PCBs. But without high-intensity incinerators to destroy the substance, stockpiles of the banned PCB solutions totalling 5.2 million pounds exist across the country in storage tanks and aging transformers. And a further 6.1 million pounds are still in use in old electrical equipment.

The Kenora incident began when Hydro-Québec decided to ship five transformers contaminated with PCBs from Varennes, across the river from Montreal, to the storage facilities of Kinetic Ecological Resource Group in Nisku, Alta., 20 km south of Edmonton. Four of the transformers had been purged. A fifth was full, and it did not have a drain valve. An Environment Quebec official, Gilles Legault, said last week that when his inspectors checked the truck Kinetic operators insisted that four transformers loaded on the flatbed were empty. Kinetic's regional manager, Michael Zidle, later said that he told the officials, "Four transformers were empty, and we took four transformers." A fifth empty transformer was left behind for a future shipment—one that probably now will never take place—and the truck set out on its fateful ride. As it moved along the Trans-Canada, the undrained transformer sprang a leak. And at Ignace the fluid began to slosh over the truck's spill pan and onto the highway at every sharp corner or bump in the road."He could see the stuff coming off his truck," Eyjolfson insisted."It was a cloud."

Confusion: The hazard was not reported until the truck pulled into a Husky service station in Kenora and the driver alerted company officials. The disclosure triggered public panic, political confusion and bureaucratic stumbling (page 18). Although local and provincial police converged on the station rapidly, the highway remained open for 22 hours, while thousands of motorists drove through or past the PCB splotches. That tragedy of errors continued throughout the week. Provincial officials advised worried motorists to put on rubber gloves and wipe the PCBs off their vehicles with Varsol cleaner and a dry rag. University of Western Ontario geneticist Dr. Joseph Cummins angrily countered that PCBs cut through clothing and rubber—and he dismissed the self-help advice as "the dumbest, stupidest thing that I have ever heard." Then, RCMP officers in Toronto —for undisclosed reasons—briefly seized Kenora soil and asphalt samples that had been transported to Lester B. Pearson Airport in Toronto and Air Canada refused to carry samples of Kenora's drinking water from Winnipeg to a Toronto laboratory for testing.

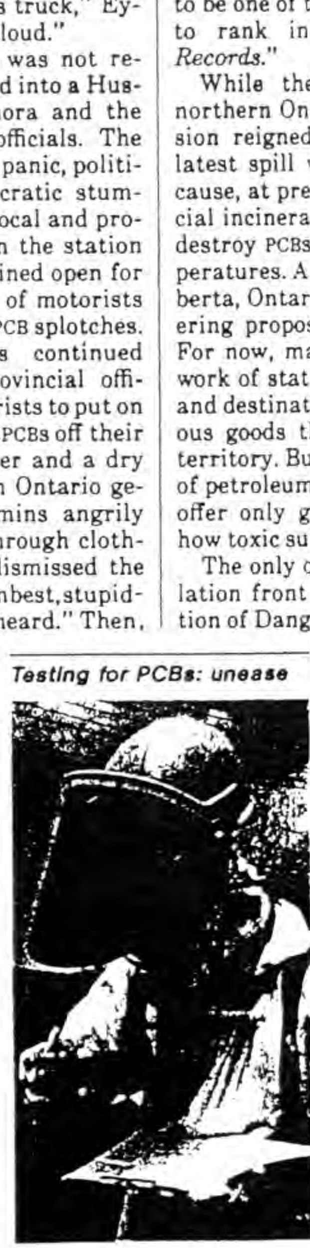
Meanwhile, 900 people in one 48-hour period alone flooded emergency telephone hotlines in Kenora with inquiries —and doctors examined at least six people for PCB exposure. Winnipeg electrician William Melnichuk was splashed with spray from the truck while he checked for overheating under the hood of his vehicle. Two days later he went to his doctor, complaining that he could still smell an ether-like odor, that his eyes hurt and that he had a burning sensation in his chest. "I haven't slept too good for the past few nights," he said "You start thinking, 'Oh boy, you're going to get cancer.' That's on your mind all the time."

Risk: Although local health officials attempted to play down the seriousness of the PCBs spill, one of North America's leading experts on low-level exposure to toxic chemicals took issue with those reassurances. "There is a health risk —absolutely," Dr. John Laseter, president of Vancouver-based Dallas Enviro Health Systems, told *Maclean's*. "These people have a serious problem when a spill such as this happens in a downtown area and when so many people have been exposed. It [Kenora] is going to turn out to be one of the major spills—it is going to rank in the *Guinness Book of Records*."

While the unease spread through northern Ontario and Manitoba, confusion reigned on Parliament Hill. The latest spill was especially chilling because, at present, there are no commercial incinerators in Canada designed to destroy PCBs at the required high temperatures. At least three provinces—Alberta, Ontario and Quebec—are considering proposals to build the facilities. For now, many provinces use a patchwork of statutes to regulate the timing and destination of shipments of dangerous goods that begin or end on their territory. But with the crucial exception of petroleum products, the governments offer only guidelines, but no laws, on how toxic substances should be shipped.

The only optimistic note on the regulation front is the federal Transportation of Dangerous Goods Act, a law that was proclaimed in 1980 but whose regulations are only coming into effect on staggered dates throughout this year. That act governs air, marine, rail and interprovincial highway shipments. Each province has agreed to adopt similar laws for highway shipments limited to its territory. When the final group of regulations takes effect on July they will cover the classification, documentation and safety markings of those shipments. But there will still be no binding regulations to govern how a shipment of toxic substance

Testing for PCBs: unease



Road-cleaning near Kenora: 'In there with the Guinness Book of Records'

should be contained—and, until the dramatic Kenora spill, none were scheduled.

The confusion over those rules plagued the politicians. Federal Environment Minister Suzanne Blais-Grenier—already under opposition fire as a poorly briefed minister—insisted last week that the July regulations will control the type of containers. Still, Transport Minister Don Mazankowski tabled a protective direction issued under the Dangerous Goods Act late last week that insisted that PCBs must be enclosed in a "rigid, leak-proof container." A grim Solicitor General Elmer MacKay added that the RCMP may soon investigate allegations of negligence in the Kenora spill. "The people of northern Ontario are frightened," thundered Liberal Keith Penner, MP for the riding of Cochrane-Superior. "We have had mercury in the water, we have acid rain and now we have a PCB spillage on the Trans-Canada Highway."

Mushrooming: Penner's rage came as legislators belatedly came to grips with the broader problem that embraces the estimated three million annual tons of hazardous waste—including dioxins, pesticides and mercury—generated by major industries which operate with few controls and fewer disposal facilities. Each waste requires a different method of disposal—and each province has its own requirements. Meanwhile, the federal government has a list of 150 chemicals that have "a significant spill potential" in Canada, and it has prepared manuals for each of the most hazardous 50 chemicals in case of an accident. "It is commonly accepted that we are not managing hazardous wastes properly in Canada," admits Thomas Foote, a senior project engineer with the federal environment department.

The provinces are not well prepared for their role as industrial waste policemen. Only Ontario and Alberta have set up provincial disposal corporations in an effort to control the mushrooming stockpile of chemicals. But although Ontario pumps out 1.5 million tons of hazardous waste each year, the government does not even have an accurate inventory to show which industries pump out wastes, or the volumes involved. Alberta now disposes of half its hazardous wastes on the factory site. In 1987 a $30-million plant will open at Swan Hills, 160 km northwest of Edmonton, to destroy the remaining 20,000 to 40,000 tons each year, including PCBs. John Elson, chairman of the Alberta Special Waste Management Corp., points out that his province is the only one to establish a hazardous waste disposal plant. In most cases, other provinces cannot even win agreement on sites for proposed disposal facilities.

Advances: Other provinces are making slow advances in handling toxic wastes. Under a 1984 act Saskatchewan has established a spill response unit and a 24-hour hotline for spill reports. After four years of study the Quebec government is finally rushing through cabinet the final version of regulations to govern the storage and disposal of wastes. British Columbia will soon introduce a system of storage permits for chemical wastes, including PCBs, although both bureaucrats and environmentalists insist that hazardous wastes are handled and stored safely.

That confidence seems misplaced, given the federal government's chronicle of 20,000 industrial spills across Canada between 1972 and 1980. In that period there were 44 spills involving 4,300 tons of sulfuric acid. More than two tons of mercury spilled in seven incidents. And there were a staggering 102 spills totalling 10.2 tons of PCBs.

The PCB spills included several major incidents, although the three largest did not immediately threaten local communities, and there were no reports of injuries. In 1973 a CP Rail derailment cracked open two electrical transformers that leaked 968 gallons litres of PCB fluid and required a $900,000 cleanup. In 1976 an underground pipe burst at Fed-

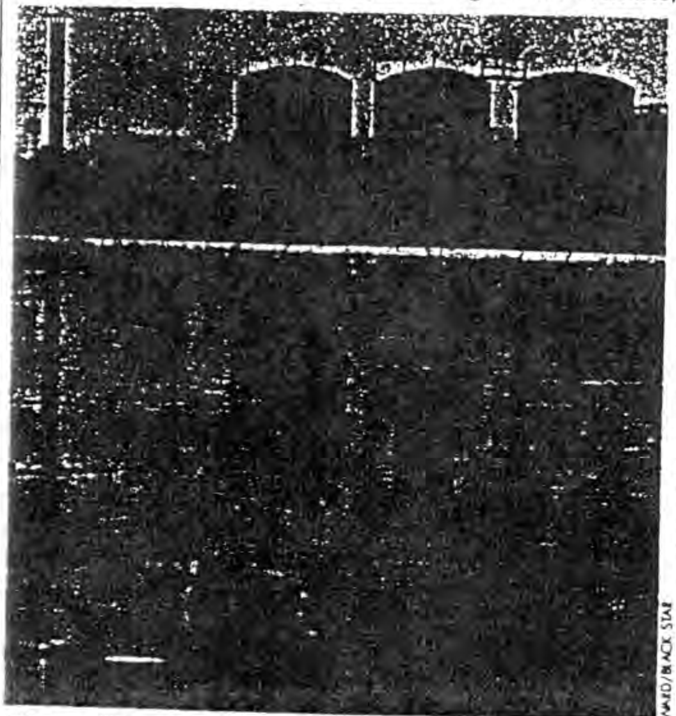
Van Fleet (left) with federal and local officials in Kenora: chilling lesson

eral Pioneer Ltd., an electrical company in Regina that produces transformers. An estimated 1,450 to 2,900 gallons of PCB-laden coolant seeped into the surrounding ground. And in 1977 a total 3,870 gallons of transformer oil containing PCBs spilled from transformers cracked in an explosion at the Inco Ltd. plant in Sudbury.

Bizarre: In addition to plans for high-powered incinerators in three provinces, the Ontario government is studying a proposal from a London, Ont., firm called Microbe Inc. to demonstrate the use of a special enzyme that neutralizes PCBs by removing the chlorine atom from the PCB molecule. In the meantime, Canadian authorities can no longer use operating transformers. All unused PCBs on Prince Edward Island are stored in a Charlottetown electrical building, and last week provincial Environment Minister George McMahon ordered an investigation into PCB transport and storage. Nova Scotia has almost 64,000 gallons of PCBs, including 4,400 gallons in storage, scattered at 90 sites.

In Central Canada the PCB problem is even more serious. The provincially owned power utility, Hydro-Québec, has almost 139,000 gallons of PCBs in use, and storage facilities in the province are full. Last week, in the wake of the Kenora tragedy, the province authorized the commercial storage of a further 49,494 gallons. In Ontario, there are 1.3 million tissues where chemicals congregate. In the Yukon, there are only 440 gallons of PCBs, but large amounts of the chemical move along the Alaska Highway from Alaska to the southern United States each year.

In London, Ont., residents of an area of the city beside Pottersburg Creek have experienced directly the hazards of PCB pollution. The creek carries effluents from factories to the Thames River. Gifford Burgess, 33, and William Woods, 31, frolicked in Pottersburg Creek when they were growing up. Within the past three years both men have developed rare skin cancers. Burgess has had malignant growths removed from his spleen and his lungs. "I



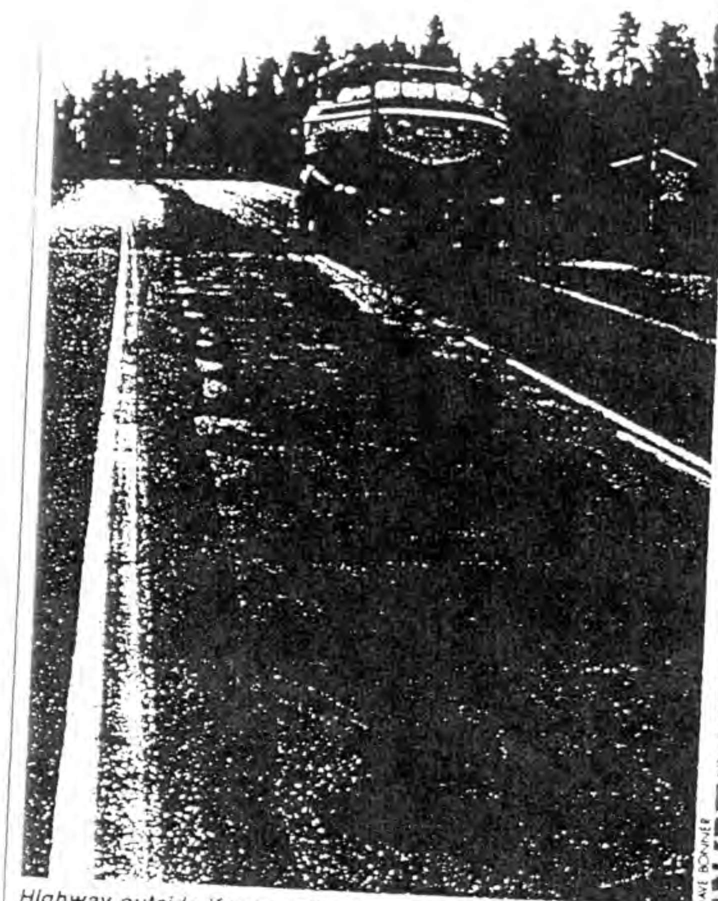
Three million gallons of PCB-contaminated oil in New Jersey; geneticist Cummins: 'the dumbest thing I have ever heard'

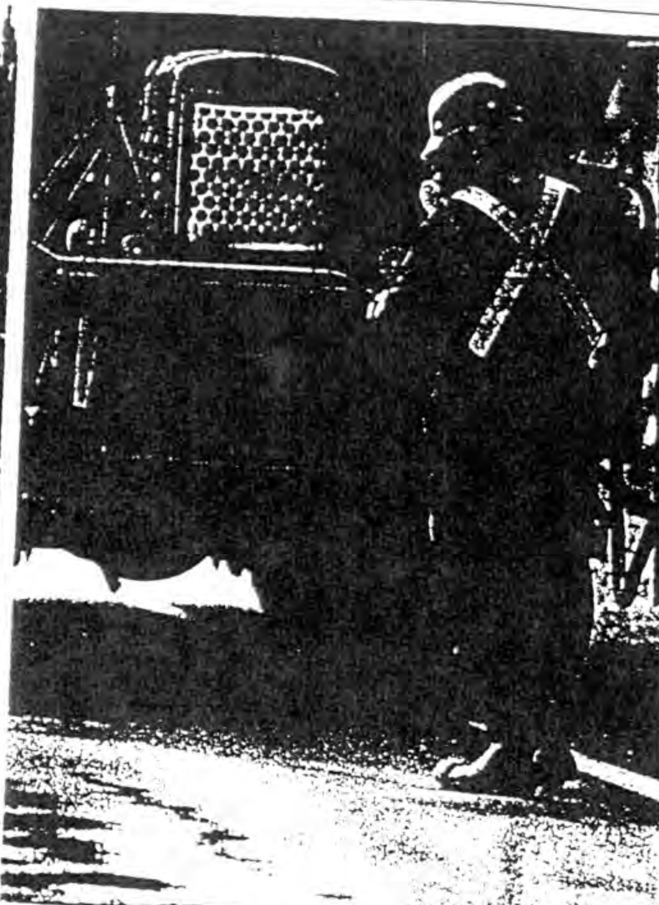
incinerators in the United States and Europe, since the United States banned PCB imports in 1980 and most European sites will no longer accept them. That means that until the provinces begin building disposal plants or approve mobile incineration units, the PCBs must be stored. And the five major commercial storage sites for PCBs are either full or are not permitted to accept waste from other provinces. After May 15 Kinetic can no longer transport PCBs into Alberta. "We tell firms that if a transformer is functioning well, leave it—because there is no place to take it," says David Edwards, a project manager with the Ontario environment ministry. "

That bizarre situation means that PCBs are stored in every province and in the two northern territories, usually on the site where they were used and often in poorly monitored conditions. Newfoundland has 2,860 gallons of PCB fluid in storage and almost 13,200 gallons in gallons of PCBs in use and another almost 330,000 gallons in storage at 148 locations in Metro Toronto—including abandoned transformers stored in Toronto's downtown Toronto Dominion Centre—and at sites in another 180 Ontario communities.

Staggering: The problem persists across the West. Manitoba has 450 tons of PCBs in use and another 17 tons in storage. Alberta has a staggering 5,500 tons of PCBs in storage, largely because of the Kinetic operation at Nisku. BC Hydro has two main storage sites for PCBs: in suburban Surrey, 30 km east of Vancouver and in McKenzie, about 100 km from Prince George. Most of the Northwest Territories' PCBs are scattered across the land at 21 abandoned Distant Early Warning (DEW Line) sites. Although PCB levels in local fish do not constitute a health hazard, native leaders are worried because their people prefer the head and liver—the fattier have no bad habits. I am not a smoker and I have been a vegetarian for eight years," maintains Gifford, a postal worker. Charles Heath, 55, a London resident who has lived on a tributary of the creek for 12 years, blames PCBs for the cancer that has afflicted him and his two beagles. Now he worries that his two children played in the creek when they were young. "How will it affect them 10 or 20 years down the road?" he asks in anguish. That question hangs over all Canadians today as they face the consequences of society's casual and profligate use in the past of chemicals that offered immediate miracles while storing up future nightmares.

With Bruce Wallace in Montreal, Hilary Mackenzie in Ottawa, Ann Walmsley, Ann Finlayson and Sherri Aikenhead in Toronto, Andrew Nikiforuk in Kenora, Suzanne Zwarun in Calgary and Ian Austen in Washington.





Highway outside Kenora after temporary repairs from PCB spill: a response that was uncertain and disturbingly offhand

COVER

The anatomy of Kenora's PCB spill

By Andrew Nikiforuk

Patrick Winter, a 33-year-old Kenora building contractor, became alarmed the moment that he saw a white flatbed truck spilling fluid when it turned off the Trans-Canada Highway, outside of Kenora, Ont. Recognizing the cargo as electrical transformers, Winter said that he immediately thought the substance splashing from the vehicle might be toxic polychlorinated biphenyls (PCBs), often used to insulate transformers, like those the truck was carrying. Three hours later, as he drove past the service station again on his way to a party, his suspicions were confirmed when he found the area cordoned off and ablaze with flashing lights. Declared Winter: "As soon as I saw that, I knew there was something serious about that stuff."

Winter and most of the 9,600 other residents of the northwestern Ontario community 55 km east of the Manitoba border swiftly learned that the liquid was indeed a highly concentrated form of potentially deadly PCBs. At least six people, including a pregnant woman, were directly exposed to the substance, which can cause skin and kidney disorders, birth defects and possibly cancer. In the days that followed, people in Kenora reacted with shock, alarm, confusion and—finally—anger as they witnessed an official response that was at best uncertain.

A day-by-day chronology of the disturbing events:

Saturday, April 13. Two drivers of a truck operated by the Alberta-based Kinetic Ecological Resource Group pull into the Husky station at 4:30 p.m. for coffee. Motorist Lloyd Eyjolfson, travelling from Red Lake, Ont., to Winnipeg, stops to tell the two drivers that part of their cargo of four aging electrical transformers is leaking. After a quick inspection, the truckers discover that one of the transformers is spilling a stream of PCBs. One of the drivers immediately telephones Kinetic's head office in Nisku, Alta., which in turn alerts the Thunder Bay office of Ontario's environment ministry that a major toxic spill has occurred. Within 30 minutes, Kenora and Ontario Provincial Police officers, firemen and municipal officals arrive at the station and seal off the immediate area. Municipal workers—who are told that the substance is oil—spread sawdust and sand on pools of PCBs while police officers search the Trans-Canada Highway for other spills. Provincial police report areas of discoloration on the Trans-Canada as far west as Vermilion Bay, 70 km east of Kenora.

Sunday, April 14. An officer of Ontario's environment ministry surveying the highway between Vermilion Bay and Kenora discovers three major spill areas—the largest a 1,000-metre-long trail of PCBs varying from one to three metres in width near Dogtooth Lake, about 20 km east of Kenora. Local and provincal officials now realize that the leaking transformer has dumped a significant volume of PCBs onto the road, and they decide to involve a higher level of authority by notifying senior Ontario government officials. As Rick Belair, coordinator for the Kenora District Emergency Measures Organization, explained later: "We looked after things until it got bigger than we could handle."

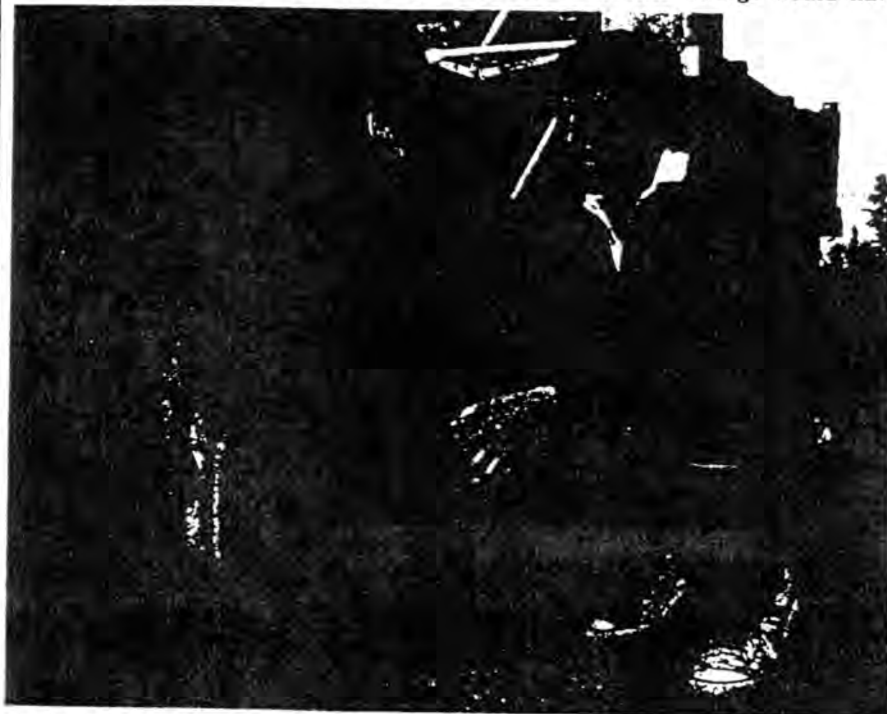
Meanwhile, a sample of the spilled substance has arrived at a Manitoba government laboratory for tests. Those confirm that the spilled liquid contains a solvent and 42-per-cent pure PCBs. During an afternoon conference telephone call, provincial representatives of three different ministries decide to close the highway between Kenora and Vermilion Bay. By now, 22 hours have passed since the spill's discovery and nearly 4,000 motorists have driven on or past stretches of PCB-splashed highway.

Later in the afternoon William Lees, deputy minister of the federal department of northern affairs, and Gordon Van Fleet, deputy regional director of the Ontario environment ministry, arrive in Kenora from Thunder Bay to co-ordinate the cleanup. They have never handled a PCB spill larger than a small discharge in a parking lot.

In Kenora an emergency hotline is established at the town hall, and a press release informs Kenorans that a "brief single exposure to PCBs produces no harmful effects" but that the spill threatens the environment.

Monday, April 15. Environment officals cannot yet accurately estimate the volume of PCBs spilled on the highway. Later in the day officials learn that the spill is at least 150 km longer than they had originally believed. More PCB spills are located in Dryden and Ignace.

When Patrick Winter asks what do about the splotches of PCBs around his truck's wheels, a government official tells him to put on rubber gloves and wipe off the contaminant with Varsol and a dry rag. "I can't believe you are saying that," Winter replies. "There is no bloody way I'm touching it."



Winter: 'I knew there was something serious about that stuff'

At an afternoon press conference, Mervin Nobel, the national sales manager for the Kinetic Ecological Resource Group, says that he thought of killing himself when he first heard about the spill. He adds that the decision to ship a transformer containing PCBs was a "judgment call. It turned out to be a bad call, I guess."

Tuesday, April 16. Kenora Mayor Kalvin Winkler denies that the people of Kenora are "seriously concerned" about the spill, accusing the media of exaggeration. But Charlene Schabler, a clerk at a local pharmacy, says, "If this were downtown Toronto things would have been acted on a lot quicker."

Dr. Peter Friesen, regional medical health officer, tries to dispel fears that PCBs pose an immediate health hazard. Declares Friesen: "It would be safer to walk along a highway with PCBs than sitting in a room with a smoker."

Wednesday, April 17. Health officials announce that a "handful" of people have suffered acute exposure to PCBs. They include Eyjolfson, his pregnant wife and two young children, who drove behind the leaky transformer for 25 km, and an unidentified man who got PCBs on his arms and hands while cleaning off his windshield. Says Pamela Kellaway, a child care worker who is worried about the long-term effects of the spills on local drinking water supplies: "We don't have the experts or the outcry you would have in an urban centre. But that doesn't change the effects. We have a disaster on our hands."

Without explanation, Winnipeg RCMP agents prevent samples of PCBs from being loaded on commercial airlines for testing at a Toronto lab. Federal transport officials say that the samples are not labelled and packaged according to regulations governing the transport of hazardous wastes. In response, the co-ordinating team hires a private carrier and eventually receives a waiver from Transport Canada to ship the testing samples to Toronto. Federal transport officials order five commercial airlines that carried the samples earlier in the week to be decontaminated.

Thursday, April 18. At 10 a.m. the Trans-Canada Highway reopens. In Kenora a half inch of pavement has been ground off all of the PCB spill sites including patches outside a nursing home and on Main Street. Lees, the deputy northern affairs minister, concludes that the PCBs have been satisfactorily contained in the short term.

In the afternoon Randy Perchuk rushes into the Town Hall angry and upset. "What the hell is going on here?" he wants to know. He and his wife had been trapped in the Husky gas station last Saturday for an hour while police decided what to do about the spill. They had both become dizzy and nauseated from the PCB fumes and the scare, but had been later reassured by Friesen that they had nothing to worry about. Now the local health unit wants all individuals who believe they have been directly exposed to the spills to come forward. Kinetic employees finally set up a compound to decontaminate vehicles, including Winter's.

Friday, April 19. A field epidemiologist arrives in Kenora to interview 50 residents who may have been exposed to the PCBs. For the first time, health officials distribute 2,000 leaflets on the spill. The co-ordinating committee effectively disbands but the hotlines remain open for the weekend. Negotiations begin between Ontario and Alberta on where 130 45-gallon drums of PCB-contaminated gravel and asphalt will eventually be stored. Transport department officials discover that the truck carrying the generator is still leaking and cannot be moved.

Saturday, April 20. A new flatbed truck is ordered from Edmonton. It is to be equipped with a drip pan beneath the transformer and covered with a rubberized tarpaulin. Meanwhile, the notorious transformer remained immovable and its journey to Alberta was not exto begin until midweek.

Although provincial authorities now pronounce Kenora clean, questions about the spill's aftereffects promise to haunt the community almost as detminedly as the enduring PCBs now bound to 220 km of pavement along the Trans-Canada Highway.

An enduring menace

By Ann Finlayson

Until researchers began to express alarm in the mid-1960s, polychlorinated biphenyls, or PCBs, appeared to be a safe and simple solution to a wide variety of industrial problems. Because the opaque PCB liquids—molasses-like compounds of chlorine, hydrogen and carbon—are chemically inert, they are not affected by acids or corrosive chemicals, they will not conduct direct electric currents and they burn only at extremely high temperatures. Those properties made PCBs one of the wonder chemicals of the 1930s and 1940s. As well, they appeared to be an ideal material to be used in cooling electrical transformers. But the same properties of durability that made PCBs useful to industry make it virtually certain that the lethal toxin will continue to threaten the environment—and human lives—for decades.

Kinetic Ecological Resource Group plant in Nisku, Alta.: a political dilemma

RAY GIGUERE

Until the 1970s PCB fluid was used freely and without restriction around the world. Indeed, some industrializing countries continue to sanction its use, primarily as an insulator and coolant in closed-system electrical transformers and capacitors. At the same time, industrialized nations like Canada—which banned the use of PCBs in 1979—continue to use old equipment containing the chemical. PCBs had other uses as well. The oil traditionally sprayed on country gravel roads as a dust suppressant often contained PCBs, and the chemical was extensively used as a plasticizer in paints, rubbers, waxes and asphalts. So versatile are PCBs that millions of North Americans lived with the substance for years in their television screens and wallcoverings, in the colored comics in their newspapers and even in some brands of cosmetics and gum.

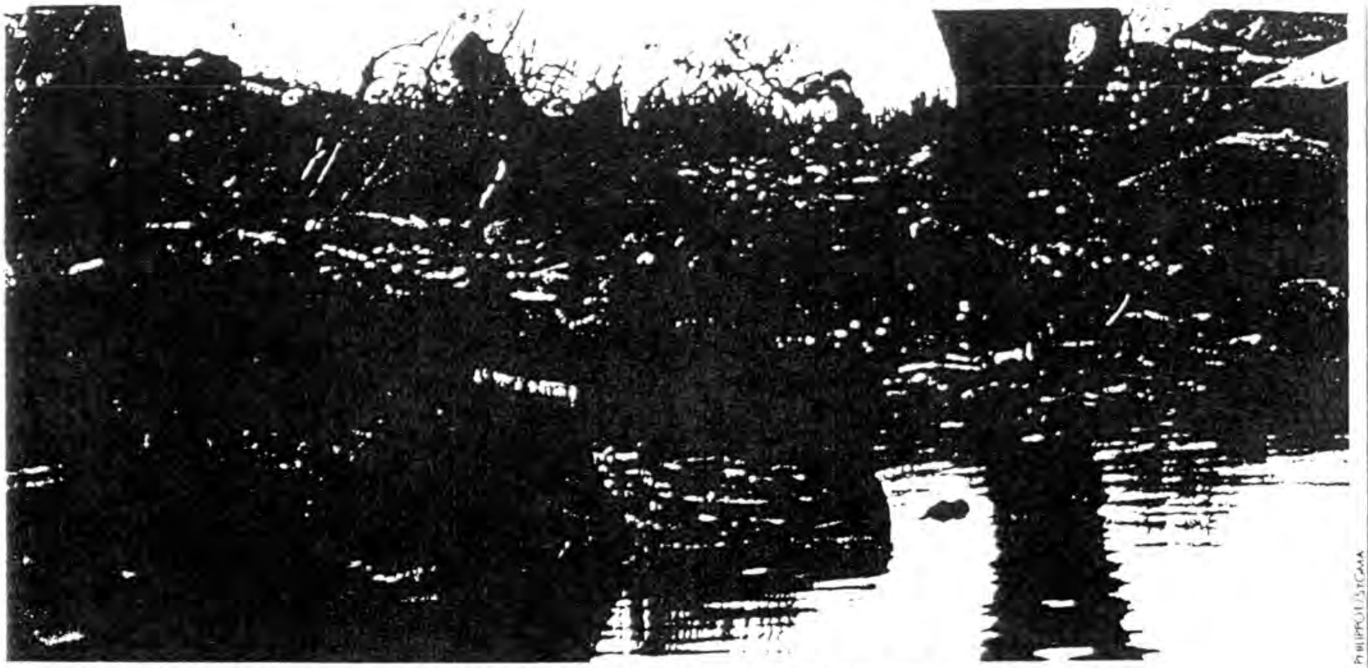
Threat: Although PCBs were first identified more than 100 years ago and used industrially from the 1920s, the threat they pose to the environment and to life was not recognized until 1966. At that time, Swedish researchers found PCBs in the embryos and feathers of diseased sea eagles. Then, in 1968 a human disaster focused international attention on the chemical when the use of PCB-contaminated cooking oil in Japan resulted in skin cysts, nausea, numbness and an above-average incidence of malignant tumors, stillbirths and birth defects among 1,300 victims.

Since then, studies have linked PCBs to cancers of the liver in rats, skin disorders, hair loss and abnormal pigmentation in human beings and infertility and birth abnormalities in monkeys and birds. Researchers have also found PCBs in varying amounts in 90 per cent of all North Americans.

Unpredictable: Still, short-term human exposure to PCBs can result in nothing more serious than a temporary rash or eye irritation. Said Peter Mazerolle, an environmental emergencies chemist with Environment Canada: "Short-term exposure is generally not much of a problem if people wash immediately afterward."

Indeed, most experts in the field now agree that the long-term risks are much greater, but the exact nature of the threat posed by PCBs to human life continues to generate controversy. Said Dr. Roger Cortesi, director of the U.S. Environmental Protection Agency's office of exploratory research: "These things are largely unpredictable in human populations. Prediction demands proof of cause and effect that scientists cannot now provide."

Dilemma: But U.S. authorities considered PCBs dangerous enough to ban their use in all new industrial equipment in the United States in 1972. Canada instituted the same policy seven years later. Now Environment Canada estimates that at the time of the ban 16,130 tons of PCBs were in use throughout Canada. A large part of that is probably still being stored around the country because no Canadian province possesses the highly specialized treatment facility needed to burn PCBs at sufficiently high temperatures—more than 1,600°C—to destroy them. In the meantime, PCBs can enter the environment through spills like that in Kenora, Ont., and in less dramatic ways. They can leak slowly from hydraulic and heating systems or leak into the surrounding countryside from municipal dump sites or sewage facilities. They can remain in the soil for decades as a residue of the runoff from treated roads. Even when they are safely contained in steel drums, PCB wastes pose a major practical and political dilemma for provincial authorities, who find that most Canadians are opposed to having storage and disposal sites near their communities. But, said Mazerolle, with every year of delay "we lose more to the environment"—and in so doing build the potential for an environmental and human tragedy.



Dump site on the Love Canal: a flurry of interest followed by political strife within the Reagan administration

The United States' toxic deadlock

By Ian Austen

The cleanup campaign clearly bore the marks of the Love Canal aftershock. Coining the catchy name Superfund, the United States government set out five years ago on a $1.6-billion program to clean up the poisonous chemical graveyards that dot the country's landscape from Maine to California. Now, with a September expiry date for the program rapidly approaching, it is clear that Superfund has fallen far short of its grand title. The plan created bureaucratic and political strife within the Reagan administration and opposition from the states. And so far Superfund has accomplished the cleanup of only six to 12 dump sites. Said Kenneth Kamlet, director of the Washington-based National Wildlife Foundation's pollution and toxic substances division: "It's pretty clear that we've just scratched the surface."

Flurry: In spite of the flurry of interest in toxic wastes sparked by the 1978 discovery of the deadly Love Canal chemical dump beneath a residential neighborhood of suburban Niagara Falls, N.Y., the extent of the U.S. problem remains unclear. Estimates of the number of sites in the United States where PCBs, dioxins, acids, industrial poisons and other toxic chemicals have been dumped range as high as 15,000. The Superfund program itself has a "worst case" target list of just under 1,000. Of those, the Environmental Protection Agency under administrator Lee Thomas now claims that a mere 12 have been cleaned up.

Passion: The idea of the fund was simple. All but about 12 per cent of the funding was to come from a special tax on feedstocks such as oil, natural gas and coal purchased for conversion into chemicals. In addition to the money the EPA was granted broad powers to persuade polluters to clean up the messes they had made. But the program was introduced just as President Ronald Reagan, who has evinced little passion for environmental concerns, took office. As a result, the launch of the Superfund program was flawed. Then, in 1983, felony charges were laid against Rita Lavelle, the first head of the toxic waste Superfund program. A jury found Lavelle guilty on four counts of perjury and impeding congressional investigations into a toxic waste enforcement case against her former employer, the California-based Aerojet-General Corp.

Thomas: 'worst case'

In the meantime, the Superfund program found itself facing other financial and political problems that, to a large extent, persist to this day. Many states are financially unable to meet the cost-sharing burden imposed on them by the Superfund program. For their part, environmental groups charge that the EPA has yet to develop a standard of cleanliness for detoxified sites.

While few observers doubt that Congress will renew the Superfund before it expires in the fall, concerns are growing over the country's shrinking capacity for handling toxic wastes. Tougher dumping rules have improved disposal methods. But the stricter standards have also reduced the number of firms willing to, or capable of, handling the deadly waste. The United States still has only six licensed incinerators capable of meeting the EPA requirement of 99.99-per-cent destruction of PCBs.

Scrapped: That stockpile of unwanted substances is likely to grow in the future. According to EPA regulations, all electrical equipment containing PCBs located near animal feed or human food must be disposed of by October. Then, in 1988, any electrical device with more than three pounds of the toxic fluid must be scrapped. As a result, as many as 750 million pounds of PCBs may have to be destroyed. While laws against poisoning the environment are on the books and the Superfund will have a new lease on life, the ultimate solution to the festering problem of toxic wastes remains elusive.

FOR MORE THAN 50 YEARS, THREE OF AMERICA'S LARGEST CORPORATIONS HAVE KNOWN THAT PCBS ARE DEADLY. BUT THEY WERE TOO BUSY MAKING MONEY TO TELL YOU.

pandora's poison

In the blackness of a freezing morning in December 1991, a driver lost control of her car on an isolated road in upstate New York and slammed into an electric-utility pole. Two miles away, the electrical system at the state-university campus at New Paltz went haywire. Minutes later, a Westinghouse electrical transformer cooled with supposedly nonflammable polychlorinated biphenyls (PCBs) exploded and burned, pouring deadly white smoke through Gage Residence Hall. Volunteer firefighters, thinking they were handling a routine electrical fire, searched the dorm for students—all of whom, fortunately, were away on winter break.

The chain reaction continued. Within minutes, PCB transformer explosions, ruptures, and fires rocked six campus buildings, including four residence halls that normally house 1,000 students. Polychlorinated biphenyls and their even-more-toxic by-products, dioxins and dibenzofurans, poured through the buildings and spilled outside, contaminating groundwater, storm sewers, utility manholes, lawns, and roads at levels up to a million times the state's legal limit.

Decontamination crews wearing respirators and moonsuits soon swarmed over the campus, filling thousands of 55-gallon drums with toxic waste. Within weeks, 560 students were returned to two of the dormitories. Now, nearly three years and $35 million later, decontamination work is still not complete, underground toxic plumes continue to spread, and thousands of students living and studying in contaminated buildings continue to be exposed to dangerous chemicals. Some have filed class-action lawsuits against the state, alleging that the campus was reopened prematurely.

The New Paltz disaster is often referred to as an "accident," as are similar fires and explosions in San Francisco, Santa Fe, Chicago, Shreveport, and many other cities. It was not, however, a surprise to the country's largest manufacturers of products that use PCBs. A 1974 General Electric in-house memo reveals that both GE and Westinghouse were secretly aware of the possibility of transformer explosions ten years before the EPA issued warnings about it.

"As you know," GE engineer T. L. Mayes cautioned his colleagues, "Westinghouse had a network transformer explosion recently, resulting in two fatalities." Mayes also mentioned that some grades of PCBs apparently create an explosive gas when transformers malfunction—a danger the company concealed from its customers. Neither were customers informed that when burned (as in an explosion), PCBs create dioxins and dibenzofurans—although the manufacturers knew this by 1970 at the latest. In fact, PCBs were aggressively marketed as safety products; the manufacturers even convinced insurance companies to require their customers to use PCB transformers.

Across the country, utilities, workers, and consumers are

BY ERIC F. COPPOLINO ■ ILLUSTRATION BY RICHARD DOWNS suing those who profited from PCBs for their failure to warn them of the chemical's fatal hazards. The million pages of internal memos, correspondence, lab reports, and private studies made public through these lawsuits show that three of the largest corporations in the United States have known since the 1930s about many of the horrible health effects associated with PCBs—and yet concealed this information from the government, the media, the public, and their own customers.

Moreover, Monsanto (the source of all PCBs in the United States), Westinghouse, and GE publicly denied those problems. Monsanto even went so far as to falsify cancer research and use the fudged results to delay the federal regulation of PCBs, which did not occur until 1976. While the companies stonewalled, thousands of workers were exposed to high levels of PCB contamination, and are now dying of cancer at a higher-than-average rate. Millions of pounds of PCBs were used around the country in everything from electrical transformers to french-fry cookers, yet for decades the companies did little or nothing to warn the public of the danger.

On the contrary, great effort was spent covering it up. While an internal Monsanto "Pollution Abatement Plan" in 1969 admitted that "the evidence proving the persistence of these compounds and their universal presence as residues in the environment is beyond questioning," it warned that "the corporate image of Monsanto as a responsible member of the business world genuinely concerned with the welfare of our environment will be adversely affected with increased publicity." More to the point, "direct lawsuits are possible" because "all customers using these products have not been officially notified about known effects nor [do] our labels carry this information." Now that such lawsuits are being filed across the country, we are getting our first glimpse of what happens behind the scenes when a poison is too profitable to give up.

"THE MONSANTO PLEDGE"

"It is our pledge to ensure no Monsanto operation poses any undue risk to our employees and our communities."

Peter Montague of the Environmental Research Foundation describes the invention of PCBs as an outgrowth of this century's infatuation with the automobile. "As gasoline was extracted from crude oil," he writes in *Hazardous Waste News,* "great quantities of other chemicals, like benzene, were left over. Chemists started playing around with these chemicals, to see if something useful could be made." Heating and pressurizing chlorine and benzene under the right conditions, they found, yielded PCBs, a range of compounds (209 in all) that generally take the form of a heavy, syrupy liquid. Because PCBs are stable, conduct heat but not electricity, and are not water-soluble, they proved extremely useful, most prominently as insulation fluid in electrical transformers and capacitors. They have also been made into plastics and mixed with adhesives, inks, paper, paints, and fabric dyes, with many more tons employed as hydraulic liquids, heat-transfer fluids, and lubricating oil in everything from natural-gas pipelines to food-packing plants. They were once the heating medium of choice in the coils of industrial deep fryers for fish and potato chips, and were even mixed with pesticides and sprayed directly onto crops.

When Congress regulated the manufacture of PCBs in 1976, it merely closed the lid on Pandora's box. The evil is still loose in the world: up to two-thirds of all PCBs ever manufactured remain in use, and much of the rest has escaped into the environment. Since PCBs are fat-soluble, they bio-accumulate as one species eats another, passing up the food chain in magnified form. These poisons are now ubiquitous, and are especially concentrated in the flesh of predators. Potentially dangerous levels of PCBs can be found in the fatty tissues of seals, whales, eagles, many fish, and virtually every human on earth.

This summer, crucial sections of the EPA's fundamental reassessment of PCBs and their chlorinated-chemical cousins, dioxins, were leaked. The judgment is dire. Once lodged in the human body, PCBs are implicated in breast cancer, brain cancer, malignant melanoma, non-Hodgkin's lymphoma, and soft-tissue sarcomas. Even at current background levels, the EPA found, PCBs can damage the body's immune and reproductive systems. The average amount of dioxin-like substances in the body is 9 nanograms (a nanogram is a billionth of a gram) per kilogram (ng/kg), although burdens vary widely due to diet, workplace exposure, proximity to toxic-waste dumps, and so on. At 13 ng/kg, sex hormones are diminished in men; at 47 ng/kg, decreased growth is observed in children.

The latter effect is now held to be the chemical's most serious danger, because PCBs mimic natural hormones such as estrogen and can severely disrupt the body's endocrine system, resulting in birth defects and sterility. (Among other species, raptors and large marine mammals are particularly vulnerable to the hormonal effects of PCBs, which have been linked to catastrophic crashes in their populations.) Some 42 varieties have been identified in human fat, and the 65 varieties polluting breast milk are passed on to nursing infants at crucial stages of their development, causing learning disorders and disrupting the child's developing immune system.

Scientific knowledge about the dangers of PCBs has advanced along two tracks, one private and one public. The secret studies began in 1936 when many workers at the Halowax Corporation in New York City exposed to PCBs (then called chlorinated diphenyls) and related chemicals

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called chlorinated napthalenes started coming down with chloracne, a painful, disfiguring skin disease. Three workers died. Autopsies of two revealed severe liver damage. Halowax asked Harvard University researcher Cecil K. Drinker to investigate.

Drinker presented his results at a 1937 meeting at Harvard attended by Monsanto, GE, Halowax, the U.S. Public Health Service, and state health officials from Massachusetts and Connecticut. Like the Halowax workers, Drinker's test rats had suffered severe liver damage. "These experiments leave no doubt as to the possibility of systemic effects from the chlorinated napthalenes and chlorinated diphenyls," he concluded.

Minutes of a discussion held later that day include a telling remark by GE official F. R. Kaimer: "We had 50 other men in very bad condition as far as the acne was concerned," he told the group. "The first reaction that several of our executives had was to throw [the PCB] out—get it out of our plant. But that was easily said but not so easily done. We might just as well have thrown our business to the four winds and said,

GE's "Warm, Caring Impression"

In 1989, when Steve Sandberg went to work for General Electric's processing plant in Anaheim, California, he had never heard of PCBs or the Toxic Substances Control Act, the federal law that banned their manufacture 13 years earlier. He had never heard of dioxins or dibenzofurans, super-toxins created when PCB oil burns or ages. Put to work in highly toxic areas without protective clothing or a respirator, Sandberg says he was given no warnings about the chemicals.

Instead, GE told him—and maintains to this day—that PCBs are essentially harmless. At GE's PCB training school in Cincinnati, Sandberg says, he and other new workers were given an article from the magazine *Hippocrates* suggesting that exposure to PCBs is less risky than exposure to the toxins naturally occurring in peanut butter, beer, or raw mushrooms. "They showed us a video with Walter Cronkite saying PCBs were as toxic as table salt," Sandberg said.


PCB victim Steve Sandberg

Sandberg's job was to clean out hundreds of exploded, burned-up PCB transformers in preparation for shipment to incinerators or landfills. He was sent to the scenes of PCB transformer explosions, operated waste-drum crushing machines, and pumped black, burned PCB oil and other chemicals out of the destroyed transformers. His work put him in direct contact with dioxins and dibenzofurans, chemicals so toxic they are measured in parts per trillion and parts per quadrillion.

Yet at the GE Anaheim plant, barrels and burned transformers were left out in the rain; the drum-storage room contained a couch, desks, and an eating area; and everything was covered by a film of PCB oil and soot. Sandberg says that Mike Nagle, who was in charge of PCB operations at the plant, wouldn't let him move his desk out of the PCB drum-storage room: "He laughed at us and said, 'Oh, this stuff don't hurt ya.'"

Eighteen months into his career at GE, Sandberg started to show signs of systemic poisoning, beginning with severe chloracne. A quarter-inch-thick coating of dead skin covered the bottoms of his feet. One day, Sandberg found a fat folder on his boss's desk containing numerous documents on the dangers and health impacts of PCBs. He confronted his boss, who assured him that PCBs were essentially harmless to humans. It wasn't until several months later, when he read in *Business Week* about the lawsuits containing allegations of badly exposed PCB workers at a Westinghouse capacitor-manufacturing plant in Bloomington, Indiana, that he finally began to warn his co-workers of the danger.

General Electric was also spurred to action. An October 28, 1991, memo from GE attorney Bill Thornton outlines a plan for dealing with Sandberg, who, he wrote, "seems to be escalating the situation day by day." General Electric established a public-relations team and called an all-employee meeting at which medical experts flown in from around the country presented GE's side of the story. One such expert was Marie Johnson, an industrial-hygiene nurse from GE's plant at Hudson Falls, New York—best known for its massive PCB discharges into the Hudson River. Johnson is described in the memo as someone who "is very knowledgeable and gives a warm, caring impression."

"It is not expected that we could win the heart and mind of Sandberg," Thornton wrote. "Rather, the meeting is intended to prevent him from infecting the others. Depending on how he reacts, Sandberg could be seen by his fellow employees as someone who is off the wall." Ironically, on the day of the all-employee meeting, Sandberg was moved out of the PCB area of the operation on orders from a GE physician, who concluded that he could not tolerate any further exposure to PCBs.

Yet his managers stuck by their story that PCBs were harmless. Mel Dinkel, a GE manager who insisted that the plant was in full compliance with all PCB regulations, dared Sandberg to go to the state and federal authorities. "He gave me the phone numbers, addresses, everything," Sandberg says. "He said, 'If you feel this company is not in compliance with all the laws and regulations, feel free to call these numbers.' And I did. Boy, did all the shit hit the fan."

Two days later, EPA officials showed up at the door, flipped out their badges, and walked through in yellow moonsuits with sampling kits. Sandberg describes the reactions of the other employees: "They were just in shock. They just stood still. Everything just stopped. All work, all noise, it was silent. All you could hear was the hum of the lights."

In February 1992, the plant's PCB-handling license was suspended by the EPA because further acceptance of waste into the plant posed "an unreasonable risk to human health and the environment." In November the plant was shut down by state and federal authorities, and in March 1993 the EPA fined General Electric $353,000, one of the highest PCB fines ever levied by the agency.

"They lied to us, that's the bottom line," says Sandberg. His civil suits against GE, Monsanto, and other chemical suppliers are still pending. *—E.C.*

'We'll close up,' because there was no substitute and there is none today in spite of all the efforts we have made through our own research laboratories to find one."

Sanford Brown, the president of Halowax, concluded the meeting with another thought that would echo through the next five decades. Brown stressed the "necessity of not creating mob hysteria on the part of workmen in the plants" where chemical-safety inspections were being made. Problems with PCBs and napthalenes, he predicted, "may continue, probably will continue for years." The silence of those at the meeting ensured that effect.

Meanwhile, the damning evidence continued to spill out of corporate laboratories. A 1938 study of PCB-oil mixtures manufactured by Westinghouse and GE demonstrated that liver damage could be caused by skin contact alone, and called for the "greatest personal hygiene" in minimizing exposure. In further research for Monsanto, Drinker warned that adequate ventilation was necessary when handling the chemicals. By 1951, Monsanto also had in its files a 1947 scientific finding that there was "need to give warning" about PCBs because "the toxicity of these compounds has been repeatedly demonstrated."

Yet this "need to give warning" was ignored. A 1950 GE instruction manual for PCB transformers assured utilities that "transformer Pyranol [GE's trade name for PCBs] may be handled in the same manner as mineral oil." Even though by 1956 GE's own files contained a bibliography of 43 references on the health dangers and possible lethality of PCBs and PCB component chemicals, the company seems never to have retracted this statement.

Monsanto also knew by 1956 that PCB products could be contaminated with dioxins and dibenzofurans from the time they were shipped from the factory—a piece of information it sat on until the late 1960s, when independent researchers discovered this hazard. According to the record of one lawsuit, new PCB oil can be contaminated with dibenzofurans at concentrations of up to 10 parts per million. As the oil ages, according to documents from Monsanto's files, the concentration becomes considerably higher. The company knew in 1965 that dioxin "can be a potent carcinogen."

It is curious, in this light, that Monsanto's R. E. Keller should have noted in an October 20, 1970, internal memo that specially prepared PCB samples sent to a lab for animal toxicity testing were free of troublesome dibenzofurans "which might bias the results." As an aside, he added that they were free from dioxin contamination as well. According to attorney Paul Merrell, "The implication is that the PCBs they tested did not contain the toxic material, but that it was common in their product. It's evidence of a cover-up."

Merrell is an attorney in a far-reaching lawsuit challenging the informed silence of the PCB manufacturers. His client, the Nevada Power Company, is charging GE, Westinghouse, and Monsanto in federal district court with fraud and deliberate failure to warn the utility and its customers about product defects and negative health effects associated with PCBs. The companies' initial defense was to argue that the utility was aware of the dangers long before it filed its suit in 1988 and should have suspected fraud earlier, but that the statute of limitations had now passed. "Nevada Power actually knew of the product defects and of facts contrary to those represented" by the PCB manufacturers at the time of sale, argued Monsanto attorney Bruce Featherstone in 1991.

Where There's Smoke . . .

Perhaps it was a mistake, or maybe it was leaked—but somehow a 22-page Westinghouse Electric evidence-destruction plan found its way into the hands of attorneys suing the company. Signed by Jeffrey Bair, an in-house Westinghouse lawyer, and Wayne Bickerstaff, an industrial-hygiene manager, the proposal boldly recommends the destruction of "smoking gun" evidence that might be used against the corporation in PCB and related litigation—litigation the writers say "shows no signs of abating in the near future."

"The majority of the documents in Industrial Hygiene's files are potential 'smoking gun' documents," they write. "The files are filled with technical information which critiques and criticizes, from an industrial-hygiene perspective, Westinghouse manufacturing and nonmanufacturing operations. This documentation oftentimes points out deficiencies in Westinghouse operations and suggests recommendations to correct these deficiencies. The files contain many years of employee test results, some of them unfavorable. . . . In our opinion, the risks of keeping these files substantially exceed the advantages of maintaining the records."

Westinghouse attorneys testifying in a Texas case, including Bair himself, said that the memo was only a draft. "The decision was made not to implement this at all," says Westinghouse spokesperson Jay McCaffrey.

Yet other evidence in the record contradicts this assertion. "Informed Wayne to begin discarding documents," says a March 2, 1988, note on Bair's letterhead. On March 8, Bair writes that "Wayne Bickerstaff and his staff are currently discarding documents as per our retention guidelines."

When the evidence-destruction proposal surfaced in asbestos-related litigation in Texas in November 1992, Westinghouse fought to keep it out of the record, claiming that because it was co-signed by a lawyer, it was an "attorney-client work product" and therefore privileged. But Judge Paul R. Davis ruled that the document "described a plan to commit fraud on the courts of this nation" and was thus admissible as evidence.

Asked under oath what the words "smoking gun" meant to him, Bair's boss, Ronald Lawrence, responded, "If you're asking me with regard to a television program, I assume that it means right after a probable murder was created, somebody found the gun still smoking. . . . I know that phrase is used in this memorandum, but it didn't have that kind of content or meaning from the television program. What I understood it to mean . . . was the kind of document from which an attorney such as yourself could try to draw some inference adverse to Westinghouse." —E.C.

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"They had actual knowledge of the facts constituting a fraud."

In more-recent pleadings, the manufacturers have taken an alternative tack, denying that they committed fraud or failed to warn their customers, and maintaining—numerous scientific studies to the contrary—that their products pose no genuine threat to human health.

"Monsanto's actions involving PCBs have always been responsible," spokesperson Diane Herndon wrote in a 1993 statement. According to GE's Jack Batty, "Public perception about the health risks of PCBs and the scientific facts are in conflict. Most scientists agree that PCBs are not the hazard to human health that was feared in the 1970s." [Actually, the EPA's reassessment found them to be a greater hazard than was feared then.] "PCBs have produced tumors in some laboratory animals, but there is no proof—based on human exposure of more than 40 years—that PCBs cause cancer or any other serious health problems in people." Substitute "cigarettes" for "PCBs," and it could be the tobacco industry talking.

Sierra Club Fights PCBs in the Great Lakes

While transformer explosions account for the most dramatic incidences of PCB poisoning, the main source of human exposure in this country is the toxic muck at the bottom of the Great Lakes. Entering the food chain through bottom-dwelling organisms, PCBs work their way up in increasingly lethal concentrations. In some heavily contaminated waters, four out of five bottom-feeding fish have cancers or tumors. Great Lakes coho salmon exceed the EPA's PCB threshold 70-fold, Great Lakes ducks contain PCBs at levels 60 times the health standard for domestic poultry, and cormorants suffer from cross-bill syndrome, a PCB deformity, at 42 times the natural occurrence. In one study, mink fed a 30-percent diet of Lake Michigan salmon failed to produce live young.

What does this mean for Great Lakes humans? Children whose mothers regularly consumed two or three meals of Great Lakes fish a month before and during pregnancy weigh less at birth and have smaller head circumferences, weaker reflexes, and slower movements than their unexposed peers. In 1991, the EPA estimated that exposure to PCBs in the Great Lakes ecosystem would cause more than 38,000 cancers. The risk is particularly acute among subsistence anglers like the Ojibway and Hmong, whose chances of developing cancer from PCB exposure may be as high as one in 250.

Combating PCB contamination is a major focus of the Sierra Club's Great Lakes Ecoregion Program. The Club is championing S.1183, introduced by Ohio senators Howard Metzenbaum (D) and John Glenn (D), which would fund five more pilot projects like the recently completed PCB cleanup at Waukegan Harbor, Wisconsin, which once contained more PCBs than any site in the world. "Our experience shows that we have to clean up PCBs now, or we'll have sick children and toxic fish tomorrow," says Brett Hulsey, the Sierra Club's Great Lakes regional representative. "That's why we're pushing the government and polluters to develop cost-effective technology and just do it." *—Paul Rauber*

For three decades, the PCB problem remained invisible to the public—and indeed to everyone except the top managers of the companies that produced and used the chemical. That changed suddenly in 1966 with the accidental discovery of global PCB pollution by Swedish chemist Sören Jensen.

In 1964 Jensen was trying to study DDT levels in human blood when a mysterious group of chemical compounds kept recurring in his samples, interfering with his analyses. The chemical was so pervasive that his first task was to determine whether it was natural or synthetic. Finally concluding that it was some sort of artificial pollutant, Jensen set to work to find out what it was.

A two-year investigation established that the mystery compound was chlorine-based and chemically similar to DDT. Jensen knew it wasn't a pesticide, though, because he found it in wildlife specimens collected in 1935, years before chlorine-based pesticides were in general use. All of Sweden and its adjacent seas were contaminated, he discovered; even hair samples taken from his wife and three children showed traces of the compound, with the highest levels in his nursing infant daughter. The mystery pollutant was everywhere he looked.

Eventually, Jensen says, "I was convinced that what I had to deal with were chlorinated biphenyls, but I didn't have the faintest idea where such compounds were used in the society." Searching the literature, Jensen learned of PCBs' industrial uses. A German chemical manufacturer provided Jensen with a sample, which he analyzed and found to match the "peaks," or chemical readings, found in a massively contaminated white-tailed eagle.

"The circle was closed," Jensen said. "There was no doubt that the unknown peaks came from the use of polychlorinated biphenyls, which I gave the name PCB."

Jensen's discovery, first reported in 1966 in the English journal *New Scientist*, set in motion the chain of events that Monsanto, GE, and Westinghouse had hoped to avoid. The European press took notice immediately, and other scientists soon began investigating PCBs. Industry also took note: by January 1967, according to Monsanto telephone logs, Shell Oil had called to inform the company of the Swedish press reports, and to ask for PCB samples for its own analytical studies.

Widespread PCB contamination of the food chain in the United States was first demonstrated in 1969 by Dr. Robert Riseborough of the University of California at Berkeley, who happened upon it in the course of his research on peregrine falcons. *San Francisco Chronicle* reporter David Perlman learned about Riseborough's findings; his story, "A Menacing New Pollutant," ran on February 24, 1969, and was

Continued on page 74

Continued from page 45

picked up by numerous other papers.

Monsanto launched its public-relations defense the next day by denying that the chemicals were PCBs. "The Swedish and American scientists . . . imply that polychlorinated biphenyls are 'highly toxic' chemicals," Monsanto said in a statement widely distributed to its customers and the press. "This is simply not true. The source of marine-life residue identified as PCB is not yet known. It will take extensive research, on a worldwide basis, to confirm or deny the initial scientific conclusions."

Monsanto, however, had all the information it needed to confirm or deny the claim itself. Shortly after Jensen's 1966 discovery, Monsanto executives visited him in Sweden, and company records indicate that Monsanto obtained an unpublished 1968 paper he wrote with two colleagues detailing the analytical method for detecting PCBs in the environment. Neither did Riseborough's findings take the company by surprise: a January 18, 1968, internal memo about PCBs in shorebirds warns a Canadian colleague to "expect publication from California." Riseborough's results were published a year later.

There was also plenty of evidence by this time that PCBs were "highly toxic." The first known mass food-poisoning by PCBs occurred in Japan in February 1968, when PCB fluid leaked into a batch of rice-bran oil, or yusho. More than 1,600 people were initially exposed, with many showing immediate symptoms including severe chloracne, respiratory ailments, and failing vision. It was from the "Yusho Incident" that scientists would soon document birth defects, low birth weights, and numerous other chronic effects from PCB exposure. Nine years after the Yusho Incident, there was a sixfold increase in liver-cancer deaths among affected men and threefold among women.

Despite international attention to the Yusho Incident, just two months later Monsanto's corporate-development committee set a four-year goal of increasing by 20 times its sales of Therminol heat-transfer fluid—essentially the same PCB product that poisoned the Japanese victims. In the United States, Therminol was used as a heating medium inside the coils of deep-fat fryers.

In 1969, while publicly denying the problems linked to PCBs, Monsanto privately acknowledged them in its internal "Pollution Abatement Plan," which admitted that "the problem involves the entire United States, Canada and sections of Europe, especially the United Kingdom and Sweden. . . . [O]ther areas of Europe, Asia and Latin America will surely become involved. Evidence of contamination [has] been shown in some of the very remote parts of the world."

The Pollution Abatement Plan (really more of a liability abatement plan) proposed three options, with charts showing their potential profits and liabilities. Should Monsanto "Do Nothing," profits would likely decline and liability extend into the future. "We cannot deny the findings and the accusations of various agencies," the plan said. "If we took no action we would likely face numerous suits."

Under the "Discontinue Manufacture of PCB" option, profits would cease and liability would soar because "we would be admitting guilt by our actions."

But with the "Responsible Approach," which involved acknowledging certain aspects of the problem, tightening restrictions, and continuing to manufacture and sell PCBs, profits theoretically would increase and liability slowly decline, all but vanishing by the mid-1970s. It was this latter approach that Monsanto chose, making some adjustments to its business practices but going to battle with the government to keep PCBs on the market, despite growing scientific evidence that they constituted a public-health menace and an environmental nightmare.

Henceforth, Monsanto required its customers to sign indemnity agreements to hold it harmless from any future liability. Monsanto also vowed to

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sell PCBs only to customers who would use them in "totally enclosed systems"—even as it continued to market PCBs in products that directly contacted food. On March 30, 1970, Monsanto physician Emmett Kelly revealed to W. B. Papageorge (who would eventually take on the role of Monsanto's PCB czar) that tons of cattle feed from several Ohio silos had been contaminated by leaching and flaking paint based on the company's Aroclor 1254 PCB-oil. As a result, the milk from three herds was tainted. Kelly estimated that up to 50 other silos in the state were painted with the same PCB-based formulation.

"All in all, this could be quite a serious problem, having legal and publicity overtones," the Monsanto doctor warned. "This brings us to a very serious point. When are we going to tell our customers not to use any Aroclor in any paint formulation that contacts food, feed, or water for animals or humans? I think it is very important that this be done. . . . I think we should make a blanket recommendation against these uses." Despite years of discovery in lawsuits, the manufacturers have not produced any evidence that such a warning was issued.

Between July 1969 and August 1971, at least nine major PCB contaminations of food occurred. Shredded wheat contaminated by packaging material was shipped all over the country; in upstate New York, Campbell Soup had to destroy 140,000 tainted chickens. Monsanto continued to view the crisis as a public-relations problem. In 1971, Papageorge addressed a special committee of the American National Standards Institute that was searching for ways to extend the use of PCBs. "We cannot overlook the emotions that have set in," he said, "and believe me, there are many and they are deep. As you know, the references in the popular press to hazardous poisons and birth defects, which have not been substantiated, are most difficult to overcome."

At Westinghouse, another special committee met to discuss the growing PCB crisis. The December 28, 1971, minutes of the meeting (stamped "PROPRIETARY CLASS 1—DESTROY BY BURNING OR SHREDDING") acknowledged the problems of PCB accumulation in wildlife, and indicated that PCBs caused reproductive disorders in chickens and birth defects in victims of the Yusho Incident. They also acknowledged that Yusho might have involved dibenzofurans, which are created when PCB oil is heated.

At this point the crisis entered its darkest hour. In order to maintain its 1971 position that "PCBs are not and cannot be classified as highly toxic," Monsanto engaged Industrial Bio-Test Labs of Northbrook, Illinois, to do safety studies on its Aroclor PCB products. Seven years later, IBT Labs would be at the center of one of the most far-reaching scandals in modern science, as thousands of its studies were revealed through EPA and FDA investigations to be fraudulent or grossly inadequate. One of IBT's top executives was Dr. Paul Wright, a Monsanto toxicologist who took a job at IBT Labs in part to supervise the PCB tests, and then returned to Monsanto. Wright was eventually convicted of multiple counts of fraud in one of the longest criminal trials in U.S. history—with his legal fees paid by Monsanto.

While fraud on the PCB tests was not raised in the IBT trial, it is strongly suggested by memos and letters that came to light in later civil lawsuits. Several of these show how, at Monsanto's request, IBT Labs customized its studies. "I think we are surprised (and disappointed?) at the apparent toxicity at the levels studied," Monsanto's Elmer Wheeler wrote in March 1970 to IBT president Joseph Calandra. "I doubt that there is any explanation for this but I do think that we might exchange some new thoughts."

In a letter to IBT Labs two months later commenting on a set of PCB test results, Wheeler wrote, "We would hope that we might find a higher 'no effect' level with this sample as compared to the previous work."

In later years, Monsanto's requests would become even more blatant. "In two instances, the previous conclusion of 'slightly tumorigenic' was changed to 'non-carcinogenic,'" Monsanto wrote in July 1975. "The latter phrase is preferable. May we request that the Aroclor 1254 report be amended to say 'does not appear to be carcinogenic.'"

Two weeks later, Calandra responded: "We will amend our statement in the last paragraph on page 2 of the Aroclor 1254 report to read, 'does not appear to be carcinogenic' in place of 'slightly tumorigenic' as requested." Testimony about the IBT Labs scandal in a Texas lawsuit against Monsanto indicates that IBT was aware that PCBs caused extremely high numbers of tumors in test rats, with 82 percent developing tumors when fed Aroclor 1254 at 10 parts per million and 100 percent at 100 parts per million. Yet with a stroke of the pen, IBT Labs certified PCBs a noncarcinogen.

Working behind the scenes of such scientific miracles was Paul Wright. In July 1976, after returning to Monsanto, he was given a $1,000 award for "forestalling EPA's promulgation of unrealistic regulations to limit discharges of polychlorinated biphenyls." A year later, IBT Labs was found out, and Wright, Calandra, and another IBT exec were eventually convicted of federal fraud charges.

The first proposal for a total ban on PCBs was made by Representative William Fitz Ryan (D-N.Y.) in 1970. But partly due to the IBT tests, the substance stayed on the market until the Toxic Substances Control Act of 1976. Before the lid clamped down, industry continued to minimize reports of PCB toxicity. "The low order of toxicity to man is supported by several decades experience in the U.S. electrical industry," GE wrote the EPA in November 1973, urging the agency not to regulate PCBs. In its comments, Monsanto stated that "PCB has always been considered less hazardous than many other chemicals in everyday use."

Denials of the dangers would continue even after the ban. "There has never been a single documented case in this country where PCBs have been shown to cause cancer or any other serious human health problems," said Monsanto toxicologist John Craddock in a January 30, 1981, speech. "In the classical short term exposure, or acute toxicity sense, PCBs are classified as 'slightly toxic' by oral ingestion." Their toxicity was similar, he said, to table salt. "Monsanto, the government and the electrical industry together concluded that the benefits to society of continued PCB use far outweighed the risk." Decades after the Drinker study demonstrated PCBs' toxicity, 25 years after Monsanto's files indicated that dioxin and dibenzofurans were contaminants in PCBs, and with a former Monsanto official standing trial for fraud, Monsanto still claimed that PCBs were safe.

Six days after Craddock's speech, a PCB transformer from GE filled with Monsanto's Aroclor 1254 exploded and burned in Binghamton, New York—the first such U.S. explosion that was publicly acknowledged to involve PCBs. "Binghamton's tallest building, centerpiece of a modern, multi-million-dollar downtown government complex, is now a landmark of the Chemical Age, an empty monolith filled with deadly dioxins," wrote the Associated Press. "What started out as a routine electrical fire eventually released some of the most toxic chemicals on Earth throughout the interior of the 18-story structure." Thirteen years later, the building is still closed to the public.

Although sale of PCBs has been banned in the United States for 18 years, billions of pounds are still with us: in electrical transformers, leaking from landfills, and lodged in the fatty tissues of humans and other animals, passed on to new generations through mother's milk and contaminated food, causing cancer, birth defects, and sterility. For the few extra years of profit for Monsanto, GE, and Westinghouse, we are all now paying the price. ■

ERIC F. COPPOLINO *is a New York–based investigative reporter specializing in PCBs and related issues.* *Additional research assistance was provided by Hilary Lanner and Brenda Shawley.*

►For more information, see "Resources," p. 86.

WHERE TO WRITE, WHO TO CALL, WHAT TO DO...

EXPRESS YOUR VIEWS!

Write or call your senators and representative:

The Honorable ________________
U.S. Senate
Washington, DC 20510

The Honorable ________________
U.S. House of Representatives
Washington, DC 20515

U.S. Capitol Switchboard
(202) 224-3121.

Join activists working on issues that concern you. Contact the Campaign Desk, Sierra Club, 730 Polk St., San Francisco, CA 94109; phone (415) 776-2211.

AFIELD

"Hearth & Home," page 18

How to Get Water Smart by Buzz Buzzelli et al. (Terra Firma, P.O. Box 91315, Santa Barbara, CA 93190; 1991) has a useful section on recycling household water. *The Natural Gardening Book* by Peter Harper with Chris Madsen and Jeremy Light (Simon & Schuster/Fireside, 1994) details a way to clean graywater by filtering it through a planting of reeds before using it on your garden.

"Body Politics," page 20

To find out more about the work of the Senior Environment Corps, contact John Grupenhoff at 6410 Rockledge Dr., Suite 203, Bethesda, MD 20817. Write or call the Environmental Alliance for Senior Involvement (EASI) at P.O. Box 368, The Plains, VA 22171; (703) 330-5667.

DEPARTMENTS

PRIORITIES

Campaign Reform, page 26

With or without campaign-finance reform, this November's congressional elections are crucial to the Sierra Club's goals. To help elect Club-endorsed environmentalists to the House and Senate, contact the Club's Campaign Desk at the address above.

The Center for Responsive Politics has just started a free newsletter, *Capital Eye: A Close-Up Look at Money in Politics*. To receive it, write the Center at 1320 19th St., N.W., Suite 700, Washington, DC 20036, or call (202) 857-0044.

The Working Group on Electoral Democracy is seeking groups and individuals to endorse its call for democratically financed elections. The organization may be reached at Keets Road, Deerfield, MA 01342; (413) 773-8187.

Green Republicans, page 33

To find out how your senators and representative scored on environmental votes in 1993, contact the League of Conservation Voters, 1707 L St., N.W., Suite 550, Washington, DC 20036; (202) 785-8683. For a copy of the 1992 Republican platform, write to the Republican National Committee, Dwight D. Eisenhower Republican Center, 310 First St., S.E., Washington, DC 20003; (202) 863-8500.

Black Caucus, page 37

For more on the Black Caucus, see Bunyan Bryant's *Race and the Incidence of Environmental Hazards* (Westview Press, 1992), which devotes a chapter to the Caucus' environmental-voting record.

IN PRINT

Readings, page 82

Four volumes have appeared so far in the Sierra Club Natural Travelers Series: *Wild Britain, Wild France, Wild Italy,* and *Wild Spain*. The guidebooks are $16 each, paperbound; you can order them, and other Sierra Club Books, by phone (Visa or MasterCard); call (800) 935-1056.

CLUBWAYS

Rachel Carson, page 84

A bequest or life-income trust to benefit the Sierra Club is a commitment to the environment—a plan today for an investment tomorrow. The Planned Giving staff of the Sierra Club provides confidential assistance to aid members and friends in shaping an enduring legacy suitable to their needs. For more information, contact the Planned Giving Program, Sierra Club, 730 Polk St., San Francisco, CA 94109; (415) 923-5639.

FEATURES

PCBs, page 40

For more on the Sierra Club's Great Lakes program to clean up contaminated sediments, including PCBs, see *Clean Lakes, Clean Jobs*, a 50-page report available for $10 from the Club's Midwest Office at 214 N. Henry St., Suite 203, Madison, WI 53703.

Wilderness, page 46

Ask your congressional representatives to support Sierra Club–endorsed legislation that will be introduced next year to protect wilderness in Utah, the Arctic, and the Northern Rockies. Club chapter and group wilderness committees can receive periodic updates on wilderness and other land-protection legislation; send the committee contact person's name and address to Leslie England at the Sierra Club's Washington office, 408 C St., N.E., Washington, DC 20002.

Population, page 52

The Global Fund for Women, headed by Anne Firth Murray, has granted more than $3 million to women's groups in 97 countries. Contact the Fund at 2480 Sand Hill Road, Suite 100, Menlo Park, CA 94025; (415) 854-0420. Pathfinder International, represented at *Sierra*'s roundtable by Claudia Ford, is at 9 Galen St., Suite 217, Watertown, MA 02172; (617) 924-7200. Pathfinder provides financial support, technical assistance, and contraceptive supplies to organizations throughout the world.

For a wide-ranging exploration of the population debate, consult *Beyond the Numbers: A Reader on Population, Consumption, and the Environment* (Island Press, 1994) edited by Laurie Ann Mazer. Questions of immigration are debated in Sierra Club Books' just-published *How Many Americans?* by Leon F. Bouvier and Lindsey Grant. ∎

THE CONSENT DECREE

HEALTH

ASPECTS

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
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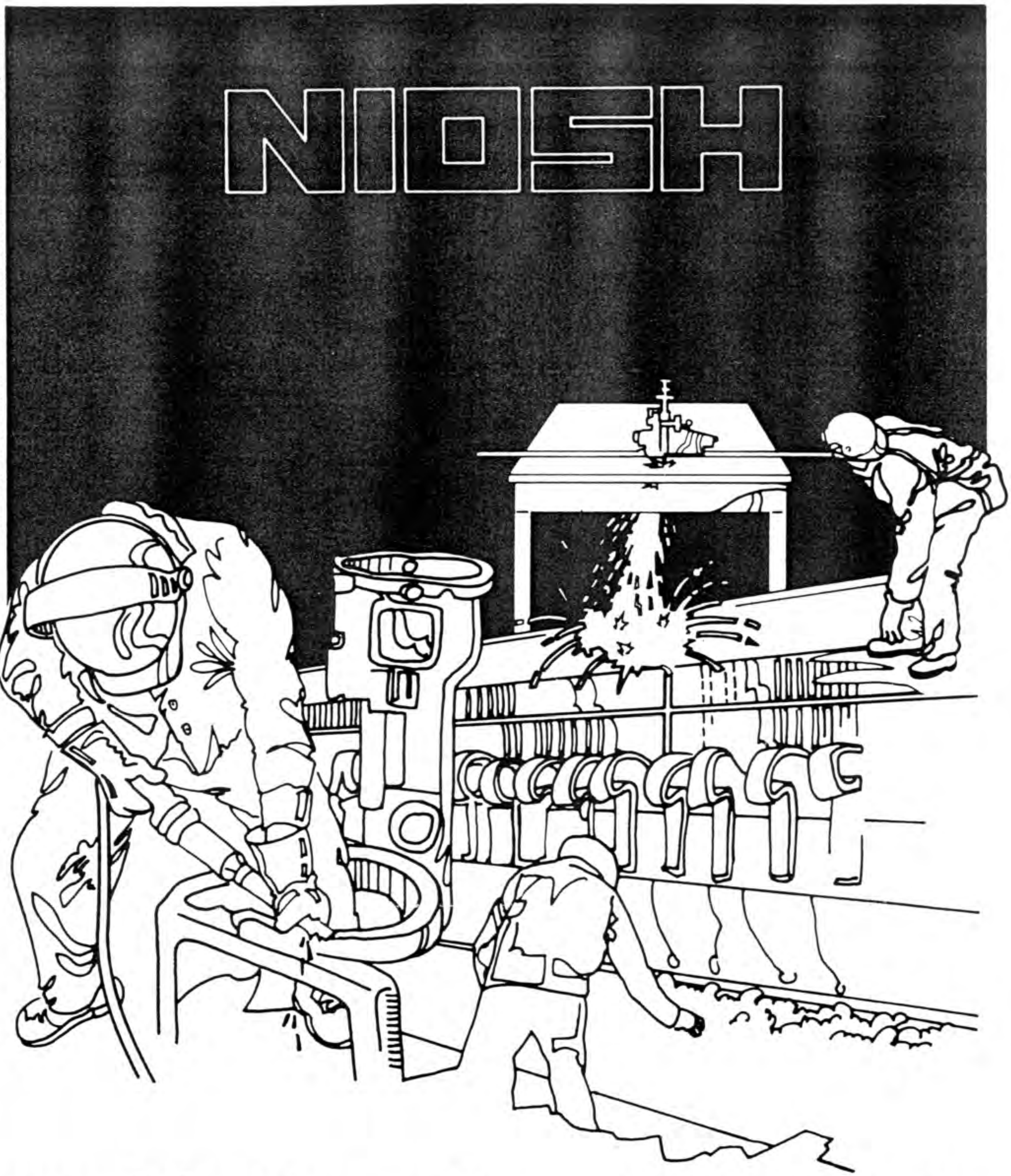

Health Hazard Evaluation Report

HETA 89-116-2094
WESTINGHOUSE ELECTRIC CORPORATION
BLOOMINGTON, INDIANA

PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to Federal, state, and local agencies; labor; industry and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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WESTINGHOUSE ELECTRIC CORPORATION
BLOOMINGTON, INDIANA

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I. SUMMARY

We conducted a retrospective cohort mortality analysis of 3588 persons who ever worked at an electric capacitor manufacturer where they were exposed to PCBs. Cox proportional hazards modelling was performed to examine occupational risk factors for specific causes of death within the cohort. All causes mortality (SMR=0.7, 95% CI 0.6, 0.8) and total cancer mortality (SMR=0.8, 95% CI 0.6-1.1) were less than expected. More deaths were observed than expected for skin cancer (8 malignant melanoma deaths, SMR=4.1, 95% CI 1.8-8.0) and cancer of the brain and nervous system (5 deaths, SMR=1.8, 95% CI 0.6-4.2). In the proportional hazards analysis, the average estimated cumulative dose for brain cancer cases (22.9 units) was greater than for other workers in the risk sets (12.9 units), but this difference was not statistically significant. Malignant melanoma was not related to cumulative PCB exposure. These results provide some evidence in support of an association between employment at this plant and malignant melanoma. The brain cancer finding suggests that this outcome be carefully observed in further follow-up of this cohort. The possibility that these observations resulted because of chance, bias, or confounding cannot be excluded as alternative explanations. Additionally, these findings conflict with those from other studies of PCB exposed populations. The continued follow-up of this, and several other large studies of PCB exposed populations, will be essential for the final determination of whether or not PCBs are carcinogenic to man.

NIOSH found that workers at the plant were at excess risk of malignant melanoma. Based on the results of this study, NIOSH recommends that workers included in he study be notified of the study results on an individual basis. NIOSH also recommends that the affected workers be periodically examined according to consensus recommendations for medical screening of malignant melanoma. NIOSH will continue to conduct periodic follow-up of this cohort.

KEYWORDS: SIC 3629 (Electrical industrial apparatus, not elsewhere classified) polychlorinated biphenyl, PCB, Aroclor, malignant melanoma, brain cancer, mortality.

II. INTRODUCTION AND BACKGROUND

Although banned from production and distribution in the United States, polychlorinated biphenyls (PCBs) remain in the environment. Exposed workers include those involved in the maintenance and replacement of electrical transformers and capacitors and the disposal of materials containing PCBs.[1] In 1985, the Environmental Protection Agency (EPA) estimated that 1.6 million substation capacitors and 21,000 transformers containing PCBs remained in use.[2] Another two million mineral oil transformers were contaminated with more than 50 ppm PCBs. With approximately 2.5% transformers removed from service annually, there will remain 1.4 million contaminated transformers in service in the year 2000.

PCBs are considered potentially carcinogenic to man, based primarily on evidence from animal studies.[3-5] Even so, studies of PCB exposed populations have been inconsistent. The various studies have found excess cancer risks from malignant melanoma, liver and biliary tract cancer, cancer of the rectum, hematopoietic malignancies, and lung cancer.[6-9] Also of note, a meta-analysis[10] of the various PCB cohorts identified an excess from kidney cancer among PCB exposed men.

To further evaluate the carcinogenicity of PCBs, National Institute for Occupational Safety and Health (NIOSH) conducted a retrospective cohort study of workers manufacturing electrical capacitors with known exposure to PCBs.[11,12] The mortality experience of this cohort was previously unknown.

III. MATERIALS AND METHODS

The study cohort manufactured electric capacitors in the midwest United States beginning in 1957. PCBs were used as a dielectric fluid until late in 1977 when they were replaced with isopropyl biphenyl. Aroclor (Monsanto trade name) 1242 was used through 1970 and Aroclor 1016 was used afterwards. Both mixtures contained 42% polychlorinated biphenyls, the difference being that Aroclor 1016 had fewer biphenyl homologues with 5 or more chlorine atoms per biphenyl nucleus. The facility was contained under a single roof with administrative offices and certain process areas isolated by walls (Figure 1). Manufacture of capacitors involved the production of bails made from foil, paper, and plastic which were placed into metal capacitor boxes. Several capacitors were bound together, placed into a vacuum chamber, and heated to 150°C to remove moisture. The vacuum chambers were then flooded with dielectric fluid to fill and impregnate the capacitors. After five days, the remaining fluid was pumped out and filtered for reuse. The doors of the ovens were then opened, releasing PCB containing fumes into the plant. After release from the ovens, these fumes spread throughout the facility, settling onto exposed surfaces. When the capacitors were removed from the ovens, the fill-holes were plugged and soldered shut and the capacitors were degreased and spray-painted. Approximately 10% of the workforce was directly involved in PCB-containing capacitor production. Solvents used at the plant included toluene, xylene, methyl ethyl ketone, trichlorethylene, and 1,1,1-trichloroethane. Personal and area environmental sampling of plating, brazing, and soldering operations was conducted for several metals from 1977 through 1984. The results indicated that metal exposures were well below the recommended standards.

Retrospective Cohort Study

Included in the analysis were 3588 male and female workers employed for at least one day between January 1, 1957, when the plant opened, and March 31, 1977, the year when PCB use was discontinued. All personnel records and all death records in possession of the company were microfilmed and abstracted for name, date of birth, sex, race, social security number, and detailed job history. Race was indicated on 12% of the personnel records with the majority of these workers (96%) being white. We considered those workers whose race was unknown to have been white and excluded non-whites from the cohort analysis. (In 1980, 2.6% of the population in the county were black.[13]) Also excluded were persons for whom dates of birth or hire were missing. Detailed job histories were used to identify the dates of first and last employment as well as job location within the facility (department) and dates of employment for each job held. Date first employed at the plant was considered the first day of exposure. The last day of exposure was March 31, 1977 or the actual last day of employment, whichever was earlier.

Vital status was determined through the Social Security Administration (SSA) which reported deaths into 1987 and persons known to be alive as of December 31, 1984. If the SSA could not ascertain vital status, we determined the last known address and verified current mail delivery. Workers whose mailing address was verified were considered alive, otherwise the worker's vital status was unknown. Copies of all death certificates were requested from the respective state vital statistics offices. Underlying cause of death was determined by a qualified nosologist according to the International Classification of Diseases in effect at the time of death. For certain causes of death, medical records and pathology reports were collected for confirmation of diagnosis. We considered only those deaths which occurred before

July 1, 1986 in the life-table analysis. Workers known to have been alive as of December 31, 1984 were assumed alive as of June 30, 1986 unless the SSA had reported their subsequent death. Those lost to follow-up and those who died after June 30, 1986 were also considered alive for the purpose of this analysis.

Person-years at-risk (PYAR) of dying were accumulated for each worker starting January 1, 1957 or on their first day of employment at the plant, whichever occurred later and continued until the date of death or the study-end date (June 30, 1986), whichever occurred first. The NIOSH Life Table Analysis System was used to distribute PYAR over sex specific five-year calendar time periods and five-year age groups.[14] Expected numbers of cause-specific deaths were calculated by multiplying the age, sex, and calendar time specific United States mortality rates for all whites by the corresponding number of person-years at-risk. The number of observed cause-specific deaths was divided by the number of expected cause-specific deaths to yield a Standardized Mortality Ratio (SMR). Ninety-five percent confidence intervals (95% CI) around the SMR were calculated using an approximation based on the Poisson distribution.[15]

PYAR were stratified into 5-year duration of employment and latency categories. Latency was calculated from the day of first employment. SMRs were calculated for each duration of employment and latency category.

Cox Proportional Hazards Analysis

The primary purpose of the Cox proportional hazards modelling[16] was to determine if a dose-response relationship existed between cumulative PCB exposure (duration of employment multiplied by an exposure intensity rating) and mortality from either malignant melanoma or brain cancer. Pertinent exposure information included the process description, environmental data collected in 1977,[11] and serum PCB levels collected during a cross-sectional study conducted a few months later.[12] While the environmental and serologic data confirmed that all workers were potentially exposed (Table 1), these data were of limited usefulness for constructing a job-exposure matrix. The environmental sampling was limited by the relatively few samples collected outside of the capacitor processing area. The serologic data were constrained since only the current workforce could contribute sera. Furthermore, the concentration of PCBs in serum were affected by its long half-life[17] and several individual factors; including body weight, age and sex.[12]

Our principal cumulative dose estimate (CUMYR) was based on knowledge of the manufacturing process and available environmental data. We assumed that both airborne and dermal PCB exposures decreased with distance from the ovens and that the lowest exposures were in the office areas which included the engineering and drafting departments. The office area was assigned an exposure weight of 1 and was designated as Zone 1 (Figure 1). The production area was then divided by three equi-distant and concentric semi-circles centered on the baking ovens. The zone surrounding the capacitor ovens was assigned an exposure score of 5 based on the environmental sampling results (Table 1). The process area furthest from the ovens was assigned an exposure score of 2 (Zone 2) and the area adjacent to the ovens a score of 3 (Zone 3). Departments were assigned an exposure weight according to the zone which contained 50% or more of that department. If a department was equally divided by two zones, it was assigned an average weight. Maintenance workers were assigned to Zone 5 if they worked in department F-44, located within Zone 5, or to Zone 4 if their primary work area was in Zone 3 but they were called upon to work in Zone 5 (N=34). The paint area and a clean room within the capacitor winding area (Departments A-35 & F-14) were given scores of 1 because they were isolated from the remainder of the production areas by walls and separate ventilation systems. Hourly workers who could not be located by department (N=125) were assigned to Zone 2.

CUMYR was calculated by multiplying the number of days worked in each department by its exposure weight, summing across departments, and dividing by the number of days in a year. In this manner, five CUMYR units were equivalent to working in Zone 5 for one year or working in Zone 1 for five years. If CUMYR was a predictor variable; 1 year, 5 year, and 10 year lagged doses were calculated in which exposures cumulated just prior to the cases failure were subtracted from CUMYR.

While the environmental data lend support to the weighting scheme for CUMYR, these data include only 14 area samples collected outside Zone 5 (Table 1). At the same time, the serologic data do not support the weights for Zones 2-4. Since the accuracy of CUMYR could not be verified, we estimated cumulative PCB exposure using two additional weighting schemes. One estimate (DURZONE5) was based on the serologic data, assigning a weighting factor of 1 to Zones 1-4 and a weighting factor of 5 to Zone 5. The second estimate (CUM2.5) assumed no exposure difference in Zones 2-4, which were weighted by a factor of 2.5. Zone 1 and Zone 5 retained their original weights.

Environmental sampling data collected in April 1977[11] or obtained through company records and collected from April 1977 to November 1984 were used to identify departments where exposures to 1,1,1 trichloroethane, trichlorethylene, toluene, methyl ethyl ketone, and xylene had been present. Workers were categorized as potentially exposed (or not exposed) to each solvent. Other exposure variables considered were employment in each of the PCB exposure zones (dichotomous) and ever having worked outside of Zone 1. Duration of employment and years since first employment were also analyzed. The analysis did not consider exposure to the various metals as the environmental measurements indicated that these exposures were minimal.

Cases were selected from the entire original population at risk. Those who had died with a primary cancer of the brain or a malignant melanoma listed as an underlying or contributory cause of death were included. If a case had been diagnosed prior to their first day of employment, they were excluded. All workers born within 5 years of a case, and the same sex as the case, were eligible for inclusion in a risk set for that case. Risk sets were further limited to workers who survived to the age at which the case died and were employed at the facility prior to that age. The work history of each member of the risk set was truncated at the age at which the index case had died.

An exposure-response relationship was determined if the regression coefficient for cumulative dose was statistically significant for a two-tailed test. Ninety-five percent confidence intervals were calculated for the estimated rate ratios using a test based method proposed by Miettinen.[18]

IV. RESULTS

The entire cohort included 3,643 workers; 2,785 of whom were men and 858 were women (Table 2). Excluded were 15 known non-whites and 40 workers whose work histories were incomplete or otherwise failed to meet study inclusion criteria. This left 3,588 persons in the final cohort to be analyzed. Of these, 192 were dead and 3,396 were considered alive at the study end date. For the final cohort; the median latency was 18.6 years (mean=19.2 yrs; range: 0.04 to 32.5 yrs), the median duration of employment was 1.3 years (mean=4.1 yrs; range: 1 day to 20.2 yrs), and the median age at hire was 24.2 years (mean=27.0; range: 16.8 to 62.6 yrs). The distribution of PYAR by duration of employment and latency is provided in Table 3.

Overall mortality was significantly less than expected (observed=192: SMR=0.7; 95% CI 0.6-0.8), as were mortality from diseases of the heart (observed=60: SMR=0.7; 95% CI 0.5-0.9) and accidental deaths (observed=28: SMR=0.7; 95% CI 0.5-1.0) (Table 4). The SMR for all cancers was also below expected (observed=54: SMR=0.8; 95% CI 0.6-1.1). There were no excess deaths from cancers of the rectum, the lung, or hematopoietic malignancies. A single death from cancer of the biliary passages, liver, and gall bladder was observed as were two deaths from kidney cancer. The SMR for deaths due to cancer of the skin was significantly elevated (8 observed: SMR=4.1; 95% CI 1.8-8.0). All eight skin cancer deaths were due to malignant melanoma. A nonsignificant increase was also noted for cancer of the brain and nervous system (5 observed: SMR=1.8, 95% CI 0.6-4.2).

Both men and women experienced excess mortality from melanoma and brain cancer. The risk of mortality from skin cancer in men (6 observed: SMR=3.6; 95% CI 1.3 - 7.9) was lower than that in women (2 observed: SMR=6.3; 95% CI 0.8 - 22.7). For brain and central nervous system cancers, men (4 observed: SMR=1.8; 95% CI 0.5 - 4.5) and women (1 observed: SMR=2.0; 95% CI 0.1 - 11.1) had similar SMRs, though the SMR for women was based on a single case.

For malignant melanoma there was no clear relationship between latency or duration of employment and risk (Table 5). All 8 melanoma deaths occurred five or more years after initial employment and three cases worked at the plant for more than ten years. A ninth worker (Case G) died in 1987 with a malignant melanoma listed as a contributory cause of death (Table 6). He was not included in the life-table analysis. Case G had worked for 1 month at the plant and had accumulated 20 years of latency before his death.

Pathology reports were obtained for eight of the nine cases and all confirmed malignant melanoma. The primary site for Case C was reported to be the gallbladder. Although rare, primary and metastatic melanomas have been reported at this site.[19,20] A pathology report was not obtained for Case E, but the medical record confirmed the diagnosis. Case H had been diagnosed with a malignant melanoma approximately two months prior to working at the facility. He was then employed for ten years and died of metastatic disease 14 years after the original diagnosis. The excess mortality remained after this case was removed from the life-table analysis (SMR=3.5, 95% CI 1.4 - 7.3). Two malignant melanoma deaths occurred during 1965-69, four more during 1975-79, one during 80-84, and two during 1985-87. At diagnosis, three cases (Cases A, B, I) had extensive metastatic disease and died within 6 months.

All five brain cancer deaths occurred five or more years after the date of hire (Table 5). There was an indication that the brain cancer deaths were more common among those with a longer duration of employment. Three deaths occurred among those with 10 or more years duration of employment (3 obs., SMR=4.8, 95% CI 1.0 - 14.0). Two additional brain cancer cases were not included in the life-table analysis (Table 6). A white male worker (Case DD) died of a glioblastoma 7 months after the study-end date, having accumulated 24 years latency and approximately 6 months duration of employment. A black female (Case GG) died 13 years after beginning work at the plant where she was employed for 11 years.

One pathology record for a brain cancer case was obtained and identified the tumor as a glioblastoma. Medical records or death certificates indicated that two additional cases were glioblastomas while two others were astrocytomas. The death certificates for the remaining two cases indicated carcinomas of the brain, but did not specify the cell type. The underlying cause of death for all 7 cases was coded as a primary cancer of the brain by an independent, certified nosologist.

Cox proportional hazards models

Malignant melanoma

The proportional hazards analysis for malignant melanoma included 8 cases and 3455 workers in all risk sets combined. The eight risk sets varied in size from 111 to 1112 workers. Excluded from this analysis was Case H, who had been diagnosed with a primary malignant melanoma two months prior to his employment at the plant. Four cases and 33 percent of the comparison group worked in Zone 1 (Table 7). Two cases and 33 percent of the comparison group worked in Zone 5, closest to the baking ovens. Only one case worked in a department that had been monitored for solvents. There were no statistically significant differences between cases and the comparison group for years since first employment, duration of employment, or cumulative PCB exposures (Table 8).

Cancer of the brain.

The Cox proportional hazards models of brain cancer included 7 cases and 1670 workers in all of the risk sets combined. The risk sets varied in size from 42 workers to 489 workers. Two brain cancer cases worked in Zone 1 compared to 37% of the workers in the comparison group (Table 7). In contrast, five cases (72%) and 47% of the comparison group worked in Zone 3 (rate ratio = 3.4, 95% CI 0.7 - 16.8). Only one case worked in a department where environmental samples for solvents had been collected.

The number of years since first employment was similar between both the cases and their comparison group. Brain cancer cases had a longer average duration of employment than the comparison group, but this difference was not statistically significant.(Table 8) Of the three measures of cumulative exposure, the two estimates that weighted departments by proximity to the capacitor ovens (CUMYR and CUM2.5) were stronger predictors of brain cancer. On average, brain cancer cases had more than twice the estimated cumulative PCB dose (CUMYR) than the comparison group, but again, this difference was not statistically significant. The rate ratio associated with a ten unit increase in CUMYR was 1.27 (95% C.I 0.88 - 1.86).

V. DISCUSSION

This group of workers had an overall survival that was better than expected when compared to standardized mortality rates for white men and women in the United States. At the same time, we observed a four-fold excess mortality from cancer of the skin, which was entirely due to malignant melanoma. Malignant melanoma risk did not vary by duration of employment, latency, or estimated cumulative PCB exposure. There was also a nonsignificant excess of brain cancer mortality which increased with duration of employment. The average estimated cumulative PCB exposure for the brain cancer cases was twice that of a comparison group comprised of other workers at the plant, but this difference was not statistically significant.

Predisposing risk factors or environmental exposures probably do not account for the excess deaths reported in this study. Since, in contrast to brain cancer, several strong predisposing risk factors have been reported for malignant melanoma,[21] the next-of-kin of eight of the workers who died of malignant melanoma were interviewed (Table 9). The spouse of one case reported that the cases's mother also died of malignant melanoma, but the medical record for the case indicated that another type of cancer had been responsible. None of the cases were related and five had no known risk factor for malignant melanoma other than race. An environmental cause, peculiar to the geographic area where the plant was located, was also unlikely since the county mortality rates for malignant melanoma and brain cancer were similar to the state and national rates.[22]

The skin is a recognized target organ for several nonmalignant effects caused by PCBs and, in the workplace, is a primary route of exposure. Chloracne[23-25] and hyperpigmentation[26] have been reported among PCB exposed workers. While PCBs appear to affect melanocytes, their ability to promote or initiate melanoma in these cells is unknown and the mechanisms of hyperpigmentation and carcinogenesis probably differ.

Our results, and those of similar studies,[6-9] have been inconsistent. Excess malignant melanoma has been reported once, in a retrospective cohort morbidity study of 72 workers thought to be exposed to Aroclor 1254.[6] That study was considered inconclusive[27] since PCB exposures could not be quantified, the presence of other known carcinogens was considered possible but had not been evaluated, and the excess was based on only three cases. PCB exposed workers with a history of skin cancer, type unknown, have been reported in two cross-sectional surveys.[28-29] Since none of the previously published studies reported an excess mortality from brain cancer, we did not consider it an a priori hypothesis. However, an unpublished cohort mortality analysis[30] of transformer manufacturing workers exposed to Aroclor 1254 did find such an excess (4 observed, 0.8 expected). In addition, an Italian cohort[8] experienced a similar excess (2 observed, 0.3 expected) that was not reported until a later meta-analysis.[10]

Other retrospective cohort studies reported excesses in hepatobiliary cancers,[7,9] carcinoma of the rectum,[7] hematopoietic tumors,[8] and lung cancer.[8] Two small cohorts[31-32] reported no cancer excesses. Three investigators[7,10,33] followed workers from the same plants and their results should not be considered independently. Unrecognized differences between the study populations, exposures from subtle manufacturing differences, exposures to other carcinogens in the workplace, or chance may explain the discrepancies between the various studies. At the same time, statistical power[34] for even the largest cohort studies has been limited by the relatively small numbers of deaths observed (Table 10).

One of the strengths of this study was the substantial evidence that most of the cohort had been exposed to PCBs. Exposures occurred throughout the study facility, and there exists limited documentation that workers developed nonmalignant skin problems related to their exposure. In 1977, biological serum PCB data for workers in the plant, compared to persons in the community, were 7-fold greater for salaried workers and 50-fold greater for capacitor processing workers, the most heavily exposed workers in Zone 5. Zone 5 workers were also more likely to report unusually darkened areas of the skin than workers in other areas of the plant, and this difference was statistically significant.[35] Also of interest, the personnel record of Case G, documented that he had developed a severe dermatitis while working in Zone 5 as a result of contact with the dielectric fluid containing Aroclor 1242.

Our study had several limitations. Mortality may not be the best index of risk for malignant melanoma as differences in health care quality and access may affect survival. Besides PCBs, solvents, and metals, other workplace exposures were not evaluated since the necessary data were unavailable. Fewer than 10% of the PYAR were accumulated with 20 or more years of latency. In addition, there have been relatively few deaths in this cohort. Thus, it has not been possible to assess the risk of cancers with long latency periods and the small number of observed deaths resulted in risk estimates with relatively broad confidence intervals. The sparsity of the environmental data resulted in weighting scales that should be considered approximations and a detailed job-exposure matrix that incorporated changes over time could not be created.

Various forms of bias or confounding should also be considered. A selection bias known as the healthy worker effect[36] could explain, in part, the low overall SMR. This effect may be enhanced in a relatively young cohort, such as this, where the median age at the study-end date was 44.5 years. Since the pathology records could not be obtained for several brain cancer cases, the possibility of misclassification cannot be excluded. The limitations of the weighting scales may have lead to substantial exposure misclassification and obscured a dose-response relationship.[37] Finally, any association of excess mortality with PCBs may have been confounded by simultaneous exposures to PCB contaminants, such as polychlorinated dibenzofurans,[10] or other unidentified substances in the workplace.

VI. CONCLUSIONS

Despite the conflicting results from the epidemiologic studies, PCBs are considered potentially carcinogenic to man by NIOSH[3] and EPA[5]. The International Agency for Research on Cancer (IARC) classifies PCBs as animal carcinogens with limited evidence to suggest that they are also carcinogenic to man.[4] This study provides some evidence for an association between PCB exposure in an occupational environment and mortality from malignant melanoma. The brain cancer finding suggests that this outcome be carefully observed in further follow-up of this cohort. The possibility that these observations resulted because of chance, bias, or confounding cannot be excluded as alternative explanations. The continued follow-up of this, and several other large studies of PCB exposed populations, will be essential for the final determination of whether or not PCBs are carcinogenic to man.

VII. RECOMMENDATIONS

NIOSH found that workers at the plant were at excess risk of malignant melanoma. Based on the results of this study, NIOSH recommends that workers included in the study be notified of the study results on an individual basis. NIOSH also recommends that the affected workers be periodically examined according to consensus recommendations for medical screening of malignant melanoma. NIOSH will continue to conduct periodic follow-up of this cohort.

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X. DISTRIBUTION AND AVAILABILITY OF REPORT

Copies of this report are currently available upon request from NIOSH, Hazard Evaluations and Technical Assistance Branch, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal, Springfield, Virginia, 22161. Information regarding its availability through NTIS can be obtained from NIOSH Publications Office at the Cincinnati address. Copies of this report have been sent to:

1. Westinghouse Electric Corporation
2. ABB Corporation
3. International Brotherhood of Electrical Workers
4. Federation of Westinghouse Independent Salaried Unions
5. Indiana State Board of Health
6. Environmental Protection Agency
7. Agency for Toxic Substances and Disease Registries
8. International Agency for Research on Cancer
9. Occupational Safety and Health Administration

For the purpose of informing affected employees who are still employed at the facility, copies of this report shall be posted by the employer in a prominent place accessible to the employees for a period of 30 calender days.

Table 1: Environmental and biologic measurements for polychlorinated biphenyls in March 1977.

Environmental Measurements ug/m^3	Zone 1 N mean (sd)	Zone 2 N mean (sd)	Zone 3 N mean (sd)	Zone 5 N mean (sd)
Area air sampling	2 16 (15)	4 48 (13)	8 59 (19)	4 76 (52)
Personal Sampling	ns	ns	ns	38 94 (68)

Serum Measurements (ng/ml)	All Salaried Workers	Hourly Workers Only		
		Zone 2	Zone 3	Zone 5
Current job	66 126 (101)	51 199 (377)	23 98 (45)	71 305 (479)
Only worked in	36 119 (26)	7 121 (61)	5 100 (27)	8 763 (1117)

ns = not sampled.
Serum PCB values are lower chlorinated biphenyl molecules with no more than 4 chlorine atoms per molecule.[6]
Salaried workers could not be separated into exposure zones according to serum PCB values.
No environmental or serum data were collected for Zone 4.

Table 2: Cohort description and vital status.

	A. Cohort Status Breakdown		
Sex	Total Cohort	Rejected	Final Cohort
Males[*]	2785	43	2742
Females[*]	858	12	846
Total	3643	55[**]	3588
	B. Vital Status		
Vital Status	Total Cohort	Rejected	Final Cohort
Alive	3288	47	3396
Dead	216	7	192[***]
Unknown	139[****]	1	
Total	3643	55	3588

[*] Persons of unknown race were included as white.

[**] Rejected from analysis because of an unknown date of first employment, not employed between January 1, 1957 and March 31, 1977, and 15 non-whites (10 men and 5 women).

[***] 17 workers died after June 30, 1986 and were considered to be alive at the study end date.

[****] 139 workers with a vital status unknown (3.8%) were included in the analysis and considered alive as of June 30, 1986.

Table 3: Person-years at-risk by latency and duration of employment.

	Duration of Employment					
	<6 mos	6 mos - 4yrs	5-9 yrs	10-14 yrs	≥15 yrs	Total
Latency						
< 5 yrs	6999	10863				17862
5-9 yrs	5768	7005	4977			17750
10-14 yrs	5407	6458	2041	2873		16778
15-19 yrs	3873	4495	1536	1528	1248	12681
≥ 20 yrs	1176	2463	1012	653	1795	7109
Total	23223	31284	9566	5055	3043	72180

Table 4: Observed and expected deaths, standardized mortality ratios (SMR), and 95% Confidence Intervals.

	Observed Deaths	Expected Deaths	SMR	95% C.I. Lower - Upper
Underlying Cause of Death				
All Causes	192	283.3	0.7**	0.6 - 0.8
All Cancers	54	63.7	0.8	0.6 - 1.1
Site Specific Cancers				
Buccal & Pharynx	0	1.7	----	
Digestive Organs	8	13.9	0.6	0.2 - 1.1
Biliary Passages, Liver and Gall Bladder	1	0.8	1.1	0.0 - 6.4
Pancreas	2	2.8	0.7	0.1 - 2.5
Rectum	1	1.2	0.8	0.0 - 4.5
Respiratory System	15	20.2	0.7	0.4 - 1.2
Kidney	2	1.5	1.3	0.2 - 4.8
Lymph & Hematopoietic	7	7.2	1.0	0.4 - 2.0
Skin***	8	2.0	4.1**	1.8 - 8.0
Brain & Nervous Sys****	5	2.8	1.8	0.6 - 4.2
All other sites combined	5	8.5	0.6	0.2 - 1.4
Diseases of the Heart	60	85.4	0.7**	0.5 - 0.9
Diseases of the Respiratory System	10	12.3	0.8	0.4 - 1.5
Accidents	28	41.1	0.7*	0.5 - 1.0
Violence	14	21.5	0.6	0.5 - 1.1

* - $p < 0.05$; ** - $p < 0.01$

*** - Expected number of deaths were calculated using mortality rates for basal cell carcinoma, squamous cell carcinoma, and malignant melanoma combined. All observed skin cancer deaths were malignant melanomas.

**** - Cancer of the brain and central nervous system included the following ICD codes: ICD 193 (6th & 7th revision); ICD 191, 192 (8th & 9th revision).

Table 5: Deaths (observed/expected) from selected causes; by duration of employment and latency.

Latency		Duration of Employment					
		<6 mos	6mos -4yrs	5-9 yrs	10-14 yrs	≥15 yrs	Total
<5	all neoplasms	0/1.8	2/3.7				2/5.4
	skin	0/0.1	0/0.1				0/0.2
	brain&CNS	0/0.1	0/0.2				0/0.4
5-9	all neoplasms	4/2.2	1/2.8	4/3.6			9/8.6
	skin	1/0.1	0/0.1	1/0.1			2/0.3
	brain&CNS	1/0.1	0/0.2	1/0.2			2/0.5
10-14	all neoplasms	5/3.3	3/4.1	3/1.7	5/4.1		16/13.2
	skin	1/0.1	0/0.2	0/0.1	2/0.1		3/0.5
	brain&CNS	0/0.2	0/0.2	0/0.1	1/0.2		1/0.6
15-20	all neoplasms	4/4.1	4/4.9	1/2.0	4/3.5	2/2.5	15/17.0
	skin	0/0.1	1/0.2	0/0.1	1/0.1	0/0.1	2/0.5
	brain&CNS	0/0.2	0/0.2	0/0.1	1/0.1	1/0.1	2/0.7
≥ 20	all neoplasms	1/2.8	4/5.2	0/2.4	2/3.4	5/6.2	12/19.4
	skin	0/0.1	1/0.1	0/0.1	0/0.1	0/0.1	1/0.1
	brain&CNS	0/0.1	0/0.2	0/0.1	0/0.1	0/0.2	0/0.6
Total							
	all neoplasms	14/14	14/21	8/10	11/10	7/9	54/64
	skin	2/0.5	2/0.7	1/0.3	3/0.2	0/0.2	8/2.0
	brain&CNS	1/0.7	0/1.0	1/0.4	2/0.3	1/0.3	5/2.8

Expected numbers of skin cancer deaths calculated for basal cell carcinoma, squamous cell carcinoma, and malignant melanoma combined. All observed skin cancer deaths were malignant melanoma.

Expected numbers of cancer of the brain and central nervous system included the following ICD codes: ICD 193 (6th & 7th revision); ICD 191, 192 (8th & 9th revision).

Table 6: Descriptive Statistics of Malignant Melanoma and Brain Cancer Deaths.

Malignant Melanoma

	Sex	Age at death	Hire Date	Diagnosis Date	Date of Death	Microscopic Confirmation	Location of primary
A	F	37	02/58	09/67	11/67	Yes	anterior chest
B	M	44	06/58	10/74	01/75	Yes	scalp
C	M	43	03/59	01/67	03/69	Yes	gallbladder
D	M	52	04/66	08/78	10/81	Yes	neck
E	M	32	08/64	11/72	02/75	Yes*	shoulder
F	M	47	05/59	10/80	06/85	Yes	back
G	M	63	10/66	06/87	06/87	Yes	anterior chest
H	M	68	01/61	11/60	10/75	Yes	back
I	F	40	06/70	05/76	01/77	Yes	unknown

G - malignant melanoma considered a contributory cause of death.
H - began employment two months after diagnosis.

Cancer of the Brain and Nervous System

	Sex	Age at death	Hire Date	Diagnosis Date	Date of Death	Microscopic Confirmation	Histology
AA	M	66	08/74	11/81	10/82	NA	glioblastoma
BB	M	51	03/62	NA	04/75	NA	unknown
CC	F	52	01/59	NA	12/74	NA	unknown
DD	M	45	08/62	03/86	02/87	Yes	glioblastoma
EE	M	67	11/59	11/75	04/76	NA	astrocytoma
FF	M	34	07/58	NA	10/64	NA	astrocytoma
GG	F	44	05/66	NA	01/79	NA	glioblastoma

DD - died of brain cancer after June 30, 1986.
GG - non-white female.

* Pathology report not available. Tumor was microscopically confirmed as a malignant melanoma according to the hospital tumor registry.

NA = medical record or pathology reports could not be obtained. If medical record and pathology report were not obtained, histology refers to statement on death certificate.

Table 7: Work in PCB exposure zones and potential exposure to solvents.

	Malignant Melanoma		Brain Cancer	
	Cases	All Workers in Risk Sets	Cases	All Workers in Risk Sets
N	8	3455	7	1670
Ever working in:				
Zone 1	4	1144	2	618
Zone 2	4	1176	1	554
Zone 3	0	1680	5	790
Zone 4	0	37	1	26
Zone 5	2	1136	2	544
Any job with exposure to:				
Trichlorethylene	0	269	1	111
1,1,1 trichloroethane	1	411	0	179
methyl ethyl ketone	1	133	0	49
toluene & xylene	0	480	0	208

Cases include deaths listing malignant melanoma or brain cancer as an underlying or contributary cause of death with the date of diagnosis following the date of first employment.

Jobs with potential for exposure to various solvents were those in departments where environmental sampling conducted by NIOSH in April 1977 or by the company from 1977 to 1984 found the presence of these solvents.

Table 8: Cox proportional hazards modelling; years since first employment (YSFE), duration (DURATION), and estimates of cumulative PCB exposure.

	N	YSFE mean (s.d.)	DURATION mean (s.d.)	CUMYR mean (s.d.)	DURZONE5 mean (s.d.)	CUM2.5 mean (s.d.)
Malignant Melanoma						
Cases	8	14.5 (6.5)	4.5 (4.5)	8.2 (11.9)	7.3 (10.6)	8.6 (12.5)
All workers in risk sets:	3455	13.5 (6.8)	4.6 (5.5)	10.8 (14.9)	7.2 (11.3)	10.9 (15.1)
Rate Ratio*		1.16	0.82	0.83	0.97	0.85
Lower bound		0.21	0.22	0.47	0.50	0.50
Upper bound		6.48	3.03	1.44	1.88	1.46
Brain Cancer						
Cases	7	14.1 (6.1)	8.8 (6.5)	22.9 (22.0)	14.2 (16.4)	21.8 (20.4)
All workers in risk sets:	1670	14.9 (7.5)	5.2 (5.7)	12.0 (15.8)	8.3 (12.7)	12.1 (16.1)
Rate Ratio		0.54	2.18	1.27	1.18	1.23
Lower bound		0.10	0.61	0.88	0.75	0.84
Upper bound		2.82	7.80	1.86	1.84	1.75

*The rate ratios 95% confidence intervals presented estimate the risk associated with a 10 unit increase in these continuous variables.

CUMYR= estimate of cumulative PCB dose based on duration weighted by distance from capacitor ovens.

DURZONE5= estimate of cumulative PCB dose based on duration with a weight of 5 for days worked in Zone 5.

CUM2.5= estimate of cumulative PCB dose based on duration with a weight of 1 for days worked in Zone 1, a weight of 2.5 for days worked in Zones 2-4, and a weight of 5 for days worked in Zone 5.

Table 9: Malignant melanoma risk factors in case series; results of interviews with next-of-kin.

CASE	A	B	C	D	E	F	G	H	I
Family history	+*	–	–	–	–	–		–	–
Dysplastic mole	+	–	–	–	–	–		–	–
Congenital mole	DK	–	–	–	–	–		–	–
Previous melanoma	–	–	–	–	–	–		–	–
Sun sensitivity	DK	+	–	–	+	–		DK	DK
Celtic origin	DK	–	–	–	+	–		DK	DK

\+ = next-of-kin reported the presence of the risk factor.

– = next-of-kin reported the absence of the risk factor.

DK = next-of-kin did not know.

The next-of-kin for Case G could not be located.

* Spouse's report that case's mother died from malignant melanoma conflicts with patient's medical record which indicated that the mother died of cancer of the female organs.

Table 10: Power considerations for the three mortality studies of electrical capacitor workers exposed to polychlorinated biphenyls.

	Study by Author		
	Sinks et al	Brown et al[5]	Bertazzi et al[6]
N	3583	2588	2150
PYAR	71985	55545	41007
Cancer Outcome Observed/Expected (Study Power*)			
M. Melanoma	8/2.0**	1/1.5 (80%)	0/0.1 (14%)
Brain & CNS	5/2.8**	0/2.7 (30%)	2/0.3 (9%)
Liver & Biliary	1/0.9 (31%)	5/1.9**	2/0.4 (13%)
Rectum	1/1.2 (26%)	4/1.9**	0/0.4 (11%)
Hematopoietic	7/7.2 (99%)	5/7.4 (99%)	7/2.6**
Lung & Bronchus	15/19.2 (99%)	10/16.9 (99%)	4/2.1**

* The power to detect a statistically significant excess of the magnitude reported by one of three studies using a one-sided hypothesis with p less than 0.05.[15]*

** This ratio of observed/expected was used to calculate the power of the other two studies.

Observed and expected numbers for Bertazzi et al come from Nicholson[10].

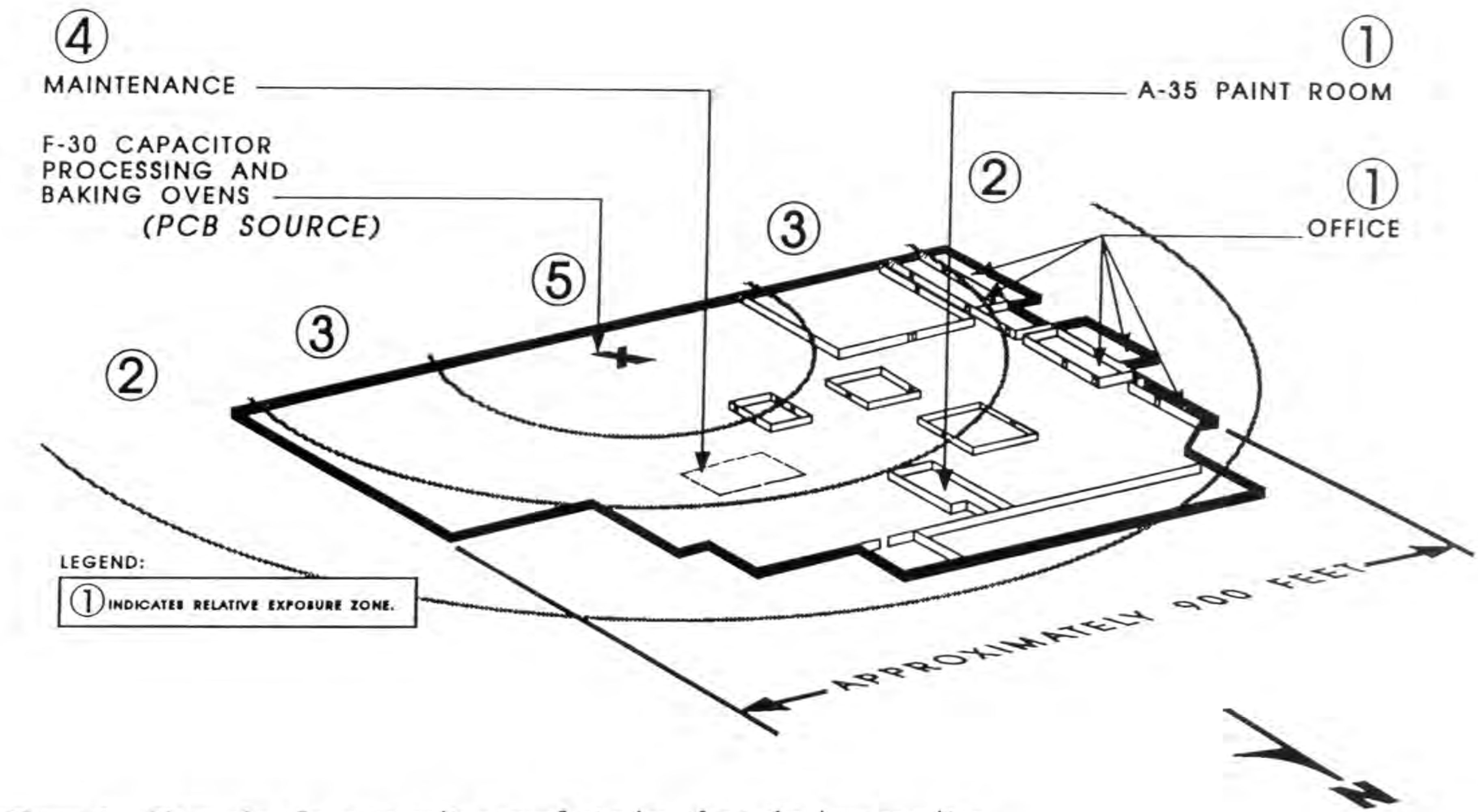


Figure 1: Floor plan for a capacitor manufacturing plant showing capacitor baking ovens and PCB-exposure zones based on a point source exposure.

INCINERATION

March ~~6~~, 1989
20

GN C   Ash Disposal
3/89

LEAGUE OF WOMEN VOTERS OF BLOOMINGTON-MONROE COUNTY

MANAGEMENT OF INCINERATOR ASH

To ensure maximum protection of the environment, the League of Women Voters of Bloomington-Monroe County specifically supports:

1) source separation and recycling - initially to be voluntary, but could be mandatory as soon as feasible;
2) incineration (either waste-to-energy or simple incineration) only if provision is made for a) protection against air and water pollution, and b) testing, proper handling, and safe disposal of fly and bottom ash;
3) pollution controls - for all aspects of solid waste management.

Because landfills are reaching their capacity, and siting for additional space may be difficult or even impossible, incineration is being used increasingly today as an alternative means to deal with the vast amounts of municipal solid waste (MSW) generated each day. MSW incineration reduces the volume of waste that requires landfilling; at the same time, however, it concentrates toxic substances, particularly metals, that are present in the waste stream, by combusting the burnable fraction and leaving behind the unburnable fraction in the form of ash.

To date, little attention has been given to ash, the major product of incineration. However, new information about the nature of ash, and concern over the rapidly growing volume of ash being produced, has renewed interest in the environmental consequences of MSW incineration, particularly in the need to develop proper ash management practices.

MSW incineration produces two types of ash: bottom ash and fly ash. Bottom ash consists of the unburned waste left on the grates after burning. Fly ash is composed of smaller particles which, during incineration, escape the combustion chamber and are carried with gas products up the stack. More recent pollution control devices in the stacks can be effective in trapping and collecting (precipitating) many of the toxic metals in the fly ash so that they do not escape into the air. This has the effect, however, as Environmental Defense Fund attorney Michael Herz has noted, that "incinerators, far from being waste disposal facilities, are processors of municipal trash, and they are processing it into a hazardous waste." Dr. Richard Denison, EDF scientist, points out that "metals are not destroyed by burning, only concentrated in the ash and, under current practices, released back into the environment."

While MSW itself is legally exempt from coverage by the Hazardous Waste Amendments of 1984 to the Resource Conservation and Recovery Act (RCRA), ash residues produced by MSW incinerators are not. Even though fly ash is not listed as a hazardous waste, the EPA has stated that it considers ash produced by MSW incineration to be a hazardous waste (regulated under Subtitle C of RCRA) if the ash exhibits any of the characteristics of hazardous waste, e.g. EP-toxicity. The EP-toxicity is determined by the EPA's "extraction procedure" test, which measures the ability of toxic materials to leach from ash. It measures only that amount which can be solubilized and removed from the particles when they are exposed to water or other solutions. Since leaching is not the only route by which ash can cause exposure to toxics, this test probably underestimates the true risks associated with the high levels of metals in ash. Other routes are airborne dust, particles suspended in surface water, and contaminated soil.

It should be noted - this from the report of the Toxic Substance Control Commission, State of Michigan, August 1988 - that there is some criticism about the reliability of the EP toxicity test, both for testing toxicity and mobility and even for reproducibility in the laboratory on an identical sample. A number of other tests have been developed, but it seems unlikely that a single test can completely account for the high variability in the waste stream and the actual long-term leaching conditions in disposal facilities.

Deciphering the EPA's position has been very difficult because of conflicting statements and continued delays on issuing regulations and even guidance. Congress may eventually make the decision. Several bills have been proposed - as of last year H.R. 4902 and H.B. 4110. The former called in part for improved testing and classification procedures by the EPA.

Even so, virtually all of the fly ash samples that have been tested leach quantities of lead and/or cadmium sufficient to classify the ash as a hazardous waste. These high levels appear regardless of the type of technology employed: testing was done on mass burn and refuse-derived fuel facilities, old, new, large, small, and on facilities employing a wide variety of pollution control devices. "The levels of lead in ash are so high," says Dr. Ellen Silbergeld, EDF's senior toxicologist, "that incinerator ash itself is as dangerous as lead-based paint, the same paint banned in the U.S. in 1973." Nonetheless, in the U.S. ash has largely been disposed of as a non-hazardous waste.

Because fly ash is not specifically listed as a hazardous waste under federal regulations, it is not subject to the RCRA mixture rule, which states that hazardous wastes cannot be mixed with non-hazardous wastes in order to dilute toxic constituents. Nevertheless, the current practice of mixing fly and bottom ash violates the spirit, if the not letter, of the RCRA mixture rule. Moreover, there is little point in requiring operators to install state-of-the-art particulate control devices to prevent fly ash from being dispersed into the air, and then to ignore the dispersal of fly ash via handling, transport, and disposal processes. At least some states (e.g. Washington and California) have designated fly ash as a hazardous waste and require that it be disposed of in accordance with stricter regulations. In Indiana, Senator Vi Simpson had intended to propose, during the current legislative session, that fly ash from incinerators be listed as a hazardous waste in this state, as well. However, she has had so many other environmental concerns of higher priority to her that she has postponed this.

In March of 1987, after compiling data from tests done by the EPA, by state authorities, and by private laboratories, the EDF determined that high levels of toxic metals had been found in ash generated by incineration, and it notified more than 100 of the nation's MSW incinerator operators of these findings. The toxic metals most often found in high amounts were lead, cadmium, arsenic and mercury. These are undisputedly hazardous to human health.

Attached is a summary of the EP leaching tests performed on ash from MSW incinerators, showing high levels of lead and cadmium in the ash. Underlined values represent hazardous waste, i.e. those that exceed the regulatory limits specified by the EPA for identifying a hazardous waste. These limits are 1.0 milligram/liter for cadmium and 5.0 milligrams/liter for lead.

Also attached are tests performed on ash from the Chicago Northwest incinerator built in 1971. Twelve out of twelve tests on the same day (8/10/87) exceeded the regulatory limits for both cadmium and lead in fly ash. Even in the supposedly diluted combined ash (fly plus bottom), ten out of twelve tests exceeded the limit for lead.

As the law stands now, generators are not required to test their ash (and few do) unless they have reason to believe it is hazardous. The point is, no matter what the controversy may be over methods of testing, disposal methods, etc., operators can no longer simply assume that their ash is non-hazardous. The EDF asserts that as a result incinerator operators should be considered legally obligated to test their ash. The EDF has written to public health and solid waste officials and to the attorneys general in the appropriate states to alert them to the legal and public health implications of this new information.

When the State's representatives, Ms. Henson and Mr. Roeter, were here early in February 1989, they told us that Indiana will propose more stringent amendments to the State's new MSW regulations concerning the toxic nature of ash and its subsequent disposal. For example, they will propose that landfills for ash be built equivalent to those for hazardous waste, based on the assumption that MSW exhibits hazardous waste characteristics most of the time.

The League of Women Voters of Bloomington-Monroe County's proposed approach to managing MSW incinerator ash, based on the members' position on solid waste management and on currently available information concerning ash toxicity, is as follows:

1) Frequent, thorough, and separate testing should be carried out on both fly and bottom ash. Tests should be conducted monthly at a minimum, and should include chemical characterization of the ash. If tests indicate that the ash is EP-toxic, it must be managed as a hazardous waste.

2) Strictly controlled handling, transportation, and disposal for all MSW ash. It is poor planning to construct a MSW incinerator without knowing how the ash is going to be managed. Comprehensive "ash management" plans should be a basic requirement for any proposed facility.

3) Fly ash should be listed as a hazardous waste. If testing continues to indicate that fly ash is routinely EP-toxic, it should be specifically listed as a hazardous waste. It is imperative that hazardous materials should not be deposited routinely in sanitary landfills where ground water contamination is imminent. Listing fly ash as a hazardous waste would mean that any combination of fly and bottom ash would also be a hazardous waste, thereby prohibiting the current practice of mixing fly and bottom ash and disposing of the mixture in an unsafe manner.

CONCLUSION: Ash management is just one segment of a truly comprehensive waste management plan designed to deal with the large quantities of MSW that are being generated each day. Recent studies have shown that recycling can significantly reduce the levels of toxics in MSW incinerator ash. Recycling and other means of source reduction can be viewed as alternatives, or at least as complements, to the use of MSW incineration. Achieving improvements in overall MSW management requires attention to all steps of the process, beginning with reduction at the source and ending with the safe management of the ash.

The League of Women Voters of Bloomington-Monroe County will continue to encourage and support comprehensive solutions for managing solid waste, our top priority being waste reduction, through methods that should include source separation and recycling, the "front end" of the waste stream. We are currently participating in the door-to-door publicity campaign for the city's recycling program.

Incineration may need to be used as a complementary alternative to waste reduction, but only with vigorous controls on waste composition, air emissions, and ash residue. Without these controls incineration can not be safe, either for the environment or for human health.

COMBINED ASH

Data Source	Date of Test	Facility Location	Type of Facility	Amount of Metal in Leachate (mg/L) Cadmium	Lead
Signal	1985	Baltimore, MD	MB/2250 tpd/ESP	0.2	0.6-2.4
State of Maryland	1984	Baltimore, MD	MB/2250 tpd/ESP	0.83	12.8
Gascoyne Laboratories	1987	Baltimore, MD	MB/2250 tpd/ESP	0.40	8.4
Signal Co.	1984	Westchester, NY	MB/2250 tpd/ESP	0.3-1.0	0.5-3.7
State of Washington#	1986	East Chicago, IL	MB/150 tpd/Wet Scrubber	---	5.2
State of New York	1986	Oswego, NY	MOD/200 tpd/ESP	0.47	6.5
	1987			0.25-1.1	2.6-16
City of Waukesha##	1985	Waukesha, WI	MB/350 tpd/ESP	1.33	11.3
State of New Hampshire	1986	Portsmouth, NH	MOD/200 tpd/Baghouse	0.25	6.9
State of California	1985	Lassen, CA*	MOD/100 tpd/Baghouse	0.9	6.1
	1983	Chicago, IL (NW)	MB/1600 tpd/ESP	0.71	5.8
		Gallatin, TN	MB/200 tpd/ESP	0.24	6.4
		Hampton, VA	MB/200 tpd/ESP	0.50	10.3
		Auburn, ME	MOD/200 tpd/Baghouse	0.02	3.2
USEPA	1984	Philadelphia (NW)	MB/750 tpd/ESP	0.3	1.8
	1981	Montgomery, OH	MB/900 tpd/none	0.43	1.54
		Chicago, IL (NW)	MB/1600 tpd/ESP	0.25	0.34
		Salem, VA	MOD/100 tpd/none	0.02	0.87
		Nashville, TN	MB/720 tpd/ESP	---	0.7
		Saugus, MA	MB/1500 tpd/ESP	0.8-5.3	6.7-31
EP LIMITS (underlined values exceed these limits)				1.0	5.0

Abbreviations used in table:

MB - mass burn
RDF - refuse derived fuel
MOD - modular mass burn

ESP - electrostatic precipitator
mg/L - milligrams per liter
--- - not available

Underlined values in the table exceed the regulatory limits specified by EPA for identifying a hazardous waste(40 CFR 261.24):

1.0 mg/L for cadmium

5.0 mg/L for lead

Footnotes to table:

* Tests conducted on ash from the Lassen, CA facility employed the California waste extraction test (WET) rather than the EP test. The WET is more aggressive at leaching metals than is the EP. Studies conducted for the California Waste Management Board comparing the two tests indicate that the WET leaches roughly 3 times more cadmium and 5 times more lead than does the EP. Applying these factors to the Lassen data shown in the table, fly ash could be expected to still significantly exceed the EP limits, while combined ash would be under the limits. All other results shown in the table were determined using the EP.

** Individual facilities were not identified in the original Washington study. Their identity was obtained through a Freedom of Information action under state public disclosure laws.

Combined ash from an additional facility (Glen Cove, NY) was tested and found not to exceed the EP limits, although leachate values were not given. This sample would nevertheless be designated as hazardous waste under additional criteria used by the State of Washington (but not used by EPA).

The EP values for cadmium and lead represent averages of 24 samples collected from the Waukesha facility over an 8-day period. Cadmium ranged from 0.72 to 1.99 mg/L, with 19 of the 24 samples over the EP limit of 1.0 mg/L. Lead ranged from 2.68 to 39.1 mg/L, with 20 of the 24 samples over the EP limit of 5.0 mg/L.

Exhibit 4 ILL. EPA

ASH FROM CHICAGO NORTHWEST INCINERATOR BUILT 1971

		CADMIUM EP (mg/L)*	CADMIUM TOTAL (ppm)	LEAD EP (mg/L)*	LEAD TOTAL (ppm)	PH INITIAL	PH FINAL
ESP Ash							
8/10/87	8:45	<u>10.20</u>	285.00	<u>29.90</u>	10325.0	10.0	5.7
	9:50	<u>3.80</u>	152.00	<u>28.10</u>	5800.0	11.9	5.3
	10:45	<u>10.90</u>	292.50	<u>35.30</u>	11463.0	7.1	5.3
	11:50	<u>6.90</u>	196.25	<u>31.45</u>	8405.3	10.8	5.6
	12:40	<u>3.00</u>	89.25	<u>26.65</u>	3981.3	11.8	5.3
	1:45	<u>7.05</u>	207.50	<u>31.40</u>	8000.0	11.4	5.7
	2:45	<u>1.22</u>	51.00	<u>7.52</u>	2910.0	12.1	5.8
	3:45	<u>4.45</u>	128.00	<u>28.25</u>	5106.3	11.6	5.6
	4:50	<u>6.10</u>	164.50	<u>17.33</u>	5743.8	11.3	6.4
	5:45	<u>5.40</u>	144.00	<u>20.80</u>	4968.8	11.8	6.0
	6:50	<u>3.95</u>	148.00	<u>9.93</u>	4456.3	12.1	6.4
	7:40	<u>2.92</u>	82.50	<u>26.25</u>	4218.8	11.8	5.6
	MEAN	<u>5.49</u>	161.71	<u>24.41</u>	6281.6	11.1	
Combined Ash							
8/10/87	8:45	0.78	58.50	<u>8.39</u>	5006.3	10.0	5.3
	9:50	<u>1.18</u>	48.50	<u>17.15</u>	3377.5	11.7	5.2
	10:45	0.99	49.50	<u>30.25</u>	4143.8	11.5	5.1
	11:40	<u>1.74</u>	51.75	<u>12.48</u>	2869.0	11.7	5.2
	12:40	0.254	19.00	<u>7.19</u>	1742.5	11.8	5.0
	2:40	0.34	20.50	4.01	2545.0	11.9	5.2
	3:45	0.24	15.00	2.64	1301.3	11.8	5.1
	4:50	0.93	45.75	<u>7.79</u>	3027.5	11.9	5.3
	5:45	0.50	39.25	<u>6.02</u>	2335.0	11.9	5.0
	6:50	0.39	30.75	<u>18.53</u>	3450.0	11.8	5.0
	7:40	0.16	27.25	<u>7.56</u>	3145.0	11.6	5.1
	MEAN	0.68	36.89	<u>11.09</u>	2994.8	11.6	

* Underlined values are above the EPTOX regulatory limits: cadmium 1.0 mg/L; lead 5.0 mg/L

SOURCE: Special Analysis Forms of the Illinois Environmental Protection Agency, Division of Land/Noise Pollution Control, sampling dated August 10, 1987.

1% OF ASH IS LEAD

85,000 TONS ASH/YR.

Exhibit 4

Westinghouse Electric Corporation

Advanced Power Systems Divisions

Waste Technology Services Division

Box 286
Madison Pennsylvania 15663-0286
(412) 722 5000

TSS:TAZ:87-017

January 23, 1987

Valdas V. Adamkus
Regional Administrator
U.S. EPA Region V
230 South Dearborn Street
Chicago, Illinois 60604

Dear Mr. Adamkus:

Attached for your information is a preliminary risk assessment for the PCB incineration phase of the Bloomington incinerator. This risk assessment supplements the information contained in the application for a TSCA Facility Permit and Trial Burn Approval submitted to your office on 12 January 1987.

This risk assessment is based upon the incinerator design described in the TSCA Permit Application. It should be regarded as preliminary because the detailed facility design is not yet complete. As has been discussed with members of your staff, as the design process continues, additional information on the design will be submitted to your office to append to the TSCA Permit Application. When the design process is fully complete, Westinghouse will complete a more comprehensive risk assessment for the PCB incineration phase of the Bloomington Project.

If you have any questions, please call T. A. Zordan of my staff at (412) 722-5299.

Sincerely,

E. P. Rahe
General Manager
Environmental Technology Division

Attachment

RISK ASSESSMENT:

SCOPING STUDY OF INCINERATION OF PCB CONTAMINATED LANDFILL MATERIAL

1.0 Purpose and Limitations of the Scoping Study

As a portion of the studies that have been performed on the Bloomington Incinerator, a risk assessment of the MSW phase of operations has been conducted (Westinghouse Electric Corp., Bloomington Incinerator Project Risk Assessment, 1986). That risk assessment covers:

- o releases from normal and off-normal operating conditions
- o pathways of human exposure
- o risk related impacts

For the PCB incineration phase, several operational differences will occur whose impact on potential exposure and risk are expected to be minimal. This is because the same quantity of MSW will be incinerated in both phases and because of the low level of average PCB contamination on the excavated soils. In addition, the incinerator will be operated at a higher temperature (2200^{o}F vs 1800^{o}F) in the PCB incineration phase than in the MSW phase. This PCB phase scoping study provides a means of identifying some of the potential effects of the co-incineration of MSW and PCB containing landfill material.

The MSW phase risk assessment indicated that all the scenarios which are the leading contributors to risk are based on chronic exposure to steady- state emissions to the atmosphere. Upset conditions, acute exposures or groundwater considerations were shown not to be leading contributors to risk.

The MSW phase risk assessment concluded that the upper bound of potential cancer risk does not exceed 10^{-6} (1 in 1 million) for any of the potentially carcinogenic emissions. In addition, the exposure to non-carcinogenic chemicals is significantly below the health criteria levels.

Consequently, this scoping study includes only an evaluation of the potential steady-state, chronic impacts of increased PCB concentrations in the feed material to the incinerator. This evaluation can be made in a rather straightforward manner because the amount of MSW used as fuel in both phases of the project is expected to be the same (normally 210 tons per day). The excavated landfill material (ELM) that will be co-incinerated with the MSW contains PCB's. The fundamental plant operational difference in the PCB phase will be the operation of the afterburner at 2200^{0}F, rather than 1800^{0}F. This operational difference will have an impact on the potential emission of hydrocarbons, including PCBs.

2.0 PCB Emission Factor

The PCB stack emission factors used in the MSW risk assessment were based on stack measurements taken at operating MSW incinerators. These emission factors are presented in Table 1. As discussed in Chapter 6 of the Risk Assessment, the use of those emission factors was judged to be conservative for the MSW phase of the Bloomington Incinerator, because of its appreciably longer gas phase residence time at elevated temperatures (1800^{0}F) than is typical in MSW incinerators. Thus, the Bloomington Incinerator is expected to have lower PCB emissions than those used in the MSW incineration risk assessment.

Because there is no direct way to adjust the MSW phase PCB emission factors for the opposing factors of increased PCB input and increased afterburner operating temperature in the PCB phase, it was decided to estimate the PCB emission factors from the basic design and performance characteristics of the facility.

Table 2 presents the basic data for the Bloomington Incinerator during the MSW incineration and PCB incineration phases. Figure 1 presents operational information for the combustion train during the MSW incineration and PCB incineration phases.

To estimate the PCB emission factors and corresponding stack emission, the following model was used:

(1) It was assumed that the MSW used as fuel contained 50 ppm PCB's. This value was chosen because it is the regulatory limit for disposal of PCB's in sanitary landfills. As such, it represents a conservative maximum for the level of PCB's expected to be present in the residential and commercial solid waste which compose the MSW in Bloomington and Monroe County.

(2) The excavated landfill material is assumed to contain 250 ppm PCB. Prior estimates of the PCB concentration in the sites covered by the Consent Decree have concluded that 50 ppm is a reasonable average value. Some individual spot analyses exceed this range, but since this scoping study is based on a long-term, steady-state emission, the use of an average PCB concentration of 250 ppm is a very conservative approach.

(3) The incinerator will operate with the afterburner at 2200^{o}F ($\pm$180^{o}F) as as will be required by the TSCA permit.

(4) The incinerator will operate with the 99.9999% Destruction Removal Efficiency (DRE) as will be required by the TSCA permit. This performance will be verified in the TSCA trial burn before the Bloomington Incinerator goes into service to co-incinerate MSW and PCB containing ELM.

(5) The processing data presented in Table 2 and Figure 1 are used as the nominal steady-state operating values.

This model is applied to the PCB incineration phase. The mass of PCB incinerated (per unit time) is found from the equation.

$$M_{pcb} = M_{msw} \times 50 \text{ ppm} + M_{elm} \times 250 \text{ ppm}$$

Note that the presence of sewage sludge is not included. The sewage sludge from the Dillman Road Sewage Treatment Plant (DRSTP) is very small in comparison to the amount of MSW and ELM processed daily. In addition, the DRSTP has been shown to contain no PCB contamination.

The PCB feed to the incinerator (M_{pcb}) is then modeled to undergo incineration at the DRE for the plant. The remaining PCB, per unit time, is given by the expression

$$M'_{pcb} = 0.000001M_{pcb}$$

Thus, M'_{pcb} corresponds to the emission rate (gm per unit time) of PCB which is potentially available for release from the stack. This value would be reduced by adsorption on fly ash particles, condensation caused by temperature reduction in the boiler sections and air pollution control systems (APCS) and removal by the scrubber/baghouse. (Recent tests in Canada have shown that the APCS is effective in removing more than 99% of the PCB from the flue gas stream.)

The stack gas concentration of PCB is found by the expression

$$C_{pcb} = M'_{pcb}/V_{stack}$$

Where C_{pcb} is the stack gas concentration of PCB and V_{stack} is the volumetric flow rate of flue gas in the stack (Figure 1). When M'_{pcb} is reduced by the action of the APCS, the value of C_{pcb} is reduced by a corresponding factor.

The PCB emission rate is the product of the stack flow rate and the stack gas concentration.

3.0 Results and Conclusions

The stack PCB emission during steady-state ELM incineration is presented in Table 3. It can be seen that the stack emissions are a factor of 10 below the stack emissions used in the MSW phase risk assessment . That emission corresponded to a very low risk factor for the the population, even taken over an assumed 20 year MSW incinerator operating period. Since the PCB incineration stage must be completed within 15 years, and since the PCB stack emissions are less than that incorporated into the MSW phase risk assessment, the risk to the population from the increased PCB present in the ELM is bounded by the results of the PCB risk determined for the MSW incineration phase.

In summary, this scoping study has been completed for the steady-state co-incineration of MSW and PCB containing ELM materials. The PCB stack emissions caused by presence of the increased PCB concentration in the feed material to the incinerator are shown to be below those PCB stack emissions incorporated into the MSW incineration risk assessment. Consequently, the risks to the public from exposure to these emissions should be bounded by the risks from PCB emissions discussed in the MSW risk assessment.

In the future, the MSW phase risk assessment will be supplemented by a PCB phase risk assessment that is more comprehensive than this scoping study. Other emissions, off-normal plant operating conditions and other potential sources of risk will be evaluated. However, this scoping study provides a measure of assurance that the risks associated with the PCB incineration phase will be comparable to those identified in the MSW phase.

TABLE 1
DATA ON DISTRIBUTION OF PCB EMISSIONS FROM OPERATING MSW INCINERATORS

FACILITY	TEST RUNS	UNITS REPORTED	ug/Nm3[a]
Chicago, N.W.		ng/m^3,dry	
	1	20	0.026
	2	13	0.018
	3	93	0.135
	average	42	0.060
Prince Edward Island		ng/Nm^3,@12%CO2 dry	
	average of 3 runs	801	0.801
Undisclosed[b]		ng/m^3,dry	
	1	130	0.129
	2	1100	1.067
	3	800	0.888
	4	900	0.928
	5	450	0.447
	average	676	0.692
Average			0.518
Maximum			0.801
Minimum			0.060

[a]micrograms per normal cubic meter; reported values converted to 12% CO2,dry

[b]Site not identified. See Chapter 6 of the Risk Assessment for additional information.

TABLE 2

BLOOMINGTON INCINERATOR PROCESS DATA

(2 INCINERATION TRAINS IN OPERATION)

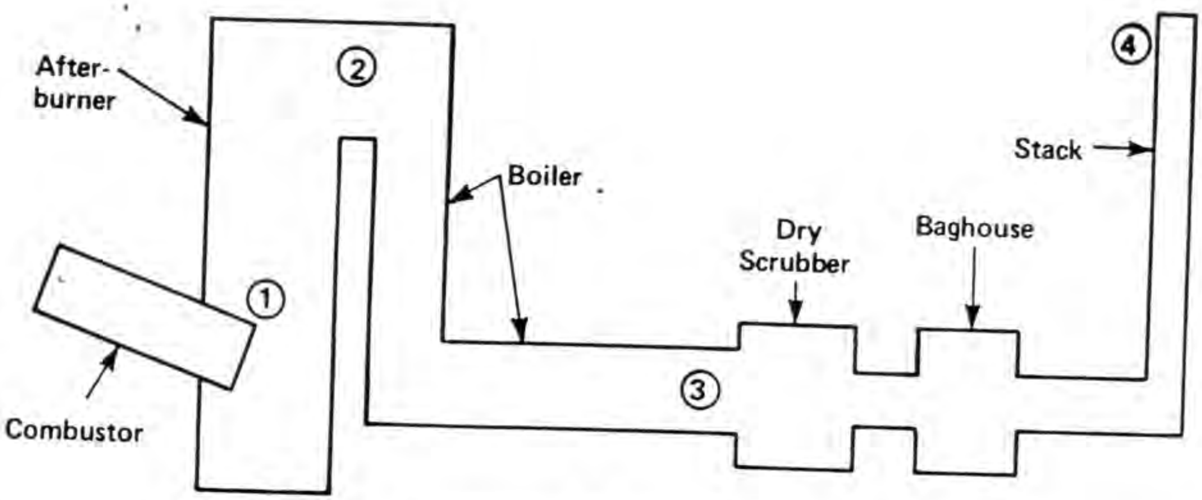
	MSW INCINERATION	PCB INCINERATION
MSW Processed (tons/day)	210	210
Sludge Processed (tons/day)	10	10
ELM Processed (tons/day)	0	147
Air Supplied (lb/hr)	101936	127406
Stack Gas Flow Rate (dry Nm^3/min)	551	675

TABLE 3

PCB STACK EMISSIONS

		PCB (gm/min)
MSW Phase		2.85×10^{-4}
PCB Phase		
Unabated		0.297×10^{-4}
Abated	50%[a]	0.148×10^{-4}
	90%[a]	0.030×10^{-4}
	99%[a]	0.003×10^{-4}

[a]Percent Efficiency of APCS



		1	2	3	4
MSW[(a)] Phase	Flue Gas (Single Train)	57911 ACFM	57911 ACFM	21430 ACFM	276 Nm^3/min (Dry)
	Temperature	1864°F	1864°F	400°F	225°F
PCB[(b)] Phase	Flue Gas (Single Train)	58829 ACFM	84358 ACFM	27273 ACFM	338 Nm^3/min (Dry)
	Temperature	1825°F	2200°F	400°F	225°F

(a) 210 Tons/Day MSW, 10 Tons/Day Sludge (Two Trains)

(b) 210 Tons/Day MSW, 10 Tons/Day Sludge, 147 Tons/Day ELM (Two Trains)

Figure 1. Operational Information

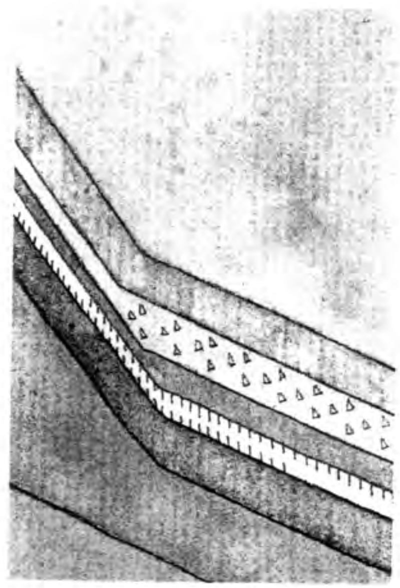
767569-1A

The

Bloomington

Ash

Landfill



Answers To Your Questions

The Westinghouse Landfill

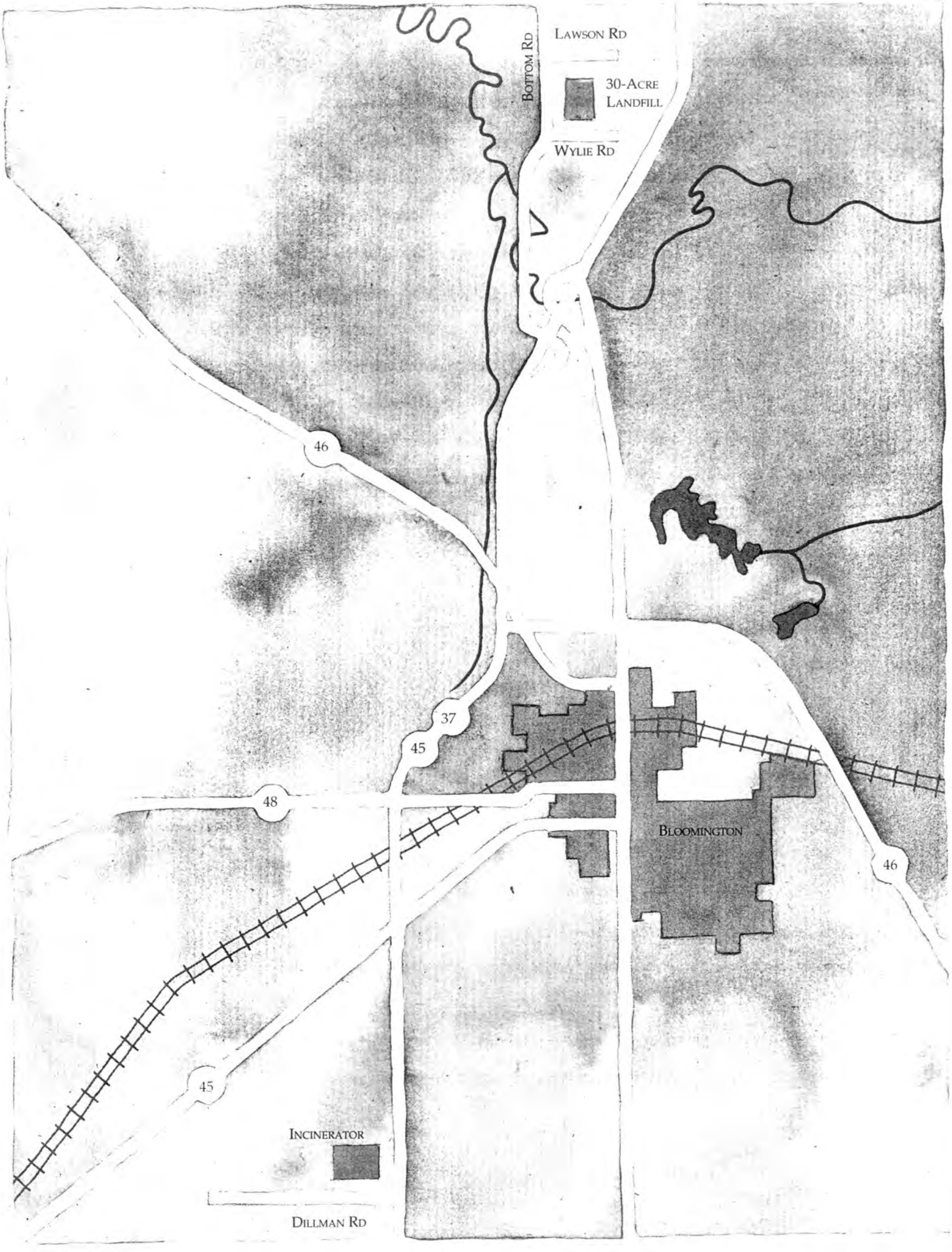
Westinghouse Electric Corporation plans to build a small, 30-acre landfill on a 247-acre tract off Route 37 and bordering Bottom, Lawson and Wylie Roads in Washington Township. The landfill will be used exclusively for materials processed during the Bloomington PCB cleanup.

The site on which Westinghouse will build its landfill was chosen following an intensive review of numerous potential sites throughout Monroe County. A geological analysis of the selected site has shown that it is geologically sound and well-suited for a landfill.

Westinghouse, which will build and operate a first-class facility in compliance with all laws and regulations, fully realizes the mere mention of a landfill can cause anxiety. That is why the corporation will provide information regarding all aspects of the landfill and its operation.

This booklet should answer many of the questions you and your neighbors might have about the landfill. If you have additional questions, please contact us.

The Westinghouse landfill will be built in one of the most geologically sound areas in Monroe County. It will be located off state route 37 six miles north of Bloomington. Other boundaries are Bottom, Lawson and Wylie Roads.



Lawson Rd
Bottom Rd
30-Acre
Landfill
Wylie Rd
46
37
45
48
Bloomington
46
45
Incinerator
Dillman Rd

Q. Why does Westinghouse need a landfill in Monroe County?

A. Westinghouse Electric Corporation is cleaning up PCB contamination at several sites in and around Bloomington. Under terms of the consent decree which governs the cleanup, Westinghouse will build an incinerator which will burn municipal solid waste—trash—to generate heat to safely and efficiently destroy PCBs in approximately 650,000 cubic yards of soil.

Regulations require that ash, the byproduct of municipal solid waste incineration, and the decontaminated material from the consent decree sites, be placed in regulated landfills. Westinghouse, therefore, must build a landfill to house the ash and the other materials which will be processed through the incinerator.

Q. What other material will Westinghouse put in its landfill?

A. The landfill will be used solely for incinerator ash, processed material and nonincinerables originating from the sites outlined in the consent decree.

The Westinghouse landfill will include two synthetic liners similar to the one being installed here. The synthetic liners are an integral part of the landfill's advanced collection and monitoring system that will virtually eliminate the potential for leaks.

Q. Will Westinghouse operate the landfill commercially?

A. No. The landfill will be used exclusively for locally originating, cleanup-related material. Westinghouse will accept no other waste of any type at its landfill.

Q. What assurances can Westinghouse provide to show it will build and operate its landfill in a responsible manner?

A. The law requires that Westinghouse submit detailed design and construction plans to the Indiana Department of Environmental Management (IDEM) and the EPA well before any construction can begin. Once the plans are approved, the regulatory agencies will monitor construction and operation to further ensure the landfill's integrity.

Q. Why will the incineration of the PCBs create ash?

A. Ash is the primary byproduct of municipal solid waste incineration. The ash that Westinghouse will place in the landfill will result from the use of municipal solid waste as a fuel source to provide heat to destroy the PCBs in the contaminated material.

However, only about 150,000—or 18 percent—of the 800,000 cubic yards of material which will be placed in the landfill will be ash. The remainder will be processed and cleaned excavated landfill material originating from the contaminated sites.

Q. But won't ash and the processed material be tainted with PCBs?

A. During the first stage of incineration, the PCBs—exposed to temperatures in excess of 1,400 degrees Fahrenheit in the rotary combustor—will volatilize or "boil off" to a specially designed gas-fired afterburner which will permanently destroy the PCBs. Both the municipal solid waste, which will continue to burn until reduced to ash, and the excavated landfill materials will be essentially free of PCBs.

In fact, U.S. EPA regulations for PCB incinerators require that concentration levels of PCBs in ash must be below two parts per million. This level is far below 50 parts per million, the level of concentration below which the EPA requires no treatment.

Q. Will PCBs be released into the atmosphere?

A. No. The volatilized PCBs, exposed to temperatures in the 2,200 degree Fahrenheit range in the afterburner, will be permanently destroyed.

Q. If incineration is so efficient why is the ash byproduct so heavily regulated?

A. Concern for the environment is heightening, and this is reflected in the regulations which govern many segments of life in modern society. When the consent decree was signed, the regulations in effect allowed incinerator ash to be placed in more traditional landfills. Today, even though the material that will result from the incineration process is classified non hazardous, regulations require that it be placed in "special waste" landfills.

Westinghouse, in anticipation of even more stringent regulations in the future, will go one step further and construct its landfill to the more stringent hazardous waste specifications.

In addition to the synthetic liners, the Westinghouse landfill will be constructed on top of both recompacted and naturally occurring clay barriers.

Q. Isn't it possible that Westinghouse is building its landfill to hazardous waste specifications because the corporation isn't convinced the incinerator can actually destroy PCBs? In other words, is it possible that Westinghouse believes its ash may still be contaminated with high levels of PCBs?

A. Westinghouse's decision to build its landfill to hazardous waste specifications is simply an effort to provide a first-class facility to house the decontaminated materials and ash. Westinghouse is convinced the incinerator will effectively destroy the PCBs. The corporation is confident of this because the thermal destruction of PCBs is a proven technology. When PCBs are exposed to temperatures of 2,200 degrees Fahrenheit for two seconds, they are destroyed. Westinghouse's incinerator, using municipal solid waste and natural gas as fuel, will easily produce temperatures required to destroy the PCBs.

Q. Why doesn't Westinghouse transport the ash to existing landfills?

A. No existing commercial landfills in Indiana have the volume capacity for the materials which will be processed by the Bloomington incinerator. Even if a commercial facility were able to accept the materials, the cost of transportation alone would be excessive.

Q. The Bloomington incinerator will generate more byproduct material than is now present at the consent decree sites. Why doesn't Westinghouse eliminate the incineration step and move the contaminated material directly into the landfill?

A. Westinghouse has no choice. The consent decree which ended the litigation brought against Westinghouse by the EPA, the state, city and county requires that the PCB-contaminated material be destroyed through incineration. In addition, U.S. EPA regulations require treatment of PCB contaminated soils, effectively preventing direct landfilling.

Q. How will the landfill be constructed and what precautions will be taken to protect groundwater?

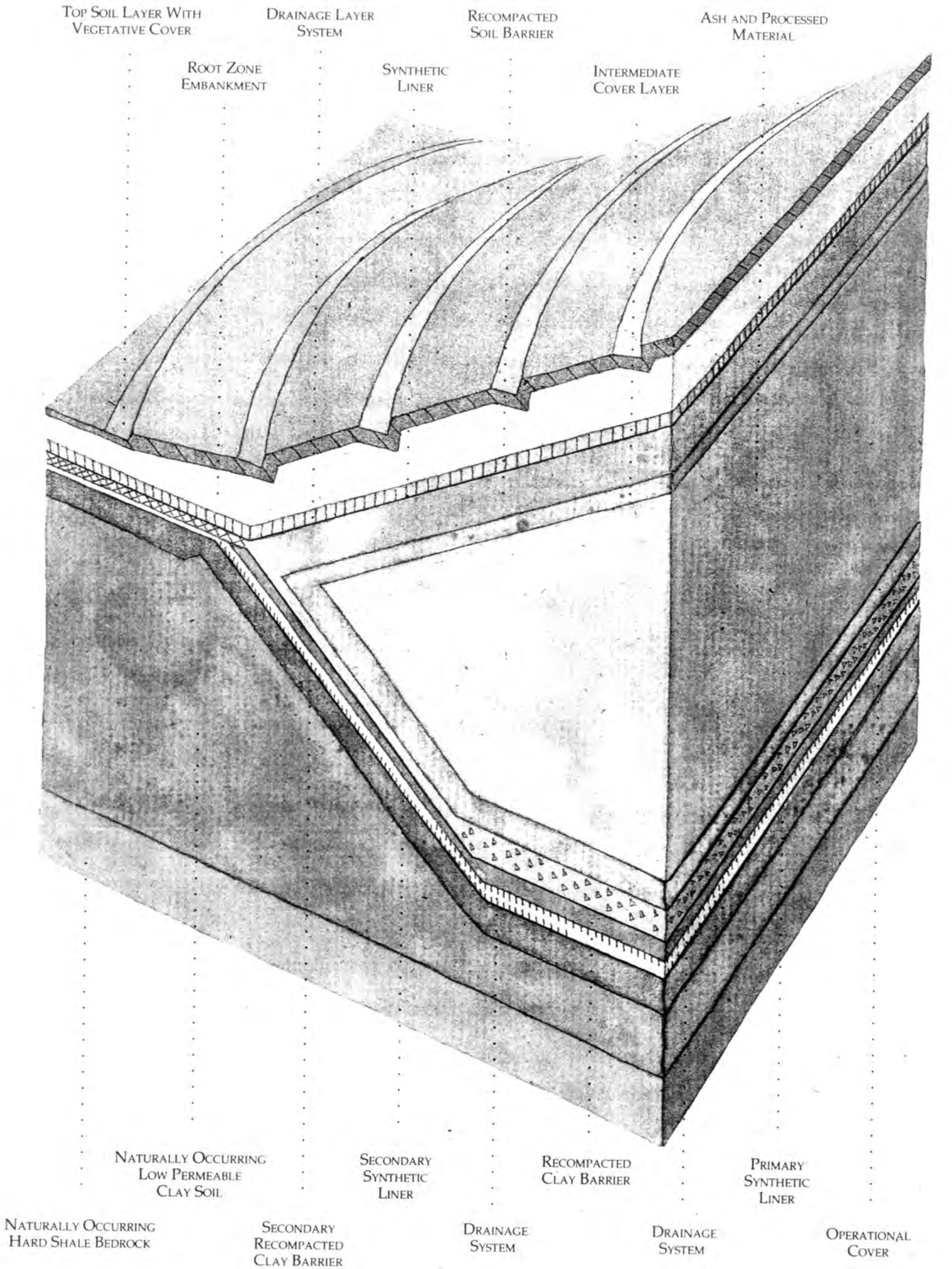
A. Construction and operation of the Westinghouse landfill will comply with all state and federal regulations, with protection of groundwater the primary consideration.

For example, the landfill will include two separate advanced fluid collection and monitoring systems to ensure that any potentially contaminated liquid is captured well before it can threaten groundwater. In addition, the landfill will be built on solid clay and bedrock, away from any karst areas.

Q. Many experts have said that all landfills, no matter how well built, will eventually leak. What does Westinghouse believe?

A. No liquid wastes of any type will be placed in the Westinghouse landfill. And since specific precautions will be taken to preclude rain water and runoff from entering the landfill, the potential for any leak at all is greatly reduced.

Additionally, the double fluid collection systems will direct any migrating fluids to designated collection and monitoring areas. In other words, the Westinghouse landfill will be designed, built and operated in a manner that virtually eliminates the potential for leaks.


Top Soil Layer With Vegetative Cover
Drainage Layer System
Recompacted Soil Barrier
Ash and Processed Material
Root Zone Embankment
Synthetic Liner
Intermediate Cover Layer
Naturally Occurring Low Permeable Clay Soil
Secondary Synthetic Liner
Recompacted Clay Barrier
Primary Synthetic Liner
Naturally Occurring Hard Shale Bedrock
Secondary Recompacted Clay Barrier
Drainage System
Drainage System
Operational Cover

Q. In what manner will collected liquids be disposed?

A. Any collected material will be monitored, treated and then disposed of in compliance with all laws and regulations.

Q. What other design characteristics will the landfill feature?

A. The foundation of the Westinghouse landfill is a layer of low permeable recompacted clay resting on top of naturally occurring low permeable clay which rests on hard shale bedrock.

The recompacted clay barrier will be covered with a synthetic liner and a drainage layer which will promote effective drainage to a designated collection area of any fluids which might migrate through the landfill.

The drainage bed will be covered with another recompacted clay barrier and another synthetic liner. Another drainage bed will rest on this synthetic liner. Overlying the drainage layer will be a soil operational cover.

Ash and other material brought to the landfill will be placed directly on this top layer.

Q. How can Westinghouse build a landfill in Monroe County, which is known for its karst geology?

A. The site on which Westinghouse will build its landfill was chosen following an intensive, one-year study of virtually every potential site in Monroe County. Additionally, comprehensive geological evaluations of the site prove it to be geologically sound and well-suited for a landfill.

Even though karst terrane is prevalent in this part of Indiana, the Westinghouse landfill will not be built on karst. Instead, the landfill will sit on top of between 10 and 60 feet of geologically stable, naturally occurring, low permeable clay which rests on hard shale bedrock. There are no caverns, crevices or sinkholes that in any way could affect the safe and effective operation of the landfill.

Q. Doesn't the site rest in a floodplain?

A. No. The lower portion of the property Westinghouse will purchase does become flooded in the spring, but that area is well below the actual landfill site. The site itself rests outside the 100-year flood line as determined by the Federal Emergency Management Agency.

Q. How many truckloads of material will be delivered to the landfill each day and on what routes will the trucks travel?

A. On average, approximately 17 trucks per day will visit the landfill. The trucks will travel (see accompanying map) from the incinerator site on Dillman Road to the landfill via state route 37. No trucks will travel through downtown Bloomington and all trucks and drivers will operate under strict safety guidelines. All trucks will be inspected regularly to ensure they remain in optimum operating condition.

Q. What precautions will be taken to ensure ash does not fall from the trucks along the route?

A. All trucks will be cleaned before leaving both the incinerator site and the landfill. Additionally, all material will be covered during transit to prevent any release.

Q. What precautions will be taken to control dust from the landfill?

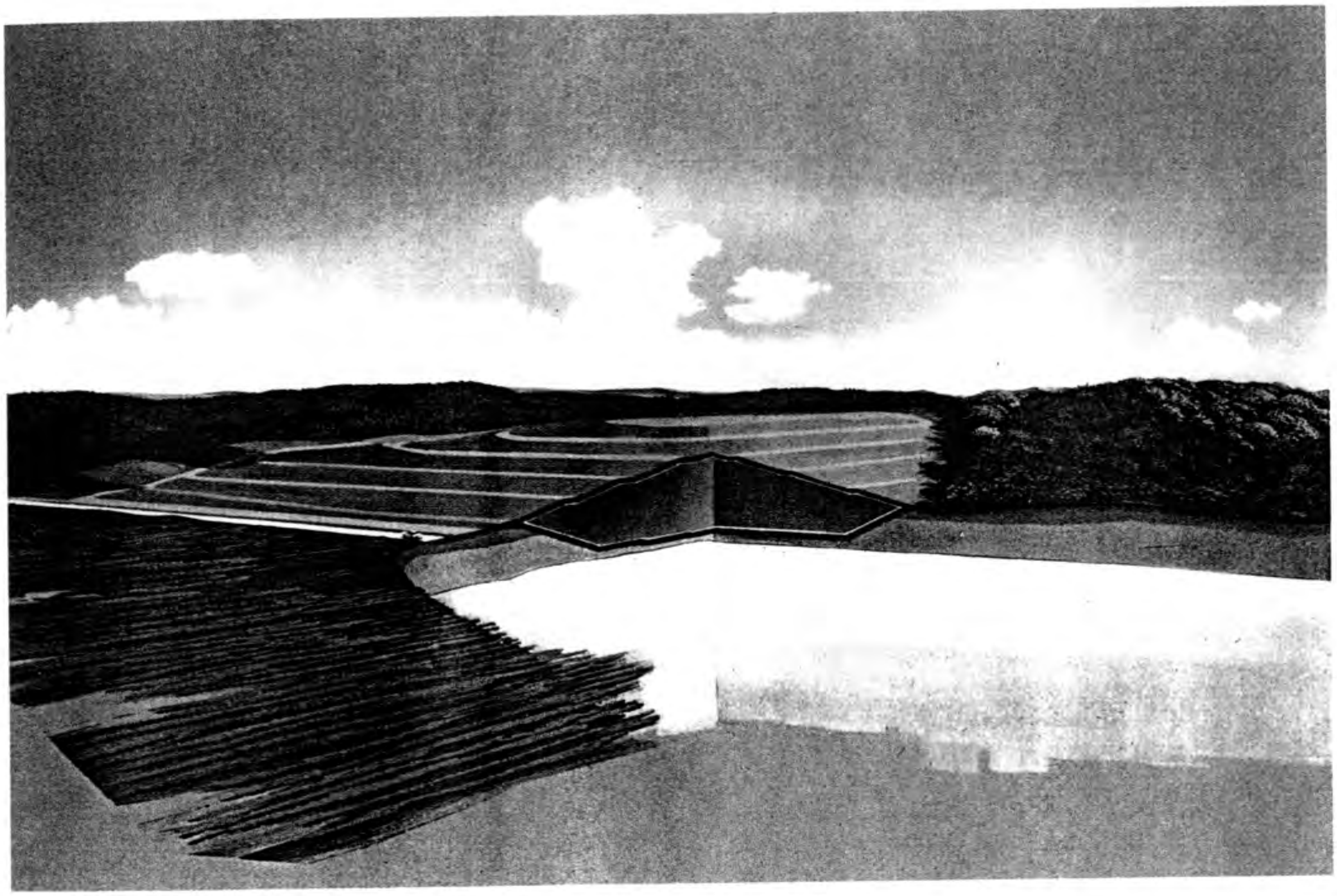
A. It is important to realize that the ash to be placed in the landfill is quite different from fireplace ash. The ash from the incinerator will be thick and dense, making it highly unlikely to become airborne. Additionally, all material brought to the landfill will be covered daily to control dust.

Q. What impact will the landfill have on the surrounding area?

A. Westinghouse will make every effort to build and operate the landfill in a manner that has as little impact as possible on the surrounding area.

For example, the company will construct well-contoured earthen barriers, complete with ground cover, trees and shrubs, to shield the landfill from Bottom Road. Other roads bordering the property Westinghouse will buy will be shielded from the actual landfill by naturally occurring trees and hills.

Additionally, any area of the site which is disrupted during construction or operation will be replanted so that the site remains as aesthetically pleasing as possible.



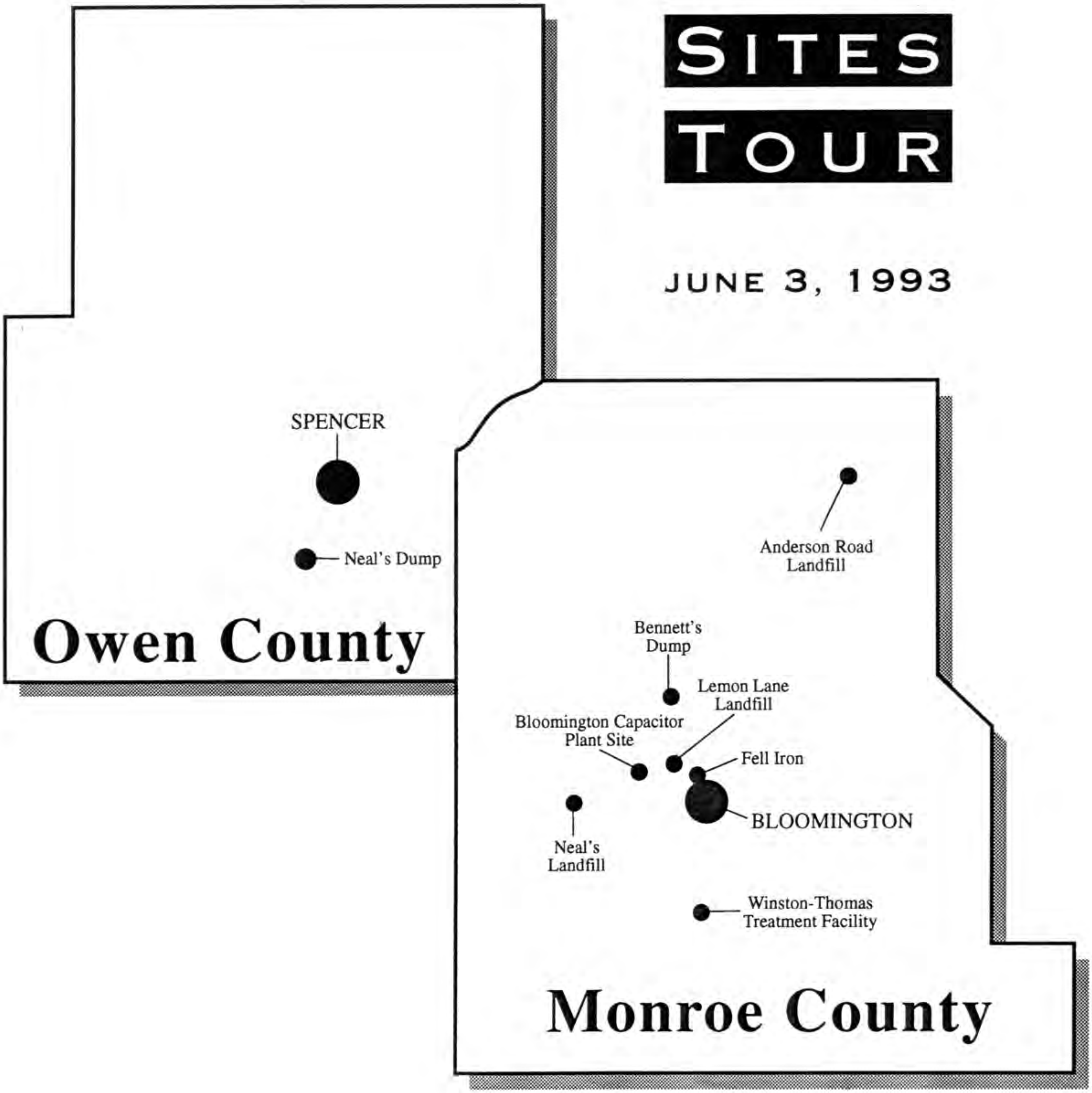
When the Bloomington project is completed, the landfill will be terraced and completely replanted as shown above. The brown area under the terraces represents the material to be placed in the landfill. The gray areas represent the low permeable, naturally occurring clay and hard shale bedrock on which the landfill will be built.

THE

SITES

STATE OF THE SITES TOUR

JUNE 3, 1993



Westinghouse Electric Corporation

Bloomington Project

1501 Ardmore Boulevard
Pittsburgh, Pennsylvania 15221
(412) 247-6400
WIN 262-6400

June 3, 1993

This state of the sites booklet provides current "snapshots" of the six sites included in the 1985 consent decree governing the PCB cleanup in Monroe and Owen Counties. It also summarizes the condition of two sites the federal Environmental Protection Agency (EPA) added to Westinghouse's cleanup obligations after the consent decree was reached.

The consent decree sites are Lemon Lane Landfill, Neal's Landfill, Neal's Dump, Bennett's Dump, the Winston-Thomas Treatment Facility and Anderson Road Landfill. The remaining two sites are the Fell Iron Site and the former Westinghouse Bloomington capacitor plant, now owned and operated by Asea Brown-Boveri.

The consent decree outlines specific steps required to remove potential public and environmental risks from PCB-bearing materials at the sites. The agreement also details a number of site remediation activities. Westinghouse completed these protective measures in the late 1980s, with full approval and cooperation from the government consent decree parties.

On the following pages, you'll find an outline of what Westinghouse has done to meet its commitments at each of the sites. Westinghouse, in conjunction and cooperation with the government consent decree parties, continues to monitor and study the sites. Over the years, Westinghouse, the federal EPA and other government consent decree parties have performed a number of site investigations including:

Geophysical surveys
Surface water monitoring
Sediment sampling
Precipitation monitoring
Air sampling
Hydraulic conductivity testing
Aerial photo analysis
Springs monitoring
Soil Sampling
Seismic refraction surveys
Fish sampling
Groundwater elevation monitoring
Groundwater monitoring
Bedrock sampling
Sludge sampling
Gravity surveys
Groundwater dye tracer tests

These studies examine potential environmental pathways to human exposure. We are pleased to report that analyses to date show that potential PCB exposure from these sites is small to negligible. This finding is consistent with a study conducted last year by the Indiana Board of Public Health. The study concluded that Monroe County residents do not have higher PCB blood serum levels than residents in other areas of the country.

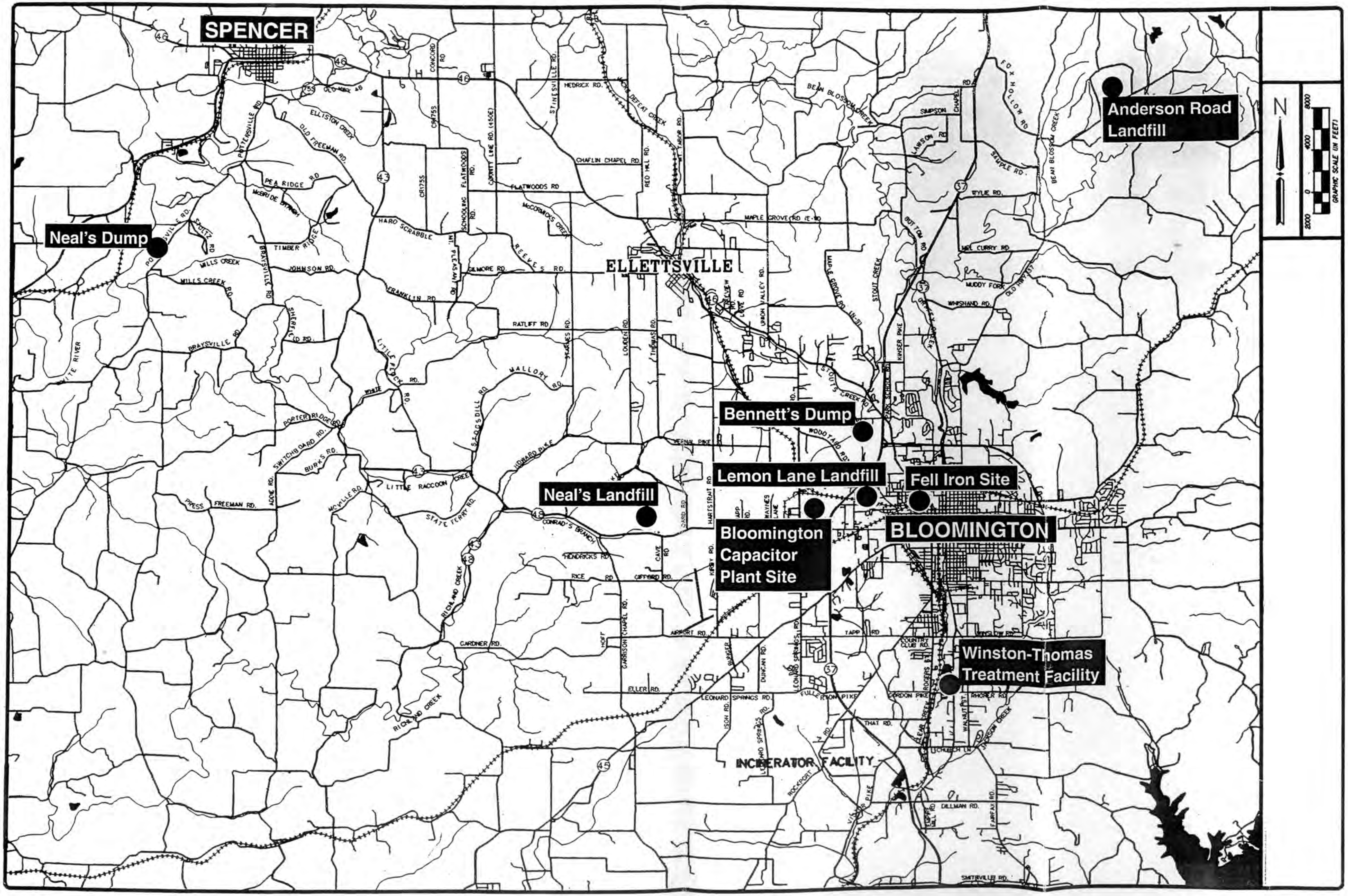
We have made our site study findings available to the Agency for Toxic Substances and Disease Registry (ATSDR), a sister agency of EPA, and the State Department of Public Health. They are working together on still another evaluation of potential local PCB exposure.

As always, we welcome and encourage your views.

Sincerely,

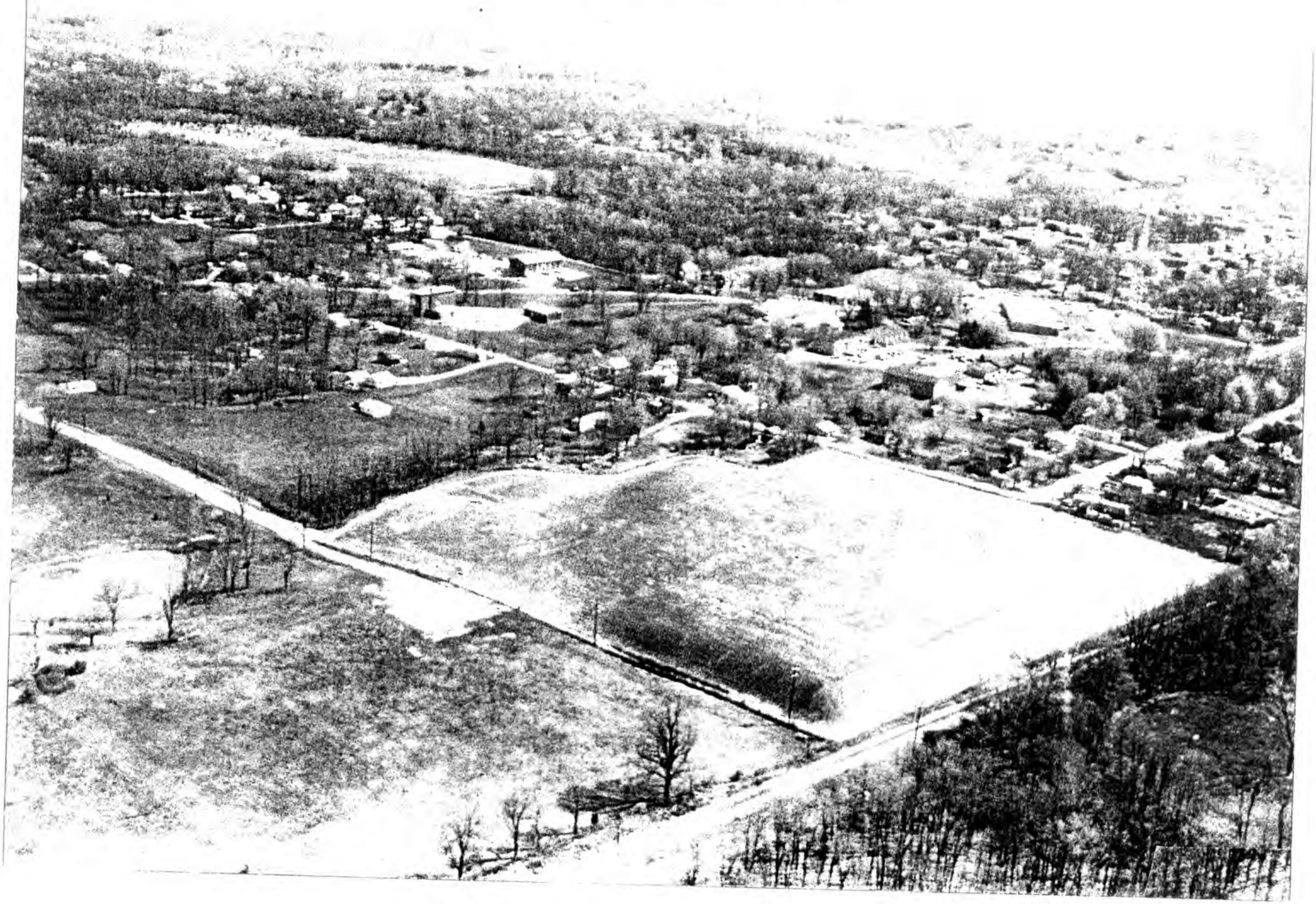
Louise Goeser

Louise Goeser
Director
Westinghouse Bloomington Project



SPENCER
Neal's Dump
ELLETTSVILLE
Bennett's Dump
Lemon Lane Landfill
Fell Iron Site
Neal's Landfill
Bloomington Capacitor Plant Site
BLOOMINGTON
Winston-Thomas Treatment Facility
INCINERATOR FACILITY
Anderson Road Landfill
N
2000
0
4000
8000
GRAPHIC SCALE (IN FEET)

Lemon Lane Landfill



- EPA has determined negligible potential for human exposure to PCBs from Illinois Central Spring and Quarry Spring. Springs are isolated; Illinois Central Spring is fenced. These springs are not used as potable water and do not discharge into surface waters used as potable supply.
- Sediment PCB levels in areas downstream of Illinois Central and Quarry Springs are less than 1 part-per-million, posing negligible potential for human exposure.

Neal's Landfill

Neal's Landfill

The Site

Neal's Landfill occupies nearly 18 acres approximately three miles west of Bloomington. The landfill is surrounded primarily by undeveloped land and woods, with only a few residences within a half mile of the site.

The landfill was a municipal and industrial waste site from 1949 until 1972. As early as 1962 and as late as 1970, Westinghouse contractors deposited electrical capacitors at the landfill in accordance with local ordinances and regulations.

Environmental Protection Measures

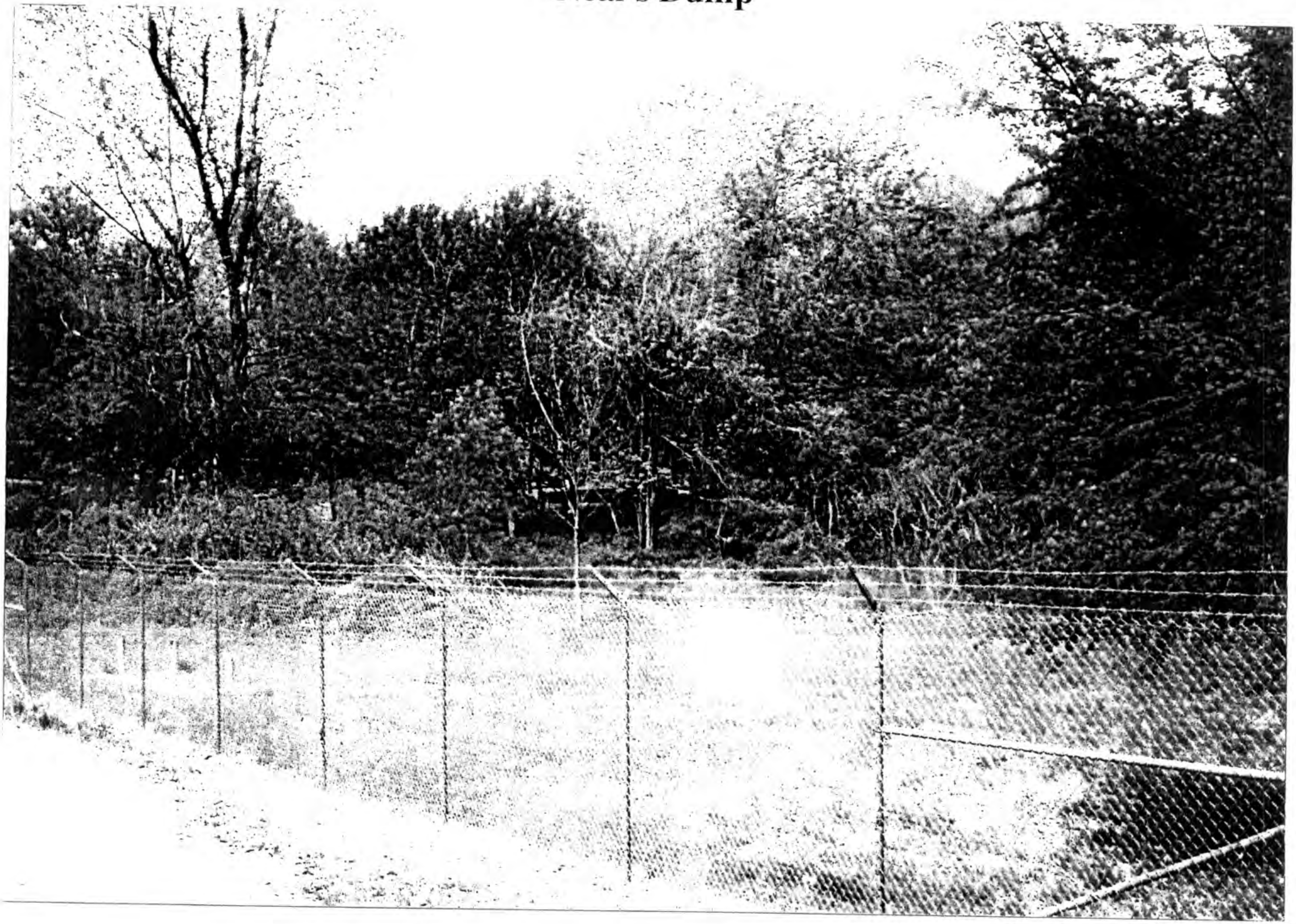
- Westinghouse completed interim environmental protection measures in 1987.
    - Installed a locked chain-link security fence around site perimeter.
    - Removed visible capacitors and stained soils and disposed of them at a permitted facility.
    - Removed sediments and creek bank soils from the entire 4,500 feet of Conard's Branch to Richland Creek.
    - Sent 1,877 tons of excavated creek bank material and 2,748 tons of stream bed sediments to Interim Storage Facility.
    - Installed a two-foot thick clay cap over primary landfill areas.
    - Installed silt fences and sediment collection traps to enhance drainage and control sediment runoff and erosion.
    - Installed 23 groundwater monitoring wells.
    - Monitor groundwater wells and tested private wells for PCBs.
    - Installed spring collection and water treatment system. The system treats base groundwater flow collected from North Spring, South Spring and Southwest Seep, handling flows up to one cubic foot per second (450 gallons per minute) to a PCB discharge level of less than 1 part per billion.

Pathway Analyses

- Clay cap, security fencing, erosion and drainage controls and vegetative cover effectively eliminate potential for direct human exposure to site soils, airborne materials or evaporated compounds.
- Spring treatment facility effectively eliminates exposure to PCBs from springs and surface water.

- No PCBs were detected in Richland Creek water or sediments by recent sampling by Westinghouse, the EPA and the Indiana Department of Environmental Management. PCB levels found in Richland Creek fish are below Food and Drug Administration standard.
- There is no municipal water supply in the vicinity of the landfill, thus all private residences rely on private water wells. The 1985 private well survey indicated there were 48 private wells within a 5,000-foot radius of the site. Sampling of 35 selected private wells was conducted in 1986. Thirty of the wells sampled were non-detect for PCBs. The other five wells detected PCBs at concentrations less than 0.01 parts-per-billion, which is well below the drinking water standard of 0.5 parts per billion.

Neal's Dump



Neal's Dump

The Site

Neal's Dump occupies a half acre four miles southwest of Spencer, in Owen County, and about 15 miles northwest of Bloomington. The site is bounded to the north by a steep embankment and is surrounded by residential property to the south, east and west.

From 1968 until 1971, Neal's Dump was a disposal site for industrial wastes. Contract waste haulers deposited capacitors containing PCBs, capacitor parts, filter and sawdust from the Westinghouse Bloomington capacitor plant during those years.

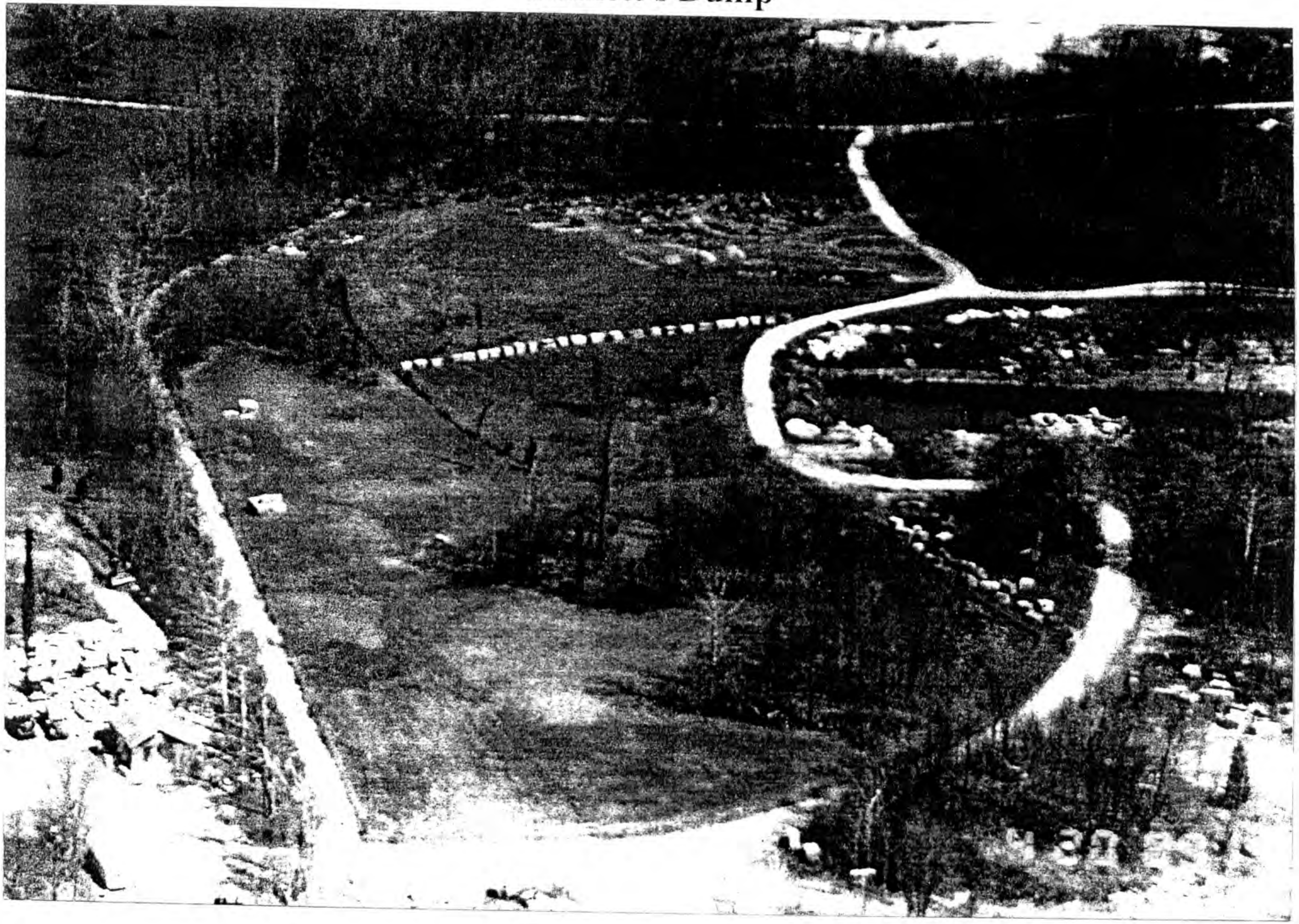
Environmental Protection Measures

- Interim environmental protection measures completed in 1983.
    - Installed a locked chain-link security fence around the site perimeter.
    - Surface and subsurface capacitors and stained soil were removed and disposed of at a permitted facility.
    - Installed 18- to 24-inch clay cap over site.
    - Installed silt fences along the north, east and west fence lines to control sediment runoff and prevent erosion.
    - Installed 20 groundwater monitoring wells.
    - Tested nearby residential wells and monitor site groundwater wells.

Pathway Analyses

- Clay cap, security fence, erosion and drainage controls and vegetative cover eliminate potential for direct human exposure from site soils, airborne materials or evaporated compounds.
- EPA site soil data did not find detectable levels of PCBs.
- Negligible potential for exposure to PCBs from potable groundwater. No PCBs have been found in residential wells near the site or in the groundwater zone from which residents draw their potable groundwater.
- Insignificant potential for exposure to soils and sediments from site drainage. Soil and sediment sampling prior to the environmental protection measures found no PCBs.

Bennett's Dump



Bennett's Dump

The Site

Bennett's Dump is in a rural setting about 2.5 miles northwest of Bloomington. It sits within the Bennett's Quarry, a former limestone quarry.

In the 1960s, a portion of Bennett's Quarry was a landfill for industrial wastes, including electrical capacitors from Westinghouse's Bloomington capacitor plant.

The site has three fill areas. The main fill area occupies 3.5 acres of the site to the east of Stout's Creek. This area is bounded to the south and east by quarry access roads. The second fill area, comprising about one-half acre, is adjacent to the main fill area. The third fill area, only 30 feet by 60 feet, is 750 feet north of the main fill area.

Environmental Protection Measures

- The EPA and Westinghouse completed environmental protection measures in 1988.
  - Installed a locked chain-link fence around site perimeter.
  - Visible capacitors and stained soils were removed and disposed of at a permitted facility.
  - Installed 14- to 16-inch clay cap over site and covered with 6 inches of soil.
  - Posted warning signs along Stout's Creek.
  - Removed 1,600 feet of sediments in the Stout's Creek drainage channel and transported them to the Interim Storage Facility.
  - Installed 7 groundwater monitoring wells.
  - Monitored groundwater wells.

Pathway Analyses

- Clay cap, security fencing and vegetative cover effectively eliminate potential for direct human exposure from site soils, airborne materials or evaporated compounds.
- Site-influenced groundwater flow direction is toward Stout's Creek, making exposure from potable wells negligible. A 1985 private well survey identified about 75 private wells within a 5,000-foot radius of the site. However, since 1985, most of these wells have been replaced by connections to the Bloomington water system.
- Clay cap and sediment removal have mitigated PCB exposure from Stout's Creek.

- Although Stout's Creek is of sufficient size to contain fish populations, water quality from surrounding quarry operations limit the quality of habitat.
- EPA sampling of fill area adjacent to the main fill area in 1992 did not detect PCBs.

Winston-Thomas Treatment Facility

Winston-Thomas Treatment Facility

The Site

This former sewage treatment plant is about 2.5 miles south of Bloomington. The site is bounded by State Route 37 to the east, Gordon Pike to the south, Clear Creek to the west and a business district to the north.

The 26-acre site features a 17-acre tertiary water treatment lagoon with an 18-inch-deep water level, two abandoned sludge lagoons, three sludge drying beds, four digesters, a trickling filter and several buildings.

The City of Bloomington operated the treatment plant from 1933 until 1982, when it retired the outmoded facility. In the period between 1958 and 1977, the plant received PCB discharges from Westinghouse's Bloomington capacitor plant via the sewer system.

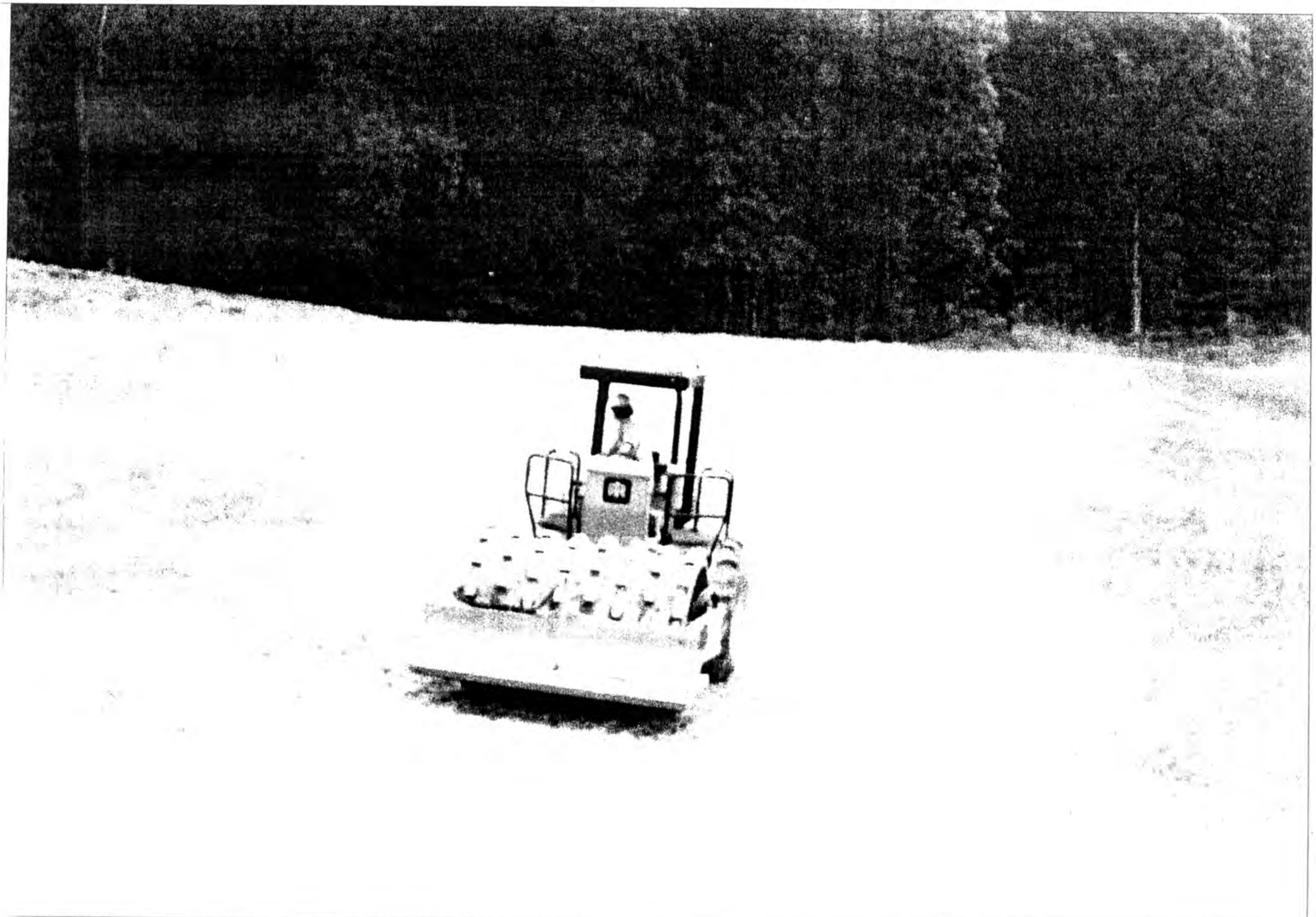
Environmental Protection Measures

- Westinghouse completed interim environmental protection measures in 1987.
    - Built Interim Storage Facility at the site to store excavated PCB-bearing materials from other sites.
    - Removed sediment along 1,100 feet of Clear Creek and moved the material to the Interim Storage Facility.
    - Site is enclosed with a locked security fence.
    - Installed 11 groundwater monitoring wells.
    - Monitored groundwater wells.

Pathway Analyses

- Restricted site access and maintained water cover in the lagoon limit the potential for direct exposure to sludge.
- Negligible potential for exposure via surface or potable water. All nearby residents are served by the municipal water system.
- Sediment removal eliminated potential for exposure via fish consumption from Clear Creek.

Anderson Road Landfill



Anderson Road Landfill

The Site

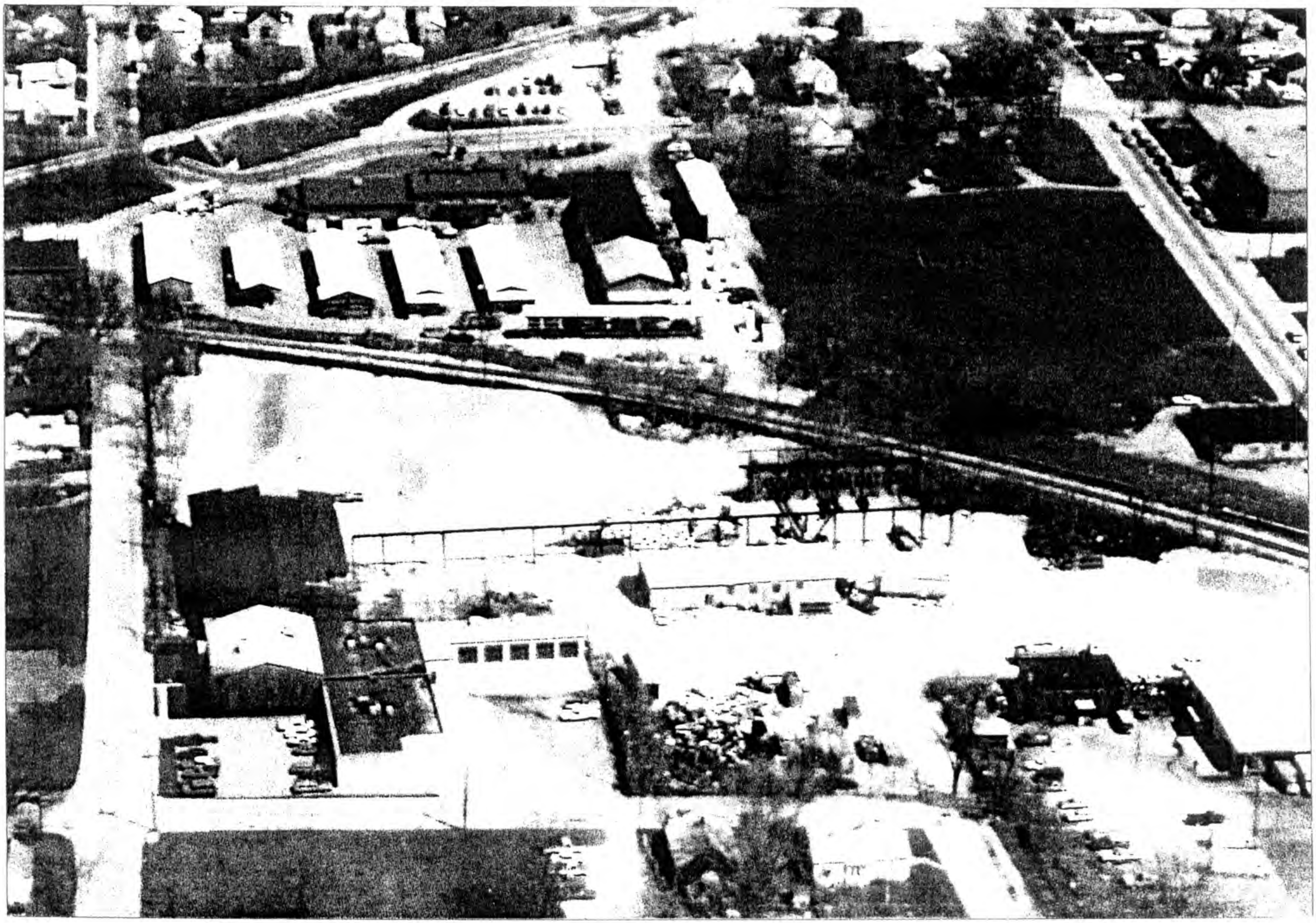
The Anderson Road Landfill, now the Monroe County Landfill, is 11 miles northeast of Bloomington. About three-quarters of an acre of the landfill once contained PCB-contaminated capacitors and materials from the Westinghouse Bloomington capacitor plant.

Environmental Protection Measures

- Westinghouse completed environmental protection and cleanup measures in 1987.
  - Excavated and transported 4,847 tons of capacitors and soil to the Interim Storage Facility.
  - Destroyed capacitors removed from the site in a licensed commercial incinerator.
  - Removed all water and silt from a landfill pond.
  - Water sent to the Winston-Thomas tertiary lagoon.
  - Silt sent to the Interim Storage Facility.
  - Regraded and backfilled all excavated areas.
  - Monroe County placed a clay cap and soil cover capable of supporting vegetation over the affected area.

The landfill requires no further action.

Fell Iron Site



Fell Iron Site

The Site

This 5.4-acre site, on the west side of Bloomington, is bounded by Rogers Street to the east, Fairview Street to the west, Ninth Street to the south and a railroad to the north.

Quarry stone mill operations took place at the site from the late-1890s until 1948. A Salem limestone block quarry occupied the southern portion of the site.

In 1948, Fell Iron and Metal, Inc. began a scrap metal salvaging business at the site. From 1958 until 1968, Fell Iron and Metal salvaged electrical capacitors from the Westinghouse Bloomington capacitor plant at the Fell Iron Site.

Environmental Protection Measures

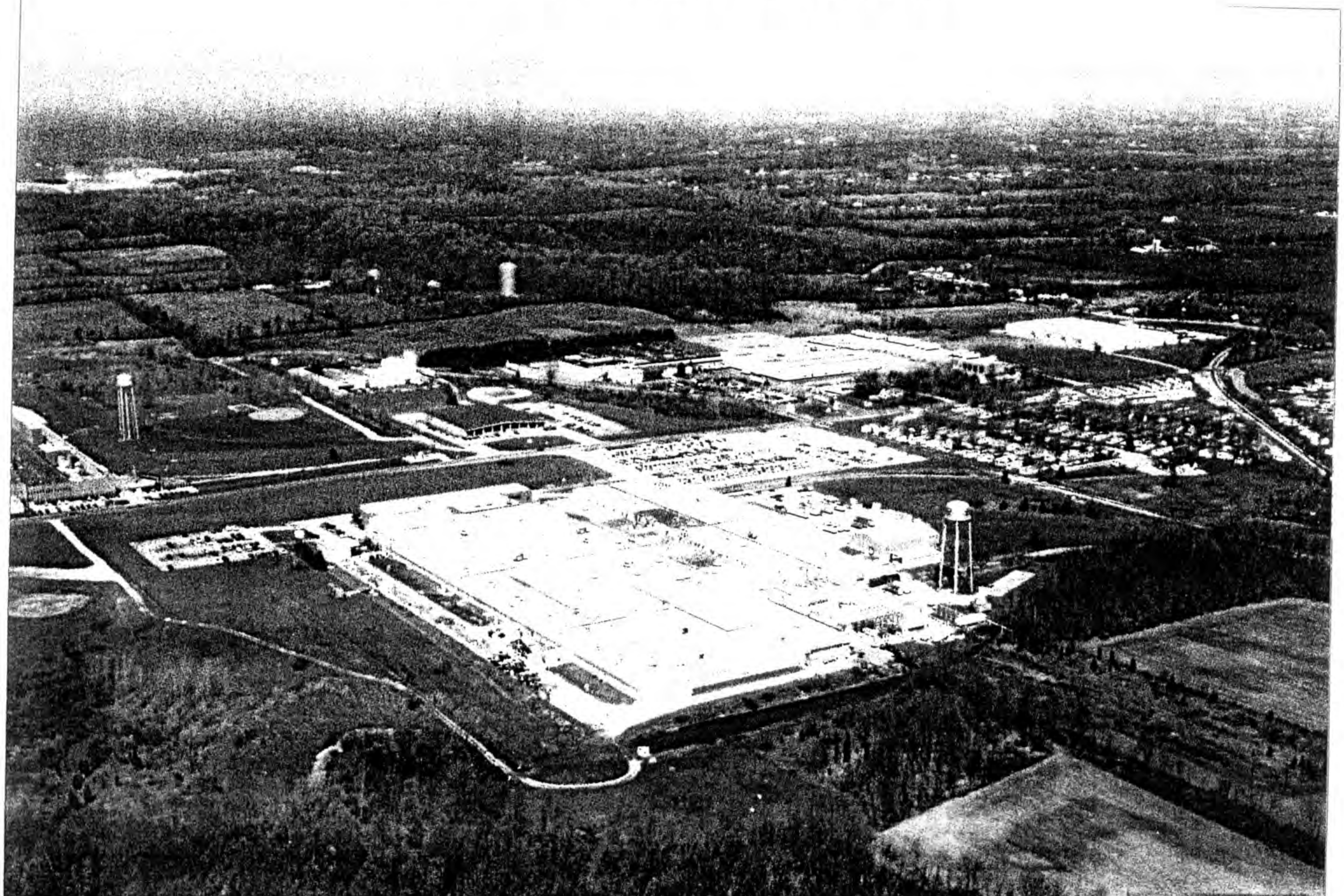
Westinghouse and EPA completed environmental protection measures in 1989.

- Removed all surface and subsurface capacitors.
- Westinghouse disposed of 151 of the capacitors in a licensed incinerator. EPA disposed of the remaining 375 capacitors in another licensed commercial facility.
- Excavated and stockpiled 16,000 cubic yards of PCB-bearing soil at the site.
- Installed chlorinated polyethylene liner system over excavated material. The liner is 45 mills thick.
- Installed a locked chain-link security fence around the stockpiled material.
- Installed and perform quarterly sampling of 6 groundwater monitoring wells.

Pathway Analyses

- Liner and security fence eliminate potential human exposure from site soils, airborne materials or evaporated compounds. In April 1993, EPA acknowledged that the Fell Iron Site soils and materials "could remain at the site for a substantial period providing there is adequate inspection, monitoring, maintenance and upgrading of the liner system."
- All residents in the vicinity of the site are connected to the Bloomington water system, eliminating the potential for human exposure to PCBs from drinking water.
- No one uses groundwater wells near the site, eliminating the potential for exposure from potable groundwater negligible.
- This site has been remediated to EPA's requirements.

Bloomington Capacitor Plant Site



Bloomington Capacitor Plant Site

The Site

This facility is at 300 North Curry Pike in Bloomington. Westinghouse manufactured capacitors at the plant from 1958 until 1989, when it sold the plant to Asea Brown-Boveri. Before the late 1970s, capacitor insulating fluid contained PCBs. The corporation completed a phaseout of PCBs in 1977.

Over the years, seven areas adjacent to the plant and two drainage ditches outside the plant site boundary became contaminated with PCBs.

Environmental Protection Measures

Westinghouse began interim environmental protection measures in 1992.

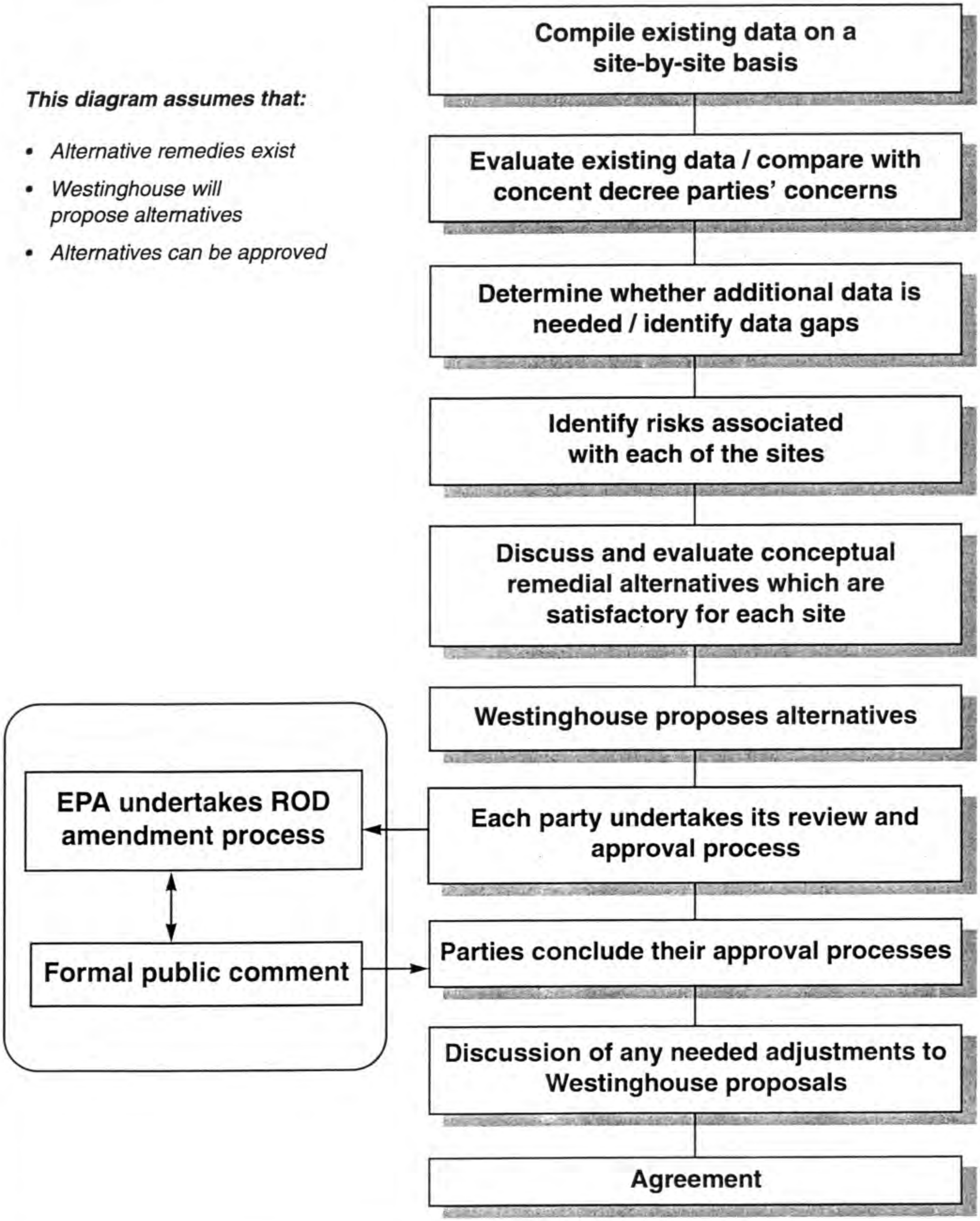
- Began excavating soil from the plant property and two drainage ditches. To date, the corporation has excavated and stockpiled more than 11,000 cubic yards of material.
- Destroyed 1,240 tons of soil containing tetrachloroethylene and trichloroethene, both organic solvents, in a licensed incinerator.
- Initiated grading and revegetation work in affected areas.
- Installed and operate air monitoring system at nearby trailer park.
- Redirected surface runoff water from drainage ditches to collection and sampling point.
- Collecting and treating any water that could come into contact with PCBs during excavation work through a multi-media water treatment system. Only water that meets city standards goes to the local sewer system. Water treatment is through a multi-media filter system.
- Built temporary storage facility to contain excavated soils. The facility sits on a compacted clay foundation and includes two 60-mills-thick synthetic liners and a leak detection system. Once the facility is filled, Westinghouse will cover it with a durable polyethylene cap and two feet of soil and vegetation to keep out storm water.

ALTERNATIVE TECHNOLOGIES

Alternative Remedy Development Process

This diagram assumes that:

- *Alternative remedies exist*
- *Westinghouse will propose alternatives*
- *Alternatives can be approved*



Process that Results in the Issuance of an Amended Record of Decision (ROD): General Procedures

Remedial Design/ Remedial Action (RD/RA) Underway

Information received or generated by Lead Agency

Lead Agency determines:
- Information should be considered; and
- A fundamental change to the remedy results

ROD Amendment Process

Lead Agency:
- Prepares amended proposed plan; and
- Gives support agency opportunity to comment

Lead Agency:
- Publishes newspaper notice; and
- Places proposed plan and relevant information in Administrative Record file

Lead Agency:
- Gives public opportunity to comment; and
- Provides opportunity for public meeting

Lead Agency:
- Responds to comments;
- Prepares ROD Amendment; and
- Regional or Assistant Administrator signs ROD Amendment

RD/RA

Lead Agency:
- Publishes newspaper notice; and
- Places ROD Amendment into Administrative Record file

U.S. Environmental Protection Agency
Region 5

Date: November 15, 1993

To: File

From: Dan Hopkins, Sr. Remedial Project Manager

Subject: Consent Decree party technical meetings held November 4, 1993 and November 9, 1993

Background: On October 27, 1993, Westinghouse, IDEM, and Region 5 representatives met to discuss whether Westinghouse was interested in pursuing an alternative remedy for the Bloomington, Indiana Consent Decree sites through a ROD amendment-like process. At the conclusion of the meeting, several committees were formed; a legal committee, a technical committee, and a public relations committee. It was agreed that the organizational heads present would meet on a quarterly basis to assess the progress of the committees. Following the October 27, 1993, meeting, Steve Creech (Administrator, Monroe County Health Dept.) and John Langley (PCB Coordinator, City of Bloomington) were asked to participate on the technical committee. Both Creech and Langley agreed to participate and meet on November 4, 1993.

On November 4, 1993, the technical committee composed of Louise Goeser (Bloomington Project Director, Westinghouse), Rex Osborn (Superfund Project Manager, IDEM), Steve Creech, John Langley, and I met in at Westinghouse's office at One City Center in Bloomington. This meeting was the first technical committee meeting formed by the parties which met in U.S. EPA Region 5's offices on October 27, 1993.

November 4, 1993, discussion summary: Much of the first technical committee meeting was spent discussing concerns about the process of exploring alternative remedies. Foremost among the concerns was whether EPA would discuss alternative site remedies with the parties before preparing a ROD amendment. Other concerns were identified as described below:

City - The City expressed concerns about providing funds (either Westinghouse or City funds) for consultants only to have EPA "pull the rug out from under the City" (i.e. select a remedy which is inconsistent with what the City can accept)

City and County - Both would like to see a resolution of the disposal of the contaminated materials from the Fell Iron and Metal and ABB sites in conjunction with a resolution of the Consent Decree sites.

The committee agreed to identify the specific concerns that each member had regarding each of the sites. It was suggested that the compilation of existing site specific data would be made more valuable by relating that data to those site specific concerns identified by the committee (i.e. whether the data or information found was sufficient to adequately address the concerns). We agreed that the list of concerns developed could be later expanded, but that it was useful to begin the process of identifying concerns. The Lemon Lane Landfill was the focus of the remainder of the November 4, 1993 meeting. The following concerns were identified for the Lemon Lane Landfill:

1) Risks to human health and the ecology of spring systems (primarily the Illinois/Central and Quarry Spring streams) associated with the release of contaminants from Lemon Lane.

2) Risks of exposure to PCBs (and potentially other contaminants) to neighbors adjacent to the landfill. The routes of exposure include groundwater contamination of well water and airborne migration of contaminants.

3) Economic value of the property (landfill site itself) and neighboring properties resulting from the implementation of a remedy.

4) The aesthetic conditions at the site resulting from the implementation of a remedy.

5) Responsibility and liabilities for future maintenance of the site.

6) Whether the contamination of springs and streams is the only groundwater contamination of concern. The possibility of contamination of deeper groundwater (beneath that groundwater which resurges at springs) was discussed.

7) Location of "hot-spots."

Mike McCann, Westinghouse hydrologist, discussed the Lemon Lane landfill with the technical committee. Mike explained that some of the work that Westinghouse has done regarding Lemon Lane included an evaluation of the subterranean stormwater drainage pattern around Lemon Lane. He said that the sinkholes at and near Lemon Lane direct stormwater to the Illinois Central/ Quarry Spring system. The subterranean stormwater drainage pattern has, as Mike portrayed, definable boundaries around the Lemon Lane Landfill. Residential wells outside these boundaries (and also in the headwater areas of the drainage pattern) will not be affected by the landfill.

I asked Louise Goeser if Dick Powell could have access to the information that Mike and Noel Krothe (IU professor working with Westinghouse) were collecting for Lemon Lane and Neal's Landfill. Louise told me that Dick could have access to that information.

November 9, 1993, discussion summary:

During the November 9 discussion the technical committee continued to identify concerns related to the other Consent Decree sites. The following lists summarizes the concerns expressed during the meeting:

Neal's Landfill

1) Possibility of the migration of contaminated groundwater to nearby residential wells and springs (e.g. Branham Spring).

2) Location of "hot-spots".

3) Ability of the springwater treatment system to collect and process enough springwater to prevent the eventual recontamination of Conard's Branch and Richland Creek.

4) Whether the existence of other contaminants (other than PCBs) in Neal's Landfill (and their actual or threatened release) poses an unacceptable risk to human health or ecological systems.

Neal's Dump

1) Threat of contaminated groundwater to nearby residential wells, particularly in light of the PCB concentrations found in deep monitoring wells at the site.

2) Migration of contaminants may be enhanced by the condition of the soil cap over the site. The cap may not adequately prevent percolation of stormwater through the contents of the site. The existence of trees and shrubs on-site indicate poor quality of cap.

3) Installation of the on-site monitoring wells may have introduced contaminants in the site to deeper strata. Continued pumping of groundwater from the monitoring wells may enhance the migration of contaminants at the site.

4) Extent and characterization of the contents of the site not well defined.

Bennett's Dump

1) The extent of contaminated fill (including capacitors) is probably not contained within the security fence at the site.

2) Possibility of contaminated groundwater migration to nearby residential wells. (We discussed the possibility that the ponded area near Stout's Creek, near the northwest corner of the site, may demonstrate the integrity of the rock beneath the site and may indicate that vertical migration of groundwater is unlikely.)

3) The present groundwater network doesn't provide adequate protection/detection of off-site contaminant migration.

4) That the dump may contain other contaminants which may contaminate groundwater.

5) Location of "hot-spots".

Winston Thomas Sewage Treatment Plant

1) Digestors piping may introduce contaminants to areas beneath the site.

2) City concern - The site must be useable, after implementation of a remedy. The City apparently has some future plans for site - mentioned sanitary garage/administration building.

3) No approved groundwater monitoring plan for site.

The possibility of using a biological treatment method for the tertiary treatment lagoon was discussed. Also, the possibility of using the tertiary lagoon as a biological treatment site for other contaminants from the site was discussed.

Several concerns were expressed regarding the possibility of using the tertiary lagoon as a treatment site, as follows:

a) Would a Certificate of Environmental Compatibility have to be obtained from the HWFSAA?

b) Could a biological treatment be used if the materials processed contained other contaminants?

Other topics - The committee discussed prioritizing site evaluations. Most of the committee members thought it was preferable to determine whether the process of evaluating the Lemon Lane Landfill and Neal's Landfill looked promising in terms of identifying acceptable alternative remedies. It was thought that because these landfills are the largest, the alternative selection process must give acceptable results for these sites if the selection process is to ultimately be successful.

We also discussed possible presentations for the next meeting with Sam Pitts, Dave Ullrich, and Rosemary Spaulding:

1) Brief discussion of each site,

2) Handout of a summary of the concerns identified by the technical committee,

3) Specific to Lemon Lane - a comparison of the existing data (for Lemon Lane) to the concerns identified by the technical committee, to show how well the existing information addresses the concerns identified for the site.
Next Technical Committee Meeting

The following topics were planned for the next meeting which was tentatively scheduled for November 30, 1993.

Next Technical Committee topics

1) Westinghouse's Bob Stephan would present a summary of the activities taken to date at Lemon Lane

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF:

FEB 04 1994

C-3T

VIA FEDERAL EXPRESS DELIVERY

Mr. Geoffrey Grodner
Mallor, Clendening, Grodner & Bohrer
511 Woodscrest Drive
Bloomington, Indiana 47401

Ms. Rosemary Spaulding
Deputy Commissioner
Indiana Department of Environmental Management
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Mr. James R. Trulock
Monroe County Attorney
Monroe County Courthouse
Bloomington, Indiana 47404

Mr. Stephen T. Wardzinski
Chief Counsel
Environmental Affairs
Westinghouse Electric Corporation
Westinghouse Building
Gateway Center
Pittsburgh, Pa. 15222

RE: Operating Principles of the Parties for exploration of alternative remedies for the six sites addressed by the consent decree entered in U.S. v. Westinghouse Electric Corporation, Civil Action Nos. IP 83-9-C and IP 81-448-C, consolidated.

Dear Counsel:

Accompanying this letter is a copy of the Operating Principles agreed to among the United States Environmental Protection Agency ("U.S. EPA"), the Indiana Department of Environmental Management ("IDEM"), the City of Bloomington, Indiana, the County of Monroe, Indiana, and Westinghouse Electric Corporation ("Westinghouse")(collectively the "Parties"). The Operating Principles are intended to guide the Parties in the exploration of alternative remedies for the six sites addressed by the consent decree entered in U.S. v. Westinghouse Electric Corporation, Civil Action Nos. IP 83-9-C and IP 81-448-C, consolidated (the "Consent Decree").

U.S. EPA invites the Parties to respond, in writing, as to whether the accompanying Operating Principles accurately reflect the agreement reached among the Parties. Please contact me if you have any questions or comments regarding this matter. I look forward to hearing from each of you regarding this matter.

Very truly yours,

Jeffrey A. Cahn
Associate Regional Counsel

OPERATING PRINCIPLES FOR CONSIDERING REMEDIAL ALTERNATIVES

I. Introduction

The Parties to the Consent Decree have met together to discuss how to proceed with Westinghouse's expression of interest in exploring alternative remedies for the six Consent Decree sites. The Parties have worked together to reach a consensus on an approach for such an exploration of alternative remedies. As a result of those efforts, the Parties have developed the following principles that will serve to guide the process of exploring alternative remedies.

II. Process

The Parties agree that it would be beneficial to explore together alternatives to the remedy currently provided for in the Consent Decree. Therefore, the Parties have decided to work cooperatively to identify and develop alternative remedies. Following the exploration of potential alternatives, Westinghouse may propose alternative remedies for consideration by the other Parties. Each of the governmental Consent Decree Parties will have the opportunity to consider any proposal made by Westinghouse in accordance with all lawful requirements governing their decision making process.

It is the goal of the Consent Decree Parties to reach a consensus on an alternative which is acceptable to all parties and to the Bloomington public. However, the Parties recognize that at the end of the process, the Parties may conclude that the remedy currently provided for in the Consent Decree is the most appropriate. The Parties agree that during the course of this process, the Consent Decree shall remain in full force and effect, and that each Party retains its rights under the Consent Decree.

The Parties agree that a public administrative record should be established by U.S. EPA for each of the sites, and that an additional "common record" be established by U.S. EPA to store information that is applicable to all sites. The purposes of these administrative records are to assure that the public has access to all information developed through the process described in this protocol, the information is organized in a comprehensible fashion, and the various governmental agencies will be able to proceed through the evaluation of potential alternative remedies in accordance with their formal approval processes.[1] The Parties agree that the administrative records should be established at the earliest practicable time.

The Parties agree that the following tasks will be included in the process for exploring alternatives.

Data Assessment and Development

- o The Parties agree to assemble and assess existing data concerning the sites. This data shall be evaluated from the standpoint of technical sufficiency (including quality assurance/quality control ("QA/QC") concerns). This currently available data shall be placed into the various administrative records established for the sites. In most instances, it is expected that Westinghouse will assemble existing data, but other Parties may do so as well.

- o The Parties agree to articulate concerns or potential alternative remedies with enough specificity to determine whether additional data is needed in order to assess such concerns or alternatives adequately. The Parties will determine whether additional data is needed in order to perform an adequate evaluation of alternative remedies.

- o Any new data shall be collected in a manner consistent with U.S. EPA QA/QC guidance. In most cases, this data will be collected by Westinghouse, but other Parties may do so as well. All relevant data shall be included in the administrative records. The Parties acknowledge that the process of data collection and development is a continuing process, and that additional data needs may be identified throughout the course of this process.

[1] The U.S. EPA and IDEM are required to develop and maintain administrative records in support of the decisions that are contemplated by this process. The Appendix to this document contains a fuller description of U.S. EPA's and IDEM's approval processes.

Development and Evaluation

- The Parties agree that risks to human health and the environment associated with each of the sites will be identified and that Westinghouse will perform risk assessments with participation by U.S. EPA and the other parties. The Parties have not yet agreed on the scope of risk assessment appropriate to evaluate potential remedies. Risks shall be evaluated based on the current condition of the sites. The Parties agree that some risk assessment activities may proceed based on existing data, but that other risk assessment activities may need to await the development of additional data. Development of alternatives may continue concurrently with risk assessment activities.

- The Parties shall discuss and evaluate alternatives which are appropriate for each site.

    - Alternative remedies must be technically adequate, feasible, and cost effective.

    - Alternative remedies must adequately address site risks.

    - Alternative remedies should address the concerns of the Parties.

- Westinghouse proposes a preferred alternative for each site, which could include components common to a number of sites.

Consideration of Alternatives

- Each party undertakes its review and approval process.

    - EPA undertakes its ROD amendment process, which includes formal public comment, on a proposed remedy.

- The Parties discuss any needed adjustments to Westinghouse's proposal and reach agreement on the selected remedy.

- The Parties conclude their respective review and approval processes.

Agreement and Implementation

- If an alternative remedy is approved by the Parties, it will be presented to the Court in the form of a modified Consent Decree or other legal instrument.

- The alternative or the original remedy is implemented.

III. Public Participation

The Parties recognize the need for, and the benefits of, full public participation during the process of the development of information about the sites and exploring alternative remedies. Accordingly, the Parties intend to provide broad outreach to the community to make information available to the public, to allow people to ask questions, and to provide input. As part of this process, the parties intend to: 1) hold meetings with large and small groups to provide information, answer questions, and allow for the open exchange of ideas; 2) hold availability sessions for one-on-one dissemination of information and the open exchange of ideas; 3) conduct outreach to existing community organizations for dissemination of information, answer questions, and the open exchange of ideas; 4) distribute publications in the local press media; and 5) distribute other written material, including fact sheets.

Through this process of public participation, the parties intend to be guided by the following principles:

- The public should understand that the Parties have a genuine interest in fostering public understanding and obtaining public input.

- The public should have confidence that any alternative remedy was evaluated on the basis of accurate information, realistic assumptions, and good science.

- Responsibility for contamination is not the issue; solving the problem is the issue.

- The Parties share the goal that the public accept the alternative selected, but, at a minimum, the Parties want the public to understand that the selection process was based on good science and that the selection was made in good faith and in accordance with law.

Dated: February 4, 1994

The data that is placed into each of the administrative records shall come from the already existing site data. After that data has been evaluated from the standpoint of technical sufficiency (including QA/QC concerns), and after some scoping has been performed regarding possible technical solutions that may be available, U.S. EPA, in consultation with the other parties to the Consent Decree (the "Parties"), may identify missing information (data gaps) that is needed to evaluate alternatives which will be further explored. Additional site data development shall be conducted in order to fill data gaps that need to be addressed in the context of a consideration of alternative remedies. Further, it may be necessary to conduct additional studies, investigations, and data gathering to fill gaps that may be identified after the review of existing data and the narrowing and further development of possible alternative remedies.

In the event that additional data is required by U.S. EPA for the detailed consideration of certain alternatives, additional data shall be gathered in a manner consistent with U.S. EPA QA/QC guidance. Data generated by the other Parties to the Consent Decree may also by included in the administrative records. In order to ensure that the record will be developed in a manner such that it will be useful in the consideration of alternatives, U.S. EPA will work with Westinghouse (and the other Parties) during all phases of the development of the administrative records.

Regarding timing, the administrative records shall be established at the earliest possible moment, in order to ensure that all information that might support an alternative remedy is made available for public review.

As a further timing matter, U.S. EPA's ROD amendment process, as spelled out in the NCP, does not begin until after a preferred alternative(s) has been proposed. The development of the administrative record to support an alternative is the first step in getting to the point of commencing a ROD amendment.

B. IDEM's Administrative Record requirements, and approval process.

IDEM has determined that, like U.S. EPA, its approval process requires the development of an administrative record(s) that will support any proposed alternatives. IDEM's approval will take the form of concurrence or nonconcurrence in U.S. EPA's ROD amendment. State statutory requirements may limit IDEM's ability to approve ceratin alternatives and may cause IDEM's approval process to vary slightly from the process contained in this document.

APPENDIX

A. U.S. EPA's Administrative Record requirements and ROD Amendment (approval) process.

Region V of U.S. EPA, with Headquarters concurrence, determined that, for U.S. EPA, the appropriate method of exploring, evaluating, and "approving" (if appropriate) an alternative remedy for the six sites addressed by the consent decree entered in U.S. v. Westinghouse Electric Corporation, Civil Action No. IP 83-9-C and IP 81-448-C, consolidated, on August 22, 1985 (the "Consent Decree"), is through a Record of Decision ("ROD") amendment conducted in accordance with the procedural steps required by the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA"), 42 U.S.C. § 9601, et seq. (1986), and by the National Contingency Plan ("NCP"), 40 C.F.R. § 300, et seq. (1992). Section 117 of CERCLA, 42 U.S.C. § 9617(c), establishes the statutory requirements for public participation that U.S. EPA must follow in connection with selecting a remedial action and with post-ROD changes to a remedy selected in the ROD (or, in this case, the EDD).[1] Section 300.435(c)(2) of the NCP, 40 C.F.R. § 300.435(c)(2), establishes the regulatory requirements that U.S. EPA must follow in connection with post-ROD changes to a remedy selected in the ROD. Finally, Section 113(k) of CERCLA, 42 U.S.C. § 9613, and Section 300.800, et seq., of the NCP, 40 C.F.R. § 300.800, set forth U.S. EPA's administrative record requirements.

Taken together, these provisions require that U.S. EPA develop an administrative record to support any alternative remedies, selected in a ROD amendment (with full, formal public participation), that may be proposed for the six Consent Decree sites. To satisfy U.S. EPA's statutory and regulatory requirements to develop an administrative record to support any ROD amendment (with substantial public involvement), U.S. EPA shall establish six separate administrative record files (one for each of the Consent Decree sites), with another administrative record containing documents, data, etc., common among the sites.

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1 The substantive requirements that U.S. EPA must follow in evaluating and adopting a clean-up plan are established at Sections 104 and 121 of CERCLA (42 U.S.C. §§ 9604, 9621), and Sections 300.420 through 300.435 of the NCP. [40 C.F.R §§ 300.420-300.435.] U.S. EPA guidance states that "[i]f the lead agency is amending a pre-SARA ROD (i.e., a decision document signed prior to October 17, 1986), the amended remedy will have to satisfy the requirements of section 121 of CERCLA." [Interim Final Guidance on Preparing Superfund Decision Documents, OSWER Directive 9355.3-02, June, 1989.] Thus, the standard for evaluating any proposed clean-up alternatives in this case is the current standard established at Section 121 of CERCLA. [42 U.S.C. § 9621.]

Science Aug. 28, 1987 p 975-977 V. 237

Discovering Microbes with a Taste for PCBs

Microbial ecologists and microbiologists are finding new organisms in the environment with unexpected abilities to degrade toxic chemicals

MICROBIAL ecologists and microbiologists are beginning to unearth a startling array of microorganisms with unexpected abilities to biodegrade some of the toughest and most recalcitrant environmental chemicals. In the past few years they have found entirely new types of bacteria that can carry out reactions previously thought to be impossible. Efforts are now under way to harness those natural abilities and use them in cleaning up toxic chemicals, first by enhancing the performance of nonengineered microorganisms and later by endowing them with new capabilities through genetic engineering.

Although many questions remain about how to turn these findings into practical, cost-effective systems for pollution control, work is rapidly moving from the laboratory to the field. For instance, this summer General Electric scientists began the first field test of a biological approach to degradation of polychlorinated biphenyls (PCBs), at a drag strip some 35 miles from the corporate research laboratory in Schenectady, New York.

Projects such as this one, and the basic research behind them, were discussed at a recent meeting in Seattle on biotechnology and pollution control.* Talks ranged from descriptions of bench-scale tests and field tests to actual use of nonengineered microbes to clean up Superfund sites.

Exploitation of natural biodegradative processes is not new; indeed, biological approaches have been used for years to treat industrial and municipal wastewaters. But most of these applications have occurred above ground, where the processes can be fairly easily controlled. Now the goal is to modify those techniques to work in soil and ground water, often on exceedingly recalcitrant chemicals that are biodegraded only slowly, if at all.

But before these newly found microorganisms can be harnessed, researchers must first figure out how to make them work in the right place, and at sufficient speed, on the appropriate chemicals. And that, in turns, depends on understanding the "mesmerizing complexity" of microbial ecosystems, says Rita Colwell of the University of Maryland, as well as the genetics and biochemistry of particular organisms. Fundamental knowledge is lacking, she says, because microbial ecology research has been so poorly funded. "We've had a couple of decades of intense molecular biology, but ecology and systematics have been left behind."

"We will find lots of surprises when we start prying into the corners of soil and water ecosystems."

That changed with the advent of genetic engineering. The possibility of manipulating genes to create a "superbug" with new biodegradative abilities illuminated how little is known about what microorganisms already exist, how they function, and what effect modifying them might have on natural ecosystems. In response, the National Science Foundation, which until a few years ago did not even have a separate program in microbial ecology, has dramatically increased its funding. Although genetic engineering applications remain years away, the upsurge in basic research has led to the discovery of these fascinating new microbes, which may not need any engineering at all.

James Tiedje, for instance, has isolated an entirely new anaerobic bacterium. It is able to do what was considered impossible only a few years ago: to remove chlorine from aromatic compounds, a key step in breaking down these compounds, which include such major pollutants as PCBs, dioxins, chlorinated phenols, and chlorinated benzenes.

Not only are chlorinated aromatics toxic, they are also very refractory, in part because of the aromatic ring structure but mostly because of the chlorination. If the chlorine can be removed, the remaining compound is often less toxic and more easily degraded, says Tiedje, who is a microbiologist at Michigan State University. However, although it was known that some compounds can be dechlorinated by microorganisms, until recently it was believed that aromatic compounds could not. That changed in 1982, when Tiedje observed dechlorination occurring in sewage sludge and realized the reaction was being carried out by indigenous microorganisms.

Two years later he isolated this microorganism, which he has dubbed DCB1, that can dechlorinate aromatic compounds—in this case, chlorobenzoate. "Our present knowledge [illegible] this microorganism has no known close relatives that have been previously studied," says Tiedje. It has a distinctive collar around every cell that seems to be involved in cell division. "This is a very unusual morphological structure, not previously known in microbiology. That points out the unknown nature of this organism."

Since then Tiedje has found that this new organism works in concert with two others, which act in continuous sequence to completely degrade chlorobenzoate. (Chlorobenzoate is not an important pollutant, but it provides a model system for detailed, basic studies.) DCB1 performs only one step: it removes the chlorine from chlorobenzoate to produce benzoate. Then a second organism, a benzoate oxidizer, takes over and transforms benzoate to acetate, hydrogen, and carbon dioxide. Finally a methanogen, a bacterium that produces methane, finishes off the process by converting hydrogen and carbon dioxide to methane.

Tiedje is now probing the details of the interactions of the microbial consortium, and specifically, how the key dechlorination step works at both the genetic and enzymatic levels. Another critical question is, where does DCB1 get its energy? In this way, too, DCB1 appears to be unique. Tiedje believes that the energy source may involve the dechlorination process itself. "There are only a limited number of ways an organism can make energy," Tiedje says, "and this represents a new one."

Tiedje's eventual goal is to use DCB1 and other dechlorinating microorganisms, once they are isolated, in a practical system to clean up hazardous waste. But first he needs to determine which pollutants these organisms will transform and how the reactions can be enhanced.

To Colwell, Tiedje's work hints at what lies ahead. "We will find lots of surprises when we

*The meeting, "Reducing Risks from Environmental Chemicals Through Biotechnology," was held 19 to 22 July at the University of Washington, Seattle.

start prying into the corners of soil and water ecosystems. As we start taking these communities apart and looking at the components, we will find the kinds of organisms that Jim did—strange creatures that have a mix of characteristics that are quite unexpected."

Perry McCarty, a civil engineer at Stanford University, has detected two microorganisms that can also do the unexpected—in this case, biodegrade trichloroethylene (TCE) and trichloroethane (TCA), which are major ground water contaminants. TCE and TCA belong to the broader class of halogenated aliphatics, which were thought to be completely refractory to biodegradation until McCarty found out otherwise a few years ago.

But, as McCarty's work reveals, adapting either of these microorganisms for practical use (or for that matter, Tiedje's DCB1 or the slew of other microorganisms yet to be detected) will be tricky. "We need to learn how to create the right environment for these organisms to carry out the transformation," McCarty says. "We need to understand the organisms and their growth needs, then we need to learn how to optimize the system—to get nutrients to them and make the reaction run faster."

McCarty wants to use these microbes to treat contaminated ground water in situ, but little is known about microbial processes in ground water and simply gaining access to deep aquifers is a major obstacle. Another problem is toxic intermediates. In some microbial reactions the hazardous chemical is not completely degraded, or mineralized, but is transformed to intermediates. For some chemicals, transformation is sufficient to detoxify them. But for others, it makes the problem worse. For example, methanogens, the anaerobic bacteria McCarty has detected in ground water, transform TCE to organic intermediates, one of which—vinyl chloride—is more harmful to human health than is TCE. The trick, says McCarty, is to figure out how to prod the reaction along to complete mineralization.

The other TCE degraders McCarty and his colleagues have found, aerobic soil bacteria known as methanotrophs, do mineralize TCE to harmless, inorganic components, which holds great promise for in situ treatment of contaminated soils. But if McCarty is to use methanotrophs in ground water, oxygen would have to be injected into the aquifer along with all the other substances necessary for bacterial growth.

But the biggest obstacle, at least for the compounds McCarty is working with, is a poorly understood process known as cometabolism. Biodegradation occurs fairly readily, even in ground water, if the microorganism can use the hazardous chemical as its primary energy source. But for many if not all halogenated aliphatics, this is not the case. Instead, the microorganism requires a second compound as its energy source and, in the process of metabolizing that energy source, degrades the "target" compound in a fortuitous reaction. This biochemical piggybacking is known as cometabolism.

"That is the process we are trying to capture," McCarty says, "but we know very little about it and how to optimize it." Methanogens must have either methanol or acetate to grow and to degrade TCE. Methanotrophs require methane. Finding the right balance can be tricky, as McCarty has discovered. Although methanotrophs cannot degrade TCE without methane, too much inhibits the degradation.

Researchers at the Environmental Protection Agency's Gulf Breeze laboratory in Florida are also encountering problems with cometabolism. Michael Nelson and his colleagues recently isolated another new bacterium, which they call strain G4, that also degrades TCE. The catch is that its energy source is phenol, a highly toxic aromatic compound. "You don't want to dump it in the ground water," says Nelson.

What cometabolism means in a practical sense, McCarty says, is that huge quantities of the energy source must be made available to the microorganisms. On the basis of preliminary studies, McCarty says, it looks as if the primary energy source must be present in quantities 100 to 1000 times greater than the hazardous chemical if it is to be transformed. In other words, in order to transform 1 kilogram of TCE you would need to add 100 to 1000 kilograms of the energy source. "This horrendous ratio means that large quantities of chemicals would need to be injected into an aquifer system for even a relatively small contamination." In addition, the carbon, nitrogen, and phosphorus needed for cellular growth all must be present and in proper balance for the reaction to proceed. "If it weren't for the high cost of the alternatives, it wouldn't be worth considering this at all," McCarty says. "It is very expensive."

Michigan State University

James Tiedje *has isolated a new bacterium that can do what was previously thought to be impossible.*

As these basic studies proceed, other researchers are moving toward application in the field. "We are finding, eureka, what we are seeing in the lab *does* work in the field," Colwell says. "But what we are also finding, not unexpectedly, is that the precise extrapolation does not work. Parameters like temperature and nutrient concentration in a given system are important and not always entirely controllable."

General Electric's current assault on PCBs is a good example. The company has much at stake in this research, as it was a major user of PCBs for some 50 years and now is faced with a hefty clean-up task. At the drag strip, where PCBs were sprayed to hold down dust, the soil is contaminated with roughly 525 parts per million of Aroclor 1242, one type of PCB. PCBs are a "tough nut," says Ronald Unterman, the chief scientist on the project. There are more than 200 different forms, and what works on one will not necessarily work on another. Unterman and his colleagues are testing a strain of *Pseudomonas putida*, LB400, one of two dozen bacterial strains they have isolated that can grow on biphenyls and transform PCBs.

In the laboratory, LB400 works superbly, Unterman says. In what he calls a "shake and bake" procedure, they inoculated soil from the site with LB400, mixed it, and put it into an incubator. Within 3 days, 51% of the PCBs were transformed. But when they tried it under simulated field conditions—they inoculated a few kilograms of soil with LB400 and left it at ambient temperatures in the laboratory without shaking—nothing happened. Thirty days brought a "hint" of activity, Unterman says, and by 100 days they had achieved 50% degradation.

They are now testing LB400 on a test plot at the drag strip. "It's very low tech, we just spray them on," says Unterman. He expects transformation to occur even more slowly in the field, where the bacterial concentration is more dilute and temperature and moisture content cannot be precisely controlled. At the time of the meeting, 23 days into the test, there was, not unexpectedly, no sign of activity.

In other work, Ronald Crawford of the

University of Idaho and Thomas Frick of the University of Minnesota have developed a microbial consortium to degrade pentachlorophenol, a wood preservative and increasingly common ground and surface water contaminant. In a demonstration project, BioTrol Corporation of Minnesota is using that consortium in bioreactors to clean penta- and creosote-contaminated ground water at Superfund sites. And Ecova Corporation of Washington State has used biodegradation in combination with physical processes to clean up contaminated soils at an abandoned refinery on the Gulf Coast.

"I'm very impressed with the translation of basic microbiology into field work," said Alan Bull of the University of Kent, England, at the end of these talks. "Europe and the U.K. are a good deal behind." But as Bull pointed out, these early applications were picked precisely because they stood a good chance of success. "We're not hearing about aromatic compounds or heavy metals," he said.

Similarly, while several of the speakers predicted that these processes will be cost-competitive, and eventually cheaper than the alternatives, that potential has yet to be realized. "The only thing that makes a lot of these technologies possible is the Superfund requirement that sites have to be cleaned up," McCarty said. "Otherwise, we couldn't afford it."

There are other obstacles as well, points out Martin Alexander of Cornell University. Some industrial discharges and Superfund sites are so toxic that they would "pickle" the organism before it had a chance to degrade them. In addition, he said, bacteria have to be able to work on the chemical as it appears in nature—which usually means in a mixture—rather than in isolation in the laboratory. And if the microbe or microbial consortium does not completely degrade a compound but leaves intermediates, how will those be removed?

Only one talk at the Seattle meeting focused on genetic engineering. Kenneth Timmis of the University of Geneva described his laboratory's efforts to draw on the diverse catabolic abilities scattered among soil and water microorganisms. Microorganisms have extraordinary capabilities to evolve pathways to degrade new industrial chemicals, he said. But evolution can be slow, especially when it requires multiple genetic events for which selection pressures are low. (This is especially true for catabolic pathways, which usually require 10 to 15 different enzymes.) Moreover, some chemicals appear to be inherently resistant to biological attack. For those, genetic engineering may be the only approach.

With co-workers Fernando Rojo and Juan Ramos, Timmis is trying to accelerate evolution in the laboratory. They are using two experimental strategies to construct new degradative pathways: restructuring an existing pathway and assembling an entirely new one.

The idea behind the first approach is to modify an existing catabolic pathway so that it will accept a compound that it previously would not, in this case, a model aromatic compound. *P. putida*, for example, degrades methylbenzoate and 3-ethylbenzoate but not 4-ethylbenzoate. Timmis and his colleagues set out to broaden this pathway by identifying the roadblocks to degradation of

EPA-Documerica Charles O'Rear

Toxic waste dumps *like this may be cleaned up by nonengineered microorganisms.*

4-ethylbenzoate and then engineering them.

The first obstacle they found is that the protein that stimulates synthesis of the catabolic enzymes in *P. putida* does not recognize 4-ethylbenzoate. But once they engineered that protein to recognize 4-ethylbenzoate, the organism still did not degrade it. The next roadblock turned out to be an intermediate step in the normal catabolic pathway, in which *P. putida* produces an enzyme that cleaves the aromatic ring. Timmis found that the enzyme is indeed produced and functions when 4-ethylbenzoate is present, but it is killed during the reaction. (The intermediate of 4-ethylbenzoate is a "suicide substrate" that kills the enzyme.) They selected a mutant enzyme that does work, cloned its gene, and inserted it into *P. putida*, which now degrades 4-ethylbenzoate in the laboratory.

The second approach comes into play when there is no obvious pathway related to what you want to degrade, Timmis says. The answer, he says, is to "design a new pathway on paper and then go looking in the environment for bacteria that will provide enzymes to construct it."

As their model system, Timmis and his co-workers decided to create a single pathway to degrade two types of aromatic compounds, chloroaromatics and methylaromatics. In nature these are handled by two distinct pathways (an *ortho* and a *meta* pathway). Although soil microorganisms often possess both pathways, only one is usually activated, depending on which substrate is present. When both compounds are present, however, both pathways can be switched on, which results in quite a muddle; intermediates are channeled down the wrong route, and, in the end, neither compound is degraded. Through a series of steps, the Geneva researchers recruited enzymes and assembled a pathway in *P. putida* that accommodates both. "It works," Timmis says. "It can simultaneously degrade mixtures of both types of compounds in the lab." And that, he says, holds promise for dealing with mixtures of toxic chemicals in the environment. The next step is to try both of these approaches on such major pollutants as PCBs and dioxin.

Such applications for major pollutants are thought to be several years away, however, for both scientific and regulatory reasons. Concern about releasing altered organisms into the environment is certainly one obstacle. But as Tiedje pointed out, no U.S. researcher has yet applied for permit to use a genetically altered microbe for pollution control. "There are no well-developed GEMs [genetically modified microorganisms] that people are waiting to test. We aren't there yet." And, as several speakers mentioned, Ananda Chakrabarty's oil-degrading microbe, the first genetically modified microbe to be patented, has not been used in the field, not for regulatory reasons but simply because it doesn't work very well.

For genetic engineering, says Colwell, "a key question is expression at the ecological level. You may get the gene expressed in the organism but not in the field. Factors such as temperature, the amount of nutrients, and the presence of heavy metals may affect the function of the organism you have so carefully engineered." And if the organism does work in the field, she asks, "how do you prime it and keep it primed so it will continually function?"

The difficulty is compounded, Tiedje says, by how little is known about these newly discovered microbes. "Comparatively, getting *E. coli* to produce insulin was far simpler because the biochemistry was well known." McCarty concurs. "The real need now is to understand the diverse abilities of natural organisms if we are to have any hope of improving them through recombinant DNA." ■ LESLIE ROBERTS

Behavior

Leaving hyperactivity behind

Young boys with hyperactivity have more than their share of problems in concentrating, keeping a rein on their impulses and sitting still during school lessons. On top of their early difficulties, a recent study found that boys diagnosed as hyperactive between ages 6 and 12 were twice as likely as nonhyperactive boys to have psychiatric disorders as they approached adulthood, between the ages of 16 and 23 (SN: 10/19/85, p.245). In addition to a continuing excess of hyperactivity, the former group was more likely to abuse drugs and engage in recurring delinquent and aggressive acts.

Not a bright picture, but the January ARCHIVES OF GENERAL PSYCHIATRY contains some encouraging news from the same study. In the group of 101 hyperactive boys, those who had no psychiatric disorders in adolescence and young adulthood – a total of 52 – were about as well adjusted as the 80 nonhyperactive boys who continued to be free of psychiatric disorders. Another 20 subjects from the nonhyperactive group were excluded from the comparison because of psychiatric problems that emerged during adolescence.

Interviews with each subject and one or both of his parents, as well as a review of school records, indicated that former hyperactives and controls were no different in a number of areas: job adjustment, control of temper outbursts, delinquency, violent behavior and drug use, including alcohol. Former hyperactives report more trouble concentrating and a greater tendency to be "on the go," but not to the point that it disrupts work or school functioning, say Salvatore Mannuzza of the New York State Psychiatric Institute in New York City and his colleagues. Academic achievement and extracurricular activity in high school was, however, higher among the controls.

The findings contradict a theory held by some researchers that hyperactive children who shed the full-blown disorder in their teenage years still tend to have lingering problems, such as frequent drug use or symptoms of depression.

The long and short of welfare

Recent studies have questioned the belief that, in most cases, welfare programs help to perpetuate poverty (SN: 3/17/84, p.169). Greg J. Duncan of the University of Michigan in Ann Arbor and his colleagues review the available evidence on welfare in the Jan. 29 SCIENCE and conclude that "the welfare system does not foster reliance on welfare so much as it acts as insurance against temporary misfortune."

From the mid-1960s to the late 1970s, recipients of Aid to Families with Dependent Children (AFDC) were typically on the welfare rolls for less than four years, say the researchers. About 30 percent of recipients received welfare for one or two years, and 40 percent received it for three to seven years. AFDC benefits are generally available only to women heading households with dependent children. Furthermore, only about one out of five women in their early 20s who grew up in a family that received AFDC throughout a three-year survey period was similarly dependent on the welfare program. But it is difficult to estimate the transmission of welfare dependence from generation to generation, note Duncan and his co-workers. A child's use of welfare as an adult may be affected by a number of factors that researchers have not yet accounted for, such as parents' involvement with children and the quality of schooling.

Despite indications that much welfare use is short-lived, about 30 percent of AFDC recipients remain on welfare for eight years or more. According to the researchers, this raises questions of whether, in some instances, welfare promotes divorce or out-of-wedlock births, discourages marriage, erodes work effort or instills counterproductive attitudes that encourage reliance on welfare.

Chemistry

A superoxide way to get rid of PCBs

The large family of chemical compounds known as polychlorinated biphenyls (PCBs) has a reputation for toxicity. Once used as nonflammable, heat-dissipating, insulating liquids in transformers and other electrical devices, these oily substances are no longer manufactured. Left behind, however, is the problem of safely cleaning up, degrading or destroying the large quantities of these noxious materials that were generated in the past (SN: 9/5/87, p.154). Recently, a team of chemists at Texas A&M University in College Station happened upon a chemical reaction that efficiently converts PCBs and related compounds into sodium bicarbonate and sodium chloride. The unexpectedly complete chemical degradation shown by this reaction makes it a possible alternative to methods such as incineration for disposing of PCBs.

The new chemical reaction, discovered by Donald T. Sawyer and his colleagues, uses superoxide ions to convert the PCBs. Each superoxide ion can be thought of as an oxygen molecule, made up of two oxygen atoms, with an extra electron to give the ion a negative charge. Cosmic radiation creates superoxide ions in the upper atmosphere, and biological processes generate these ions during respiration. In the laboratory, superoxide ions can be generated in electrochemical cells.

One big advantage of the process is that it seems likely to work on any scale – in small batches or in large loads. The reaction is also highly selective, reacting only with PCBs and their relatives, even when they happen to be mixed with other hydrocarbons. However, superoxide ions also react readily with water. Any reactions involving the ions must be done in nonaqueous solvents, and PCB samples must be kept dry. The new reaction is described in the Dec. 23 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY.

Measuring the lengths of molecules

"Small is beautiful" has become the motto of chemists investigating molecular arrays on the nanometer (10^{-9} meter) scale. Besides learning about the properties of molecules as they begin to form such assemblies, these tiny arrays may one day be the building blocks of minuscule electronic devices and chemical sensors (SN: 10/3/87, p.214).

But in order for good things to come from these tiny molecular packages, scientists must devise tools for imaging and measuring them. In the Jan. 20 JOURNAL OF THE AMERICAN CHEMICAL SOCIETY, researchers describe a kind of "molecular ruler" for doing that. Larry L. Miller at the University of Minnesota in Minneapolis and his colleagues developed an improved method for using a scanning transmission electron microscope (STEM) to measure organic molecules' lengths.

Normally these molecules cannot be imaged with a STEM because it only detects atoms that have a dense enough electron cloud to deflect the STEM's probing electron beam. So scientists have sized up organic molecules by marking their ends with a protein called ferritin, which contains electron-rich iron atoms. However, ferritin is large and unpredictable in the way it binds to the molecules, making it difficult to measure structures smaller than about 20 nanometers. Moreover, says Miller, it wasn't entirely clear that this method was accurate, since past work was done on biological molecules that could distort when ferritin was attached.

Miller's group showed that the labeling method does indeed work by measuring *rigid* organic molecules of previously calculated lengths. And instead of ferritin, the researchers attached smaller iridium clusters to the molecules' ends, which enabled them to resolve distances as small as 2 nanometers. Miller expects that with refinement, the technique will allow his group to measure separations 10 times smaller – distances just a bit larger than the typical length of molecular bonds.

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p.34(L)

Patents | Teresa Riordan

A new process promises to remove the chlorine from PCB's, rendering them harmless.

WASHINGTON

ONCE widely used by industry, polychlorinated biphenyls — suspected carcinogens better known as PCB's — have long been banned in the United States. But because the compound breaks down extremely slowly, PCB's persist as a costly, difficult cleanup headache.

Now two Princeton University chemists say they have come up with an elegant and inexpensive way to render soil contaminated by PCB's harmless. The Patent Office has notified them that a patent for the process will be issued on Sept. 6.

"There are a lot of brute-force cleanup methodologies that are expensive and not very effective," said Jeffrey Schwartz, a professor of chemistry at Princeton. "Some use high-temperature incineration, which are problematic since one of the reasons industry liked PCB's so much in the first place was they don't burn, at least not easily."

Professor Schwartz said known chemical methods for breaking down PCB's have also proved disappointing either because they are impractical or inefficient.

2 Benzene Rings

A PCB molecule consists of two hexagon-shaped benzene rings bonded together by two carbon atoms at one vertex of each ring. Forming the five other vertexes of each hexagon are five carbon atoms, each of which is bonded to either a hydrogen atom or a chlorine atom. The more chlorine, rather than hydrogen, present in PCB's, the more persistent they are in the environment and the more difficult they are for common soil organisms to degrade into benign substances.

"We figured out a way to turn the bad PCB's, which have lots of chlorine and little hydrogen, into the parent biphenal, which has only hydrogen and no chlorines," Professor Schwartz said.

Sodium borohydride, a common source of hydrogen, is combined with a common titanium compound and dissolved into a chemical solvent, he said, and when contaminated soil is washed with the solvent mixture, chlorine atoms from the PCB's essentially switch places with hydrogen atoms in sodium borohydride.

The chlorine gone, the PCB's turn into simple biphenal — a substance that when consumed later by bacteria will break down rapidly into harmless metabolites. At the same time, the chlorine binds with the sodium from sodium borohydride to turn into a compound that makes up ordinary table salt.

The whole mixture is then rinsed with water and dried, yielding in addition titanium dioxide, a substance used as a whitener in toothpaste, and sodium borate, a typical laundry by-product.

"It's all very common stuff at the end," Professor Schwartz said. This alchemy, however, is not without its own environmental drawback. Although Professor Schwartz estimates that 90 percent of the chemical solvent can be recaptured and re-used, the water used during the process will be contaminated with the remaining 10 percent of the solvent.

The Xetex Corporation, a two-year-old New York company, has licensed the technology and will be field-testing it at a site in Pennsylvania belonging to the Texas Eastern Corporation, which financed the research behind the technology.

Professor Schwartz and a Princeton postdoctoral fellow, Yumin Liu, are expected to be granted patent 5,345,031, which will be assigned to Princeton University.

Detoxifying PCBs

Everything from microbes to vitamin C is being considered in new approaches to degrade PCBs

By JANET RALOFF

Officials at the New York Department of Environmental Conservation estimate it will cost the state at least $40 million to dredge up and bury just 12.5 of the more than 70 tons of the polychlorinated biphenyls (PCBs) that contaminate the Hudson River. However, at about the same time as New York officials were giving taxpayers this bad news in May, researchers working for General Electric Co., one of the companies responsible for the Hudson's PCB contamination, were reporting some good news about this toxic cache: They've found that microbes in the river's sediment are munching away on buried PCBs, breaking them down into nontoxic substances.

While these yet-unidentified bacteria are dining slowly – too slowly to satisfy state and federal environmental-cleanup specialists – they do point toward a potential solution to the toxic pollution.

And the hunt for such solutions is intensifying. While PCB production was banned in 1979, an estimated 250 million pounds of these oily fluids are still in service – largely as nonflammable and insulating heat-dissipators in capacitors and transformers – and must be disposed of within the next three years. Moreover, the Environmental Protection Agency (EPA) has identified many sites where the chemicals have been illegally dumped or accidentally spilled. As a result, safe disposal of these suspected carcinogens is becoming not only big business but also an environmental imperative.

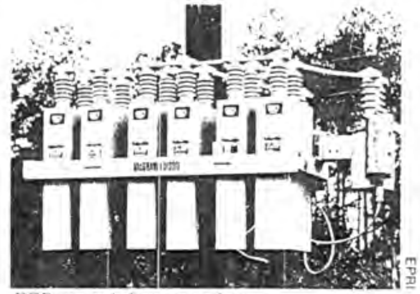
And that may explain why there are probably 100 or more different U.S. research efforts aimed at developing better PCB detoxification destruction or cleanup technologies. These programs embody concepts as simple as sprinkling a nontoxic chemical over the soil, then periodically raking the soil for enhanced sunlight-driven dechlorination, to subjecting PCBs to detoxifying chemical baths.

PCBs are a family of 209 species, each containing a pair of linked, ring-shaped structures. As many as 10 chlorine atoms may dangle off a PCB's rings. How toxic and persistent any one of them will be in the human body is determined by how many chlorines it has and where they reside.

In the May 8 SCIENCE, John F. Brown Jr. and his co-workers at the General Electric Research and Development Center in Schenectady, N.Y., described the activity of PCB-degrading anaerobic bacteria in aquatic sediment. Brown, manager of health research, reports that the more highly chlorinated PCBs – those with four or more chlorines – tend to be more toxic. However, he notes, even among the more highly chlorinated ones, those of greatest toxicological concern to humans are the species that contain chlorines linked in the "para," or 4, positions, on the ends of the molecule.

"If you remove even one of those para chlorines and leave everything else," he says, "you have a PCB that will not be persistent in humans or other warm-blooded animals, and will no longer belong to this restrictive group of [species] that have toxic activity."

And, according to his research, that is the key to the success of the Hudson River bacteria. Bacteria feeding on PCBs at the bottom of the Hudson appear to have a particularly avid appetite for just those critical para-position chlorines. What's more, the microbes are not unique to the Hudson. "In every area where there's been a major PCB spill that's gotten into aquatic sediment" – and that includes seven other waterways that Brown has studied – "we have found evidence of a [natural] dechlorination process occurring," he told SCIENCE NEWS.



EPRI

PCB-containing capacitor.

The mere presence of PCBs in water, however, is not sufficient for attracting the degrading microbes. In fact, the GE research indicates that it's not until the PCBs settle out into the sediment and eventually become buried that they become susceptible to anaerobic detoxification. Moreover, the buried PCBs must reside in sufficient quantity to attract and support a population capable of carrying out the dechlorination. To date, Brown's lab has confirmed the presence of several different populations of dechlorinating anaerobes – some preferring four- to six-chlorine PCBs and at least one with a preference for more heavily chlorinated ones.

Because most of the PCB "hotspots" Brown has examined result from contamination that occurred decades before his sampling began, he says it's still unknown how long it takes the chemical to become buried to the critical depth (roughly 2 to 6 inches) and whether there is also some typical threshold period – a time before which colonization and dechlorination begin. However, he says, once these microbes begin to chow down on the PCBs, the pollutant cache appears to become detoxified at a rate of approximately 50 percent every three to five years.

Brown, a chemist, is most interested in continuing to map the extent of this phenomenon. He notes that others (some under contract to GE) are studying the growth conditions of the dechlorinating "bugs" and attempting to identify them. These studies should prove useful to those who have already expressed interest in growing and harnessing these microbes for the commercial cleanup of PCB-contaminated water or sediment.

One of them is Sandra Woods, a civil engineer at Oregon State University in Corvallis. The porous-membrane bioreactor system she is developing to treat wastewater – like that generated by a process that washes PCBs from contaminated soils – would use Brown's PCB-dechlorinating anaerobes, together with aerobes, for commercial PCB detoxification. Woods is now attempting to grow these bacteria on a gas-permeable membrane. Though she is optimistic her bioreactor will work, she has yet to demonstrate microbe-mediated dechlorination with it.

Sept. 5, 1987 p 154-155, 159

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At West Virginia University in Morgantown, scientists are trying to coax sunlight and chemicals into emulating the dechlorination activity of the Hudson microbes for the low-cost, environmentally benign detoxification of contaminated soils. "By replacing a chlorine with a hydrogen atom," explains chemist John Penn, the PCB "becomes much less toxic." Sunlight is capable of fostering this reaction (SN: 12/17/83, p.390). However, Penn notes, sunlight is slow. Since electrons help cleave chlorine atoms, Penn throws in an electron-donating chemical to encourage the hydrogens to substitute for the chlorines. This step alone speeds the sunlight-driven dechlorination process 50-fold, Penn says. But his research shows that adding water accelerates the process more dramatically still. Working with a PCB-surrogate molecule, his addition of 3 percent water increased the dechlorination rate 1-million-fold over what would occur with sunlight alone. This suggests, he says, that detoxification of PCBs could probably be accomplished in less than one day.

Today, decontaminating soils usually involves excavating the polluted ground and running this soil through an expensive incineration process or a sodium/polymer dechlorinating reactor. Penn envisions being able to achieve the same PCB-detoxification by merely sprinkling an electron donor – perhaps something as innocuous as vitamin C – onto the contaminated ground, then periodically raking the soil to expose initially buried PCBs to light. It probably wouldn't even be necessary to add extra water, he notes, since most soils already contain more than his studies indicate would be needed to speed the reaction.

The process has already been demonstrated in a solvent-based system involving PCB surrogates – such as chloronaphthalene. If all goes well, Penn expects to establish its utility on PCBs in soil within three years.

Chemists at the University of Connecticut in Storrs are pursuing a radically different route to detoxifying PCBs – but one that also benefits from sunlight. Their approach uses a catalyst to transfer an electron from an electrode to a PCB. "This initiates a reaction that eventually leads to the loss of the PCB's chlorines," explains James F. Rusling, who is directing the work.

Originally working with PCBs in organic solvents, Rusling and his colleagues have recently adapted this electrocatalysis for a water-based system by using surfactant (soap-like) molecules to dissolve and attract both the oily PCBs and the catalyst (a polyaromatic-hydrocarbon derivative) into tiny, concentrated "microcatalytic packages." Though this process might be used for PCBs in a number of environments, if used on dredged-up PCB-contaminated river sediment, its surfactant might take on an additional cleaning role – dissolving PCBs off contaminated sediment particles.

In fine-tuning their system, the researchers have identified several tricks for speeding the electrochemical reaction rate. Rusling points out that any reaction involving an electrode will slow down once the reactant in the area adjacent to the electrode is depleted. It's possible to replenish the near-electrode environment by stirring things up – something the Connecticut chemists accomplish with ultrasound. Ultrasound waves create high-pressure bubbles in the solution. "When they burst," Rusling says, "things scatter all over the place," stirring the PCB-contaminated bath very efficiently.

More recently, he and his co-workers have shown that they can speed the electrochemical dechlorination even more – by 10 to 20 times – simply by shining sunlight or other visible light on the electrode. This "excites" the catalyst, dramatically improving its efficiency.

Ultrasound, light and ozone are the main ingredients in another PCB detoxification concept, which a new EPA report ranks as especially promising for the treatment of sediment.

For many years, EPA has permitted the use of ozone and ultraviolet light for the breakdown of PCBs in dilute (parts per billion) liquid concentrations. Ultraviolet light activates the PCB molecule by transferring energy to it. Once activated, ozone (O_3) is able to initiate an oxidative attack on the PCBs: Not only does it strip off their chlorines, but it will also "go on to oxidize the remaining biphenyls," explains Ben H. Carpenter of Research Triangle Institute in Research Triangle Park, N.C. He says research suggests the final product of biphenyl oxidation may be just carbon dioxide and water.

Together Carpenter and Edward Pedzy, president of Ozonics Technology Inc. in Closter, N.J., came up with a way to adapt this ozone treatment for sediment. A detergent is used not only to dissolve PCBs off sediment particles and into a water bath, but also to increase the amount of PCBs that will stay dissolved in the bath. Then the PCB-water slurry is hit with the ultraviolet-ozone combination. It will take the addition of ultrasound, however, to make this process truly effective, Carpenter believes.

When ozone is bubbled through a solution containing PCBs, the bubbles tend to coalesce into increasingly larger ones, decreasing the surface area of the bubbles available for reaction with passing PCBs. Pedzy's studies have shown that by subjecting the ozonated PCB-water bath to ultrasound, he can largely prevent the bubbles from coalescing. The result should be an increase in detoxification efficiency and efficacy, Carpenter says.

While a workable system is still under development, Carpenter says, "we're close to a viable process." And, he adds, "cost estimates are very good for it" – roughly one-seventh that of high-temperature incineration, the only other technology EPA has approved for destruction of PCBs in soils or sediment.

Researchers at EPA's Hazardous Waste Engineering Research Laboratory in Cincinnati are spearheading studies of potassium polyethylene glyocolate (KPEG) as a PCB-dechlorinating agent. Explains Donald L. Wilson, a physical scientist involved in the research, KPEG treatment knocks the chlorines off PCBs (or related chlorinated compounds, like dioxin) and replaces them with part of the KPEG molecule. Both the former PCB and the resulting byproducts are nontoxic, Wilson says, adding that the treatment costs considerably less than incineration or most other conventional technologies in which PCBs are concentrated in oils or other liquids.

At IIT Research Institute in Chicago, scientists are attempting to marry KPEG and radio-frequency heating for the treatment of PCB-contaminated soils. A radio-frequency (6- to 45-megahertz) alternating current applied to rows of electrodes implanted into the ground causes a warming of the earth through a process similar to the one that heats foods in a microwave oven. Temperatures to 400°C in blocks of earth up to 880 cubic feet are possible. This heating not only speeds the KPEG-dechlorinating reaction, but also drives off some of the soil water, a factor that improves the chemical's efficiency.

In small-scale IIT experiments involving just 25 grams of soil premixed with KPEG, 99.9 percent decontamination of the PCBs occurred with an 8-hour heating. According to IIT cost estimates, *in situ* radio-frequency decontamination might be achieved for just $30 to $60 per ton of soil (not counting the cost of the KPEG) – a figure IIT says not only would be competitive with most soil-incineration techniques, but also would eliminate the need for excavation. IIT has just applied for a patent on the technique, and field testing is planned for later this year.

Unison, a wholly owned subsidiary of Union Carbide Corp. in Tarrytown, N.Y., is developing strategies for dechlorinating PCBs in transformer fluids. Currently, incineration is the preferred destruction technique for transformer PCBs. However, says Eugene C. Ward, incineration "is not very cost effective," and there are only about four EPA-approved incinerators in service today – far from enough to provide sufficient processing capacity for all the PCB-transformer fluids that must be taken out

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of service by 1990. At the recent American Chemical Society meeting in Denver, Ward described one process his firm is working on that involves a pair of solvents.

According to Ward, several alcohols — such as isopropyl, propanol and methanol — dechlorinate PCBs, leaving behind nontoxic biphenyls. However, the process they use is slow and inefficient. Dimethyl formamide, on the other hand, rapidly produces the same biphenyls, but leaves them linked as an undesirable, sludge-like polymer. By pairing the solvents, says Ward, "we get the best of two worlds" — a quick reaction that leaves individual biphenyls. Stripped-off chlorines are recovered in a nontoxic salt.

This is not only useful for detoxifying pure PCBs, Ward says, but also for treating PCBs that occur as dilute contaminants in other transformer oils. Currently, it's hard to extract the PCBs out, he says, meaning that cleanup of contaminated fluids, like the relatively expensive silicone — might require destroying the silicone along with the PCBs. With the new Unison treatment, these oils could be treated and then recycled back into the transformer.

The Electric Power Research Institute in Palo Alto, Calif., has developed a solvent-extraction process removing PCBs from contaminated mineral oil, another of the fluids being used in many transformers. A recyclable solvent, methylcarbitol, dissolves the PCBs out of the oil and into a waste stream, from which they will be captured and destroyed. Then the mineral oil can be cleaned up and put back into the transformers. "The alternative to this is to treat the PCB-contaminated oil with a reagent containing sodium that destroys the PCBs," explains Gil Addis, who has been managing the institute's role in the project. "We are hoping that [our new process] will be at least as competitive as and possibly less hazardous than dealing with sodium," he told SCIENCE NEWS. He says the Atlanta-based Georgia Power Co. has successfully tested this process in the first commercial-scale, 500,000-gallon-per-year plant.

While the total quantity of PCBs as minute contaminants in U.S. transformer fluids is small — perhaps some 100,000 pounds — the market for dealing with them is large. Notes Martin Halper of EPA, "There are 22 million potentially contaminated transformers in the United States" containing just 50 to 500 parts per million PCBs.

Taken together, these projects offer a glimpse of the breadth of research efforts under way to detoxify PCBs. But this list is far from exhaustive. For example, a June assessment for EPA of potential alternatives to landfill burial and incineration — just for dealing with PCB-contaminated river sediments — identified at least 64 different experimental technologies. Others are being explored for dealing with the high-concentration PCB liquids now filling some 100,000 electrical transformers and 8 million capacitors.

Which will win out as commercial leaders in the burgeoning PCB-destruction marketplace is anyone's guess, although safety, cost and reliability will undoubtedly be major determining factors. How any will score in those categories is difficult to predict at the experimental stage.

Explains Halper: "We put people through lots of hoops to get a permit. And we see a fairly significant number of failures — more than you'd believe." In part, he says, it indicates how hard it is to scale up a winning bench-scale experimental process into a commercial-size plant. Even EPA's own mobile incinerator system (SN: 7/20/85, p.39) has failed Halper's tests to obtain a permit for use on contaminated soils — twice. As a result of such setbacks, Halper says, "A lot of people with wonderful ideas drop by the wayside." □

SUPERFUND

United States Environmental Protection Agency

Office of Solid Waste and Emergency Response

Publication 9200.5-008B
November 1990

EPA

History of Superfund

During the 1970s a series of events—culminating in 1977's Love Canal crisis in Niagara Falls, NY—dramatically brought the problem of hazardous wastes on land to the public's attention. Congress reacted to the problem of land pollution by passing the Resource Conservation and Recovery Act (RCRA) in 1976 and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980. With CERCLA began the Superfund program to clean up uncontrolled releases of hazardous wastes.

A Slow Start

Superfund got off to a rocky start. CERCLA was signed by President Jimmy Carter shortly before he left office. The incoming Reagan Administration viewed Superfund as a five-year program which would not be reauthorized and which warranted few resources.

Progress in identifying hazardous waste sites, investigating the sites' threats to human health and the environment, and cleaning up the worst sites was agonizingly slow in the early years.

Decision-making in the early program was highly centralized and conservative.

Expertise in hazardous waste cleanup was limited, and cleanup technologies were practically non-existent.

Several Steps Forward

Appointed head of the Superfund program in 1984, Lee Thomas made key decisions to speed up the program. He lowered administrative hurdles and delegated more authority to the 10 EPA Regional Offices.

1984 and 1985 saw much activity and many accomplishments in all aspects of Superfund.

One Step Back

Delays in CERCLA's reauthorization severely curtailed Superfund's activities in late 1985 and 1986. Almost all non-emergency worked ceased as taxing authority ran out and remaining funds were carefully rationed.

Superfund was finally reauthorized in October 1986.

The nation's hazardous waste problem had proved to be bigger than anyone had realized in 1980.

EPA's dilemma was how to reduce environmental risks from a growing list of increasingly complex sites in a situation characterized by incomplete knowledge, immature technology, and relentless pressure on limited resources. Rampant public criticism added pressure and an increased sense of urgency.

A New Game Plan

In 1989, EPA's new Administrator, William K. Reilly, commissioned a candid evaluation of Superfund which became known as the Superfund *90-Day Study*.

The study established a new Superfund strategy. Superfund would:

- **Use enforcement first** to compel private party response;
- **Make sites safer** by controlling acute threats immediately;
- **Make sites cleaner** by addressing the worst sites and worst problems first; and
- **Develop new technologies** for more effective cleanups.

Picking Up the Pace

Superfund's new strategy has brought significant results:

- All Superfund sites have been assessed for immediate risk and action has been taken where necessary.
- Work has begun at 86 percent of the almost 1,200 Superfund sites listed on the National Priorities List (NPL).
- Almost 700 projects representing 500 NPL sites are being readied for construction. Each year, 150 projects representing 100 sites join the line.
- Roughly 250 cleanup projects are being designed.
- Responsible parties are now doing about 60 percent of new cleanups, under EPA supervision.
- Treatment technologies are being employed in over 70 percent of the projects to control hazardous waste sources.

Heading for the Finish Line

On November 5, 1990, Congress reauthorized Superfund to operate through 1994. EPA views this as an opportunity to let the recent changes in the Superfund program work.

United States
Environmental Protection
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Superfund Contracts

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) established the Superfund Program in 1980. The Superfund Amendments and Reauthorization Act of 1986 (SARA) continues the program to clean up hazardous waste sites that threaten human health or the environment. The U.S. Environmental Protection Agency (EPA) is primarily responsible for managing cleanup and enforcement activities under Superfund. Much of the cleanup is done by private contractors with EPA or State oversight.

Why Are Private Contractors Used?

From its inception, the Superfund program has used private contractors to perform much of the work related to hazardous waste cleanup. Because the workload and skills required vary over time and across Regions, Superfund needs a flexible source of expert labor. This is more easily obtained through contractors than from a permanent, in-house workforce.

What Do Contractors Do?

EPA has approximately 100 contracts currently in place, covering a wide range of Superfund activities. The major types of EPA contracts are summarized in the table below.

SUPERFUND CONTRACTS

Type	Purpose
Emergency Response Technical Assistance Team (TAT)	Provides rapid-response technical assistance on CERCLA removal actions.
Emergency Response Cleanup (ERCS)	Provides cleanup personnel and equipment to contain, recover, or dispose of hazardous substances, to analyze samples, or to restore the area.
Hazardous Site Field Investigation Team (FIT)	Provides professionals from many disciplines who do most site assessments and inspections of waste sites, helping to determine whether the sites should go on the National Priorities List.
Hazardous Site Remedial Engineering Management (REM)	Performs remedial investigations and feasibility studies to determine the type and extent of site contamination, to design remedial actions, and to support enforcement actions.
Alternative Remedial Contracts Strategy (ARCS)	Provides program management and technical services to support remedial response activities. (Will replace the REM contracts.)
Response Engineering and Analysis (REAC)	Supports EPA's Emergency Response Team by providing technologies for remediating hazardous waste sites and spills.
Contract Laboratory Program (CLP)	Analyzes environmental samples for chemical content, under a program of strict quality controls.
Environmental Service Assistance Team (ESAT)	Expands EPA's existing capabilities for analyzing hazardous waste samples; also supports non-Superfund analytical programs.
Aerial Survey and Mapping Support	Uses aerial photography techniques to characterize contaminated sites and determine the need for cleanup.
Hazardous Materials Incident Response Training	Provides training in emergency response and safety to 5,000 Federal, State, and local government employees per year.
Technical Enforcement Support (TES)	Supports Superfund enforcement efforts by providing expert witnesses, searching for responsible parties, evaluating monitoring data, and other activities.

Other Superfund contracting activities include:

- Site-specific removal contracts issued to companies that have particularly relevant qualifications or technologies;
- Planning and cleanup services purchased by States with Federal funds provided under cooperative agreements with EPA; and
- U.S. Army Corps of Engineers contracts awarded to private firms to design and construct very large remedial responses.

All contractors are selected through competitive procurements and are carefully supervised by EPA.

What Is The Future For Superfund Contracting?

EPA has completed a Long-Term Contracting Strategy (LTCS) for the Superfund Program which provides the framework for Superfund contracting through the 1990s. The LTCS direction will provide a flexible, integrated contract infrastructure to support regional based contracts and will be implemented in the early 1990s.

United States Environmental Protection Agency
Office of Solid Waste and Emergency Response
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EPA

The Challenge of Superfund

Thousands of Sites Must Be Evaluated

Hazardous waste sites are identified through procedures as varied as formal notification requirements and citizen phone calls to the Agency.

Approximately 33,000 potential National Priorities List (NPL) sites have been placed in CERCLIS, EPA's computerized inventory of sites to be evaluated.

To date, almost 31,000 potential NPL sites have received the first level of evaluation, the preliminary assessment.

At 19,000 of these sites, the Agency decided that further Federal action is unnecessary. Problems at these sites are being dealt with by State and local governments, individuals, or companies.

Approximately 11,000 sites passed the first level of evaluation and are awaiting further investigation.

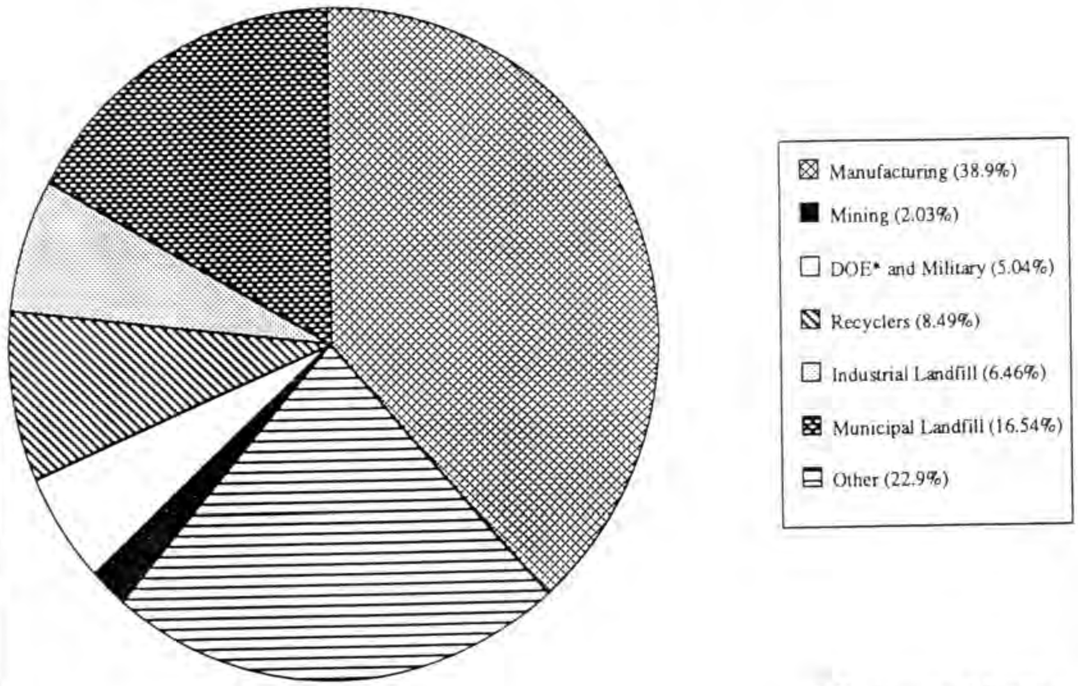
To date, the Agency has placed more than 1,200 sites on the NPL. Historically, 5-10 percent of all sites evaluated are placed on the list. Based on past experience, the Agency expects to continue listing approximately 100 sites per year.

Wastes at NPL Sites Come From Many Sources

Each NPL site is unique in its layout, type of location, and variety of wastes.

- Superfund sites range from a 1/4-acre metal plating shop to a 250-square mile mining complex.
- Every conceivable type of waste is found at Superfund sites:
  - Heavy metals,
  - Solvents,
  - Organics,
  - Pesticides, and
  - Radioactive wastes.
- Superfund sites pose threats to:
  - Groundwater,
  - Surface water,
  - Drinking water,
  - Soils, and
  - Air.

INDUSTRIES ASSOCIATED WITH SUPERFUND SITES



* Department of Energy

Superfund Must Satisfy Conflicting Expectations

The public and Congress have many — often conflicting — expectations for Superfund. Some of the mandates the program must meet are:

Rapid response	*and*	Careful planning
Cleanups at many sites	*and*	Thorough cleanup at each site
Prompt cleanup completion	*and*	Extensive public involvement
Consistent cleanup nationwide	*and*	Decentralized decision-making
Using Trust Fund money for cleanup	*and*	Suing for private party response

Meeting these expectations requires EPA constantly to make difficult decisions regarding strategies and priorities.

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

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November 1990

EPA

Superfund Enforcement — Making Polluters Pay

Who is Liable for Superfund Cleanups?

The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), commonly known as Superfund, imposes liability when there is a release or threatened release of hazardous substances. Potentially responsible parties (PRPs) are individuals or companies who may be responsible for all or part of the contamination at a Superfund site.

PRPs include:

- Present owners and operators of a Superfund site, even if they did not contaminate the property.
- Past owners and operators of the facility where the hazardous substances were disposed of improperly.
- Persons who arranged for the treatment, disposal, or transportation for treatment or disposal of hazardous substances at the site.
- Persons who transported hazardous substances to disposal or treatment facilities that they selected.

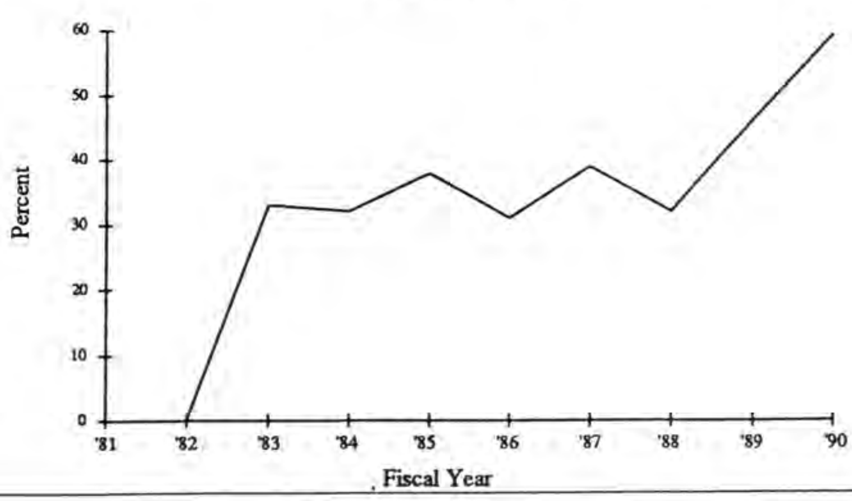
Superfund Enforcement is Getting Results

EPA Administrator William K. Reilly's 1989 management review of Superfund, also known as the *90-Day Study*, stresses enforcement to make polluters pay to clean up the hazardous waste sites they create. The Agency has incorporated that managerial mandate in its latest revision of the National Contingency Plan (NCP), the Superfund program's blueprint. Already Unilateral Administrative Orders are up 31 percent and the value of cleanup work performed, or funded, by PRPs has jumped to $1.3 billion in FY '90. EPA won its first award for treble damages from a recalcitrant PRP in FY '90. The award was worth more than $2 million.

PRPs' Cleanup Activities are Increasing

Aggressive enforcement, primarily through the use of Unilateral Administrative Orders (UAOs), has resulted in PRPs financing almost 60 percent of new cleanup construction projects in FY '90. (See Graph1.) If a PRP fails to comply with a UAO, EPA can recover its cleanup costs plus three times that amount in damages.

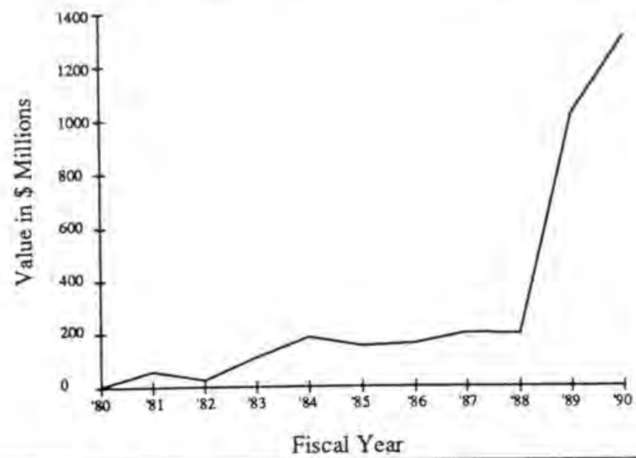
1. PERCENT OF REMEDIAL ACTIONS FINANCED BY PRPs



The Value of PRP-Funded Cleanup Grows

Since 1980, EPA has achieved 1,336 settlements with PRPs valued at an estimated $3.7 billion in FY '90, an increase of almost seven-fold in three years. (See Graph 2.)

2. VALUE OF PRP CLEANUP AGREEMENTS

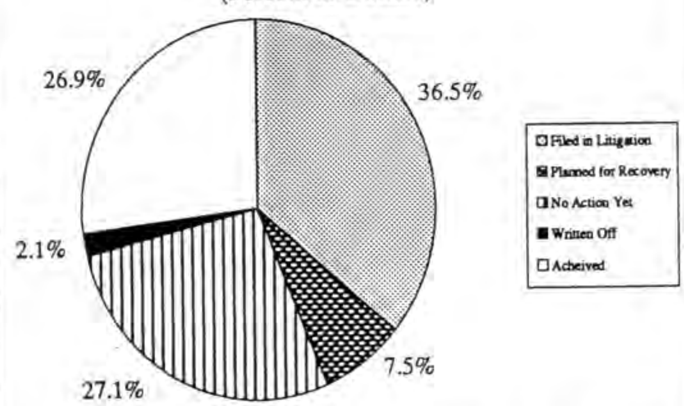


Cost Recovery is Increasing

EPA has referred for prosecution 391 cost recovery cases worth an estimated $644 million to the United States Department of Justice since 1980. The volume of cases referred by EPA has risen from $2.1 million in FY '80 to $185 million in FY '90. (See Graph 3.)

3. EPA IS TAKING ACTION TO RECOVER SEVEN OUT OF TEN DOLLARS SPENT*

(Percent of Dollars)



*Fund dollars spent at 2,039 NPL and non-NPL sites

How are Superfund Clean-ups Enforced?

Whenever possible, EPA begins looking for PRPs before beginning any cleanup activities paid for by the Superfund Trust Fund. PRPs are liable for all costs incurred by the Federal Government. The search for PRPs can be lengthy, and site cleanup often begins before all PRPs are identified.

When EPA has enough information to identify a PRP, the Agency issues a **general notice letter** informing him of his potential liability. Then EPA begins **exchanging information** with PRPs about site conditions, their connections to the site, and the identities of other potentially responsible parties.

EPA may issue **special notices** to PRPs, which begins a **formal period of negotiations** for site cleanup or for funding of cleanup efforts and establishes a **90- to 120-day moratorium** during which EPA will not begin cleaning up the site.

If PRPs decline to participate, or the time for negotiating a settlement runs out, EPA may issue a **unilateral administrative order** for cleanup. EPA also may begin cleaning up the site using Trust Fund money, then sue the PRPs to recover the costs of cleanup. EPA may also sue for treble damages against recalcitrant PRPs.

When EPA decides that judicial action may be required, the Agency refers the case to the Department of Justice, who represents EPA in court.

At all sites where PRPs are conducting or paying for cleanup, EPA oversees the cleanup activities to ensure they comply with CERCLA, with applicable regulations and policies, and with the terms of EPA's settlement agreement with the PRPs.

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EPA

Superfund Blueprint

A tightly knit set of policies and principles guides Superfund's decision-making and measures its progress. These are embodied in the National Contingency Plan (NCP), the Hazard Ranking System (HRS), and the *90-Day Study*.

The National Contingency Plan

The NCP is the regulation that implements the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Revised in February 1990, the NCP outlines EPA's national program of response to releases of hazardous substances. The NCP defines the roles and responsibilities of EPA, other Federal agencies, the States, private parties, and communities. It also maps out the entire cleanup process, from site discovery and evaluation to cleanup, long-term monitoring, and eventual deletion from the National Priorities List.

Goals

The NCP's goal is to select remedies that protect human health and the environment, that maintain protection over time, and that minimize untreated waste. EPA believes that treating waste is the best method for achieving long-term protection. The NCP promotes use of innovative technologies in order to bolster development of new methods to ensure long-term protection.

Selection of Cleanup Actions

A cornerstone of the NCP is a set of nine ground rules for selecting Superfund cleanup actions. The four most important are:

- Overall protection of human health and the environment;
- Compliance with other Federal and State environmental laws;
- Long-term effectiveness and permanence; and
- Reduction of waste toxicity, mobility, or volume through treatment.

Potential cleanup actions are also evaluated according to five additional criteria: short-term effectiveness, feasibility of implementation, cost, State acceptance, and community acceptance.

Public Participation

Congress expanded the role of communities in the Superfund Amendments and Reauthorization Act (SARA) of 1986. Consistent with this, the NCP requires EPA to consult with the public throughout cleanup. EPA must interview community groups at the start of a cleanup study to identify their concerns and must prepare a Community Relations Plan that addresses those concerns. The public must have ample opportunity to comment on all proposed remedies, and EPA must consider those comments in selecting the final remedy.

Enforcement

CERCLA holds potentially responsible parties legally and financially responsible for cleanup. The NCP spells out how EPA will use the powerful authorities CERCLA gives the Agency and the Department of Justice to compel private parties and Federal facilities to meet their cleanup obligations.

State Participation

States have a major role in all cleanup actions. Under the NCP, qualified States may lead cleanups under a cost-sharing agreement with EPA. Even when States support rather than lead the cleanup, they have a crucial role in identifying cleanup standards and reviewing proposed remedies.

Hazard Ranking System

CERCLA directs the establishment of a National Priorities List (NPL) of sites eligible for Federal funding of long-term cleanup. EPA developed the Hazard Ranking System to select sites for the NPL. The HRS is a method for:

- Identifying the risks at each site,
- Assigning numerical scores to those risks, and
- Comparing the relative severity of risks among sites.

Sites that score at least 28.50, on a 100-point scale, are eligible for the NPL.

The HRS was revised in November 1990 to improve scoring accuracy.

90-Day Study

Responding to public criticism of the slow pace of cleanup, EPA Administrator William K. Reilly initiated a *90-Day Study* of Superfund in mid-1989. The study formulated a strategy which was incorporated into the NCP. This strategy has eight major elements. Four elements constitute Superfund's environmental goals:

- **Make polluters pay** by stressing enforcement first;
- **Make sites safer** by addressing acute threats;
- **Make sites cleaner** by cleaning up the worst threats at the worst sites first; and
- **Develop and use innovative technologies** for more effective permanent cleanup.

The remaining four elements comprise EPA's approach to achieving these goals: increase efficiency within the program; expand public participation; increase cooperation with States and other groups; and monitor and maintain sites to ensure they remain safe after cleanup.

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Superfund Technology

When Superfund began 10 years ago, land disposal was the common way to get rid of hazardous waste, and EPA was working to design safer landfills. However, EPA, the scientific community, and the public quickly became concerned over the wisdom of depositing Superfund wastes in even the best designed landfills. Numerous studies suggested that these landfills might become future Superfund sites.

Congress gave Superfund two powerful incentives for developing innovative technologies to treat wastes. First, the 1984 Hazardous and Solid Waste Amendments to the Resource Conservation and Recovery Act (RCRA) required a nationwide phaseout of land disposal of certain wastes. Second, the Superfund Amendments and Reauthorization Act (SARA) of 1986 created a new Superfund Innovative Technology Evaluation (SITE) program and directed EPA to select permanent treatment technologies over land disposal.

Recent Progress

Since SARA, Superfund's use of treatment technologies has increased steadily. Treatment of waste was a part of 54 percent of remedies selected to control the sources of contamination in FY '87. This percentage increased to 69 percent in FY '88 and to 72 percent in FY '89. Where treatment was part of the remedy, use of innovative technologies increased from 26 percent in FY '87 to 40 percent in FY '88 to 51 percent in FY '89. Innovative technologies for soil treatment receiving research priority include:

- **Air Stripping**: a treatment system that removes, or "strips," volatile organic compounds from contaminated groundwater or surface water by forcing an airstream through the water and causing the compounds to evaporate. The evaporated compounds are captured and contained by activated carbon filters to prevent their release into the atmosphere.
- **Thermal desorption:** this process uses heat to remove organic contaminants from soil for further treatment.
- **In-situ Vitrification:** this process electrically melts soils and sludges contaminated with various waste types (e.g., radioactive, inorganic, and/or organic), creating an extremely stable glass-like solid.
- **Soil Washing**: this process segregates and reduces the volume of wastes by spraying and rinsing soil with a washing fluid. Contaminated fluid is treated using conventional wastewater treatment technology. This technique is potentially effective in treating various organic and inorganic wastes found in soils.
- **In-situ Vacuum Extraction**: this technique for treating volatile organics in soil is similar to the air stripping technique used for groundwater remediation. A vacuum applied through wells vaporizes the volatile organics which are then removed from the air using activated carbon.
- **Solvent Extraction**: this technique uses various solvents to extract contaminants from soil for further treatment.
- **Bioremediation**: this process uses microbes to break down organic contaminants in the soil into harmless substances. The soil can be treated in place or excavated and treated.
- **Chemical Dechlorination:** this process is used to detoxify contaminants such as PCBs by removing the chlorine atoms.

To promote greater use of innovative technologies, EPA has made it easier to test technology in the field and has made technology experts available to decision-makers in the Regions.

Technology Innovation Office

EPA has established a Technology Innovation Office to increase applications of innovative treatment technology by government and industry to contaminated waste sites, soils, and groundwater. Increased usage will be accomplished through the removal of regulatory and institutional impediments and the provision of richer technology and market information to targeted audiences of Federal agencies, States, consulting engineering firms, responsible parties, technology developers, and the investment community. The scope of this mission extends to corrective action under the Resource Conservation and Recovery Act and underground storage tank cleanups.

SITE Program

Recognizing the need for long-term protection of public health and the environment, EPA is cautious about the use of unproven treatment technologies. The SITE program lets EPA test and evaluate promising technologies. Under the demonstration portion of the program, EPA matches a technology developer with an appropriate Superfund site. Typically, the developer is responsible for all logistics and costs associated with setting up and operating the demonstration unit. EPA monitors the demonstration and prepares a detailed set of reports identifying the technology's effectiveness on the wastes treated and its applicability to other wastes commonly found at Superfund sites. These reports are publicly available. Today, approximately 70 vendors with technologies at various stages of development are participating in the demonstration and other elements of the SITE program.

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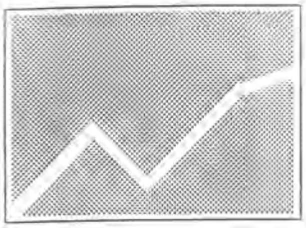
EPA

Superfund: Future Strategy and Directions



When Superfund was established in 1980, EPA and Congress believed that only a few hundred sites nationwide would require cleanup. Congress directed EPA to clean up acute threats that posed immediate risks to human health and the environment. Congress also directed the Agency to evaluate additional hazardous waste sites as they were discovered and to place the most dangerous sites on a National Priorities List (NPL).

A Big Job

When Superfund was reauthorized six years later, it was apparent that the problem of uncontrolled hazardous waste sites was larger than anyone had believed originally. More than 28,000 sites had been scheduled for preliminary review; more than 900 sites had been placed on the NPL; and more than 800 emergency actions had been taken.

The program's progress increased dramatically with the passage of the Superfund Amendments and Reauthorization Act of 1986 (SARA), which quadrupled the resources available to Superfund. But it was clear that the growing size of the hazardous waste problem — and EPA's growing understanding of the complexity of site cleanups — called for a new strategy.

A New Strategy

In June 1989, EPA Administrator William Reilly's *Superfund Management Review*, also known as the *90-Day Study*, articulated a new strategy for the Superfund program. The strategy emphasizes:

- Increased use of EPA's enforcement powers to force potentially responsible parties to clean up problems they create; and
- A revitalization of the Agency's approach to pay for site cleanups out of the Superfund Trust Fund.

Simply stated, the new strategy emphasizes addressing the worst problems at the worst sites first, in accordance with the Agency's goal of overall risk reduction. Employing this new strategy, EPA will:

- **Use enforcement first** to compel private party response,
- **Make sites safe** from acute threats,
- **Make sites clean** over the long term, and
- **Bring new technology to bear** on the problem of hazardous waste contamination.

The new strategy also calls for EPA to improve program efficiency, encourage public involvement in program decisions, and communicate program success more clearly.

Superfund is making solid progress in implementing the strategy, and for the first time in the program's history the cost of projects in the construction pipeline exceeds the available funding.

Cleanup of sites already on the NPL is expected to cost an additional $19 billion beyond the $7.5 billion already obligated. And the NPL is expected to grow from approximately 1,200 sites to more than 2,000 sites by the end of the century.

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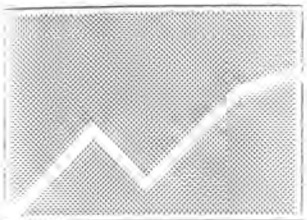
EPA

Who Pays for Superfund?



Superfund is the Federal program for protecting the public and the environment from uncontrolled releases of hazardous substances. More than 1,200 sites are listed on the National Priorities List (NPL) and slated for cleanup under Superfund. The United States Environmental Protection Agency (EPA) is adding more sites to the NPL every year.

The Superfund Trust Fund provides tax money to pay the Federal share of site cleanups, but whenever possible EPA forces those responsible for contaminating a site to clean it up.

Sharing Cleanup Costs

Businesses often create Superfund sites by improperly disposing of hazardous wastes. Private individuals and Federal agencies also have created such sites. Entities suspected of having contaminated a site are called **potentially responsible parties** (PRPs).

Whenever possible, EPA compels responsible parties to clean up a site they created or contributed to. (If EPA cannot identify the responsible parties or compel them to respond, the Agency will pay for site cleanup out of the Trust Fund.)

The Superfund law requires States to contribute at least 10 percent of EPA's costs of cleaning up NPL sites within their borders.

Federal agencies pay for cleanups of Federal hazardous wastes, such as military bases or weapons plants, out of their own budgets. They do not use Trust Fund monies.

Superfund Trust Fund

The Superfund Trust Fund was authorized in 1980 at $1.6 billion. The Superfund amendments in 1986 authorized the Trust Fund at $8.6 billion. In November 1990, a third authorization added $5.1 billion.

Superfund expects to spend an additional $19 billion to clean up sites now on the NPL, according to the FY 1989 Annual Report to Congress.

The Superfund trust fund receives money from three major sources annually:

- $553 million from petroleum excise taxes;
- $273 million from chemical feedstock excise taxes; and
- $504 million from environmental income taxes.

Numerous smaller sources — primarily cost recovery, penalties, income taxes, and interest income — add another $440 million annually.

Responsible Party Contributions

Potentially responsible parties are performing and financing almost 60 percent of the new construction projects that began in FY '90.

Responsible parties pay for site cleanups with funds from profits, asset liquidation, borrowing, and insurance.

To date, PRPs are obligated in 1,336 settlements to pay over $3.7 billion in cleanup costs.

To date, PRPs have agreed to repay government cleanup costs of almost $475 million. EPA has recently been awarded its first treble damages case, valued at over $2 million.

Other Federal Agency Contributions

As of September 30, 1989, Federal agencies estimated they would spend $4 billion on Superfund-related cleanups from FY 1987 through FY 1991.

The Departments of Defense and Energy will spend an estimated $2.7 billion and $1 billion respectively.

The Federal Government owns some of the largest Superfund sites, but it owns the smallest percentage of sites, compared to private industry and other owners of Superfund sites.

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EPA

Superfund: Fact vs. Fiction

Many misconceptions about Superfund have arisen since the Federal hazardous waste cleanup program began 10 years ago. The rapid increase in Superfund sites, the slow pace of cleanup due to complex technical and programmatic problems, and limited resources were some challenges Superfund faced. In this fact sheet, the United States Environmental Protection Agency (EPA) separates the facts from the fictions about Superfund.

Fiction	**Fact**
Superfund has spent billions of dollars to clean up only a few sites.	EPA has evaluated over 30,000 sites and slated over 1,200 for cleanup. We have conducted engineering studies at over 1,000 sites, started cleanup at almost 500, and responded to almost 2,000 emergencies.
Contractors do all the work.	Federal officials make all cleanup and policy decisions. They oversee and direct contractors with special expertise, equipment, or manpower to perform certain cleanup tasks.
Potentially responsible parties are not doing their share of the cleanup.	Potentially responsible parties are now conducting almost 60 percent of new remedial actions. Their cleanup agreements with EPA have exceeded $2 billion in the last two years.
Potentially responsible parties don't do as good a cleanup job as government does.	Potentially responsible parties meet site cleanup requirements just as well as the government does, a recent EPA survey shows.
Superfund provides only temporary solutions, such as containment, and not long-term cleanup at hazardous waste sites.	Superfund protects people and the environment by attacking the worst problems first. Long-term cleanups follow on a priority basis. Over 70 percent of cleanup decisions in 1989 reduced the toxicity, mobility, or volume of hazardous wastes at Superfund sites through the use of treatment technologies.
The quality of Superfund cleanups varies across the country.	Although each Superfund site is unique, EPA applies the same cleanup standards nationwide.

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EPA

The Superfund Cleanup Process

Superfund's cleanup process is designed to control short- and long-term threats to public health and the environment from uncontrolled releases of hazardous substances. The program responds to hazardous waste emergencies wherever they occur; but only sites listed on the National Priorities List (NPL) are eligible for long-term cleanup under Superfund.

EPA uncovers potential hazardous waste problems through many sources including reports from States, communities, businesses, the U.S. Coast Guard, and citizen reports to the National Response Center's 24-hour hotline (800/424-8802). Most long-standing hazardous waste sites took years to develop. Cleaning them up to protect people and environments is also a lengthy and painstaking process.

How the Process Works

The major steps in the cleanup process are:

- Site discovery and investigation, usually by State officials.
- EPA evaluation of possible hazards posed by site contaminants and, if warranted, addition of the site to the NPL. Hazardous materials that pose imminent threats may be removed anytime during the cleanup process.
- Negotiations to encourage potentially responsible parties to pay for cleanup during each of the following steps.
- Detailed studies to assess what contaminants are present, how serious the contamination is, and what are the potential risks to the community. Studies are done to determine which cleanup methods may be most effective. This process can take 18 to 30 months and the average cost is about $1 million.
- After a public comment period on EPA's proposed cleanup plan, selection of a cleanup method to be used at the site.
- EPA then designs a site-specific cleanup that implements its plan. This takes about 12 to 18 months and costs an average of $1 million.
- Actual cleanup. Depending on the method used, this step may take from one to six years. Cleanup of groundwater is one of the most difficult problems found at Superfund sites. It may take decades to cleanse groundwater.

Why It Takes So Long

The Superfund program addresses releases of hazardous materials to the land, air, surface water and groundwater. The program encounters many situations never dealt with before, such as dump sites in residential areas, buried wastes in unknown amounts and concentrations, and hazardous wastes leaking into drinking water sources.

Unlike other EPA programs, Superfund has had to develop many of its cleanup techniques almost from scratch. This process takes time, but innovative technologies increasingly are available to clean up sites efficiently, effectively, and permanently.

Superfund cleanups can involve Federal agencies other than EPA, States, communities, businesses, and private citizens. Coordination among so many groups is often time consuming. In addition, issues may arise among groups that must be resolved before cleanup can begin.

The Superfund program stresses enforcement to make polluters pay for, or perform, as much of the cleanup work as possible. This process is lengthy because potentially responsible parties (PRPs) must receive due process of law. EPA oversight of PRPs' cleanup activities and dispute resolution during cleanup also take time.

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Solid Waste And
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(OS-240)

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National Priorities List Sites:

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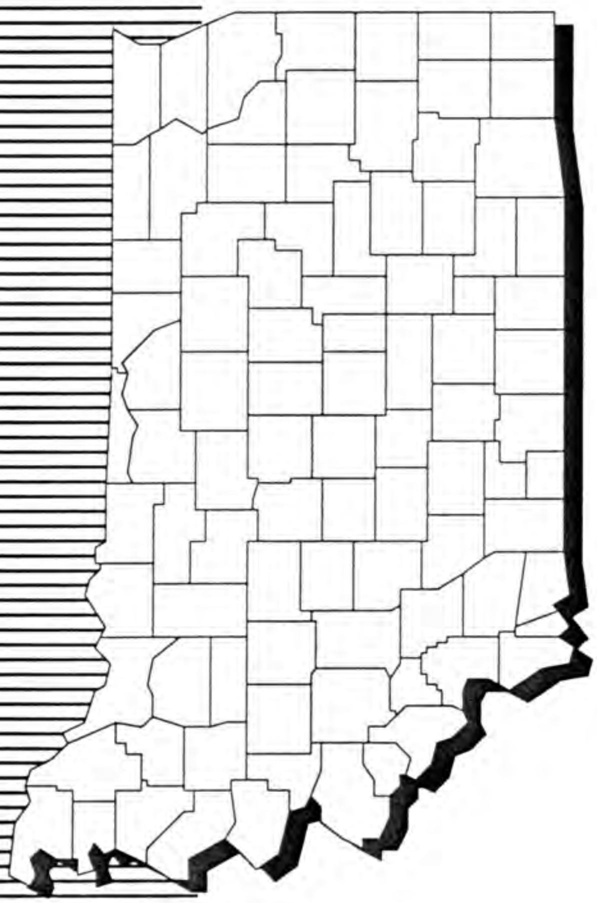

1991

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Table of Contents

A Brief Overview

WHY THE SUPERFUND PROGRAM?

As the 1970s came to a close, a series of headline stories gave Americans a look at the dangers of dumping industrial and urban wastes on the land. First there was New York's Love Canal. Hazardous waste buried there over a 25-year period contaminated streams and soil, and endangered the health of nearby residents. The result: evacuation of several hundred people. Then the leaking barrels at the Valley of the Drums in Kentucky attracted public attention, as did the dioxin-tainted land and water in Times Beach, Missouri.

In all these cases, human health and the environment were threatened, lives were disrupted, and property values were reduced. It became increasingly clear that there were large numbers of serious hazardous waste problems that were falling through the cracks of existing environmental laws. The magnitude of these emerging problems moved Congress to enact the Comprehensive Environmental Response, Compensation, and Liability Act in 1980. CERCLA — commonly known as Superfund — was the first Federal law established to deal with the dangers posed by the Nation's hazardous waste sites.

After Discovery, the Problem Intensified

Few realized the size of the problem until the Environmental Protection Agency (EPA) began the process of site discovery and site evaluation. Not hundreds, but thousands of potential hazardous waste sites existed, and they presented the Nation with some of the most complex pollution problems it had ever faced.

Since the Superfund program began, hazardous waste has surfaced as a major environmental concern in every part of the United States. It wasn't just the land that was contaminated by past disposal practices. Chemicals in the soil were spreading into the groundwater (a source of drinking water for many) and into streams, lakes, bays, and wetlands. Toxic vapors contaminated the air at some sites, while improperly disposed or stored wastes threatened the health of the surrounding community and the environment at others.

The EPA Identified More than 1,200 Serious Sites

The EPA has identified 1,245 hazardous waste sites as the most serious in the Nation. These sites comprise the National Priorities List; sites targeted for cleanup under Super-fund. But site discoveries continue, and the EPA estimates that, while some will be deleted after lengthy cleanups, this list, commonly called the NPL, will continue to grow by approximately 50 to 100 sites per year, potentially reaching 2,100 sites by the year 2000.

THE NATIONAL CLEANUP EFFORT IS MUCH MORE THAN THE NPL

From the beginning of the program, Congress recognized that the Federal government could not and should not address all environmental problems stemming from past disposal practices. Therefore, the EPA was directed to set priorities and establish a list of sites to target. Sites on the NPL (1,245) thus are a relatively small subset of a larger inventory of potential hazardous waste sites, but they do comprise the most complex and compelling cases. The EPA has logged more than 35,000 sites on its national inventory of potentially hazardous waste sites and assesses each site within one year of being logged.

THE EPA IS MAKING PROGRESS ON SITE CLEANUP

The goal of the Superfund program is to tackle immediate dangers first and then move through the progressive steps necessary to eliminate any long-term risks to public health and the environment.

Superfund responds immediately to sites posing imminent threats to human health and the environment at both NPL sites and sites not on the NPL. The purpose is to stabilize, prevent, or temper the effects of a release of hazardous substances, or the threat of one, into the environment. These might include tire fires or transportation accidents involving the spill of hazardous chemicals. Because they reduce the threat a site poses to human health and the environment, immediate cleanup actions are an integral part of the Superfund program.

Immediate response to imminent threats is one of Superfund's most noted achievements. Where imminent threats to the public or environment were evident, the EPA has initiated or completed emergency actions that attacked the most serious threats of toxic exposure in more than 2,700 cases.

The ultimate goal for a hazardous waste site on the NPL is a permanent solution to an environmental problem that presents a serious threat to the public or the environment. This often requires a long-term effort. The EPA has aggressively accelerated its efforts to perform these long-term cleanups of NPL sites. More cleanups were started in 1987, when the Superfund law was amended, than in any previous year. By 1991, construction had started at more than four times as many sites as in 1986! Of the sites currently on the NPL, more than 500 — nearly half — have had construction cleanup activity. In addition, more than 400 more sites presently are in the investigation stage to determine the extent of site contamination and to identify appropriate cleanup remedies. Many other sites with cleanup remedies selected are poised for the start of cleanup construction activity. In measuring success by "progress through the cleanup pipeline," the EPA clearly is gaining momentum.

THE EPA MAKES SURE CLEANUP WORKS

The EPA has gained enough experience in cleanup construction to understand that environmental protection does not end when the remedy is in place. Many complex technologies — like those designed to clean up groundwater — must operate for many years in order to accomplish their objectives.

The EPA's hazardous waste site managers are committed to proper operation and maintenance of every remedy constructed. No matter who has been delegated responsibility for monitoring the cleanup work, the EPA will assure that the remedy is carefully followed and that it continues to do its job.

Likewise, the EPA does not abandon a site even after the cleanup work is done. Every five years, the Agency reviews each site where residues from hazardous waste cleanup still remain to ensure that public and environmental health are being safeguarded. The EPA will correct any deficiencies discovered and will report to the public annually on all five-year reviews conducted that year.

CITIZENS HELP SHAPE DECISIONS

Superfund activities also depend upon local citizen participation. The EPA's job is to analyze the hazards and to deploy the experts, but the Agency needs citizen input as it makes choices for affected communities.

Because the people in a community where a Superfund site is located will be those most directly affected by hazardous waste problems and cleanup processes, the EPA encourages citizens to get involved in cleanup decisions. Public involvement and comment does influence EPA cleanup plans by providing valuable information about site conditions, community concerns, and preferences.

The State and U.S. Territories volumes and the companion National overview volume provide general Superfund background information and descriptions of activities at each NPL site. These volumes clearly describe what the problems are, what the EPA and others participating in site cleanups are doing, and how we, as a Nation, can move ahead in solving these serious problems.

USING THE STATE AND NATIONAL VOLUMES TOGETHER

To understand the big picture on hazardous waste cleanup, citizens need to hear about both environmental progress across the country and the cleanup accomplishments closer to home. Citizens also should understand the challenges involved in hazardous waste cleanup and the decisions we must make, as a Nation, in finding the best solutions.

The National overview, *Superfund: Focusing on the Nation at Large (1991)*, contains important information to help you understand the magnitude and challenges facing the Superfund program, as well as an overview of the National cleanup effort. The sections describe the nature of the hazardous waste problem nationwide, threats and contaminants at NPL sites and their potential effects on human health and the environment, vital roles of the various participants in the cleanup process, the Superfund program's successes in cleaning up the Nation's serious hazardous waste sites, and the current status of the NPL. If you did not receive this overview volume, ordering information is provided in the front of this book.

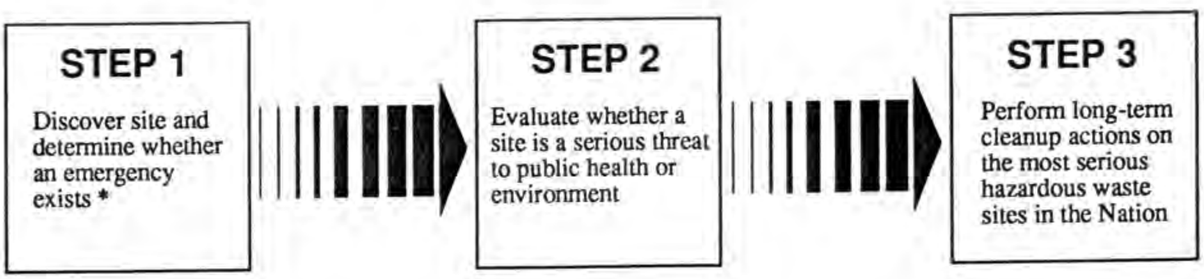
This volume compiles site summary fact sheets on each State or Territorial site being cleaned up under the Superfund program. These sites represent the most serious hazardous waste problems in the Nation and require the most complicated and costly site solutions yet encountered. Each book gives a "snapshot" of the conditions and cleanup progress that has been made at each NPL site. Information presented for each site is current as of April 1991. Conditions change as our cleanup efforts continue, so these site summaries will be updated annually to include information on new progress being made.

To help you understand the cleanup accomplishments made at these sites, this volume includes a description of the process for site discovery, threat evaluation, and long-term cleanup of Superfund sites. This description, *How Does the Program Work to Clean Up Sites?*, will serve as a reference point from which to review the cleanup status at specific sites. A glossary defining key terms as they apply to hazardous waste management and site cleanup is included as Appendix A in the back of this book.

How Does the Program Work to Clean Up Sites?

The diverse problems posed by hazardous waste sites have provided the EPA with the challenge to establish a consistent approach for evaluating and cleaning up the Nation's most serious sites. To do this, the EPA has had to step beyond its traditional role as a regulatory agency to develop processes and guidelines for each step in these technically complex site cleanups. The EPA has established procedures to coordinate the efforts of its Washington, D.C. Headquarters program offices and its front-line staff in ten Regional Offices, with the State and local governments, contractors, and private parties who are participating in site cleanup. An important part of the process is that any time during cleanup, work can be led by the EPA or the State or, under their monitoring, by private parties who are potentially responsible for site contamination.

THREE-STEP SUPERFUND PROCESS



** Emergency actions are performed whenever needed in this three-step process.*

The process for discovery of the site, evaluation of threat, and the long-term cleanup of Superfund sites is summarized in the following pages. The phases of each of these steps are highlighted within the description. The flow diagram above provides a summary of the three-step process.

Although this book provides a current "snapshot" of site progress made only by emergency actions and long-term cleanup actions at Superfund sites, it is important to understand the discovery and evaluation process that leads to identifying and cleaning up these most serious uncontrolled or abandoned hazardous waste sites in the Nation. The discovery and evaluation process is the starting point for this summary description of Superfund involvement at hazardous waste sites.

STEP 1: SITE DISCOVERY AND EMERGENCY EVALUATION

How does the EPA learn about potential hazardous waste sites?

Site discovery occurs in a number of ways. Information comes from concerned citizens. People may notice an odd taste or foul odor in their drinking water or see half-buried leaking barrels; a hunter may come across a field where waste was dumped illegally. There may be an explosion or fire, which alerts the State or local authorities to a problem. Routine investigations by State and local governments and required reporting and inspection of facilities that generate, treat, store, or dispose of hazardous waste also help keep the EPA informed about actual or potential threats of hazardous substance releases. All reported sites or spills are recorded in the Superfund inventory (CERCLIS) for further investigation to determine whether they will require cleanup.

What happens if there is an imminent danger?

As soon as a potential hazardous waste site is reported, the EPA determines whether there is an emergency requiring an immediate cleanup action. If there is, they act as quickly as possible to remove or stabilize the imminent threat. These short-term emergency actions range from building a fence around the contaminated area to keep people away, or temporarily relocating residents until the danger is addressed, to providing bottled water to residents while their local drinking water supply is being cleaned up or physically removing wastes for safe disposal.

However, emergency actions can happen at any time an imminent threat or emergency warrants them. For example, if leaking barrels are found when cleanup crews start digging in the ground or if samples of contaminated soils or air show that there may be a threat of fire or explosion, an immediate action is taken.

STEP 2: SITE THREAT EVALUATION

If there isn't an imminent danger, how does the EPA determine what, if any, cleanup actions should be taken?

Even after any imminent dangers are taken care of, in most cases, contamination may remain at the site. For example, residents may have been supplied with bottled water to take care of their immediate problem of contaminated well water, but now it's time to determine what is contaminating the drinking water supply and the best way to clean it up. The EPA may determine that there is no imminent danger from a site, so any long-term threats need to be evaluated. In either case, a more comprehensive investigation is needed to determine if a site poses a serious, but not imminent, danger and whether it requires a long-term cleanup action.

Once a site is discovered and any needed emergency actions are taken, the EPA or the State collects all available background information not only from their own files, but also from local records and U.S. Geological Survey maps. This information is used to identify the site and to perform a preliminary assessment of its potential hazards. This is a quick review of readily available information to answer the questions:

- Are hazardous substances likely to be present?

- How are they contained?
- How might contaminants spread?
- How close is the nearest well, home, or natural resource area such as a wetland or animal sanctuary?
- What may be harmed — the land, water, air, people, plants, or animals?

Some sites do not require further action because the preliminary assessment shows that they do not threaten public health or the environment. But even in these cases, the sites remain listed in the Superfund inventory for record-keeping purposes and future reference. Currently, there are more than 35,000 sites maintained in this inventory.

If the preliminary assessment shows a serious threat may exist, what's the next step?

Inspectors go to the site to collect additional information to evaluate its hazard potential. During this *site inspection*, they look for evidence of hazardous waste, such as leaking drums and dead or discolored vegetation. They may take some samples of soil, well water, river water, and air. Inspectors analyze the ways hazardous materials could be polluting the environment, such as runoff into nearby streams. They also check to see if people (especially children) have access to the site.

How does the EPA use the results of the site inspection?

Information collected during the site inspection is used to identify the sites posing the most serious threats to human health and the environment. This way, the EPA can meet the requirement that Congress gave them to use Superfund monies only on the worst hazardous waste sites in the Nation.

To identify the most serious sites, the EPA developed the Hazard Ranking System (HRS). The HRS is the scoring system the EPA uses to assess the relative threat from a release or a potential release of hazardous substances from a site to surrounding groundwater, surface water, air, and soil. A site score is based on the likelihood that a hazardous substance will be released from the site, the toxicity and amount of hazardous substances at the site, and the people and sensitive environments potentially affected by contamination at the site.

Only sites with high enough health and environmental risk scores are proposed to be added to the NPL. That's why 1,245 sites are on the NPL, but there are more than 35,000 sites in the Superfund inventory. Only NPL sites can have a long-term cleanup paid for from Superfund, the national hazardous waste trust fund. Superfund can, and does, pay for emergency actions performed at any site, whether or not it's on the NPL.

Why are sites proposed to the NPL?

Sites proposed to the NPL have been evaluated through the scoring process as the most serious problems among uncontrolled or abandoned hazardous waste sites in the U.S. In addition, a site will be proposed to the NPL if the Agency for Toxic Substances and Disease Registry issues a health advisory recommending that people be moved away from the site. The NPL is updated at least once a year, and it's only after public comments are considered that these proposed worst sites officially are added to the list.

Listing on the NPL does not set the order in which sites will be cleaned up. The order is influenced by the relative priority of the site's health and environmental threats compared to other sites, and such factors as State priorities, engineering capabilities, and available technologies. Many States also have their own list of sites that require cleanup; these often contain sites that are not on the NPL and are scheduled to be cleaned up with State money. And, it should be noted again that any emergency action needed at a site can be performed by the Superfund, whether or not a site is on the NPL.

A detailed description of the current progress in cleaning up NPL sites is found in the section of the 1991 National overview volume entitled *Cleanup Successes: Measuring Progress.*

How do people find out whether the EPA considers a site a national priority for cleanup under the Superfund Program?

All NPL sites, where Superfund is responsible for cleanup, are described in the State and Territorial volumes. The public also can find out whether other sites, not on the NPL, are being addressed by the Superfund program by calling their Regional EPA office or the Superfund Hotline at the numbers listed in this book.

STEP 3: LONG-TERM CLEANUP ACTIONS

After a site is added to the NPL, what are the steps to cleanup?

The ultimate goal for a hazardous waste site on the NPL is a permanent, long-term cleanup. Since every site presents a unique set of challenges, there is no single all-purpose solution. A five-phase "remedial response" process is used to develop consistent and workable solutions to hazardous waste problems across the Nation:

1. *Remedial Investigation*: investigate in detail the extent of the site contamination
2. *Feasibility Study*: study the range of possible cleanup remedies
3. *Record of Decision or ROD*: decide which remedy to use
4. *Remedial Design*: plan the remedy
5. *Remedial Action*: carry out the remedy

This remedial response process is a long-term effort to provide a permanent solution to an environmental problem that presents a serious threat to the public or environment.

The first two phases of a long-term cleanup are a combined *remedial investigation and feasibility study* (RI/FS) that determine the nature and extent of contamination at the site and identify and evaluate cleanup alternatives. These studies may be conducted by the EPA or the State or, under their monitoring, by private parties.

Like the initial site inspection described earlier, a remedial investigation involves an examination of site data in order to better define the problem. However, the remedial investigation is much more detailed and comprehensive than the initial site inspection.

A remedial investigation can best be described as a carefully designed field study. It includes extensive sampling and laboratory analyses to generate more precise data on the types and quantities of wastes present at the site, the type of soil and water drainage patterns, and specific human health and environmental risks.

The result of the remedial investigation is information that allows the EPA to select the cleanup strategy that is best suited to a particular site or to determine that no cleanup is needed.

Placing a site on the NPL does not necessarily mean that cleanup is needed. It is possible for a site to receive an HRS score high enough to be added to the NPL, but not ultimately require cleanup actions. Keep in mind that the purpose of the scoring process is to provide a preliminary and conservative assessment of *potential* risk. During subsequent site investigations, the EPA may find either that there is no real threat or that the site does not pose significant human health or environmental risks.

How are cleanup alternatives identified and evaluated?

The EPA or the State or, under their monitoring, private parties identify and analyze specific site cleanup needs based on the extensive information collected during the remedial investigation. This analysis of cleanup alternatives is called a *feasibility study*.

Since cleanup actions must be tailored exactly to the needs of each individual site, more than one possible cleanup alternative is always considered. After making sure that all potential cleanup remedies fully protect human health and the environment and comply with Federal and State laws, the advantages and disadvantages of each cleanup alternative are compared carefully. These comparisons are made to determine their effectiveness in the short and long term, their use of permanent treatment solutions, and their technical feasibility and cost.

To the maximum extent practicable, the remedy must be a permanent solution and must use treatment technologies to destroy principal site contaminants. Remedies such as containing the waste on site or removing the source of the problem (like leaking barrels) often are considered effective. Often, special pilot studies are conducted to determine the effectiveness and feasibility of using a particular technology to clean up a site. Therefore, the combined remedial investigation and feasibility study can take between 10 and 30 months to complete, depending on the size and complexity of the problem.

Does the public have a say in the final cleanup decision?

Yes. The Superfund law requires that the public be given the opportunity to comment on the proposed cleanup plan. Their concerns are considered carefully before a final decision is made.

The results of the remedial investigation and feasibility study, which also point out the recommended cleanup choice, are published in a report for public review and comment. The EPA or the State encourages the public to review the information and take an active role in the final cleanup decision. Fact sheets and announcements in local papers let the community know where they can get copies of the study and other reference documents concerning the site. Local information repositories, such as libraries or other public buildings, are established in cities and towns near each NPL site to ensure that the public has an opportunity to review all relevant information and the proposed cleanup plans. Locations of information repositories for each NPL site described in this volume are given in Appendix B.

The public has a minimum of 30 days to comment on the proposed cleanup plan after it is published. These comments can be written or given verbally at public meetings that the EPA or the State are required to hold. Neither the EPA nor the State can select the final cleanup remedy without evaluating and providing written answers to specific community comments and concerns. This "responsiveness summary" is part of the EPA's write-up of the final remedy decision, called the Record of Decision, or ROD.

The ROD is a public document that explains the cleanup remedy chosen and the reason it was selected. Since sites frequently are large and must be cleaned up in stages, a ROD may be necessary for each contaminated resource or area of the site. This may be necessary when contaminants have spread into the soil, water, and air and affect such sensitive areas as wetlands, or when the site is large and cleaned up in stages. This often means that a number of remedies, using different cleanup technologies, are needed to clean up a single site.

If every cleanup action needs to be tailored to a site, does the design ofthe remedy need to be tailored, too?

Yes. Before a specific cleanup action is carried out, it must be designed in detail to meet specific site needs. This stage of the cleanup is called the *remedial design*. The design phase provides the details on how the selected remedy will be engineered and constructed.

Projects to clean up a hazardous waste site may appear to be like any other major construction project but, in fact, the likely presence of combinations of dangerous chemicals demands special construction planning and procedures. Therefore, the design of the remedy can take anywhere from six months to two years to complete. This blueprint for site cleanup includes not only the details on every aspect of the construction work, but a description of the types of hazardous wastes expected at the site, special plans for environmental protection, worker safety, regulatory compliance, and equipment decontamination.

Once the design is completed, how long does it take to actually clean up the site, and how much does it cost?

The time and cost for performing the site cleanup, called the *remedial action*, are as varied as the remedies themselves. In a few cases, the only action needed may be to remove drums of hazardous waste and to decontaminate them, an action that takes limited time and money. In most cases, however, a remedial action may involve different and expensive cleanup measures that can take a long time.

For example, cleaning polluted groundwater or dredging contaminated river bottoms can take several years of complex engineering work before contamination is reduced to safe levels. Sometimes the selected cleanup remedy described in the ROD may need to be modified because of new contaminant information discovered or difficulties that were faced during the early cleanup activities. Taking into account these differences, each remedial cleanup action takes an average of 18 months to complete and ultimately costs an average of $26 million to complete all necessary cleanup actions at a site .

Once the cleanup action is completed, is the site automatically "deleted" from the NPL?

No. The deletion of a site from the NPL is anything but automatic. For example, cleanup of contaminated groundwater may take up to 20 years or longer. Also, in some cases, *long-term monitoring* of the remedy is required to ensure that it is effective. After construction of certain remedies, operation and maintenance (e.g., maintenance of ground cover, groundwater monitoring, etc.), or continued pumping and treating of groundwater may be required to ensure that the remedy continues to prevent future health hazards or environmental damage and ultimately meets the cleanup goals specified in the ROD. Sites in this final monitoring or operational stage of the cleanup process are designated as "construction complete."

It's not until a site cleanup meets all the goals and monitoring requirements of the selected remedy that the EPA can officially propose the site for *deletion* from the NPL, and it's not until public comments are taken into consideration that a site actually can be deleted from the NPL. All sites deleted from the NPL and sites with completed construction are included in the progress report found later in this book.

Can a site be taken off the NPL if no cleanup has taken place?

Yes. But only if further site investigation reveals that there are no threats present at the site and that cleanup activities are not necessary. In these cases, the EPA will select a "no action" remedy and may move to delete the site when monitoring confirms that the site does not pose a threat to human health or the environment.

In other cases, sites may be "removed" from the NPL if new information concerning site cleanup or threats show that the site does not warrant Superfund activities.

A site may be removed if a revised HRS scoring, based on updated information, results in a score below the minimum for NPL sites. A site also may be removed from the NPL by transferring it to other appropriate Federal cleanup authorities, such as RCRA, for further cleanup actions.

Removing sites for technical reasons or transferring sites to other cleanup programs preserves Superfund monies for the Nation's most pressing hazardous waste problems where no other cleanup authority is applicable.

Can the EPA make parties responsible for the contamination pay?

Yes. Based on the belief that "the polluters should pay," after a site is placed on the NPL, the EPA makes a thorough effort to identify and find those responsible for causing contamination problems at a site. Although the EPA is willing to negotiate with these private parties and encourages voluntary cleanup, it has the authority under the Superfund law to legally force those potentially responsible for site hazards to take specific cleanup actions. All work performed by these parties is closely guided and monitored by the EPA and must meet the same standards required for actions financed through the Superfund.

Because these enforcement actions can be lengthy, the EPA may decide to use Superfund monies to make sure a site is cleaned up without unnecessary delay. For example, if a site presents an imminent threat to public health and the environment or if conditions at a site may worsen, it could be necessary to start the cleanup right away. Those responsible for causing site contamination are liable under the law (CERCLA) for repaying the money the EPA spends in cleaning up the site.

Whenever possible, the EPA and the Department of Justice use their legal enforcement authorities to require responsible parties to pay for site cleanups, thereby preserving Superfund resources for emergency actions and for sites where no responsible parties can be identified.

How to Use the State Book

The site fact sheets presented in this book are comprehensive summaries that cover a broad range of information. The fact sheets describe hazardous waste sites on the NPL and their locations, as well as the conditions leading to their listing ("Site Description"). The summaries list the types of contaminants that have been discovered and related threats to public and ecological health ("Threats and Contaminants"). "Cleanup Approach" presents an overview of the cleanup activities completed, underway, or planned. The fact sheets conclude with a brief synopsis of how much progress has been made in protecting public health and the environment. The summaries also pinpoint other actions, such as legal efforts to involve polluters responsible for site contamination and community concerns.

The fact sheets are arranged in alphabetical order by site name. Because site cleanup is a dynamic and gradual process, all site information is accurate as of the date shown on the bottom of each page. Progress always is being made at NPL sites, and the EPA periodically will update the site fact sheets to reflect recent actions and will publish updated State volumes. The following two pages show a generic fact sheet and briefly describe the information under each section.

HOW CAN YOU USE THIS STATE BOOK?

You can use this book to keep informed about the sites that concern you, particularly ones close to home. The EPA is committed to involving the public in the decision making process associated with hazardous waste cleanup. The Agency solicits input from area residents in communities affected by Superfund sites. Citizens are likely to be affected not only by hazardous site conditions, but also by the remedies that combat them. Site cleanups take many forms and can affect communities in different ways. Local traffic may be rerouted, residents may be relocated, temporary water supplies may be necessary.

Definitive information on a site can help citizens sift through alternatives and make decisions. To make good choices, you must know what the threats are and how the EPA intends to clean up the site. You must understand the cleanup alternatives being proposed for site cleanup and how residents may be affected by each one. You also need to have some idea of how your community intends to use the site in the future, and you need to know what the community can realistically expect once the cleanup is complete.

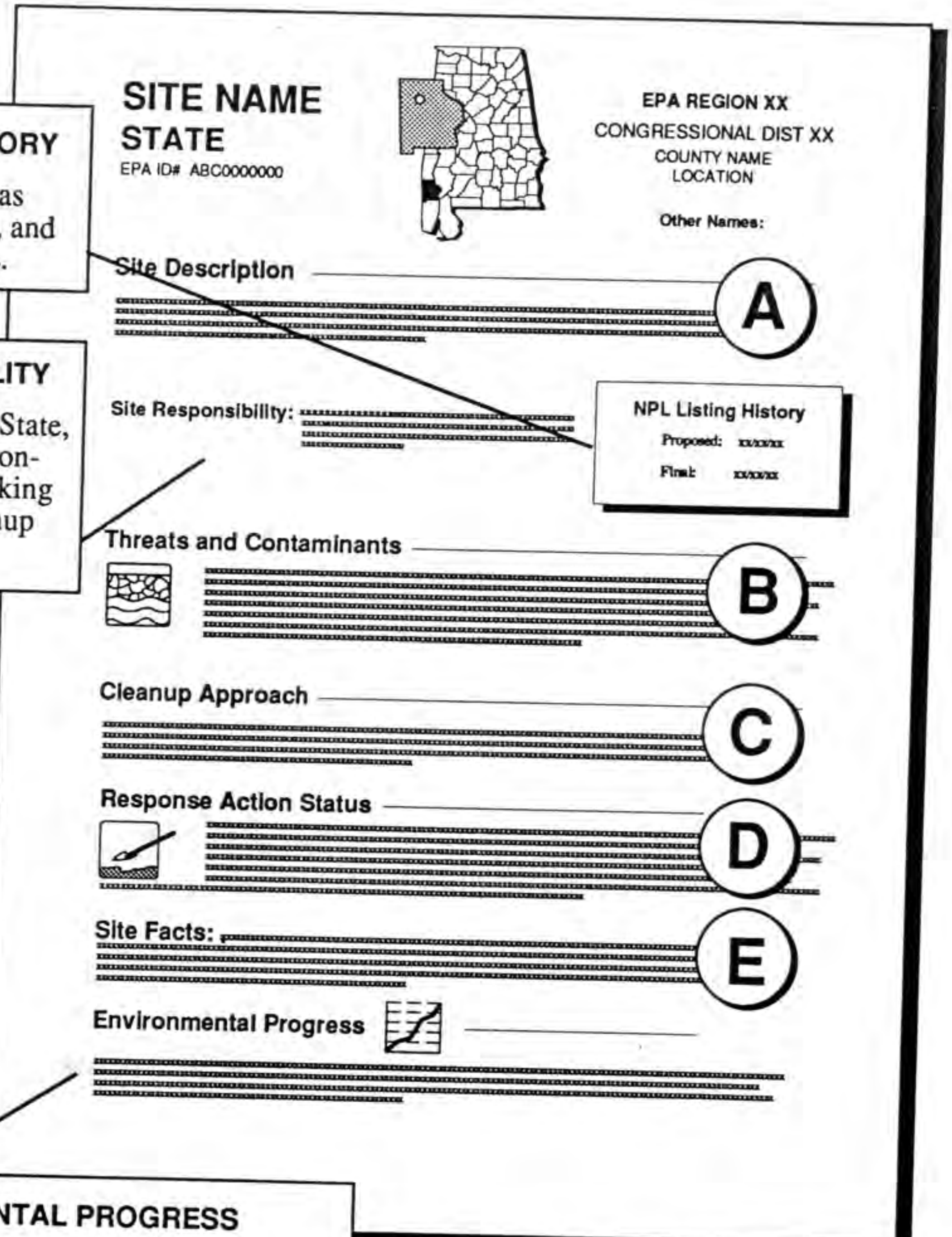
The EPA wants to develop cleanup methods that meet community needs, but the Agency only can take local concerns into account if it understands what they are. Information must travel both ways in order for cleanups to be effective and satisfactory. Please take this opportunity to learn more, become involved, and assure that hazardous waste cleanup at "your" site considers your community's concerns.

NPL LISTING HISTORY

Dates when the site was Proposed, made Final, and Deleted from the NPL.

SITE RESPONSIBILITY

Identifies the Federal, State, and/or potentially responsible parties that are taking responsibility for cleanup actions at the site.



ENVIRONMENTAL PROGRESS

A summary of the actions to reduce the threats to nearby residents and the surrounding environment; progress towards cleaning up the site and goals of the cleanup plan are given here.

A

SITE DESCRIPTION

This section describes the location and history of the site. It includes descriptions of the most recent activities and past actions at the site that have contributed to the contamination. Population estimates, land usages, and nearby resources give readers background on the local setting surrounding the site.

B

THREATS AND CONTAMINANTS

The major chemical categories of site contamination are noted, as well as which environmental resources are affected. Icons representing each of the affected resources (may include air, groundwater, surface water, soil, and contamination to environmentally sensitive areas) are included in the margins of this section. Potential threats to residents and the surrounding environments arising from the site contamination also are described.

C

CLEANUP APPROACH

This section contains a brief overview of how the site is being cleaned up.

D

RESPONSE ACTION STATUS

Specific actions that have been accomplished or will be undertaken to clean up the site are described here. Cleanup activities at NPL sites are divided into separate phases, depending on the complexity and required actions at the site. Two major types of cleanup activities often are described: initial, immediate, or emergency actions to quickly remove or reduce imminent threats to the community and surrounding areas; and long-term remedial phases directed at final cleanup at the site. Each stage of the cleanup strategy is presented in this section of the summary. Icons representing the stage of the cleanup process (initial actions, site investigations, EPA selection of the cleanup remedy, engineering design phase, cleanup activities underway, and completed cleanup) are located in the margin next to each activity description.

E

SITE FACTS

Additional information on activities and events at the site are included in this section. Often details on legal or administrative actions taken by the EPA to achieve site cleanup or other facts pertaining to community involvement with the site cleanup process are reported here.

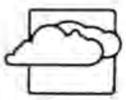
THE VOLUME

The "icons," or symbols, accompanying the text allow the reader to see at a glance which environmental resources are affected and the status of cleanup activities at the site.

Icons in the Threats and Contaminants Section

Contaminated *Groundwater* resources in the Contaminated *Groundwater* in the vicinity or underlying the site. (Groundwater is often used as a drinking water source.)

Contaminated *Surface Water and Sediments* on or near the site. (These include lakes, ponds, streams, and rivers.)



Contaminated *Air* in the vicinity of the site. (Air pollution usually is periodic and involves contaminated dust particles or hazardous gas emissions.)

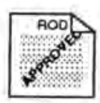
Contaminated *Soil and Sludges* on or near the site. (This contamination category may include bulk or other surface hazardous wastes found on the site.)

Threatened or contaminated *Environmentally Sensitive Areas* in the vicinity of the site. (Examples include wetlands and coastal areas or critical habitats.)

Icons in the Response Action Status Section

Initial Actions have been taken or are underway to eliminate immediate threats at the site.

Site Studies at the site to determine the nature and extent of contamination are planned or underway.



Remedy Selected indicates that site investigations have been concluded, and the EPA has selected a final cleanup remedy for the site or part of the site.

Remedy Design means that engineers are preparing specifications and drawings for the selected cleanup technologies.

Cleanup Ongoing indicates that the selected cleanup remedies for the contaminated site, or part of the site, currently are underway.

Cleanup Complete shows that all cleanup goals have been achieved for the contaminated site or part of the site.

Environmental Progress summarizes the activities taken to date to protect human health and to clean up site contamination.

The State of Indiana

Indiana is located in EPA's Region 5, which includes the six midwestern states boarding the Great Lakes. Situated on the southern edge of Lake Michigan, Indiana covers 36,185 square miles and consists of a hilly southern region, fertile rolling plains in the central region, and a flat, heavily glaciated northern region with dunes along Lake Michigan. Indiana experienced a 1% increase in population between 1980 and 1990 and currently has approximately 5,544,000 residents, ranking 14th in U.S. populations, according to the 1990 Census. Manufacturing is one of the principal industries with primary and fabricated metals, transportation equipment, electrical and electronic equipment, non-electrical machinery, plastics, chemical products, and foods as the principal manufactured goods. Other principal industries include wholesale and retail trade, agriculture, and services.

How Many NPL Sites Are in the State of Indiana?

Proposed	0
Final	33
Deleted	2
	35

Where Are the NPL Sites Located?

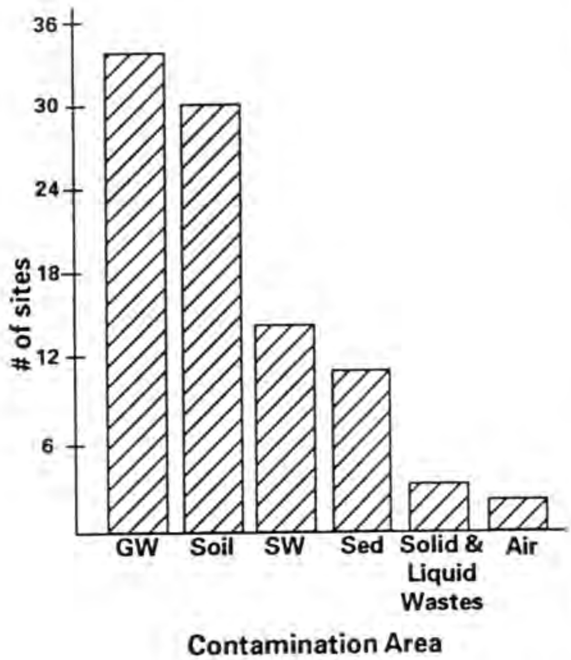
Congressional Districts 2, 10, 11	1 site
Congressional Districts 4, 5	2 sites
Congressional Districts 7, 8	3 sites
Congressional District 9	4 sites
Congressional Districts 1, 6	5 sites
Congressional District 3	8 sites

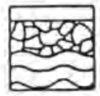
What Type of Sites Are on the NPL in the State of Indiana?

# of sites	type of sites
12	Municipal & Industrial Landfills
5	Storage Facilities
5	Waste Disposal Facilities
4	Recyclers
2	Chemicals & Allied Products
7	Other (Lumber & wood products, metals & allied products, electroplating, battery manufacture, rail yard, various manufacturers)

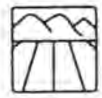
NPL SITES

How Are Sites Contaminated and What Are the Principal* Chemicals?

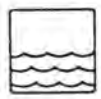




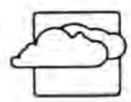
Groundwater: Volatile organic compounds (VOCs), heavy metals (inorganics), polychlorinated biphenyls (PCBs), and creosotes (organics).



Soil, Solid and Liquid Waste: Volatile organic compounds (VOCs), heavy metals (inorganics), polychlorinated biphenyls (PCBs), creosotes (organics), and other inorganics.

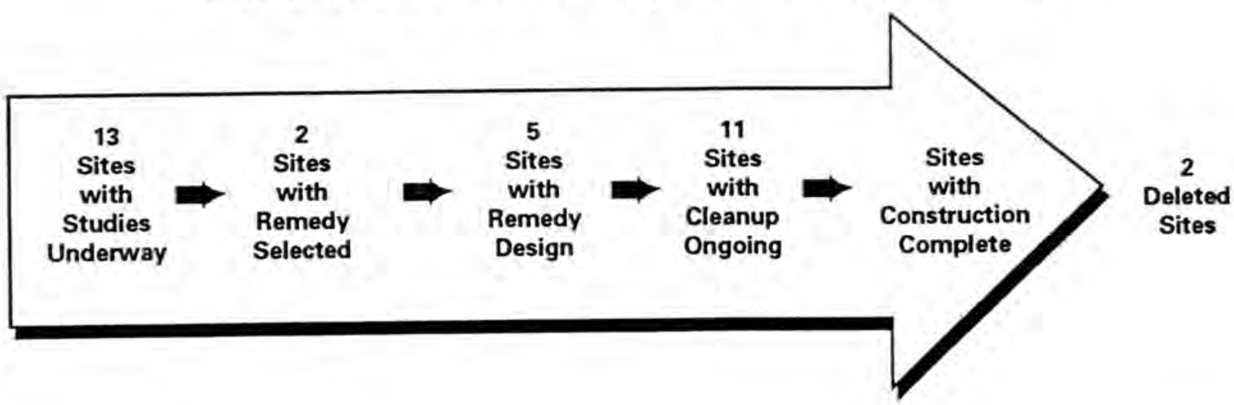


Surface Water and Sediments: Heavy metals (inorganics), volatile organic compounds (VOCs), polychlorinated biphenyls (PCBs), creosotes (organics), and pesticides.



Air: Heavy metals (inorganics) and polychlorinated biphenyls (PCBs).

Where Are the Sites in the Superfund Cleanup Process?†



In addition to the activities described above, initial actions have been taken at 24 sites as interim cleanup measures.

†Cleanup status reflects phases of site activities rather than administrative accomplishments.

Progress To Date

The following Progress Report lists all sites currently on, or deleted from, the NPL and briefly summarizes the status of activities for each site at the time this report was prepared. The steps in the Superfund cleanup process are arrayed across the top of the chart, and each site's progress through these steps is represented by an arrow (⇨) indicating the current stage of cleanup.

Large and complex sites often are organized into several cleanup stages. For example, separate cleanup efforts may be required to address the source of the contamination, hazardous substances in the groundwater, and surface water pollution, or to clean up different areas of a large site. In such cases, the chart portrays cleanup progress at the site's *most advanced* stage, reflecting the status of site activities rather than administrative accomplishments.

- An arrow in the "Initial Response" category indicates that an emergency cleanup or initial action has been completed or currently is underway. Emergency or initial actions are taken as an interim measure to provide immediate relief from exposure to hazardous site conditions or to stabilize a site to prevent further contamination.

- A final arrow in the "Site Studies" category indicates that an investigation to determine the nature and extent of the contamination at the site currently is ongoing.

- A final arrow in the "Remedy Selection" category means that the EPA has selected the final cleanup strategy for the site. At the few sites where the EPA has determined that initial response actions have eliminated site contamination, or that any remaining contamination will be naturally dispersed without further cleanup activities, a "No Action" remedy is selected. In these cases, the arrows are discontinued at the "Remedy Selection" step and resume in the "Construction Complete" category.

- A final arrow at the "Remedial Design" stage indicates that engineers currently are designing the technical specifications for the selected cleanup remedies and technologies.

- A final arrow in the "Cleanup Ongoing" column means that final cleanup actions have been started at the site and currently are underway.

- A final arrow in the "Construction Complete" category is used only when all phases of the site cleanup plan have been performed, and the EPA has determined that no additional construction actions are required at the site. Some sites in this category currently may be undergoing long-term operation and maintenance or monitoring to ensure that the cleanup actions continue to protect human health and the environment.

- A check in the "Deleted" category indicates that the site cleanup has met all human health and environmental goals and that the EPA has deleted the site from the NPL.

Further information on the activities and progress at each site is given in the site "Fact Sheets" published in this volume.

Progress Toward Cleanup at NPL Sites in the State of Indiana

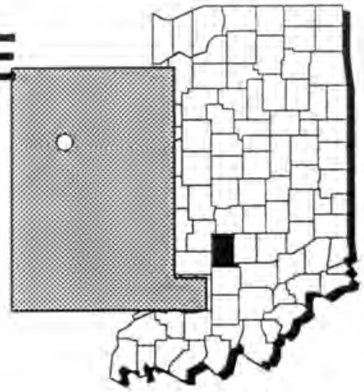
Page	Site Name	County	NPL	Date	Initial Response	Site Studies	Remedy Selected	Remedy Design	Cleanup Ongoing	Construction Complete	Deleted
25	AMERICAN CHEMICAL SERVICE, INC.	LAKE	Final	09/21/84	⇨	⇨					
27	BENNETT STONE QUARRY	MONROE	Final	09/21/84	⇨	⇨	⇨	⇨	⇨		
29	CARTER LEE LUMBER COMPANY	MARION	Final	03/31/89							
31	COLUMBUS OLD MUNICIPAL LDFL #1	BARTHOLOMEW	Final	06/10/86		⇨					
33	CONRAIL RAIL YARD (ELKHART)	ELKHART	Final	08/30/90	⇨	⇨					
35	CONTINENTAL STEEL CORPORATION	HOWARD	Final	03/31/89	⇨	⇨					
37	DOUGLAS ROAD/UNIROYAL, INC. LDFL	ST. JOSEPH	Final	03/31/89		⇨					
39	ENVIROCHEM CORPORATION	BOONE	Final	09/08/83	⇨	⇨	⇨	⇨			
41	FISHER-CALO	LA PORTE	Final	09/08/83	⇨	⇨	⇨				
43	FORT WAYNE REDUCTION DUMP	ALLEN	Final	06/10/86		⇨	⇨	⇨	⇨		
45	GALEN MEYERS DUMP/DRUM SALVAGE	ST. JOSEPH	Final	03/31/89	⇨						
47	HIMCO DUMP	ELKHART	Final	02/21/90	⇨	⇨					
49	IMC (TERRE HAUTE EAST PLANT)	VIGO	Deleted	02/11/91		⇨	⇨			⇨	✓
51	LAKE SANDY JO (M & M LANDFILL)	LAKE	Final	09/08/83	⇨	⇨	⇨	⇨	⇨		
53	LAKELAND DISPOSAL SERVICE INC.	KOSCIUSKO	Final	03/31/89		⇨					
55	LEMON LANE LANDFILL	MONROE	Final	09/08/83	⇨	⇨	⇨	⇨	⇨		
57	MAIN STREET WELL FIELD	ELKHART	Final	09/08/83	⇨	⇨	⇨	⇨	⇨		
59	MARION (BRAGG) DUMP	GRANT	Final	09/08/83		⇨	⇨	⇨	⇨		
61	MIDCO I	LAKE	Final	09/08/83	⇨	⇨	⇨	⇨			
63	MIDCO II	LAKE	Final	06/10/86	⇨	⇨	⇨	⇨			
65	NEAL'S DUMP (SPENCER)	OWEN	Final	06/10/86	⇨	⇨	⇨	⇨			
67	NEAL'S LANDFILL (BLOOMINGTON)	MONROE	Final	09/08/83	⇨	⇨	⇨	⇨	⇨		
69	NINTH AVENUE DUMP	LAKE	Final	09/08/83	⇨	⇨	⇨	⇨	⇨		
71	NORTHSIDE SANITARY LANDFILL, INC.	BOONE	Final	09/21/84		⇨	⇨	⇨			

Page	Site Name	County	NPL	Date	Initial Response	Site Studies	Remedy Selected	Remedy Design	Cleanup Ongoing	Construction Complete	Deleted
73	POER FARM	HANCOCK	Deleted	02/11/91	⇨	⇨	⇨			⇨	✓
75	PRESTOLITE BATTERY DIVISION	KNOX	Final	10/04/89	⇨	⇨					
77	REILLY TAR & CHEMICAL CORP.	MARION	Final	09/21/84		⇨					
79	SEYMOUR RECYCLING CORPORATION	JACKSON	Final	09/08/83	⇨	⇨	⇨	⇨	⇨		
81	SOUTHSIDE SANITARY LANDFILL	MARION	Final	03/31/89	⇨	⇨					
83	TIPPECANOE SANITARY LANDFILL	TIPPECANOE	Final	08/30/90		⇨					
85	TRI-STATE PLATING	BARTHOLOMEW	Final	06/10/86	⇨	⇨	⇨	⇨	⇨		
87	WASTE, INC. LANDFILL	LA PORTE	Final	07/21/87		⇨					
89	WAYNE WASTE OIL	WHITLEY	Final	09/08/83	⇨	⇨	⇨				
91	WEDZEB ENTERPRISES, INC.	BOONE	Final	09/08/83	⇨	⇨	⇨	⇨	⇨		
93	WHITEFORD SALES & SERVICE	ST. JOSEPH	Final	08/30/90	⇨	⇨					

Summary of Site Activities

EPA REGION 5

BENNETT STONE QUARRY
INDIANA
EPA ID# IND006418651



EPA REGION 5
CONGRESSIONAL DIST. 08
Monroe County
Bloomington

Site Description

The Bennett Stone Quarry site consists of 2 1/2 acres and is located approximately 1 mile northwest of Bloomington. This limestone quarry was used as a dump for old electrical parts for approximately 20 years, before it was discovered by the Monroe County Health Department (MCHD) in 1983. The MCHD subsequently defined an area of several acres that had been used for dumping electrical parts, including a large number of capacitors contaminated with polychlorinated biphenyls (PCBs). Labels found on the capacitors during the MCHD investigation attributed them to the Westinghouse Corporation. Soils adjacent to the site are stained with oil, and the entire site is devoid of vegetation. Two ponds that drain into Stout Creek are located on the western end of the site and are coated with oily sheens. Five other PCB-contaminated sites are located in the Bloomington area, three of which are listed as separate sites on the NPL: Neal's Landfill, Neal's Dump, and Lemon Lane Landfill. Anderson Road, an authorized landfill, and Winston-Thomas Treatment Plant, an inactive City-owned wastewater treatment plant, are the other sites. The majority of the residents living near Bennett Stone Quarry and the adjoining property depend on private wells for their water supply. The land along Stout Creek is used for raising dairy and beef cattle. The quarries adjacent to the site are frequented by local residents and campers for recreational activities.

Site Responsibility: This site is being addressed through Federal and potentially responsible parties' actions.

NPL LISTING HISTORY
Proposed Date: 09/08/83
Final Date: 09/21/84

Threats and Contaminants

On-site groundwater, soils, sediments, and surface water were contaminated with PCBs. Off-site sediments located in Stout Creek also were contaminated with PCBs. Smaller amounts of PCBs were found in the waters of Stout Creek. Area residents could have been exposed to contaminants through direct contact with PCB-laden oil in the ponds and on-site PCB-contaminated soil. Should further migration of site-related contaminants enter Stout Creek, area residents could be at risk when drinking or touching contaminated surface water or sediments.

Cleanup Approach

The site is being addressed in two stages: emergency actions and a long-term remedial phase directed at cleanup of the entire site.

Response Action Status

Emergency Actions: The EPA undertook an emergency cleanup in 1983 that included: (1) removal and disposal of capacitors on the surface and contaminated soils; (2) an aerial photographic survey, geophysical study, and soil sampling; (3) placement of an impervious cover over the site to prevent runoff of contaminants; and (4) construction of security fencing around the site. In 1987, contaminated sediments were excavated from Stout Creek.

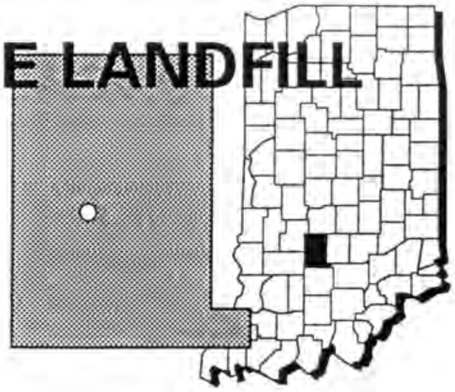
Entire Site: Activities conducted to address contamination at the site include: (1) excavation of all refuse plus a 2-foot buffer zone around the known refuse; (2) incineration of excavated materials in an approved facility; (3) hydro-vacuuming contaminated sediments from the on-site ponds and Stout Creek and storing them off site until incineration and disposal can be conducted; and (4) regrading, covering, and revegetating the area of the site. Groundwater and surface water monitoring will be continued to ensure that water quality standards are maintained.

Site Facts: In 1985, the Westinghouse Corporation and the EPA signed a Consent Decree, under which Westinghouse agreed to perform the site cleanup.

Environmental Progress 

The excavation, removal, or incineration of hazardous materials and contaminated creek sediments, installation of a security fence, and other cleanup activities have reduced the potential for exposure to contamination from the Bennett Stone Quarry site. Continuing cleanup actions and groundwater and surface water monitoring will provide protection to nearby residents and the environment.

LEMON LANE LANDFILL
INDIANA
EPA ID# IND980794341



EPA REGION 5
CONGRESSIONAL DIST. 09
Monroe County
Bloomington

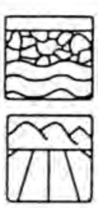
Site Description

The Lemon Lane Landfill site is located on the western edge of Bloomington. The site encompasses 10 acres, 3 of which are owned by a private citizen. From 1950 to 1964, the landfill, which had no liner or runoff controls, accepted both municipal and industrial wastes. Allegedly, wastes were incinerated on site. No records were kept of the types or quantities of wastes received. Of primary concern were large quantities of exposed and leaking capacitors containing polychlorinated biphenyls (PCBs). Starting in 1980, the State of Indiana and the EPA sampled the area several times. No PCBs were detected in nearby residential wells at the time, nor were any surface discharges observed. However, the geology of the area suggests that groundwater contamination is possible. Westinghouse Electric Corporation, the party potentially responsible for contamination at the site, is handling cleanup of Lemon Lane Landfill, as well as three other NPL sites, one authorized landfill, and an inactive, City-owned wastewater treatment plant in the Bloomington area (Neal's Landfill, Neal's Dump, Bennett Stone Quarry, the Anderson Road Landfill, and the Winston-Thomas Treatment Plant). Westinghouse is planning to construct an incinerator that will comply with all applicable local, State, and Federal laws.

Site Responsibility: This site is being addressed through Federal and potentially responsible parties' actions.

NPL LISTING HISTORY
Proposed Date: 12/30/82
Final Date: 09/08/83

Threats and Contaminants



The groundwater and soils are contaminated with PCBs. Direct contact with and accidental ingestion of contaminated soil or groundwater are potential health threats. Capping the landfill has reduced the opportunity for contaminants to reach the groundwater.

Cleanup Approach

The site is being addressed in two stages: immediate actions and a long-term remedial phase directed at cleanup of the entire site.

Response Action Status

Immediate Actions: In 1983, the EPA constructed a fence around the site to prevent access to the area. The EPA also removed exposed PCB capacitors, graded and covered the southern slopes of the site, regraded and contoured the land to prevent ponding or erosion, and capped the site. In 1988, a low-flow dye trace study of the groundwater system around the landfill was conducted to determine the hydrologic connection of springs to the site and to better define the groundwater system. On the basis of this study, the EPA concluded that effects on the local groundwater wells are minimal.

Entire Site: An alternate water supply was provided to a resident whose wells showed signs of contamination. One nearby residence was connected to the city water supply in 1988, after the dye trace study determined that its well water supply was contaminated. A synthetic cap was placed on the landfill in 1988. In 1990, Westinghouse concluded high-flow dye trace studies of the flow and presence of contaminated groundwater. Westinghouse will conduct the remaining remedies for the site: (1) excavation of approximately 176,000 cubic yards of soil and material from the landfill to a pre-Westinghouse depth plus 3 feet of buffer zone; (2) incineration of excavated materials in an approved facility; and (3) periodic groundwater monitoring. The excavation and incineration activities are contingent on the approval of the permit applications for the incinerator and a landfill for ash disposal. The permit applications are expected to be submitted in 1991.

Environmental Progress

By constructing a fence to restrict site access, removing the PCB capacitors, and grading and installing a synthetic liner cap over the site to limit movement of contaminants from the property, the potential for exposure to hazardous materials at the Lemon Lane Landfill site has been greatly reduced while cleanup activities continue.

NEAL'S DUMP (SPENCER)
INDIANA
EPA ID# IND980794549

EPA REGION 5
CONGRESSIONAL DIST. 07
Owen County
Spencer

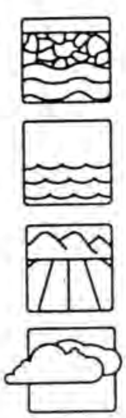
Site Description

The Neal's Dump site covers approximately 1/2 acre in Spencer. The dump operated from 1967 until 1971, when it was closed. During its operation, the owner accepted electrical capacitors, oil-stained rags, and sawdust from the Westinghouse facility nearby. The Westinghouse Electric Corporation, the party potentially responsible for the contamination at the site, is treating Neal's Dump, as well as three other NPL sites, an inactive city-owned wastewater treatment plant, and an authorized landfill in the Bloomington area. These sites are: Neal's Landfill, Lemon Lane Landfill, Bennett Stone Quarry, Winston-Thomas Treatment Plant, and Anderson Road Landfill. Westinghouse is planning to construct an incinerator that will comply with all applicable local, State, and Federal laws to begin burning municipal solid waste. After incineration of all of the materials removed from the sites, Westinghouse and the City of Bloomington will determine whether the incinerator should continue to operate as a municipal solid waste facility or be dismantled. Approximately 175 people live within 1 mile of the site, and 954 people live within 3 miles. Forty-nine wells are located within a mile of the site. Located adjacent to the site are natural springs, a stream, and a river.

Site Responsibility: This site is being addressed through Federal and potentially responsible parties' actions.

NPL LISTING HISTORY
Proposed Date: 10/15/84
Final Date: 06/10/86

Threats and Contaminants



The groundwater, surface water, soils, and air are contaminated with polychlorinated biphenyls (PCBs). Potential health risks exist for individuals who accidentally ingest or come into direct contact with the contaminants or for those who inhale contaminated particulates in the air on the site.

Cleanup Approach

The site is being addressed in two stages: immediate actions and a long-term remedial phase focusing on cleanup of the entire site.

Response Action Status

Immediate Actions: In the mid-1980s, under the EPA's monitoring, the parties potentially responsible for the contamination installed a cap and constructed a security fence and a surface drainage control system. The work was completed in 1990.

Entire Site: The Westinghouse Electric Corporation, under monitoring by the EPA, will conduct the following cleanup actions: (1) excavate all contaminated materials plus a 2-foot buffer zone; (2) incinerate excavated materials in an approved facility; and (3) monitor groundwater. The Westinghouse Electric Company has begun designing the technologies to be used in the cleanup and is expected to submit permit applications for constructing the incinerator and for landfilling its waste by-product ash. Construction of a high-temperature incinerator for the excavated materials is expected to begin in 1993. Upon receipt of the appropriate permits and completion of the incinerator construction, the Lemon Lane Landfill, Neal's Dump, Neal's Landfill and Bennett's Dump sites will be excavated in a prescribed order.

Environmental Progress

By constructing a security fence, capping the site, and installing a drainage control system, the potential for exposure to hazardous materials at the Neal's Dump site is being greatly reduced while final cleanup actions are implemented.

NEAL'S LANDFILL (BLOOMINGTON)
INDIANA
EPA ID# IND980614556

EPA REGION 5
CONGRESSIONAL DIST. 08
Monroe County
Bloomington

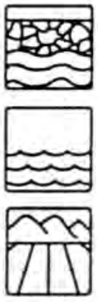
Site Description

The Neal's Landfill (Bloomington) site covers approximately 18 acres in Bloomington. The site was used as an industrial and municipal waste landfill from 1950 to 1972. The main fill area measures about 300 yards. Later, the landfill was used as a pasture for beef cattle. A number of springs surface near the site and flow to Richland Creek, a tributary of the White River. In 1966 and 1967, capacitors and arrestors containing polychlorinated biphenyls (PCBs), as well as PCB-contaminated capacitor insulation material, rags, and filter clay, were disposed of at the landfill. Capacitors and other contaminated materials are visible on the surface. PCBs have been found in surface soils in the northeast portion of the landfill, the springs near the site, and the sediments of Richard Creek. The Westinghouse Electric Corporation, the party potentially responsible for the contamination at the site, is treating Neal's Landfill (Bloomington) site, as well as three other NPL sites, an inactive City-owned wastewater treatment plant, and an authorized landfill in the Bloomington area. These areas are Neal's Dump, Lemon Lane Landfill, Bennett's Dump, Winston-Thomas Treatment Plant, and Anderson Road Landfill. Approximately 121 people live within a mile of the site, and about 1,085 people live within 3 miles of the site. Conard's Branch and Richland Creek are nearby.

Site Responsibility: This site is being addressed through Federal and potentially responsible parties' actions.

NPL LISTING HISTORY
Proposed Date: 10/22/81
Final Date: 09/08/83

Threats and Contaminants



Groundwater, surface water, sediments, and soils are contaminated with PCBs from materials dumped at the landfill. Potential health risks exist for individuals who accidentally ingest or come into direct contact with these contaminants.

Cleanup Approach

The site is being addressed in two stages: immediate actions and a long-term remedial phase directed at cleanup of the entire site.

Response Action Status

Immediate Actions: Under the EPA's monitoring, the parties potentially responsible for the contamination installed a cap, erosion control fences, a security fence, and drainage control trenches. Warning signs have been posted along Conard's Branch and Richland Creek. A sediment collection system also was installed at Conard's Branch. Westinghouse removed PCB-contaminated sediments from Richland Creek and Conard's Branch in late 1989. A treatment plant has been constructed by Westinghouse to treat spring water discharge from Neal's Landfill.

Entire Site: In 1988, Westinghouse began a cleanup program including excavating all 4,060 tons of sediment from Conard's Branch; storing excavated materials in an approved facility until an approved incinerator and by-product disposal area is developed; operating a carbon treatment system for spring water discharges; and monitoring the groundwater. Excavation and incineration of landfill materials will occur when the incinerator and ash landfill permits are issued. Westinghouse is conducting a dye trace study to investigate groundwater flow patterns from Neal's Landfill and is waiting for a sufficient rainfall to trigger a "high flow" in the water table to make this study as comprehensive as possible. Groundwater monitoring occurs on a quarterly basis for on-site wells.

Environmental Progress

Immediate actions including capping and fencing the landfill and long-term activities including excavating sediment, treating the spring water, and groundwater monitoring have reduced the potential for exposure to hazardous materials at the Neal's Landfill (Bloomington) site while final cleanup actions are being completed.

Terms Used in the NPL Book

This glossary defines terms used throughout the NPL Volumes. The terms and abbreviations contained in this glossary apply specifically to work performed under the Superfund program in the context of hazardous waste management. These terms may have other meanings when used in a different context.

Acids: Substances, characterized by low pH (less than 7.0), that are used in chemical manufacturing. Acids in high concentration can be very corrosive and react with many inorganic and organic substances. These reactions possibly may create toxic compounds or release heavy metal contaminants that remain in the environment long after the acid is neutralized.

Administrative Order On Consent: A legal and enforceable agreement between the EPA and the parties potentially responsible for site contamination. Under the terms of the Order, the potentially responsible parties (PRPs) agree to perform or pay for site studies or cleanups. It also describes the oversight rules, responsibilities, and enforcement options that the government may exercise in the event of non-compliance by potentially responsible parties. This Order is signed by PRPs and the government; it does not require approval by a judge.

Administrative Order [Unilateral]: A legally binding document issued by the EPA, directing the parties potentially responsible to perform site cleanups or studies (generally, the EPA does not issue Unilateral Orders for site studies).

Aeration: A process that promotes breakdown of contaminants in soil or water by exposing them to air.

Agency for Toxic Substances and Disease Registry (ATSDR): The Federal agency within the U.S. Public Health Service charged with carrying out the health-related responsibilities of CERCLA.

Air Stripping: A process whereby volatile organic chemicals (VOCs) are removed from contaminated material by forcing a stream of air through it in a pressurized vessel. The contaminants are evaporated into the air stream. The air may be further treated before it is released into the atmosphere.

Ambient Air: Any unconfined part of the atmosphere. Refers to the air that may be inhaled by workers or residents in the vicinity of contaminated air sources.

Aquifer: An underground layer of rock, sand, or gravel capable of storing water within cracks and pore spaces, or between grains. When water contained within an aquifer is of sufficient quantity and quality, it can be tapped and used for drinking or other purposes. The water contained in the aquifer is called groundwater. A sole source aquifer supplies 50% or more of the drinking water of an area.

Artesian (Well): A well made by drilling into the earth until water is reached, which, from internal pressure, flows up like a fountain.

GLOSSARY

Attenuation: The naturally occurring process by which a compound is reduced in concentration over time through adsorption, degradation, dilution, and/or transformation.

Background Level: The amount of a substance typically found in the air, water, or soil from natural, as opposed to human, sources.

Baghouse Dust: Dust accumulated in removing particulates from the air by passing it through cloth bags in an enclosure.

Bases: Substances characterized by high pH (greater than 7.0), which tend to be corrosive in chemical reactions. When bases are mixed with acids, they neutralize each other, forming salts.

Berm: A ledge, wall, or a mound of earth used to prevent the migration of contaminants.

Bioaccumulate: The process by which some contaminants or toxic chemicals gradually collect and increase in concentration in living tissue, such as in plants, fish, or people, as they breathe contaminated air, drink contaminated water, or eat contaminated food.

Biological Treatment: The use of bacteria or other microbial organisms to break down toxic organic materials into carbon dioxide and water.

Bioremediation: A cleanup process using naturally occurring or specially cultivated microorganisms to digest contaminants and break them down into non-hazardous components.

Bog: A type of wetland that is covered with peat moss deposits. Bogs depend primarily on moisture from the air for their water source, are usually acidic, and are rich in plant residue [see Wetland].

Boom: A floating device used to contain oil floating on a body of water or to restrict the potential overflow of waste liquids from containment structures.

Borehole: A hole that is drilled into the ground and used to sample soil or groundwater.

Borrow Pit: An excavated area where soil, sand, or gravel has been dug up for use elsewhere.

Cap: A layer of material, such as clay or a synthetic material, used to prevent rainwater from penetrating and spreading contaminated materials. The surface of the cap generally is mounded or sloped so water will drain off.

Carbon Adsorption: A treatment system in which contaminants are removed from groundwater and surface water by forcing water through tanks containing activated carbon, a specially treated material that attracts and holds or retains contaminants.

Carbon Disulfide: A degreasing agent formerly used extensively for parts washing. This compound has both inorganic and organic properties, which increase cleaning efficiency. However, these properties also cause chemical reactions that increase the hazard to human health and the environment.

Carbon Treatment: [see Carbon Adsorption].

Cell: In solid waste disposal, one of a series of holes in a landfill where waste is dumped, compacted, and covered with layers of dirt.

CERCLA: [see Comprehensive Environmental Response, Compensation, and Liability Act].

Characterization: The sampling, monitoring, and analysis of a site to determine the extent and nature of toxic releases. Characterization provides the basis for acquiring the necessary technical information to develop, screen, analyze, and select appropriate cleanup techniques.

Chemical Fixation: The use of chemicals to bind contaminants, thereby reducing the potential for leaching or other movement.

Chromated Copper Arsenate: An insecticide/herbicide formed from salts of three toxic metals: copper, chromium, and arsenic. This salt is used extensively as a wood preservative in pressure-treating operations. It is highly toxic and water-soluble, making it a relatively mobile contaminant in the environment.

Cleanup: Actions taken to eliminate a release or threat of release of a hazardous substance. The term "cleanup" sometimes is used interchangeably with the terms remedial action, removal action, response action, or corrective action.

Closure: The process by which a landfill stops accepting wastes and is shut down, under Federal guidelines that ensure the protection of the public and the environment.

Comment Period: A specific interval during which the public can review and comment on various documents and EPA actions related to site cleanup. For example, a comment period is provided when the EPA proposes to add sites to the NPL. There is minimum 3-week comment period for community members to review and comment on the remedy proposed to clean up a site.

Community Relations: The EPA effort to establish and maintain two-way communication with the public. Goals of community relations programs include creating an understanding of EPA programs and related actions, assuring public input into decision-making processes related to affected communities, and making certain that the Agency is aware of, and responsive to, public concerns. Specific community relations activities are required in relation to Superfund cleanup actions [see Comment Period].

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA): Congress enacted the CERCLA, known as Superfund, in 1980 to respond directly to hazardous waste problems that may pose a threat to the public health and the environment. The EPA administers the Superfund program.

Confluence: The place where two bodies of water, such as streams or rivers, come together.

Consent Decree: A legal document, approved and issued by a judge, formalizing an agreement between the EPA and the parties potentially responsible for site contamination. The decree describes cleanup actions that the potentially responsible parties are required to perform and/or the costs incurred by the government that the parties will reimburse, as well as the roles, responsibilities, and enforcement options that the government may exercise in the event of non-compliance by potentially responsible parties. If a settlement between the EPA and a potentially responsible party includes cleanup actions, it must be in the form of a Consent Decree. A Consent Decree is subject to a public comment period.

Consent Order: [see Administrative Order on Consent].

Containment: The process of enclosing or containing hazardous substances in a structure, typically in a pond or a lagoon, to prevent the migration of contaminants into the environment.

Glossary

Contaminant: Any physical, chemical, biological, or radiological material or substance whose quantity, location, or nature produces undesirable health or environmental effects.

Contingency Plan: A document setting out an organized, planned, and coordinated course of action to be followed in case of a fire, explosion, or other accident that releases toxic chemicals, hazardous wastes, or radioactive materials into the environment.

Cooperative Agreement: A contract between the EPA and the States, wherein a State agrees to manage or monitor certain site cleanup responsibilities and other activities on a cost-sharing basis.

Cost Recovery: A legal process by which potentially responsible parties can be required to pay back the Superfund program for money it spends on any cleanup actions [see Potentially Responsible Parties].

Cover: Vegetation or other material placed over a landfill or other waste material. It can be designed to reduce movement of water into the waste and to prevent erosion that could cause the movement of contaminants.

Creosotes: Chemicals used in wood preserving operations and produced by distillation of tar, including polycyclic aromatic hydrocarbons and polynuclear aromatic hydrocarbons [see PAHs and PNAs]. Contaminating sediments, soils, and surface water, creosotes may cause skin ulcerations and cancer through prolonged exposure.

Culvert: A pipe used for drainage under a road, railroad track, path, or through an embankment.

Decommission: To revoke a license to operate and take out of service.

Degradation: The process by which a chemical is reduced to a less complex form.

Degrease: To remove grease from wastes, soils, or chemicals, usually using solvents.

De minimis: This legal phrase pertains to settlements with parties who contributed small amounts of hazardous waste to a site. This process allows the EPA to settle with small, or *de minimis* contributors, as a single group rather than as individuals, saving time, money, and effort.

Dewater: To remove water from wastes, soils, or chemicals.

Dike: A low wall that can act as a barrier to prevent a spill from spreading.

Disposal: Final placement or destruction of toxic, radioactive, or other wastes; surplus or banned pesticides or other chemicals; polluted soils; and drums containing hazardous materials. Disposal may be accomplished through the use of approved secure landfills, surface impoundments, land farming, deep well injection, or incineration.

Downgradient: A downward hydrologic slope that causes groundwater to move toward lower elevations. Therefore, wells *downgradient* of a contaminated groundwater source are prone to receiving pollutants.

Effluent: Wastewater, treated or untreated, that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters.

Emission: Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities.

Emulsifiers: Substances that help in mixing materials that do not normally mix; e.g., oil and water.

Endangerment Assessment: A study conducted to determine the risks posed to public health or the environment by contamination at NPL sites. The EPA or the State conducts the study when a legal action is to be taken to direct the potentially responsible parties to clean up a site or pay for the cleanup. An endangerment assessment supplements an investigation of the site hazards.

Enforcement: EPA, State, or local legal actions taken against parties to facilitate settlements; to compel compliance with laws, rules, regulations, or agreements; and/or to obtain penalties or criminal sanctions for violations. Enforcement procedures may vary, depending on the specific requirements of different environmental laws and related regulatory requirements. Under CERCLA, for example, the EPA will seek to require potentially responsible parties to clean up a Superfund site or pay for the cleanup [see Cost Recovery].

Erosion: The wearing away of land surface by wind or water. Erosion occurs naturally from weather or surface runoff, but can be intensified by such land-related practices as farming, residential or industrial development, road building, or timber-cutting. Erosion may spread surface contamination to off-site locations.

Estuary (estuarine): Areas where fresh water from rivers and salt water from nearshore ocean waters are mixed. These areas may include bays, mouths of rivers, salt marshes, and lagoons. These water ecosystems shelter and feed marine life, birds, and wildlife.

Evaporation Ponds: Areas where sewage sludge or other watery wastes are dumped and allowed to dry out.

Feasibility Study: The analysis of the potential cleanup alternatives for a site. The feasibility study usually starts as soon as the remedial investigation is underway; together, they are commonly referred to as the RI/FS [see Remedial Investigation].

Filtration: A treatment process for removing solid (particulate) matter from water by passing the water through sand, activated carbon, or a man-made filter. The process is often used to remove particles that contain contaminants.

Flood Plain: An area along a river, formed from sediment deposited by floods. Flood plains periodically are innundated by natural floods, which can spread contamination.

Flue Gas: The air that is emitted from a chimney after combustion in the burner occurs. The gas can include nitrogen oxides, carbon oxides, water vapor, sulfur oxides, particles, and many chemical pollutants.

Fly Ash: Non-combustible residue that results from the combustion of flue gases. It can include nitrogen oxides, carbon oxides, water vapor, sulfur oxides, as well as many other chemical pollutants.

French Drain System: A crushed rock drain system constructed of perforated pipes, which is used to drain and disperse wastewater.

Gasification (coal): The conversion of soft coal into gas for use as a fuel.

Generator: A facility that emits pollutants into the air or releases hazardous wastes into water or soil.

Good Faith Offer: A voluntary offer, generally in response to a Special Notice letter, made by a potentially responsible party, consisting of a written proposal demonstrating a potentially responsible party's qualifications and willingness to perform a site study or cleanup.

Groundwater: Underground water that fills pores in soils or openings in rocks to the point of saturation. In aquifers, groundwater occurs in sufficient quantities for use as drinking and irrigation water and other purposes.

Groundwater Quality Assessment: The process of analyzing the chemical characteristics of groundwater to determine whether any hazardous materials exist.

Halogens: Reactive non-metals, such as chlorine and bromine. Halogens are very good oxidizing agents and, therefore, have many industrial uses. They are rarely found by themselves; however, many chemicals such as polychlorinated biphenyls (PCBs), some volatile organic compounds (VOCs), and dioxin are reactive because of the presence of halogens.

Hazard Ranking System (HRS): The principal screening tool used by the EPA to evaluate relative risks to public health and the environment associated with abandoned or uncontrolled hazardous waste sites. The HRS calculates a score based on the potential of hazardous substances spreading from the site through the air, surface water, or groundwater and on other factors such as nearby population. The HRS score is the primary factor in deciding if the site should be on the NPL.

Hazardous Waste: By-products of society that can pose a substantial present or potential hazard to human health and the environment when improperly managed. It possesses at least one of four characteristics (ignitability, corrosivity, reactivity, or toxicity), or appears on special EPA lists.

Hot Spot: An area or vicinity of a site containing exceptionally high levels of contamination.

Hydrogeology: The geology of groundwater, with particular emphasis on the chemistry and movement of water.

Impoundment: A body of water or sludge confined by a dam, dike, floodgate, or other barrier.

Incineration: A group of treatment technologies involving destruction of waste by controlled burning at high temperatures, e.g., burning sludge to reduce the remaining residues to a non-burnable ash that can be disposed of safely on land, in some waters, or in underground locations.

Infiltration: The movement of water or other liquid down through soil from precipitation (rain or snow) or from application of wastewater to the land surface.

Influent: Water, wastewater, or other liquid flowing into a reservoir, basin, or treatment plant.

Injection Well: A well into which waste fluids are placed, under pressure, for purposes of disposal.

Inorganic Chemicals: Chemical substances of mineral origin, not of basic carbon structure.

Installation Restoration Program: The specially funded program established in 1978 under which the Department of Defense has been identifying and evaluating its hazardous waste sites and controlling the migration of hazardous contaminants from those sites.

Intake: The source from where a water supply is drawn, such as from a river or water body.

Interagency Agreement: A written agreement between the EPA and a Federal agency that has the lead for site cleanup activities, setting forth the roles and responsibilities of the agencies for performing and overseeing the activities. States often are parties to interagency agreements.

Interim (Permit) Status: Conditions under which hazardous waste treatment, storage, and disposal facilities, that were operating when regulations under the RCRA became final in 1980, are temporarily allowed by the EPA to continue to operate while awaiting denial or issuance of a permanent permit. The facility must comply with certain regulations to maintain interim status.

Lagoon: A shallow pond or liquid waste containment structure. Lagoons typically are used for the storage of wastewaters, sludges, liquid wastes, or spent nuclear fuel.

Landfarm: To apply waste to land and/or incorporate waste into the surface soil, such as fertilizer or soil conditioner. This practice commonly is used for disposal of composted wastes and sludges.

Landfill: A disposal facility where waste is placed in or on land. *Sanitary* landfills are disposal sites for non-hazardous solid wastes. The waste is spread in layers, compacted to the smallest practical volume, and covered with soil at the end of each operating day. Secure *chemical* landfills are disposal sites for hazardous waste. They are designed to minimize the chance of release of hazardous substances into the environment [see Resource Conservation and Recovery Act].

Leachate [n]: The liquid that trickles through or drains from waste, carrying soluble components from the waste. **Leach, Leaching [v.t.]:** The process by which soluble chemical components are dissolved and carried through soil by water or some other percolating liquid.

Leachate Collection System: A system that gathers liquid that has leaked into a landfill or other waste disposal area and pumps it to the surface for treatment.

Liner: A relatively impermeable barrier designed to prevent leachate (waste residue) from leaking from a landfill. Liner materials include plastic and dense clay.

Long-term Remedial Phase: Distinct, often incremental, steps that are taken to solve site pollution problems. Depending on the complexity, site cleanup activities can be separated into several of these phases.

Marsh: A type of wetland that does not contain peat moss deposits and is dominated by vegetation. Marshes may be either fresh or saltwater and tidal or non-tidal [see Wetland].

Migration: The movement of oil, gas, contaminants, water, or other liquids through porous and permeable soils or rock.

Mill Tailings: [See Mine Tailings].

Mine Tailings: A fine, sandy residue left from mining operations. Tailings often contain high concentrations of lead, uranium, and arsenic or other heavy metals.

Mitigation: Actions taken to improve site conditions by limiting, reducing, or controlling toxicity and contamination sources.

Modeling: A technique using a mathematical or physical representation of a system or theory that tests the effects that changes on system components have on the overall performance of the system.

Monitoring Wells: Special wells drilled at specific locations within, or surrounding, a hazardous waste site where groundwater can be sampled at selected depths and studied to obtain such information as the direction in which groundwater flows and the types and amounts of contaminants present.

National Priorities List (NPL): The EPA's list of the most serious uncontrolled or abandoned hazardous waste sites identified for possible long-term cleanup under Superfund. The EPA is required to update the NPL at least once a year.

Neutrals: Organic compounds that have a relatively neutral pH, complex structure and, due to their organic bases, are easily absorbed into the environment. Naphthalene, pyrene, and trichlorobenzene are examples of neutrals.

Nitroaromatics: Common components of explosive materials, which will explode if activated by very high temperatures or pressures; 2,4,6-Trinitrotoluene (TNT) is a nitroaromatic.

Notice Letter: A General Notice Letter notifies the parties potentially responsible for site contamination of their possible liability. A Special Notice Letter begins a 60-day formal period of negotiation during which the EPA is not allowed to start work at a site or initiate enforcement actions against potentially responsible parties, although the EPA may undertake certain investigatory and planning activities. The 60-day period may be extended if the EPA receives a good faith offer within that period.

On-Scene Coordinator (OSC): The predesignated EPA, Coast Guard, or Department of Defense official who coordinates and directs Superfund removal actions or Clean Water Act oil- or hazardous-spill corrective actions.

Operation and Maintenance: Activities conducted at a site after a cleanup action is completed to ensure that the cleanup or containment system is functioning properly.

Organic Chemicals/Compounds: Chemical substances containing mainly carbon, hydrogen, and oxygen.

Outfall: The place where wastewater is discharged into receiving waters.

Overpacking: Process used for isolating large volumes of waste by jacketing or encapsulating waste to prevent further spread or leakage of contaminating materials. Leaking drums may be contained within oversized barrels as an interim measure prior to removal and final disposal.

Pentachlorophenol (PCP): A synthetic, modified petrochemical that is used as a wood preservative because of its toxicity to termites and fungi. It is a common component of creosotes and can cause cancer.

Perched (groundwater): Groundwater separated from another underlying body of groundwater by a confining layer, often clay or rock.

Percolation: The downward flow or filtering of water or other liquids through subsurface rock or soil layers, usually continuing downward to groundwater.

Petrochemicals: Chemical substances produced from petroleum in refinery operations and as fuel oil residues. These include fluoranthene, chrysene, mineral spirits, and refined oils. Petrochemicals are the bases from which volatile organic compounds (VOCs), plastics, and many pesticides are made. These chemical substances often are toxic to humans and the environment.

Phenols: Organic compounds that are used in plastics manufacturing and are by-products of petroleum refining, tanning, textile, dye, and resin manufacturing. Phenols are highly poisonous.

Physical Chemical Separation: The treatment process of adding a chemical to a substance to separate the compounds for further treatment or disposal.

Pilot Testing: A small-scale test of a proposed treatment system in the field to determine its ability to clean up specific contaminants.

Plugging: The process of stopping the flow of water, oil, or gas into or out of the ground through a borehole or well penetrating the ground.

Plume: A body of contaminated groundwater flowing from a specific source. The movement of the groundwater is influenced by such factors as local groundwater flow patterns, the character of the aquifer in which groundwater is contained, and the density of contaminants [see Migration].

Pollution: Generally, the presence of matter or energy whose nature, location, or quantity produces undesired health or environmental effects.

Polycyclic Aromatic Hydrocarbons or Polyaromatic Hydrocarbons (PAHs): PAHs, such as pyrene, are a group of highly reactive organic compounds found in motor oil. They are a common component of creosotes and can cause cancer.

Polychlorinated Biphenyls (PCBs): A group of toxic chemicals used for a variety of purposes including electrical applications, carbonless copy paper, adhesives, hydraulic fluids, microscope immersion oils, and caulking compounds. PCBs also are produced in certain combustion processes. PCBs are extremely persistent in the environment because they are very stable, non-reactive, and highly heat resistant. Chronic exposure to PCBs is believed to cause liver damage. It also is known to bioaccumulate in fatty tissues. PCB use and sale was banned in 1979 with the passage of the Toxic Substances Control Act.

Polynuclear Aromatic Hydrocarbons (PNAs): PNAs, such as naphthalene, and biphenyls, are a group of highly reactive organic compounds that are a common component of creosotes, which can be carcinogenic.

Polyvinyl Chloride (PVC): A plastic made from the gaseous substance vinyl chloride. PVC is used to make pipes, records, raincoats, and floor tiles. Health risks from high concentrations of vinyl chloride include liver cancer and lung cancer, as well as cancer of the lymphatic and nervous systems.

Potable Water: Water that is safe for drinking and cooking.

Potentially Responsible Parties (PRPs): Parties, including owners, who may have contributed to the contamination at a Superfund site and may be liable for costs of response actions. Parties are considered PRPs until they admit liability or a court makes a determination of liability. PRPs may sign a Consent Decree or Administrative Order on Consent to participate in site cleanup activity without admitting liability.

Precipitation: The removal of solids from liquid waste so that the solid and liquid portions can be disposed of safely; the removal of particles from airborne emissions. Electrochemical precipitation is the use of an anode or cathode to remove the hazardous chemicals. Chemical precipitation involves the addition of some substance to cause the solid portion to separate.

Preliminary Assessment: The process of collecting and reviewing available information about a known or suspected waste site or release to determine if a threat or potential threat exists.

Glossary

Pump and Treat: A groundwater cleanup technique involving the extracting of contaminated groundwater from the subsurface and the removal of contaminants, using one of several treatment technologies.

Radionuclides: Elements, including radium and uranium-235 and -238, which break down and produce radioactive substances due to their unstable atomic structure. Some are man-made, and others are naturally occurring in the environment. Radon, the gaseous form of radium, decays to form alpha particle radiation, which cannot be absorbed through skin. However, it can be inhaled, which allows alpha particles to affect unprotected tissues directly and thus cause cancer. Radiation also occurs naturally through the breakdown of granite stones.

RCRA: [See Resource Conservation and Recovery Act].

Recharge Area: A land area where rainwater saturates the ground and soaks through the earth to reach an aquifer.

Record of Decision (ROD): A public document that explains which cleanup alternative(s) will be used to clean up sites listed on the NPL. It is based on information generated during the remedial investigation and feasibility study and consideration of public comments and community concerns.

Recovery Wells: Wells used to withdraw contaminants or contaminated groundwater.

Recycle: The process of minimizing waste generation by recovering usable products that might otherwise become waste.

Remedial Action (RA): The actual construction or implementation phase of a Superfund site cleanup following the remedial design [see Cleanup].

Remedial Design: A phase of site cleanup, where engineers design the technical specifications for cleanup remedies and technologies.

Remedial Investigation: An in-depth study designed to gather the data necessary to determine the nature and extent of contamination at a Superfund site, establish the criteria for cleaning up the site, identify the preliminary alternatives for cleanup actions, and support the technical and cost analyses of the alternatives. The remedial investigation is usually done with the feasibility study. Together they are customarily referred to as the RI/FS [see Feasibility Study].

Remedial Project Manager (RPM): The EPA or State official responsible for overseeing cleanup actions at a site.

Remedy Selection: The selection of the final cleanup strategy for the site. At the few sites where the EPA has determined that initial response actions have eliminated site contamination, or that any remaining contamination will be naturally dispersed without further cleanup activities, a "No Action" remedy is selected [see Record of Decision].

Removal Action: Short-term immediate actions taken to address releases of hazardous substances [see Cleanup].

Residual: The amount of a pollutant remaining in the environment after a natural or technological process has taken place, e.g., the sludge remaining after initial wastewater treatment, or particulates remaining in air after the air passes through a scrubbing, or other, process.

Resource Conservation and Recovery Act (RCRA): A Federal law that established a regulatory system to track hazardous substances from the time of generation to disposal. The law requires safe and secure procedures to be used in treating, transporting, storing, and disposing of hazardous substances. RCRA is designed to prevent new, uncontrolled hazardous waste sites.

Retention Pond: A small body of liquid used for disposing of wastes and containing overflow from production facilities. Sometimes retention ponds are used to expand the capacity of such structures as lagoons to store waste.

Riparian Habitat: Areas adjacent to rivers and streams that have a high density, diversity, and productivity of plant and animal species relative to nearby uplands.

Runoff: The discharge of water over land into surface water. It can carry pollutants from the air and land and spread contamination from its source.

Scrubber: An air pollution device that uses a spray of water or reactant or a dry process to trap pollutants in emissions.

Sediment: The layer of soil, sand, and minerals at the bottom of surface waters, such as streams, lakes, and rivers, that absorbs contaminants.

Seeps: Specific points where releases of liquid (usually leachate) form from waste disposal areas, particularly along the lower edges of landfills.

Seepage Pits: A hole, shaft, or cavity in the ground used for storage of liquids, usually in the form of leachate, from waste disposal areas. The liquid gradually leaves the pit by moving through the surrounding soil.

Septage: Residue remaining in a septic tank after the treatment process.

Sinkhole: A hollow depression in the land surface in which drainage collects; associated with underground caves and passages that facilitate the movement of liquids.

Site Characterization: The technical process used to evaluate the nature and extent of environmental contamination, which is necessary for choosing and designing cleanup measures and monitoring their effectiveness.

Site Inspection: The collection of information from a hazardous waste site to determine the extent and severity of hazards posed by the site. It follows, and is more extensive than, a preliminary assessment. The purpose is to gather information necessary to score the site, using the Hazard Ranking System, and to determine if the site presents an immediate threat that requires a prompt removal action.

Slag: The fused refuse or dross separated from a metal in the process of smelting.

Sludge: Semi-solid residues from industrial or water treatment processes that may be contaminated with hazardous materials.

Slurry Wall: Barriers used to contain the flow of contaminated groundwater or subsurface liquids. Slurry walls are constructed by digging a trench around a contaminated area and filling the trench with an impermeable material that prevents water from passing through it. The groundwater or contaminated liquids trapped within the area surrounded by the slurry wall can be extracted and treated.

Smelter: A facility that melts or fuses ore, often with an accompanying chemical change, to separate the metal. Emissions from smelters are known to cause pollution.

Soil Gas: Gaseous elements and compounds that occur in the small spaces between particles of soil. Such gases can move through or leave the soil or rock, depending on changes in pressure.

Soil Vapor Extraction: A treatment process that uses vacuum wells to remove hazardous gases from soil.

Soil Washing: A water-based process for mechanically scrubbing soils in-place to remove undesirable materials. There are two approaches: dissolving or suspending them in the wash solution for later treatment by conventional methods, and concentrating them into a smaller volume of soil through simple particle size separation techniques [see Solvent Extraction].

Stabilization: The process of changing an active substance into inert, harmless material, or physical activities at a site that act to limit the further spread of contamination without actual reduction of toxicity.

Solidification/Stabilization: A chemical or physical reduction of the mobility of hazardous constituents. Mobility is reduced through the binding of hazardous constituents into a solid mass with low permeability and resistance to leaching.

Solvent: A substance capable of dissolving another substance to form a solution. The primary uses of industrial solvents are as cleaners for degreasing, in paints, and in pharmaceuticals. Many solvents are flammable and toxic to varying degrees.

Solvent Extraction: A means of separating hazardous contaminants from soils, sludges, and sediment, thereby reducing the volume of the hazardous waste that must be treated. It generally is used as one in a series of unit operations. An organic chemical is used to dissolve contaminants as opposed to water-based compounds, which usually are used in soil washing.

Sorption: The action of soaking up or attracting substances. It is used in many pollution control systems.

Stillbottom: Residues left over from the process of recovering spent solvents.

Stripping: A process used to remove volatile contaminants from a substance [see Air Stripping].

Sumps: A pit or tank that catches liquid runoff for drainage or disposal.

Superfund: The program operated under the legislative authority of the CERCLA and Superfund Amendments and Reauthorization Act (SARA) to update and improve environmental laws. The program has the authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health, welfare, or the environment. The "Superfund" is a trust fund that finances cleanup actions at hazardous waste sites.

Surge Tanks: A holding structure used to absorb irregularities in flow of liquids, including liquid waste materials.

Swamp: A type of wetland that is dominated by woody vegetation and does not accumulate peat moss deposits. Swamps may be fresh or saltwater and tidal or non-tidal [see Wetlands].

Thermal Treatment: The use of heat to remove or destroy contaminants from soil.

Treatability Studies: Testing a treatment method on contaminated groundwater, soil, etc., to determine whether and how well the method will work.

Trichloroethylene (TCE): A stable, colorless liquid with a low boiling point. TCE has many industrial applications, including use as a solvent and as a metal degreasing agent. TCE may be toxic to people when inhaled, ingested, or through skin contact and can damage vital organs, especially the liver [see Volatile Organic Compounds].

Unilateral [Administrative] Order: [see Administrative Order].

Upgradient: An upward hydrologic slope; demarks areas that are higher than contaminated areas and, therefore, are not prone to contamination by the movement of polluted groundwater.

Vacuum Extraction: A technology used to remove volatile organic compounds (VOCs) from soils. Vacuum pumps are connected to a series of wells drilled to just above the water table. The wells are sealed tightly at the soil surface, and the vacuum established in the soil draws VOC-contaminated air from the soil pores into the well, as fresh air is drawn down from the surface of the soil.

Vegetated Soil Cap: A cap constructed with graded soils and seed for vegetative growth, to prevent erosion [see Cap].

Vitrification: The process of electrically melting wastes and soils or sludges to bind the waste in a glassy, solid material more durable than granite or marble and resistant to leaching.

Volatile Organic Compounds (VOCs): VOCs are manufactured as secondary petrochemicals. They include light alcohols, acetone, trichloroethylene, perchloroethylene, dichloroethylene, benzene, vinyl chloride, toluene, and methylene chloride. These potentially toxic chemicals are used as solvents, degreasers, paints, thinners, and fuels. Because of their volatile nature, they readily evaporate into the air, increasing the potential exposure to humans. Due to their low water solubility, environmental persistence, and widespread industrial use, they are commonly found in soil and groundwater.

Waste Treatment Plant: A facility that uses a series of tanks, screens, filters, and other treatment processes to remove pollutants from water.

Wastewater: The spent or used water from individual homes or industries.

Watershed: The land area that drains into a stream or other water body.

Water Table: The upper surface of the groundwater.

Weir: A barrier to divert water or other liquids.

Wetland: An area that is regularly saturated by surface or groundwater and, under normal circumstances, is capable of supporting vegetation typically adapted for life in saturated soil conditions. Wetlands are critical to sustaining many species of fish and wildlife. Wetlands generally include swamps, marshes, and bogs. Wetlands may be either coastal or inland. Coastal wetlands have salt or brackish (a mixture of salt and fresh) water, and most have tides, while inland wetlands are non-tidal and freshwater. Coastal wetlands are an integral component of estuaries.

Wildlife Refuge: An area designated for the protection of wild animals, within which hunting and fishing are either prohibited or strictly controlled.